ESSAYS ON CONSUMPTION, EXCESS SENSITIVITY, AND INCOME UNCERTAINTY

by

Siobhán Lucey, M.A. (N.U.I.), H.D.E (N.U.I.)

Department of Economics,
University of Glasgow,
Glasgow

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ABSTRACT

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In this work we consider the explanations for the rejection of the Rational Expectations-Life Cycle Permanent Income Hypothesis (RE-LCPI Hypothesis), based on the finding of the "excess sensitivity" of consumption to current income. The excess sensitivity finding is well established for both time series and cross sectional data, however the reasons for excess sensitivity are less well established. A prominent explanation for the observed excess sensitivity of consumption to income, is that capital market imperfections will prevent the consumer from borrowing and hence prevent the consumer from realising her desired consumption expenditure path (liquidity constraints). Competing explanations of excess sensitivity include myopia and precautionary savings' motives. Although some studies have cited particular reasons for the rejection of the RE-LCPI hypothesis, few studies have attempted to discriminate between the alternative explanations. This dissertation proposes to identify and discriminate between these alternative explanations using the Nordic countries (Finland, Norway and Sweden).

The thesis is structured into four key chapters. Chapter Two identifies if consumption for Finland, Norway, and Sweden is excessively sensitivity to changes in income, that is, is excess sensitivity evident for these countries. From the evidence of excess sensitivity found in chapter two, Chapter Three attempts to discriminate between two alternative explanations for excess sensitivity - myopia and liquidity constraints. Chapter Four draws on material in chapter three, and extends it in a new direction. From evidence of asymmetries in Chapter Three, this chapter attempts to analyse the source of the asymmetry; in particular, it examines if the asymmetry can be accredited to liquidity

constraints or not. While Chapters Three and Four attempt to discriminate between alternative potential explanations for the excess sensitivity of consumption to income changes, by seeking to identify asymmetric behaviour of a kind consistent with optimising behaviour in the presence of liquidity constraints or in the absence of asymmetry as would be consistent with myopia, Chapter Five examines an alternative explanation: the potential mis-specification arising from the assumption of certainty equivalence. Specifically the potential role of uncertainty about future income in generating precautionary saving is examined within a two group aggregate consumption function.

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CHAPTER ONE

INTRODUCTION

The pure Rational Expectations-Life Cycle Permanent Income Hypothesis (hereafter RE-LCPI Hypothesis), implies that individual consumption growth is unpredictable; that is no information available at time t-1 can predict the change in consumption from period t-1 to period t. The failure of the hypothesis based on the finding that consumption growth responds to predictable income growth (commonly referred to as the excess sensitivity of consumption to current income), is well established in studies of both time series, cross sectional and panel data (see for example, Flavin, (1981); Campbell and Mankiw, (1989, 1990, 1991); Deaton, (1992); and Jappelli and Pagano, (1989)). The reasons for this observed excess sensitivity are less well established.

One prominent explanation for the observed excess sensitivity of consumption to income is that capital market imperfections will prevent consumers from borrowing and, therefore, will prevent consumers from realising their desired expenditure paths. This liquidity constraint explanation has been advanced by Flavin (1985), Hayashi (1985a, 1985b) and Zeldes (1989a). Competing explanations for excess sensitivity include myopia, advanced by Flavin (1991), and precautionary savings motives, offered by Skinner (1988), Cabellero (1990a) and Blanchard and Fisher (1989). Although these studies have cited particular reasons for the rejection of the pure RE-LCPI hypothesis, few studies have attempted to discriminate between the alternative explanations using a common data set. Shea's (1995b) study provides a notable exception but he still only considers the alternatives of liquidity constraints and myopia. The primary objective of this dissertation is then to identify and discriminate between three competing explanations for excess sensitivity. Each chapter presents new empirical analysis based on a data set for three Nordic countries (Finland, Norway and Sweden).

The selection of Finland, Norway and Sweden for our empirical analysis is based on the following reasons. Firstly, several studies have obtained the excess sensitivity finding for these Nordic countries (see for example, Takala (1995a) for Finland; Boug, Mork and Tjemsland (1995) for Norway; and Agell and Berg (1995) for Sweden). Such findings have frequently been attributed to either a significant fraction of liquidity constrained consumers, or alternatively a significant fraction of myopic consumers. Our work contributes to the existing literature by extending the analysis of the excess sensitivity issue in terms of identifying its underlying cause.

Secondly, these countries can be defined as small open economies[1]. Analysing the excess sensitivity issue and attempting to distinguish between its potential causes, is useful in terms of the analysis and information it can provide us with respect to other small open economies. Specifically for those economies, for which we may not necessarily have the required data etc. to undertake such a detailed analysis. For example Lucey (1996) and Roche (1995) found evidence of excess sensitivity for Irish annual data; however a more detailed analysis using higher frequency data was not possible due to the lack of such data.

Thirdly, the Nordic countries are generally regarded as similar economies with respect to policy decisions, business cycle position etc. It would be of interest to test whether the excess sensitivity finding is an issue for all three countries, and if so, can it be attributed to similar causes. Once again, this analysis will have important implications for the application of the Nordic findings to other small open economies.

[1] A small open economy is defined as an economy in which (i) a significant portion of goods and services produced in the economy are traded goods, and (ii) the economy is sufficiently small so as to have a negligible impact on world markets and, in particular, on the world interest rates.

The thesis consists of four main chapters and is structured as follows. Chapter Two examines evidence of excess sensitivity of consumption to changes in income for Finland, Norway, and Sweden. The tests presented are based upon a modified Euler equation popularised by Campbell and Mankiw (1989, 1990, 1991). A number of previous studies have explored evidence of excess sensitivity in these countries. Chapter Two seeks to contribute to the research in this area in two ways. First, the income process is explicitly modelled for each country. This allows the identification of key instruments which can be used in the estimation of the Campbell-Mankiw model. The second contribution offered by this chapter is an analysis of the time varying properties of the excess sensitivity coefficient in each country. This is akin to the work of Patterson and Pesaran (1992) for example, although the application to the Nordic countries is new (to the best of the author's knowledge). A number of methods are used to examine this. These include IV, IVMA, recursive estimation techniques, dummy variable based tests for stability (for example, Salkever's (1976) version of Chow's Predictive test), and the one step ahead prediction test. Significant time variation is investigated and evidence is offered to relate this to the timing of known developments arising from financial deregulation.

Chapter Three considers Shea's (1995b) method for discriminating between two alternative explanations for excess sensitivity: myopia and liquidity constraints. Shea's discriminatory test relies on investigating the presence/absence of asymmetries in the response of aggregate consumption to expected income growth in a modified Campbell-Mankiw model. He argues that under myopia, consumption would track income and, so consumption would respond symmetrically to both positive and negative expected real income growth. In contrast, with liquidity constraints, the response should be asymmetric. This implication follows since for consumers who face a binding credit constraint and who predict an increase in their future income, they will not be able to borrow on the basis of the expected increase in income. Hence consumption will only respond when the actual income increase is realised (that is, at some point in the future). If these same consumers predict a decrease in future income, they can respond now in anticipation of this decrease, because, liquidity constraints only impede borrowing when income is temporarily low. Hence, actual consumption responds to predictable decreases smoothly, while consumption will appear to be more sensitive to predictable increases in income, when they actually occur.

The chapter seeks to contribute to the research in this area by making a number of extensions to Shea's work and applying the analysis to the Nordic countries. First, a more appropriate estimator is employed. Second, additional and more robust ways of distinguishing positive and negative changes in income growth are examined. Third, a complementary test for detecting asymmetries, based on Sichel's (1993) work on business cycle asymmetries is employed to provide further discriminatory inference.

Chapter Four extends the work on asymmetries in a new direction. Evidence of asymmetries is sought in the growth of total consumption, income, expenditure on durables, and expenditure on nondurables and services. The intention is to investigate whether there is evidence of deepness and/or steepness in income growth, which is not reflected to the same extent in consumption growth. Such a finding would suggest that consumers do succeed in smoothing their consumption at least to some degree. We suggest that deepness in income growth could reflect temporary bad news in income, while steepness could be reflected in the relatively slow recovery of income growth in recovery from recession. This would then lead to the question of how smoothing is enacted? It is possible that (a) consumers have access to credit or (b) that they modify their expenditure on durable goods in order to smooth consumption on nonduable goods and services.

Chah, Ramey and Starr (1995) have suggested that the timing of durable goods expenditure can be used to help keep nondurable spending smooth, when borrowing is not feasible. They suggest that consumers are in fact likely to respond by reducing their durable goods expenditure, to maintain their level of consumption of nondurables and services; for example replace the car less frequently; delay buying certain luxury items etc. Such a reaction seems plausible and should in principle be reflected in the pattern of durable consumption growth. That is, there should be evidence of deepness in both the growth of income and in expenditure on durable goods. This approach allows for more sophisticated consumers than the more common rule of thumb behaviour allowed for in Campbell and Mankiw, where consumers spend all of their disposable income. Evidence of such behaviour in the data would be supportive of the prevalence of liquidity constraints.

Chapter Five turns attention away from excess sensitivity in the Campbell and Mankiw model and instead focuses on risk aversion and income uncertainty. The objective is to explore a model which allows for intertemporal optimisation in the presence of uncertainty, and which may provide a better characterisation of the data. A number of approaches have been adopted to deal with the role of income uncertainty in consumption decision making and the consequent existence of precautionary savings. For example, Hayashi (1982) allows for income uncertainty through heavy discounting of the future. In contrast, Carroll (1994) constructs several direct measures of income uncertainty and includes them in estimated decision rules for the level of consumption. Available measures of uncertainty include the variance and standard deviation of income, in addition to the "equivalent precautionary premium" as proposed by Kimball (1990a).

This chapter contributes to the literature by measuring income uncertainty and analysing the aggregate consumption profile arising from two groups of optimising consumers who face differing degrees of income uncertainty. A similar approach has been used by Campbell and Mankiw who distinguished between consumers who were liquidity constrained and those who were not. They combined an optimising group of consumers with an ad hoc group (specifically, rule-of-thumb consumers). In contrast, an aggregate consumption function which explicitly distinguishes the two groups of consumers in terms of the income uncertainty they face, is derived in our study. We address the importance of income uncertainty for the consumer's decision making process and also examine the role of income uncertainty and the consequent precautionary motive for saving as an alternative specification to the excess sensitivity model. Due to the constraints on data availability, and in particular for Norway and Sweden, the specified model is only estimated for Finland. Furthermore, the two groups of consumers are distinguished as those working in the private and public sectors. Given the Finnish data set, various measures of income uncertainty are estimated, and these are then used in the estimation of our two group aggregate consumption function.

In summary, the general contributions which this thesis makes include: first, the contribution to the study of Nordic consumption, particularly in the areas of identifying and explaining excess sensitivity, and identifying a role for income uncertainty influencing Nordic consumers; second, the contribution to the recent resurgence of interest in asymmetric consumer behaviour, and income uncertainty, by discriminating between competing hypotheses of consumption; and finally, the contribution to the income uncertainty literature through the development of a two group uncertainty model which will facilitate examining the role of precautionary savings and income uncertainty in other countries.

CHAPTER TWO

EXCESS SENSITIVITY OF CONSUMPTION: EVIDENCE FOR THE NORDIC COUNTRIES[1]

2.1 INTRODUCTION

Hall(1978) argued that consumption changes were not forecastable since innovations in consumption related to "news" about income and other relevant variables. However, successive empirical research has failed to support Hall's argument. One particular result arising from this research was the empirical sensitivity of changes in consumption to income changes which were predictable on the basis of known information (i.e. variables dated t-1). This became known as the excess sensitivity puzzle.

The central objective of this chapter is to examine whether the excess sensitivity puzzle is evident for the countries of Finland, Norway and Sweden (hereafter, the Nordic countries). Specifically the study asks whether excess sensitivity has varied over time, and in particular has there been a decrease in the excess of observed sensitivity of changes in consumption to changes in current income, over that predicted by the Life-Cycle Permanent Income hypothesis of consumption. A decrease in excess sensitivity could reflect diminished liquidity constraints facing consumers, in turn, this could be a consequence of the deregulation in financial markets which took place in each of these countries during the 1980s.

The analysis which follows has particular significance for policy makers, in that evidence of excess sensitivity casts serious doubt on the empirical plausibility of Ricardian Equivalence, and thereby on the relative effectiveness of countercyclical policy. Ricardian

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[1] In this work, we use the term Nordic countries to include Finland, Norway and Sweden (that is Denmark is not included).

Equivalence as clearly set out in Barro's (1974) paper states that some fiscal policy is irrelevant. In particular it states that for a given government budget constraint, a bond financed increase in government expenditure will not alter consumption. Conversely, a debt financed reduction in government revenue will not raise consumption.

Ricardian Equivalence relies upon the government budget constraint and the pure RE-LCPI Hypothesis. The government budget constraint states that the present value of it's purchases will be equal to it's initial wealth plus the present value of its tax revenues. This implies that if government spending remains unchanged, lower taxes today will require higher taxes in the future, so that the present value of the tax burden is the same. The pure RE-LCPI Hypothesis states that consumers base their decisions on expected lifetime resources, which in turn depends on current and future after tax income.

If the government reduces taxes today, with no planned reduction in government expenditure, and finances the reduction by the sale of government bonds, then forward looking consumers will equate bond purchase with a promise of a stream of future interest payments from the government, but also as a future tax liability because at some point in the future the bonds must be redeemed with interest. If consumers are sufficiently forward looking, they will perceive that their total tax burden is unchanged. Hence in aggregate, consumers will save an amount equivalent to the bond issue in order to pay the future taxes which the government will levy to retire the bonds. Consequently the reduction in taxes will be ineffective in influencing consumer behaviour, as consumers will not perceive bonds to constitute net wealth and their lifetime resources and consumption will remain unchanged.

The validity of Ricardian Equivalence has implications for the effectiveness of countercyclical policy (that is, fiscal policy over the business cycle). Countercyclical fiscal policy can arise automatically through the role of automatic stabilisers (through tax and transfer programmes), or can be implemented on a discretionary basis. With respect to the latter, the primary aim of countercyclical policy is to dampen the business cycle, for example, income tax rates would be cut and increased sufficiently during recessions and booms respectively, to ensure a balanced budget over the cycle and to dampen fluctuations in income. The operation of the policy relies upon a temporary but subsequently reversed fiscal boost (reduction), raising (lowering) current income and thereby consumption. If consumers are of the pure RE-LCPI Hypothesis type, they will realise that the policy induced increase in income will subsequently be reversed, and that it will therefore have no effect on their expected lifetime resources and thereby no effect on current consumption expenditure. The transmission of countercyclical policy crucially relies on consumers' expenditure responding to temporary changes in income induced by policy, rather than on consumption smoothing.

As the RE-LCPI Hypothesis is one of the fundamental ideas underlying Ricardian Equivalence and the effectiveness of countercyclical policy, its rejection based on the finding of excess sensitivity of consumption to anticipated changes in income, has important consequences for policy implementation. Furthermore if there is evidence of a decline in the observed excess sensitivity, then policy makers will need to reconsider the implementation of future policies and their effects. To the extent that the proportion of forward looking consumption smoothing type consumers increases, the scope of countercyclical fiscal policy in influencing levels of economic activity will be limited. Similarly, for Ricardian Equivalence, to the extent that the proportion of these consumers increase, then the government will need to reconsider the ways of financing their expenditure. Hence, it is relevant to observe if there is evidence of excess sensitivity, and if so, has it's extent decreased over time.

In this chapter, the pure Rational Expectations-Life Cycle Permanent Income Hypothesis (RE-LCPI Hypothesis) is tested against the alternative of the Campbell and Mankiw model. Estimation uses the method of instrumental variables. We also seek to investigate for the existence of diminished excess sensitivity through employing a series of stability tests. The argument put forward in the chapter is that the financial deregulation process which occurred in each of Nordic countries during the 1980s, should have contributed to a reduction in the incidence of liquidity constraints, and thereby diminished excess sensitivity. Informal evidence in support of the case of diminished liquidity constraints is provided, for example, in the significant growth of personal sector credit during the 1980's and the decline of the personal savings ratio.

The plan of the chapter is as follows. Section two provides a review of the Rational Expectations-Life Cycle Permanent Income Hypothesis and the excess sensitivity puzzle. Section three outlines the likely consequences of financial deregulation and examines the existing evidence on the significance of deregulation in explaining Nordic consumption. Section four outlines the specification of the model used to test the hypothesis of diminished excess sensitivity. It also provides a brief review of Nordic consumption studies. Section five presents and analyses the empirical results obtained from the model outlined in the previous section. The conclusion provides a summary of the research.

2.2 CONSUMPTION AND EXCESS SENSITIVITY

Substantial effort has been devoted to the general study of consumption behaviour. Nordic consumption expenditure is important because it accounts for approximately one-half of real GDP (see Table 2.1). This is significant for policy makers who need to know of the possible consequences of changes in fiscal and monetary regimes and other types of policies.

The most widely known and used theories of consumption behaviour are Modigliani and Brumberg's Life-Cycle Hypothesis (1954), and Friedman's Permanent Income Hypothesis (1957). Both hypotheses are based on the premise that consumers are intertemporal optimisers who will seek to smooth their consumption over their lifetime in the face of income fluctuations. The Life Cycle Hypothesis holds that the consumer's decision about the level of current consumption expenditure is based on lifetime resources, that is, financial assets plus future expected income. The Permanent Income Hypothesis states that consumption is determined by permanent income, defined as the average of expected lifetime income. When permanent income is defined as the annuity value of lifetime resources the two hypotheses are very similar (Deaton, 1992:76).

The consumer's view of current consumption expenditure from a lifetime perspective suggests that current expenditure need not equal current income, but that the present discounted value of lifetime consumption will be equal the present discounted value of lifetime resources (i.e. plans satisfy the intertemporal budget constraint). This view implies that a change in current income will be reflected in a change in consumption through its effect on a consumer's lifetime resources or alternatively through its effect on permanent income.

Table 2.1: Real Consumption/GDP ratio (1990 prices)

Date	*Finland*	*Norway*	*Sweden*
1970	0.53	0.56	0.51
1971	0.53	0.56	0.50
1972	0.54	0.55	0.51
1973	0.54	0.54	0.51
1974	0.55	0.53	0.51
1975	0.56	0.54	0.51
1976	0.56	0.53	0.53
1977	0.55	0.55	0.53
1978	0.55	0.56	0.53
1979	0.54	0.56	0.52
1980	0.52	0.54	0.51
1981	0.52	0.53	0.51
1982	0.53	0.53	0.52
1983	0.53	0.52	0.51
1984	0.53	0.51	0.49
1985	0.53	0.53	0.49
1986	0.54	0.54	0.51
1987	0.54	0.52	0.52
1988	0.54	0.50	0.52
1989	0.52	0.50	0.52
1990	0.52	0.49	0.51
1991	0.55	0.49	0.53
1992	0.55	0.48	0.53
1993	0.55	0.48	0.53
1994	0.54	0.47	0.53
1995	0.53	0.47	0.52

Source: IMF International Financial Statistics database (CD-ROM March 1998 edition)

In practice, obtaining an estimate of "predictable" income changes with a view to identifying excess sensitivity requires some explicit assumptions about how consumers form their expectations. Hall (1978) incorporated the explicit assumption of rational expectations into the pure Life Cycle Permanent Income Hypothesis. The Rational Expectations Hypothesis states that consumers will incorporate all information available to them to predict income as accurately as is possible. In the case of consumption behaviour the relevant variable is the expectation of lifetime resources. At any point in time this would reflect all the information available to the consumer up to that point. Hall argued that any difference between the expectation of lifetime resources in the current period and the expectation of lifetime resources in the previous period is not forecastable, from the viewpoint of the last period. Any forecastable information would already have been incorporated into the consumer's expectations of lifetime resources in the previous period.

Hall extended this thinking to changes in consumption between the current and previous period. Since consumption depends on expected lifetime resources, changes in consumption should simply reflect new information (that is, "news") on expected lifetime resources. Changes in consumption should not therefore respond to information which was already known in prior periods; this includes income and any other variables known in earlier periods. Since news is inherently unpredictable, changes in consumption are unpredictable. Consumption therefore follows a random walk[2]. Once lagged consumption is included in determining current consumption expenditure, all other economic variables, especially lagged values of income, should have no explanatory power with respect to consumption spending behaviour (Hall, 1978:972-3).

Mathematically expressed, a group of consumers are assumed to optimise their lifetime utility subject to the lifetime budget constraint; that is, maximise

2.1 $$\sum_{t=1}^{T} \frac{u(C_t)}{(1+\delta)^{t-1}} \quad \text{where } u' > 0 \text{ and } u'' < 0$$

subject to

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[2]A random walk is an AR(1) process, specified as follows : $C_t = C_{t-1} + \varepsilon_t$; ε_t is a white noise term, that is, distributed identically and independently over time with zero mean and constant variance.

2.2 $$\sum_{t=1}^{T}\frac{C_t}{(1+r)^{t-1}} = A_t+\sum_{t=1}^{T}\frac{Y_t}{(1+r)^{t-1}}$$

where lifetime utility u is a function of consumption in each period (C_t) up to the point of decease. In general lifetime utility is discounted using the subjective discount rate δ, which reflects the impatience of the consumer and means attaching a lower weight to the utility of future consumption. Equation 2.2 states that the present discounted value of lifetime consumption expenditure must equal the present discounted value of an individuals future (expected) labour income and existing assets; (1+r) is the discount rate in period t where r is the non-stochastic interest rate; Y_t is income in period t; and A_t are assets held at the beginning of period t.

The Lagrangian function for the consumer's maximisation problem is given by

2.3 $$L=\sum_{t=1}^{T}\frac{u(C_t)}{(1+\delta)^{t-1}}+\ell\left(A_t+\sum_{t=1}^{T}\frac{Y_t}{(1+r)^{t-1}}-\sum_{t=1}^{T}\frac{C_t}{(1+r)^{t-1}}\right)$$

The first order conditions for the constrained maximisation problem are

2.4 $$\frac{dL}{dC_t}=u'(C_t)-\ell=0$$

2.5 $$\frac{dL}{dC_{t+1}}=\frac{u'(C_{t+1})}{(1+\delta)^{t-1}}-\frac{\ell}{(1+r)^{t-1}}=0$$

where u'(C_t) are the partial derivatives of u with respect to C_t, and ℓ is the Lagrangian multiplier. If it is assumed that the individual has access to perfect capital markets, that is, they can borrow and lend to smooth their lifetime consumption, then the Euler equation can be expressed as follows

2.6 $$u'(C_t)=E\left[\frac{1+r}{1+\delta}\right]^{t-1}u'(C_{t+1})$$

This equation states that marginal utility in period t equals the mathematical expectation of the product of the ratio of discount factors and of the marginal utility in period t+1. Two issues arise in deriving an explicit functional form for the Euler equation. Firstly, in general, marginal utility is non linear in consumption so that $E[u'(C_t)] \neq u'(E[C_t])$. Secondly, r is stochastic and the expectation of the product of two stochastic variables is not in general the product of the individual expectations. Hall (1978) dealt with both of these issues, by assuming (1) quadratic preferences:

$$u(C) = -\tfrac{1}{2}(\bar{C} - C_t)^2$$

so that marginal utility is linear in consumption[3], and (2) a constant r_t that is equal to δ. In this case the first order condition for consumption implies that

2.7 $\quad C_t = E_t[C_{t+1}]$

and since

2.8 $\quad C_{t+1} = E_t[C_{t+1}] + \varepsilon_{t+1}$ where ε_{t+1} is a random error,

then

2.9 $\quad C_{t+1} = C_t + \varepsilon_{t+1}$

This is an example of a martingale process; if, the variance of the random error term is also constant then (2.9) is a random walk. Hall argued that this approximation is reasonable if the market interest rate and subjective discount rate are sufficiently close, and if consumption shocks are small relative to the level of consumption. Hence, in conclusion, Hall argued that consumption should (approximately) follow a random walk (Hall, 1978:974-6).

2.10 $\quad C_t = C_{t-1} + \varepsilon_t$

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[3] $\bar{C}$ is the bliss point, where $C < \bar{C}$ for non-satiation.

$$2.11 \qquad \Delta C_t = \varepsilon_t$$

Equation 2.10 states that current consumption C_t is equal to consumption in the previous period C_{t-1} plus ε_t which represents new information about expected lifetime resources which cannot be predicted from the previous period's information set[4]. Expressed alternatively in equation 2.11, where Δ is the first difference operator, changes in consumption are due to innovations or news about current income, that is ε_t.

2.2.1 CONSUMPTION AND EXCESS SENSITIVITY

One implication of the pure Rational Expectations-Life Cycle Permanent Income Hypothesis (RE-LCPI Hypothesis) is that the best forecast of next period's consumption is current consumption. This is important from the economic researcher's and policy maker's point of view. However, this theoretical implication is not supported by empirical analysis. More specifically, studies commonly find that current consumption is more *sensitive* to predictable changes in current income than would be the case if the RE-LCPI Hypothesis held (Flavin, 1981; Hall and Mishkin, 1982; and Hayashi, 1982). Furthermore, the studies showed that this excess sensitivity is not simply due to unanticipated changes in income (that is, news), but to the anticipated component of income. Under rational expectations these anticipated changes should already be incorporated into lagged consumption - hence the excess sensitivity puzzle.

A substantial body of empirical work has evolved in an attempt to understand the excess sensitivity puzzle (for example, Flavin, 1985; Hayashi, 1985a, 1985b; and Zeldes,

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[4] ε_t is a white noise term, that is distributed identically and independently over time with mean zero and variance σ^2.

1989). One of the main conclusions that has arisen from this work is that the empirical failings of the pure RE-LCPI Hypothesis may be attributable to the violation of a particularly restrictive assumption, that of perfect capital markets. This assumption implies that consumers can borrow and lend to smooth their lifetime consumption. For example, as the Life-Cycle Hypothesis outlines, in the early years of the consumer's life-cycle (as a student or a first-time employee), desired consumption is likely to exceed income, requiring the consumer to borrow. If capital market imperfections prevent the consumer from borrowing, then the consumer is prevented from realising her desired consumption path. The most common representation of these capital market imperfections in this context is the prevalence of liquidity constraints (Flavin, 1985; Hayashi, 1985a, 1985b; and Zeldes, 1989).

Consumers are liquidity constrained if they face quantity (credit rationing) and/or price (differential interest rates) constraints. In separate papers, both Flavin(1985) and Hayashi (1985a) contended that presence of liquidity constraints would result in a departure of consumption behaviour from a random walk. Jappelli and Pagano concluded that "the low levels of consumer debt observed in countries where the excess sensitivity is high can be interpreted as evidence that liquidity constraints are at the root of the empirical failures of the [pure RE-LCPI Hypothesis]" (1989:1101).

The effect of liquidity constraints can be illustrated using the conventional two period model of intertemporal optimisation due to Fisher (1926)[5]. The consumer maximises her lifetime utility function (time separable)

$$U = u(C_1) + u(C_2)(1+\delta)^{-1}$$

[5] This is a basic case, in which there is only a two period time horizon, but it can easily be generalised to the case of an n-period lifetime.

subject to her lifetime budget constraint

$$C_1 + C_2(1+r)^{-1} = A_1 + Y_1 + Y_2(1+r)^{-1}$$

where C_t is consumption in period t (t=1,2), u(.) is the utility function, δ is the subjective rate of time preference, A_t and Y_t are nonhuman wealth and real disposable income respectively in period t, and r is the real interest rate; the slope of the budget constraint is -(1+r), indicating that if the consumer gives up one unit of first period consumption, she can increase second period consumption by 1+r. Figure 2.1 shows the optimal consumption plan (C_1^*, C_2^*) in the absence of liquidity constraints as the point of tangency of the budget constraint with an indifference curve (point A, where the marginal rate of substitution equals the marginal rate of transformation). In this case the consumer borrows against second period income to increase her current consumption; that is the consumer has the option to smooth her lifetime consumption plan through either borrowing or lending as she has access to perfect capital markets[6].

Figures 2.2 and 2.3 illustrate the consequences of liquidity constraints for optimal consumption. Figure 2.2 illustrates the extreme case of a credit constraint where the level of consumption is limited by current liability. The consumer's preference is for point A, but as she cannot borrow, the best available choice is point B; that is the credit constraint is binding[7,8]. A similar story can be told in Figure 2.3 where the consumer faces differential rates for borrowing and lending, with the former being higher.

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[6] Any changes in income (Y_1, Y_2), will only affect optimal consumption (C_1^*, C_2^*) to the degree that they affect lifetime resources, that is current consumption is independent of changes in current income.

[7] A second situation could arise where the consumer chooses consumption in period one to be less than income in period one; in this case the credit constraint is not binding.

[8] Many consumers can borrow against the purchase of durable goods such as cars, houses etc., because these goods provide collateral; however in general consumers cannot borrow against their future income.

The excessive sensitivity of consumption to changes in income, under liquidity constraints arises as follows. Assume that the consumer receives a temporary increase in current income ($Y_1 \rightarrow Y_1 + \Delta T$, where ΔT is a change in taxes due to a debt financed tax cut); the RE-LCPI Hypothesis states the MPC out of temporary changes in income will be close to zero, and it affects consumption only to the extent that it affects the present value of lifetime resources; refer to Figure 2.4. However if consumers are credit rationed, the MPC out of the current income increase will be unity or close to unity, irrespective of whether the increase is temporary or not[9] (see Figure 2.5). If a significant number of consumers face binding constraints, the response of aggregate consumption to an increase in aggregate income will be greater than that implied by the RE-LCPI Hypothesis without liquidity constraints. Furthermore, Zeldes (1989a) noted that even if the consumer is not currently constrained, the fact that she may be constrained in the future causes the consumer to currently consume less than she otherwise would.

The role of liquidity constraints in generating the excessive sensitivity of consumption is further emphasised by their interaction with the precautionary motive for saving. Precautionary saving arises as a result of uncertainty, in particular income uncertainty. In the face of income uncertainty, consumers hold additional assets to act as a buffer stock against unpredictable fluctuations in income. According to Carroll's (1992) buffer stock theory, for those consumers with greater uncertainty about future income, their consumption streams are shifted forward, implying a lower level of current consumption, but an increase in its growth rate (that is, excess sensitivity). Deaton (1991, 1992) and Carroll (1992, 1997) outlined that the buffer stock of savings will be further

[9] Assuming that the consumer still faces a binding constraint, after the increase in income.

enhanced in the presence of current or expected liquidity constraints. If consumers cannot borrow against future bad draws of income, there is an additional motive for accumulating assets. Therefore, the presence of liquidity constraints (even if they are not currently binding) causes consumers to save as insurance against the effects of future bad draws of income (leading to lower current consumption).

If the hypothesis of a link between excess sensitivity and liquidity constraints is correct, then the financial deregulation which has occurred on an international scale over the previous two decades since the mid 1970s, should result in consumers becoming less liquidity constrained as capital market imperfections are progressively reduced (Muellbauer and Murphy, 1989; Browne, *et al.* 1991; and Bayoumi, 1993). Consumption decisions would therefore depend less on current income and consumer behaviour should be more closely approximated by the RE-LCPI Hypothesis. A decrease in the excess sensitivity of current consumption to current income would therefore be consistent with diminished liquidity constraints arising as a consequence of financial deregulation (see Figure 2.6). Prior to empirically testing the hypothesis in this work, we will firstly outline the consequences of financial deregulation for Nordic consumption in section 2.3.

Figure 2.1: Optimum Consumption - At the optimum point (A), the indifference curve is tangent to the budget constraint

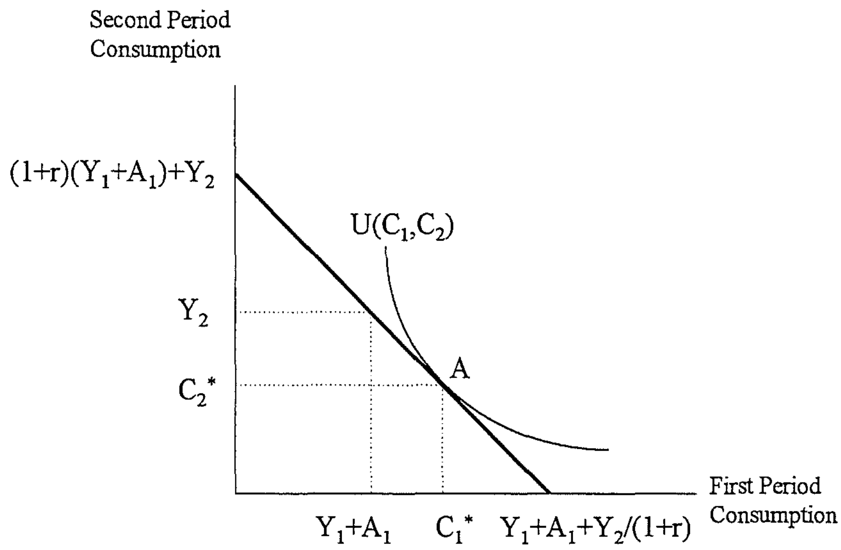


Figure 2.2: Binding Credit Constraint - The consumer would like to borrow against future income and consume at A, but because they face a borrowing constraint, the best available option is B

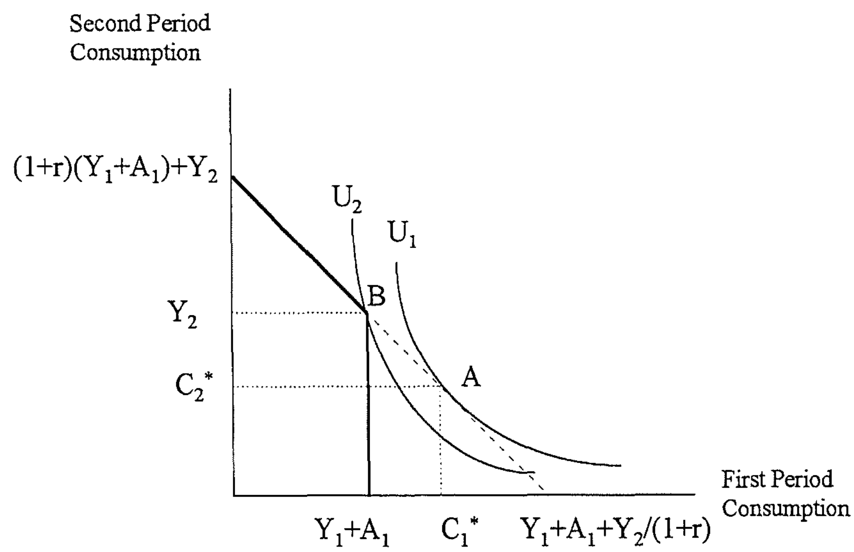


Figure 2.3: Differential Interest Rates for Borrowing and Lending

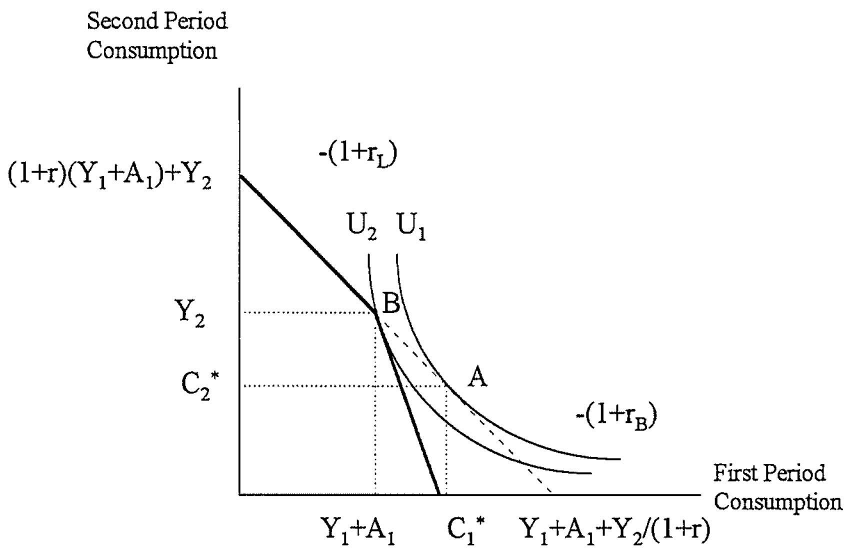


Figure 2.4: A debt-financed Tax cut: Ricardian Equivalence - When the government cuts taxes, current income Y_1 increases by ΔT, that is $Y_1 + \Delta T$, and future income is reduced by Y_2 - $(1+r)\,\Delta T$. Given Ricardian Equivalence the tax-cut does not change lifetime income or consumption (the consumer equates the tax-cut with future tax liability).

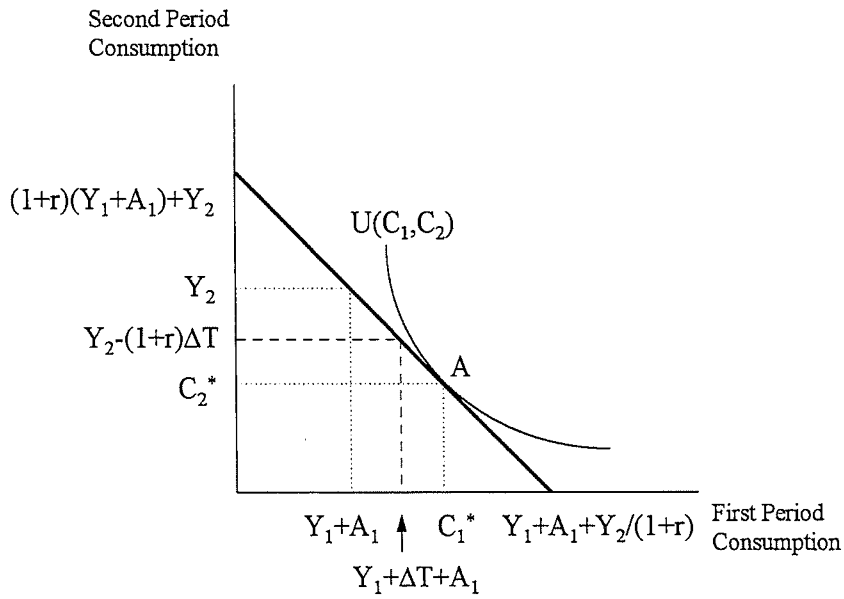


Figure 2.5: Failure of Ricardian Equivalence in the presence of a binding credit constraint. The tax cut represents an easing of the liquidity constraint facing the consumer; therefore the consumer moves from point B to A.

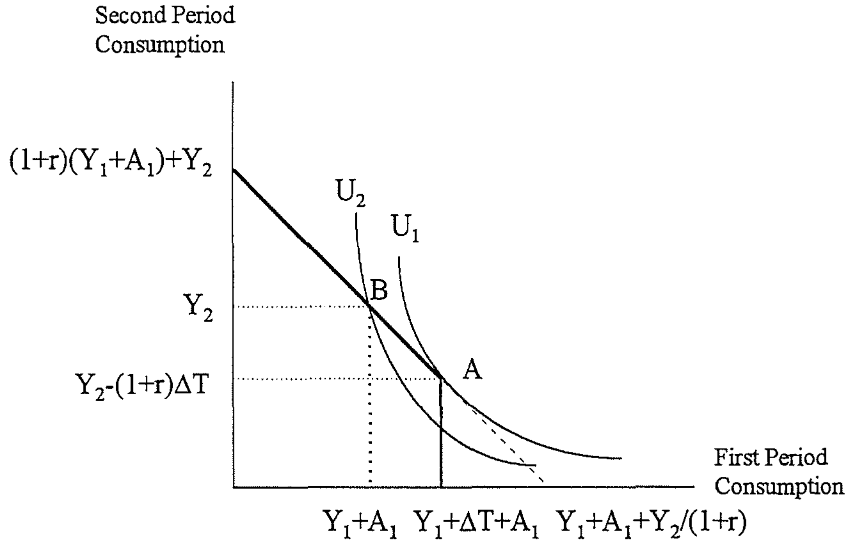
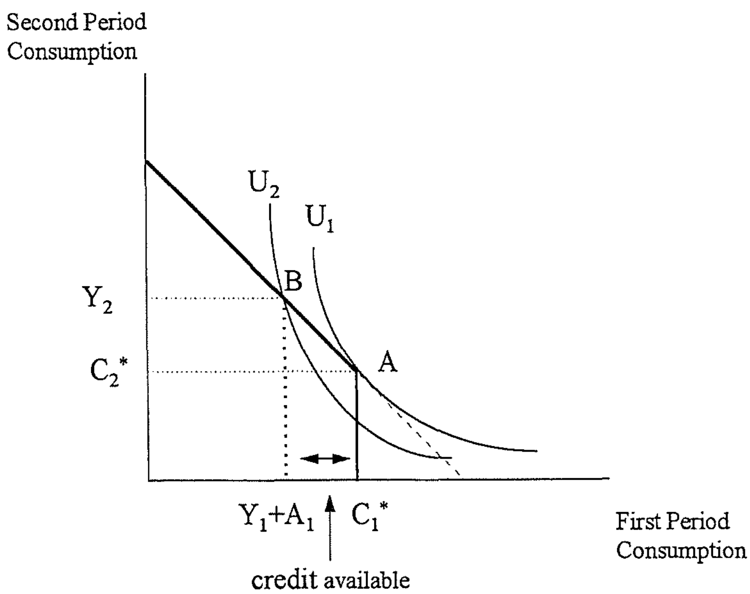


Figure 2.6: Financial Deregulation and it's effect: Financial Deregulation will lead to a reduction in liquidity constraints facing consumers. Consequently, this will lead to an increase in their current consumption (B to A).



2.3 FINANCIAL DEREGULATION AND ITS CONSEQUENCES

During the 1970s and 1980s financial systems world-wide underwent extensive structural changes as a result of financial deregulation and rapid technological innovation; for example substantial deregulatory measures were undertaken in the major industrialised economies such as the United Kingdom, Australia, United States, and the Nordic countries[10]. The principal aim of financial deregulation was to create an unrestrictive and competitive environment for all financial institutions in domestic markets and between international markets. The key features of deregulation, common to the majority of countries, included the reduction of price and quantity restrictions (for example, interest-rate ceilings and credit controls), the removal of international capital mobility and foreign exchange transactions, the liberalisation of access to foreign financial markets and entry of foreign financial institutions and the removal of restrictions on certain other activities to enhance the efficiency of the financial sector through increased competition (for example the liberalisation of institutions to offer a wider range of services and to deal in more diversified portfolios).

Financial innovation and technological development aided the deregulation process in the financial markets revolution. Van Horne described financial innovation as "one of the bedrocks of our financial system ... the life blood of efficient and responsive capital markets"(1985:621). He defined a financial innovation as either a new process or a new product which arises in response to profit opportunities created by market inefficiencies and incompleteness. He stated that the basic foundation of financial innovation is to make markets more efficient and complete. This goes hand in hand with the aims of deregulation. The

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[10] Detailed analyses of the international financial deregulation process are given in White (1986) for Australia, Llewellyn (1986) for Britain, Gart (1984) and Kaufman (1986) for the United States and Englund (1990) for Sweden.

combined effects of both financial deregulation and financial innovation resulted in the increased integration of international financial centres. As Time magazine aptly described the emerging state, "[t]he world's financial markets are so intertwined that when one itches, the others scratch"(August 3, 1992:21).

With respect to the Nordic countries, the broad pattern of deregulation has been similar for Finland, Norway and Sweden, with most of the regulations governing financial institutions being gradually abolished in the 1980s. The following section reviews the main features of the regulatory reform.

2.3.1 MAIN FEATURES OF FINANCIAL DEREGULATION IN THE NORDIC COUNTRIES

Prior to financial liberalisation, extensive controls characterised the financial markets in the Nordic countries. Examples of these controls included administratively controlled interest rates; controls on the volume of credit expansion and its destination to particular sectors; and significant restrictions on foreign bank entry and international capital movements. The key aims of such controls were to maintain low and stable interest rates, channel funds to desired uses and protect banks from competition, thereby ensuring their profitability.

In general the economic arguments put forth for regulation are resource allocation, the provision of monetary control instruments and the stability of the financial system. Such arguments were adopted by the Nordic governments to justify their use of controls. For example in Sweden, strict exchange controls were maintained to protect the low interest rates from international influences. In addition credit rationing was heavily focused on channelling funds to priority sectors, for example, government expenditure and investment in housing. In Norway, the high priority areas were regarded as those projects which were thought to be desirable (e.g. dwellings) or considered necessary for contributing to the long term growth potential (e.g. construction of hydro-power plants).

The Norwegian government justified the implementation of low interest rate policies up to the late 1970s on distribution grounds and with the intention of encouraging investment. It was argued that low interest rates would benefit the low income groups through low rents, but would disadvantage the high income groups who would have large holdings of financial assets. In Finland, the primary controls took the form of rigid lending rates and foreign exchange regulations; the Bank of Finland imposed ceilings on loan rates, and deposit rates were set by mutual agreement among deposit-taking institutions; deposit interest was tax free as well. The aim of these measures was again to encourage investment (for example in housing) and saving by lower income households, by offering them a tax break on the only financial assets they were perceived to hold. Finally the majority of financial transactions were dealt with by financial intermediaries, and savings were mostly destined for deposit accounts, with very little role for equities or bonds.

The use of interest rate controls resulted in the increase in margins between regular deposit and loan rates. Their use in conjunction with quantitatively controlled credit lead to credit rationing and a consequent excess demand for credit during the 1970s, particularly for consumers, as well as small and newly established firms (Edey and Hviding (1995:5). This excess demand was partially dealt with through the development and strong growth of unregulated lending and off-balance sheet activities through grey markets[11]. The interplay of these developments with the macroeconomic environment of the time characterised by increasing inflation, resulted in the initiation of regulatory reform. Other arguments put forth for the deregulatory measures included the possible creation of a more efficient credit market, which would have beneficial effects nation-wide for the allocation of resources in the economy.

Tables 2.2(a)-(c) outline the detailed steps of the financial deregulation process for Finland, Norway and Sweden respectively. The liberalisation of the Finnish financial markets began in the early 1980s. The key interest rate regulatory reforms occurred in the mid 1980s, with the gradual cessation of the regulation of deposit rates during the 1980s, and the removal of interest rate ceilings in 1986. Such measures resulted in the market determination of interest rates, and effectively negated the continued use of credit guidelines. Also, following deregulation, monetary policy had to be implemented through the cost as opposed to the quantity of credit. The internationalisation of the Finnish financial markets began with the liberalisation of foreign borrowing; for example, the removal of restrictions on corporate long term borrowing from abroad in 1986. Restrictions on the entry of foreign banks were removed, and resulted in significant competition. Any remaining restrictions were lifted in 1991. A similar story unfolded for Norway, where the ceilings on bank lending were removed in 1984; interest rates were gradually allowed to move upwards during the early 1980s, and in September 1985 the remaining regulation of bank interest rates was abolished. Other deregulatory steps

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[11] Lehmussaari(1990) defines a grey market as one where "...short-term lending and borrowing by firms took place outside the banking system. Part of this activity was intermediated by banks, but not through their balance sheets"(1990:75, Footnote 6).

included the gradual liberalisation of the bond market between 1982-1985, which served to create competition amongst banks and other financial institutions. Foreign exchange controls also underwent a number of changes, which were completed in July 1990.

In Sweden, the deregulation process began towards the end of the 1970s and was completed with the removal of remaining foreign exchange controls in 1989. As with Finland and Norway, the market was heavily regulated through the use of controls on interest rates and on credit growth, in the 1960s and 1970s. The important elements of the Swedish process, included the emergence of an active money market between 1982-1983; the repeal of regulation on interest rates in May 1985; and the removal of credit controls in November 1985; the latter measure substantially increased the scope of market determined credit allocation.

The overall effects of these deregulation measures included a more flexible interest rate structure resulting in increased competition between financial institutions and thereby lower borrowing costs for consumers. As a result households net financial wealth increased. In addition the portfolio composition of wealth also changed due to the more developed financial markets and the increase in financial instruments. For example, the share of liquid assets (mainly cash and deposits) declined, and that of bonds and shares increased, as returns on these financial assets increased. With the removal of entry barriers for foreign financial institutions and investors, it became much easier for foreigners to purchase Nordic stocks and shares, which was also reflected in higher financial returns. The increased internationalisation of the markets also meant an increase in the amount of loans and investments financed by foreign investment. In the next section the effects of financial deregulation for the consumer are examined.

Table 2.2(a): Major steps in the Liberalisation of Finnish Financial Markets.

Deregulation Steps	*Year*
Authorised banks allowed to take part in lending consortia with foreign banks	June 1982
Abolished the regulation of banks' average lending rates	August 1986
Removal of guidelines on prior savings for household and personal loans	October 1987
Foreign investments were allowed for households	July 1990

Note: The information in this table was obtained from Brunila and Takala(1993)

Table 2.2(b): Major steps in the Liberalisation of Norwegian Financial Markets.

Deregulation Steps	*Year*
Removal of ceiling on deposit rates	January 1978
Removal of ceiling on lending rates	September 1985
Deregulation of bond market	1982-1985
Abolition of reserve requirements	1987
Remaining deregulation of foreign-exchange market	July 1990

Note: The information in this table was obtained from Boug, Mork and Tjemsland(1995)

Table 2.2(c): Major steps in the Liberalisation of Swedish Financial Markets.

Deregulation Steps	*Year*
Deregulation of bank deposit rates	1978-79
Deregulation of issuing private bond rates	1980
Deregulation of insurance companies' lending rates	1980
Abolishment of requirement that banks hold bonds	1983
Deregulation of banks' lending rates	May 1985
Loan ceiling on banks and finance companies lifted	Nov 1985
Remaining foreign exchange controls lifted	1989

Note: This table has been reproduced from Agell and Berg(1995:26).

2.3.2 EFFECTS OF FINANCIAL DEREGULATION FOR THE CONSUMER

On an international level, a number of implications of financial deregulation for consumer behaviour have been identified. This section will outline these effects and examine whether they are evident for the Nordic countries that are examined in this work. This will indicate whether or not financial deregulation has significantly affected Nordic consumption expenditure.

Probably the most significant effect of financial deregulation was the increase in household indebtedness, which probably reflected the easier access to credit following the deregulation of financial markets. Several of the major world economies, notably the U.S., the U.K. and Australia, experienced booms during the 1980s, which were widely acknowledged to be fuelled by increased availability of credit. With the deregulation of their financial services, it became much easier for consumers to borrow money. Browne *et al.* argued that "if 'financial repression' involves forced saving, the amount of which accumulates with time, then sudden complete [deregulation] could release a wave of pent-up demand"(1991:19-20). For this reason, the expansion of credit is likely to have contributed to the consumption booms of the 1980s.

Significant increases in personal sector credit are evident for Finland, Norway and Sweden, particularly during the mid to late 1980s, as illustrated in Figure 2.7 (a)-(c). A number of empirical studies have indicated that the credit controls in place prior to these periods were effective, for example, Kostianinen and Starck(1990), Starck(1991), Campbell and Mankiw(1991), Berg(1993) and Koskela and Viren(1992). Hence their removal should be partly responsible for this observed increase in household indebtedness. Other factors such as the buoyant macroeconomic environment at the time, which reflected the high level of oil prices and a strong international economy would also have contributed to the observed surge in borrowing.

In conjunction with the increase in consumer borrowing, there was a significant decline in the personal savings ratio[12]. Muellbauer and Murphy (1989) attributed the decline in the U.K. savings ratio from 13% in 1981 to 4.5% in 1988, to the "liberalisation of financial markets and greatly enhanced personal sector wealth" (1989:25-26). Bayoumi (1993a) also concluded that deregulation played a significant role in the decline of the personal savings rate in the U.K. A similar feature is apparent in Finland, Norway and Sweden, for the 1980s. The personal savings ratio, defined as the ratio of real personal savings to real personal disposable income, declined by 7.4 percent, 2.5 percent, and 11.1 percent, during the 1980s for Finland, Norway and Sweden respectively; see Figure 2.8 (a)-(c). Again, it is likely that a large part of this decline may be attributed to the deregulation of the financial markets in each country.

The increase in household indebtedness in conjunction with the decrease in savings, was reflected in an increase in households' purchases of dwelling and consumer durables; Figure 2.9(a)-(c) shows the durable consumption - total consumption ratio. For those financial markets where housing credit was heavily regulated (e.g. Finland), a significant proportion of the noted increase in overall credit was reflected in significant increases in housing credit. For example, in the pre-deregulation period, Finland had a tightly regulated system with respect to receiving credit for the purchase of houses. Potential house owners had to have at least one-third prior savings, while first time buyers had to have 25 percent prior savings; such guidelines were removed in 1987. Deregulation of the lending rates, in conjunction with favourable tax systems led to a

[12] Generally, a decline in the savings ratio is characteristic of consumption booms.

substantial investment in property and a rapid increase in house prices[13]. Another feature was the increase in financial assets, other than bank holdings.

Campbell and Mankiw(1989, 1990 and 1991), Flavin (1985) and others argued that the consumer population could usefully be characterised by two distinct groups of consumers, forward looking optimising consumers who smoothed their consumption and consumers who were restricted to consume only their current income[14]. It has been suggested that financial deregulation changed the balance between these two groups. Muellbauer and Murphy (1989) found that the consumption share of liquidity constrained consumers fell from 20% in 1981 to 4% by 1988, for the U.K. Bayoumi (1990), using proxies for credit availability, concluded that a rise in the proportion of forward looking consumers was associated with financial deregulation. Darby and Ireland (1994) obtained similar results. A change in the balance between liquidity constrained and forward looking consumers would be indicated by a decline in the excess sensitivity of current consumption to current income. It is an important implication for this study. Empirical results indicating a decline in the excess sensitivity would be consistent with an increase (decrease) in the proportion of forward-looking (liquidity constrained) consumers in the Nordic countries.

It should be noted that for all three countries there was a tightening of credit constraints in the early 1990s, relating to the banking crisis that emerged at that time (Berg (1994), Agell et al. (1995)). The tightening of the constraints corresponded to a contraction in the stock of bank lending, which derived from both the demand and supply

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[13] Financial market developments in these countries were also accentuated by favourable tax treatment of mortgage debt, consumer loans, investments in shares coupled with high marginal personal income tax rates.

[14] Frequently referred to as "rule of thumb" or Keynesian type consumers.

side of the loan market. With regards to the demand side, each of the three countries experienced severe recessions during the early 1990s. The ensuing depressed domestic demand and increasing unemployment were key factors contributing to the reduction in households' demand of borrowing (for example, increased uncertainty about future income arising from higher unemployment would lead to a decrease in consumer borrowing). The banking sector also began to adopt a more cautious attitude with regards to loans and the collateral required for loans. Specifically less risky lending was conducted, and more and better collateral for loans was required (Brunila and Takala (1993:11)). The tightening of credit constraints in the early 1990s could be perceived as a slight trend reversal in the deregulated environment of these countries[15].

This section has briefly reviewed some of the effects of financial deregulation on Nordic consumption expenditure; specifically, (i) the increase in consumer indebtedness and an associated decline in the personal savings ratio; and (ii) the change in the proportion of forward looking and liquidity constrained consumers within the population. Evidence using Nordic data was provided for the former consequences. The next section will empirically test for the significance of the change in the proportion of forward looking consumers. Specifically the study focuses on excess sensitivity and tests for its decline over the 1980s which is hypothesised to be associated with a reduction in liquidity constraints facing Nordic consumers. The next section specifies a model which will be used to empirically test this proposition; it also contains a brief review of previous studies done in this area for the Nordic countries of Finland, Norway and Sweden.

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[15] Details on the tightening of credit constraints during the early 1990s can be found in Berg (1994) for the Nordic countries, Agell et al., (1995) for Sweden, and Brunila and Takala (1993) for Finland.

Figure 2.7(a): Finland - Annual Change in Personal Sector Credit (1990 prices)

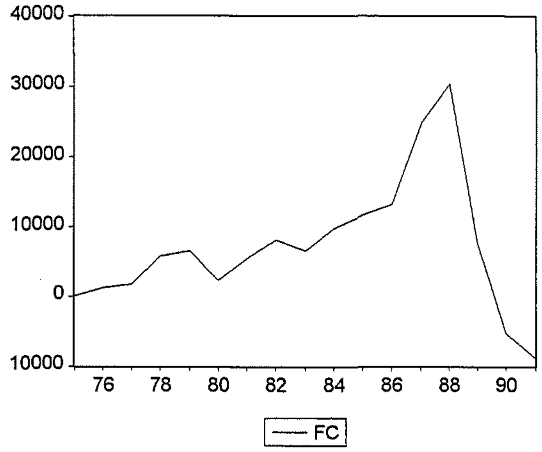


Figure 2.7(b): Norway - Annual Change in Personal Sector Credit (1991 prices)

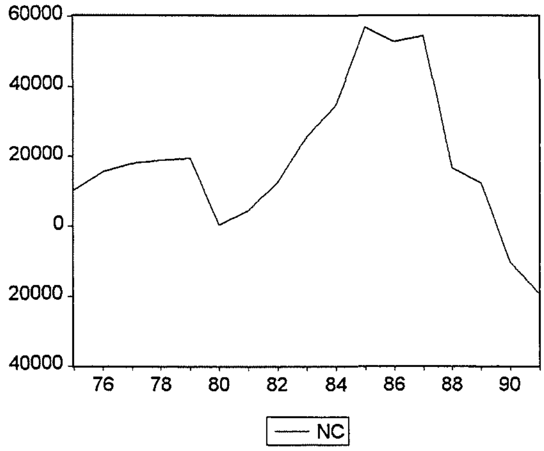


Figure 2.7(c): Sweden - Annual Change in Personal Sector Credit (1985 prices)

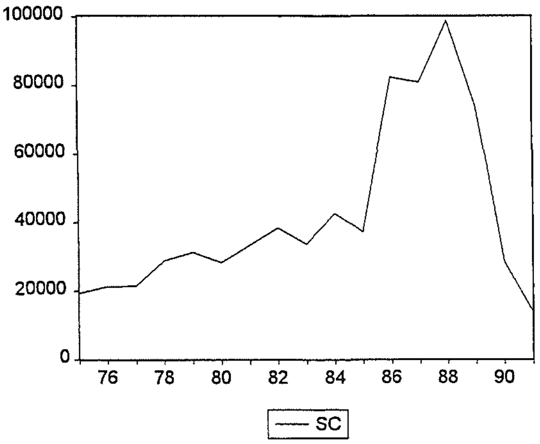


Figure 2.8(a): Finland - Real Personal Saving Ratio (%)

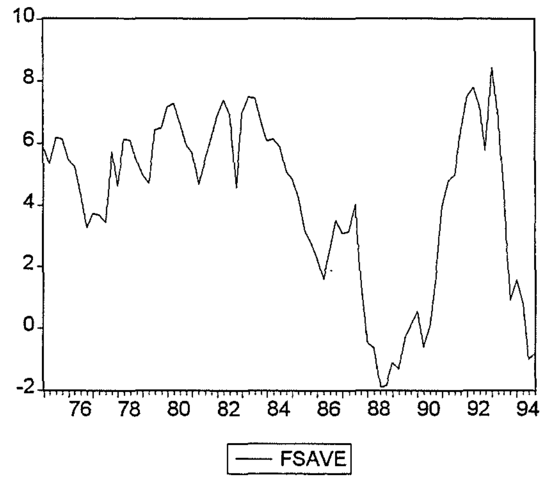


Figure 2.8(b): Norway - Real Personal Saving Ratio (%)

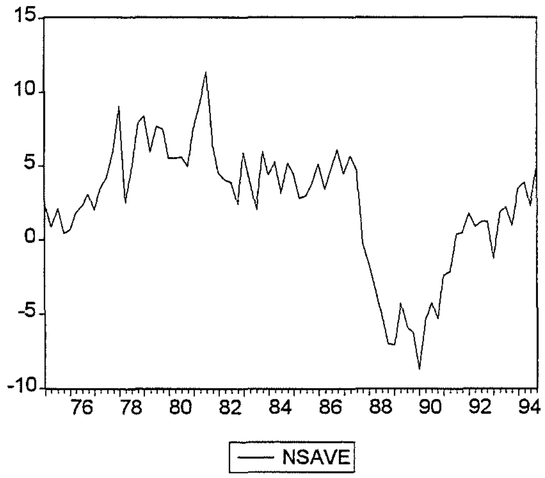


Figure 2.8(c): Sweden - Real Personal Saving Ratio (%)

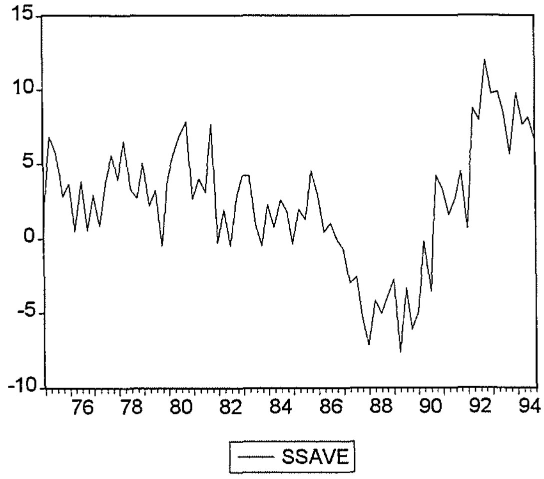
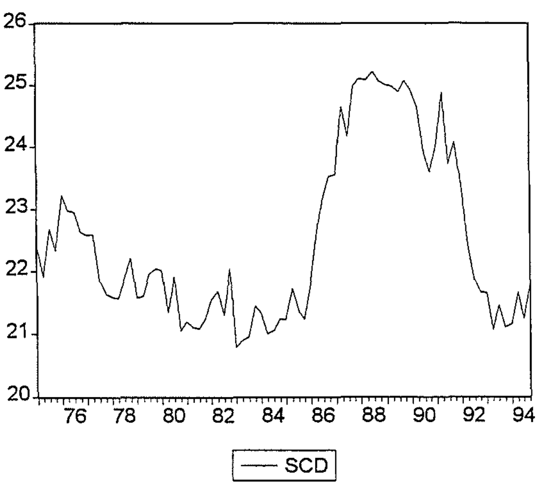


Figure 2.9(a): Finland - Durable Consumption to Total Consumption Ratio (%)

Figure 2.9(b): Norway - Durable Consumption to Total Consumption Ratio (%)

Figure 2.9(c): Sweden - Durable Consumption to Total Consumption Ratio (%)



2.4 EXCESS SENSITIVITY MODEL

2.4.1 SPECIFICATION OF THE MODEL

The genesis of "excess sensitivity" models is Hall's (1978) RE-LCPI Hypothesis. A number of subsequent studies investigated variants of his random walk model for testing this "pure" RE-LCPI Hypothesis (for example, Flavin, 1981 and Hayashi, 1982). The most common procedure for evaluating the RE-LCPI Hypothesis is to derive a general model which accounts for two types of consumers : (i) those who consume out of their permanent income (i.e. following the pure RE-LCPI Hypothesis); and (ii) those who are not actively forward looking but instead consume their current income ($C_t = Y_t$, where Y_t is current income). These consumers have commonly been referred to as rule-of-thumb (hereafter ROT) consumers. Rule-of-thumb consumers are an extreme case of the basic Keynesian Hypothesis on consumer spending. If the coefficient on the expected change in current income variable is found to be significant, then it can be concluded that consumption is excessively sensitive to predictable changes in current income. The pure RE-LCPI Hypothesis is then rejected. Hayashi (1982), Flavin (1985), Browne *et al.* (1991), and Campbell and Mankiw (1989, 1990, 1991) are among various researchers who have used this testing procedure.

In this study, the Campbell and Mankiw (1989) approach to testing the RE-LCPI Hypothesis is adopted in order to (i) identify excess sensitivity and (ii) test the hypothesis of declining excess sensitivity. Campbell and Mankiw nested the pure RE-LCPI Hypothesis in a more general model, in which it is assumed that a fraction λ_t of total income, Y_t, accrues to rule-of-thumb consumers with the remainder $(1-\lambda_t)$ accruing to permanent income-type consumers (1989:187-188)[16]. If the income of the two groups is Y_{rt} and Y_{pt}, total income is given by:

$$Y_t = Y_{rt} + Y_{pt}$$

The disposable income of the rule-of-thumb consumers Y_{rt} equals $\lambda_t Y_t$; as they consume their current income, their current consumption C_{rt} will change by the same percentage as their current income, that is:

$$\Delta C_{rt} = \Delta Y_{rt} = \lambda_t \Delta Y_t$$

The disposable income of those consumers who behave according to the RE-LCPI Hypothesis Y_{pt} equals $(1-\lambda_t)Y_t$; the change in their current consumption is:

$$\Delta C_{pt} = (1-\lambda_t)(\varepsilon_t)$$

that is the change in consumption is unforecastable. The change in total consumption C_t can therefore be expressed as:

2.12 $$\Delta C_t = \Delta C_{pt} + \Delta C_{rt}$$

Substituting for ΔC_{pt} and ΔC_{rt}, the modified model is then as follows

$$\Delta C_t = (1-\lambda_t)(\varepsilon_t) + \lambda_t \Delta y_t$$

2.13 $$\Delta C_t = \mu + \lambda_t \Delta y_t + \varepsilon_t$$

where $\mu = (-\lambda_t)\varepsilon_t$, and Δ is the first difference term.

Campbell and Mankiw reformulated (2.13) in terms of log consumption and income. This set-up had two advantages. First a log linear specification conformed to the properties of the data in so far as the change in consumption grew with its level. Secondly, a log linear model could accommodate time varying ex ante real interest rates and random ex post real

[16] It is assumed that λ_t is time varying, that is, we allow for the fraction of rule-of-thumb consumers to vary over time.

interest rates, so that some evidence could be derived on the size and significance of the intertemporal elasticity of substitution. To obtain an approximation of the log linear model, it is assumed that the representative consumer has an exponential rather than a quadratic felicity function

$$2.14 \qquad u(c_t) = \frac{c_t^{1-\gamma}}{(1-\gamma)}$$

The coefficient γ relates to the constant rate of relative risk aversion, which is the inverse of the elasticity of the marginal rate of substitution of consumption between adjacent periods. This gives the Euler equation the functional form

$$2.15 \qquad C_{t+1} = \left(\frac{1+r_t}{1+\delta}\right)^{\frac{1}{\gamma}} C_t$$

The generalisation of the consumer's Euler equation to allow for changes in the real interest rate is now well known (Grossman and Shiller 1981, Mankiw 1981, Hansen and Singleton 1983, and Hall 1988). Taking the natural logarithm of both sides of the equation, and using the Taylor approximation for log(1+x), this results in equation 2.16[17]

$$2.16 \qquad \Delta c_t = \mu^* + \left(\frac{1}{\gamma}\right) r_t + \varepsilon_t$$

where μ^* is a constant, and the lower case letters indicate the natural log of variables. According to 2.16, a rise in the expected real interest rate will increase the rate of growth of consumption.

$$\ln C_{t+1} = \frac{1}{\gamma}\ln(1+r_t) - \frac{1}{\gamma}\ln(1+\delta) + \ln C_t + \varepsilon_t$$

[17] $\Delta \ln C_{t+1} = \text{constant} + \frac{1}{\gamma}\ln(1+r) + \varepsilon_t$

$$\Delta c_{t+1} = \mu^* + \frac{1}{\gamma} r_t + \varepsilon_t$$

The log linear version of Campbell and Mankiw's two group model can therefore be expressed as

$$\Delta c_t = \lambda_t \Delta y_t + (1-\lambda_t)\left[\mu^* + \frac{1}{\gamma} r_t + \varepsilon_t\right]$$

2.17 $\Delta c_t = \mu + \lambda_t \Delta y_t + \theta r_t + \varpi_t$

where μ $= (1-\lambda_t)\mu^*$
C = Consumption
Y = Personal Disposable Income
λ = the degree of "excess sensitivity of consumption"[18]
r_t = Real rate of interest[19]
θ $= (1-\lambda_t)(1/\gamma)$
ϖ_t = the disturbance term $(1-\lambda_t)\varepsilon_t$;
Δ = first difference term

This equation reduces to the RE-LCPI Hypothesis when λ_t=0 and to the rule-of-thumb situation when λ_t=1. Campbell and Mankiw (1989) test the RE-LCPI Hypothesis by estimating λ_t and testing the null hypothesis that $\lambda_t = 0$. Browne *et al.* (1991) used this model to test whether the size and significance of λ_t had diminished over the period of time when significant deregulation took place within eight OECD countries[20]. They focused on those OECD countries in which financial markets deregulated earlier and more thoroughly[21].

In this chapter, equation 2.17 is being used to test whether the size and significance of λ_t has diminished for the Nordic countries over recent years. Specifically, three questions are

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[18] A disadvantage of the log linear version of the Campbell-Mankiw model, is that the interpretation of λ as the fraction of current income consumers is no longer exact, but it does serve as an approximation.
[19] If expected real interest rates are constant, equation 2.17 becomes $\Delta c_t = \mu + \lambda \Delta y_t + \varpi_t$
[20] United States, Japan, Germany, France, Italy, United Kingdom, Canada and Australia.

[21] United States, Japan, Canada, Australia and United Kingdom

posed to assess whether financial deregulation has significantly affected consumption expenditure in the Nordic countries, during the 1980s:

(1) is the excess sensitivity coefficient statistically significant?

(2) has the excess sensitivity coefficient declined over the deregulation period? and

(3) is any estimated decline statistically significant?.

Results indicating a significant λ_t, when equation 2.17 is estimated, would imply a rejection of the pure RE-LCPI Hypothesis. It would suggest that a significant proportion of consumption is undertaken by rule of thumb consumers. A decrease in the size of λ_t would be consistent with a reduced incidence of binding liquidity constraints. Finally, if the results indicate that λ_t has declined during the deregulatory period of the 1980s, then it is still necessary to determine whether the estimated decline is significant. A statistically significant decline would provide evidence that financial deregulation in the Nordic countries has reduced liquidity constraints facing Nordic consumers.

From the estimation of equation 2.17, it is also possible to provide some inference on the size and significance of the intertemporal elasticity of substitution. The real interest rate is an important element in the consumer's intertemporal decision making process. It signals that extra consumption that can be afforded in the future in return for each unit of consumption given up in the current period. The direction and size of intertemporal substitution depends on two effects: the income effect and substitution effect. Taken separately, these effects imply opposite reactions of aggregate consumption. The substitution effect reflects how an increase in the interest rate makes current consumption relatively more expensive, thereby resulting in the tendency of consumers to postpone consumption. However, an increase in the interest rate also implies that the consumer receives more interest income for the same amount of saving (assuming the consumer is a saver rather than a borrower) - this is the income effect. The income effect would induce higher consumption in both the current and future periods. Depending on the extent of these effects, consumers' reactions to changes in the interest rate will differ.

A number of studies including Mankiw (1981) Hansen and Singleton (1983), Hall (1988) and Campbell and Mankiw (1989)[22], have examined the strength and sign of the real rate of interest effect on consumption growth. A general conclusion from these studies was that the effect was relatively little, suggesting that the intertemporal elasticity of substitution was low. In terms of the direction of the effect, Hall (1988), for example, argued that the real rate of interest would be positively related to consumption, because higher expected real interest rates lead to deferred consumption.

Prior to empirically estimating equation 2.17, a brief review of Nordic consumption studies will be outlined in the next section. Both panel and time series data studies have been undertaken for Finland, Norway and Sweden in the past; in the following review emphasis is placed on those studies based on time series aggregate data, as these are the data used in this work.

2.4.2 REVIEW OF FINNISH, NORWEGIAN AND SWEDISH CONSUMPTION STUDIES

After Hall's (1978) paper, a considerable amount of empirical research on the random walk hypothesis was conducted, some of which was carried out for the Nordic countries. Issues which the Nordic research addressed included, firstly, whether the pure RE-LCPI hypothesis was applicable to Nordic data, or whether as other empirical

[22] Refer also to Boskin (1978), Summers (1981), and Evans (1983)

research had consistently found, consumption growth displayed excess sensitivity to income innovations. Secondly, Nordic studies explored whether the excess sensitivity of consumption had varied over time in conjunction with changes in the financial system during the 1980s. A third issue investigated was whether financial variables, such as wealth or interest rates predicted aggregate consumption. These issues are of particular relevance to this work, as they provide a source of information with respect to potential results, instruments etc. In addition, the following review illustrates how the current thesis can significantly contribute to the existing literature.

With respect to the first issue, studies that analysed the RE-LCPI hypothesis using Finnish data included Koskela and Sullstrom(1979), Kostiainen and Starck(1990) and Takala (1995a). Koskela and Sullstrom(1979) tested Hall's (1978) model using both quarterly (1960Q-1976Q4) and annual data (1952-1977). They found that lagged consumption and income were statistically significant, thereby rejecting the random walk model of consumption according to the RE-LCPI hypothesis. Kostiainen and Starck(1990) found that RE-LCPI hypothesis as tested by the Euler approach could be rejected on the finding of a significant λ of 0.326 (2.16 t-ratio). Takala's(1995a) findings supported their results[23].

[23] Other Finnish consumption studies include Koskela and Viren (1982, 1992), Starck (1989, 1991), Koskela, Loikkanen and Viren(1992), Kerttula(1989) and Takala(1995a). Koskela, Loikkanen and Viren (1992) and Koskela and Viren(1992b) analysed household saving under capital market imperfections (specifically, the wedge between the borrowing rate and lending rate). Starck (1989) compares modelling consumption and income as a bivariate time series process with univariate time series processes, and concludes that they are best modelled jointly as a VARMA(2,1) process. Takala (1995) presented estimates of an error-correction specification of a consumption function for non-durable consumption and concluded disposable income and net wealth are important for the function.

In the Norwegian context[24], Boug, Mork and Tjemsland(1995) employed the Campbell-Mankiw model to look at consumer behaviour in Norway and to test for the possible effects of financial deregulation. Using two sets of instruments they found that the proportion of current income consumers in Norway to be in the range of 56% and 60%.

Relative to work completed on Finnish and Norwegian consumption, a number of both home and international studies have been produced with respect to testing the RE-LCPI hypothesis on Swedish data. Earlier studies included Matthiessen(1972), Ettlin(1976), Lybeck(1976) and Palmer and Maskowski(1977)[25]. Many of the more recent studies have rejected the RE-LCPI Hypothesis, based on the finding of the excess sensitivity of consumption. For example, Barot(1993), Berg(1993), Agell and Berg(1995, 1996), and Agell, Berg and Edin(1995) all found evidence to reject the hypothesis. Berg (op. cit.) tested for the excess sensitivity of consumption to income estimating Hall's (1978) initial model

$$C_t = \alpha_0 + \alpha_1 C_{t-1} + \varepsilon_t$$

with additional t-1 variables, by IV using one and two periods of lagged income and consumption as instruments. Using both annual (1955-1992) and quarterly data 1966:1-

[24] Other time series studies on aggregate consumption include Brodin and Nymoen(1989, 1992) who looked at the breakdown and reconstruction of the Norwegian consumption to explain the predictive failure of existing consumption functions. Mork and Smith(1989) tested the pure LCPI hypothesis using Norwegian Panel Data, and found it to be consistent with the data. A number of other studies looked at the pure LCPI hypothesis using micro data; these include Biorn (1980), Kornstad(1993), and Willassen(1994).

[25] There have been a number of consumption studies done on Swedish data, which have not been directly related to testing the RE-LCPI hypothesis. Studies that used the ECM methodology in specifying the Swedish consumption function include, Berg and Bergstrom(1991, 1993, 1995) and Kanis and Barot(1993, 1995). Berg and Bergstrom(1996) looked at the role of consumer confidence indices in explaining consumption growth during 1975-1994. Other studies include Palmer(1981, 1985) and Assarsson(1991).

1992:4 (from National accounts of Sweden), he found that income lagged two periods had a significant effect on consumption and that aggregate financial net wealth for households also had a significant effect on total consumption expenditures. Overall, he concluded that between 20-30% of consumption expenditure was attributable to liquidity constrained consumers. Agell and Berg (1995,1996) estimated the Campbell and Mankiw "excess sensitivity" model employing annual data for the period 1950-1994, and using three different measures of per capita consumption as the dependent variable[26]. Depending on the consumption measure used, they obtained statistically significant estimates of λ in the range of 0.32-0.52.

In addition to these single country studies, a number of international studies included Sweden as part of a data set. These studies have provided somewhat less clear cut results. For example, Campbell and Mankiw (1991) examined if their excess sensitivity model worked for other countries outside of the US, in particular for the US, UK, Canada, France, Japan and Sweden[27]. They concluded in rejecting the RE-LCPI hypothesis for Sweden, based on the finding that a significant fraction of income accrued to individuals who consumed their current income rather than their permanent income. In contrast, Jappelli and Pagano(1994) and Bayoumi and Koujianou(1990), found evidence in favour of the hypothesis.

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[26] Total consumption expenditure, pure consumption, and non-durable goods and services.

[27] They used quarterly data for the UK for 1957-1988, and for Canada, France, Japan and Sweden for 1972-1988. Seasonally adjusted data was used for the US, UK, Canada and France (quarterly growth rates); Seasonally unadjusted data was used in the case of Japan and Sweden (annual growth rates measured at a quarterly frequency).

Many of the studies have also examined the time varying properties of the share of liquidity constrained consumers, based on the widespread perception that the financial liberalisation process of the 1980s had an impact on the degree of excess sensitivity by loosening credit constraints. Jappelli and Pagano (1989) argued that those countries for which aggregate consumption displayed low excess sensitivity to current income, also had relatively large consumer debt levels. Given this correlation, many researchers have argued that the financial liberalisation of the 1980s led to a lessening of credit conditions, a feature which should be reflected in a reduction in the number of credit constrained consumers.

A number of strategies have been adopted to explore the time varying properties of the excess sensitivity coefficient. Bayomi and Koujianou (1990), and Campbell and Mankiw (1991), investigated this issue for Sweden. Bayomi and Koujianou (op. cit.) added dummy variables to the basic Campbell-Mankiw model, to reflect the effects of deregulation. The dummy variables took the value of zero in the pre-deregulation period, and then increased in equal increments to unity over a 2.5 year period; the date for the start of the dummy variable representing financial deregulation was the beginning of 1984. They concluded that there was a significant decline in the proportion of liquidity constrained consumers. Campbell and Mankiw (1991), adopted two strategies to investigate the time variation of the excess sensitivity coefficient. Firstly, they allowed λ_t to be a linear function of a time trend, and secondly, they used a dummy variable to test whether there was a structural break in the 1980s; the time dummy took the value of unity from 1980Q1 onwards. Their results did not support the findings of Bayoumi and Koujianou. Similar conclusions were offered by Agell and Berg(1996) who used recursive estimates to examine the stability of λ_t during the 1980s. From visual inspection of the recursive plots they found no indication of instability.

Lehmussaari (1990) using annual data for Finland, Norway and Sweden[28] sought to "determine whether the deregulation in the 1980s led to a fundamental "structural break", or whether the predictive failure of traditional consumption functions was attributable to a mis-specification of the econometric formulation" (1990:76). He examined the out-of-sample predictive properties of the consumption models, and concluded that financial deregulation did have a significant impact on consumption in Finland, Norway and Sweden. In their Norwegian study, Boug et al. (1995) used sub-samples to explore the issue of time varying coefficients. They estimated their model for the pre- and post-deregulation periods (1968Q2-1984Q2, and 1984Q3-1994Q4 respectively), and found that the proportion of current income consumers decreased substantially, suggesting that financial deregulation did have an impact on Norwegian consumer behaviour. Prior to deregulation the fraction ranged from 37% to 75% (depending on the instrument set used), however these figures dropped to 3% and 2% for the post deregulation period. As an extension to this existing literature, this work will adopt an alternative strategy to examine the time varying properties by employing a number of formal stability tests (further details and results are outlined in Section 2.6.2).

Another issue dealt with in previous research, concerned the relevance of financial variables for the prediction of aggregate consumption. This is of interest for this work, in that it provides information with respect to the prior findings concerning the size of the estimated intertemoporal elasticity of substitution of consumption. Empirical evidence for

[28] Denmark was also included in his data set.

the Finnish economy has been mixed. Negative intertemporal elasticities of substitution were found by Koskela and Viren (1985) and Tarkka et al. (1990), while evidence supporting a positive interest rate elasticity was found by Kostianinen and Starck (1990); Starck (1990) confirmed this finding. Such inconclusive and diverse results could be attributed to the use of alternate estimators, different sample periods etc. (see Table 2.3). For Sweden, Campbell and Mankiw(1991) found no evidence of real interest rate effects on consumption growth. Agell and Berg (1996) confirmed this finding, when they allowed for a time-varying real interest rate after tax in their "excess sensitivity" model.

A number of studies also explored the role of wealth in determining aggregate consumption. Brodin and Nymoen (1989, 1992)[29] found that wealth played an important role in the Norwegian consumption function. Lehmussaari's (1990) Nordic study also found that an error correction model (hereafter ECM) modified by changes in real wealth, worked best for Norway, while an ECM modified to incorporate inflation effects was the preferred equation for Sweden. Both the lagged wealth income ratio and changes in real wealth were important for Finland. Takala (1995a) presented estimates of an error-correction consumption function for non-durable consumption for Finnish data and concluded that disposable income and net wealth were important. For Sweden, Berg and Bergstrom (1995) looked at the effects of wealth disaggregated into housing and net financial wealth in an error-correction consumption function model and concluded that financial wealth was important in determining consumption, and that household debt is an important determinant of short-run behaviour indicating credit rationing.

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[29] Brodin and Nymoen (1989, 1992) examined the breakdown and reconstruction of the Norwegian consumption function to explain the predictive failure of existing consumption functions.

Summary

We summarise the key results from the above review in Table 2.3, which presents a summary of the methodologies and results of studies that estimate the (or modified version of) Campbell-Mankiw model in order to examine if there is evidence of excess sensitivity and to assess the impact of financial deregulation on liquidity constraints. Of all three countries in this study, the majority of studies examining the RE-LCPI Hypothesis have been done for Swedish data. With regard to the three issues outlined above however, the empirical evidence for Swedish data, suggests contradictory or mixed results. Suggested reasons for the diversity of results given by the studies include the use of different methods of estimation (IV, FIML etc.), the use of seasonally adjusted versus seasonally unadjusted data; different sample periods and the diversity of instruments used (see Table 2.3). For example, with respect to the latter point of diverse instrument sets, even though every valid set of instruments will yield consistent estimates, different choices will yield different estimates in finite samples.

Relatively less work has been done in the area for Finland and Norway. One possible reason for this is that even though a number of studies on the consumption and savings for all of the Nordic countries have been undertaken in recent years, many of these focused on savings, and how savings were affected by taxation, by the housing market and by financial deregulation[30]. Of the existing studies concerned with examining the RE-LCPI, the rejection of the pure RE-LCPI hypothesis is a clear result.

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[30] The motivation underlying these studies was based on the decline in savings and the associated increase in the payments deficits during the 1980s and 1990s. As household saving rates declined, Nordic countries were forced to obtain foreign borrowing to finance domestic investment. In the late 1980s and early 1990s however, there was a huge increase in household savings, which contributed to decreased aggregate demand. The consequences were higher unemployment rates, a fall in inflation, an improved current account; and a decrease in indebtedness of households. During much of the 1980s,

Conclusion

In this chapter, we re-examine the previous evidence as well as provide further results on excess sensitivity and its potential decline over time. Specifically, the extensions upon previous work that we employ include:

(i) identifying country-specific instrument sets using the general-to-specific methodology, a practice which has not been adopted in previous work;

(ii) providing new empirical evidence of the degree of excess sensitivity for Finland, Norway and Sweden; thereby contributing to the relatively sparse body of existing work particularly for Finland and Norway; and

(iii) employing a number of stability tests to assess the potential decrease in excess sensitivity resulting from the financial deregulation process.

A discussion of the estimation procedure and related data issues involved in estimating the excess sensitivity model (equation 2.17) is presented in the next section.

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there was a low level of savings (even negative savings ratios). This led to households increasing their indebtedness, over-stimulating aggregate demand in the economy by spending more than they earned. For Nordic countries in 1980s, this consumer boom decreased the number of people unemployed, but also increased the inflation rate and worsened the balance of payments. These developments led researchers to focus on examining the factors that influenced household saving behaviour in the Nordic countries.

Table 2.3: Summary of Consumption Studies for Finland, Norway and Sweden (refer to key at end of table).

Study	Data	Technique	λ	θ	Instruments
Finland					
Takala (1995a)[a]	Q, SA 1972:1-1993:4	OLS IV	0.097(0.04) 0.403(0.17) 0.487(0.18) 0.308(0.11) 0.296(0.09) 0.291(0.09)	NA	NA $\Delta y_{t-2},\ldots,\Delta y_{t-5}$; $\Delta c_{t-2},\ldots,\Delta c_{t-5}$; $\Delta y_{t-2},\ldots,\Delta y_{t-5},\Delta c_{t-2},\ldots,\Delta c_{t-5}$; $\Delta y_{t-2},\ldots,\Delta y_{t-5},\Delta c_{t-2},\ldots,\Delta c_{t-5}$ $r_{t-2},\ldots,r_{t-5}$; $\Delta y_{t-2},\ldots,\Delta y_{t-5},\Delta c_{t-2},\ldots,\Delta c_{t-5}$ $r_{t-2},\ldots,r_{t-5},y_{t-2}-c_{t-2}$;
Norway					
Boug, Mork and Tjemsland (1995)[a]	Q, SNA 1966:1-1994:4	IV	0.603(0.24) 0.559(0.25) 0.747(0.26)[c] 0.369(0.27)[c] 0.021(0.32)[d] 0.032(0.52)[d]	NA	$\Delta_4 y_{t-5},\Delta_4 g_{t-5},\Delta_4 u_{t-5}$ $\Delta_4 y_{t-5},\Delta_4 g_{t-5},\Delta_4 u_{t-5},\Delta_4 i_{t-5},\Delta_4 s_{t-5}$
Sweden					
Agell, Berg and Edin (1995)[a]	Q, SA 1976:1-1993:4	OLS IV	0.127(0.03) 0.132(0.05) 0.185(0.09)	0.020(.07) -0.136(0.10) -0.149(0.11)	NA $\Delta y_{t-1},\ldots,\Delta y_{t-4},r_{t-1},\ldots,r_{t-4}$; $\Delta y_{t-2},\ldots,\Delta y_{t-4},r_{t-2},\ldots,r_{t-4}$;

Study	Data	Technique	λ	θ	Instruments
Campbell and Mankiw (1991)[a]	Q, SNA 1972:1-1988:1	IV	0.357(0.17) 0.257(0.12)	NA 0.0077(0.07)	$y_{t-5}-y_{t-9}, c_{t-5}-c_{t-9}, \bar{c}_{t-5}-\bar{y}_{t-5};$[b] $y_{t-5}-y_{t-9}, c_{t-5}-c_{t-9}, \bar{c}_{t-5}-\bar{y}_{t-5}, \bar{r}_{t-5};$[b]
Jappelli and Pagano (1989)[a]	A 1965-1983	NLIV FIML	0.12(0.11) -0.05(0.13)	NA NA	$c_{t-1}, y_{t-1}, g_{t-1}, ex_{t-1}, trend;$
Berg(1993)[a]	Q, SA 1966:1-1992:4 A 1955-1992	IV	0.19(0.09) 0.31(0.08) 0.23(0.06)	NA	$\Delta y_{t-1}, \Delta y_{t-2}, \Delta c_{t-1}, \Delta c_{t-2};$
Agell and Berg (1996)[a]	A 1950-1994	TSLS	0.521(0.12) 0.081(0.08) 0.327(0.10) 0.411(0.11) 0.264(0.08) 0.267(0.09)	 0.138(0.07) 0.076(0.07) 0.132(0.06)	$\Delta y_{t-1}, \Delta c_{t-1}, \Delta ex_{t-1}, \Delta bv_{t-1}$
Bayoumi and Koujianou (1990)[a]	Q, SA 1970:1-1988:1	GMM	0.33(0.25) 0.39(0.19)[c] 0.30(0.32)[d]	-0.03(0.19) 0.49(0.23) 0.12(0.19)	$\Delta y_{t-2},\ldots,\Delta y_{t-6}, \Delta c_{t-2},\ldots,\Delta c_{t-6}, r_{t-2}, (c/y)_{t-}$

Key to Table 2.3

Q: Quarterly
A: Annual
SA: Seasonally adjusted data
SNA: Seasonally unadjusted data
NA: Not applicable
Δ: First difference
Δ_4: Fourth difference
y: log (per capita) of real disposable income
c: log(per capita) of real total consumption or real consumption of nondurables and services (see footnote a)
g: log (per capita) of real government expenditure
ex: log (per capita) of real exports
bv: log (per capita) of real business investment
u: unemployment rate
s: log stock index
i: nominal interest rate
r: real interest rate

Notes to Table 2.3

a. The consumption measures used in each study are as follows:
- Takala(1995) - Consumption of nondurables;
- Boug et al. (1995) - Consumption of nondurables and services;
- Agell, Berg and Edin (1995) - Total private consumption expenditures;
- Campbell and Mankiw (1991) - Consumption of nondurables and services;
- Jappelli and Pagano (1989) - Private consumption expenditure;
- Berg(1993) - Consumption of nondurables and services; consumption of nondurables; pure consumption expenditures;
- Agell and Berg (1995) - Total private consumption expenditures; pure consumption (defined as expenditures on nondurable goods and services plus the value of services generated from the stock of durables owned by households); expenditures on nondurable goods and services;
- Bayoumi and Koujianou (1990) - Private consumption expenditure;

b. $\bar{x}$ denotes a four-quarter backwards moving average
c. Pre-deregulated period
d. Post deregulated period
e. Standard errors are in parentheses

2.5 ECONOMETRIC METHODOLOGY AND DATA

Prior to undertaking the empirical estimation of equation 2.17, issues relating to data are discussed in the section (2.5.1), whilst in section 2.5.2, issues concerning the estimation methodology are discussed.

2.5.1 DATA ISSUES

The data used in this work have been provided by a number of individuals and organisations as summarised below. I would like to express my grateful thanks to these individuals and institutions for providing the data and also for providing information and comment on this work.

Country	**Source**
Finland	Kari Takala (Economics Department, Bank of Finland)
Norway	Ragnar Nymoen (Research Department, National Bank of Norway and Department of Economics, University of Oslo);
Sweden	Torbjorn Eika (Statistics Norway) Lennart Berg (Department of Economics, University of Uppsala) Bharat Barot (Research Division, National Institute of Economic Research)

Quarterly, seasonally adjusted data is available for Finland and Sweden, over the period 1970:1-1995:4, and for Norway, over the period 1967:2-1994:4. A detailed description of the data sources is given in Data Appendix 1.

Data definitions used in the study are the following: the dependent variable in equation 2.17 is real consumption per capita and the explanatory variables are real disposable income per capita and the real rate of interest. All variables, except the real rate of interest are logged. As previously outlined in section 2.4.1, following Campbell and Mankiw (1989), a log-linear specification is adopted. They stated that in practice it is likely that the mean change and the variance in consumption and income grow with the level of consumption or income (Campbell and Mankiw, 1989:190). Without logging there is the possibility that a heteroscedasticity problem might arise. The log-linear specification also accommodates time-varying ex-ante real interest rates and random ex-post real interest rates. We approximate the real interest rate as the nominal interest rate less the rate of inflation. The rate of interest is represented by the 3-month market interest rate, and the rate of inflation is represented by the quarterly rate of change of the implicit deflator for the consumption of non-durables and services. Following Mankiw (1981) and Campbell and Mankiw (1989, 1990), we include the ex-post real interest rate in equation 2.17, and instrument using lags of the variable[31].

As explained in the next section 2.5.2, the estimation method of IV is employed; potential instruments to be used include lagged income and consumption growth rates, the consumption-income ratio (Campbell, 1987), lagged growth rates of exports, government expenditure, business investment, and net wealth, and lagged real interest, inflation and unemployment rates.

It is highly likely that some of our macroeconomic data will exhibit strong trends, that is, they are nonstationary. If this is so, then such series are not amenable to conventional regression analysis. As outlined in Grange and Newbold (1974), when nonstationary economic series are used in regressions involving the levels of such data, the standard significance tests are usually misleading. For example, the standard t and F tests would tend to

[31] Mankiw (1981) outlines that with the IV procedure, "[t]he fitted values of r_t from the first stage appear similar to ex ante rates, in that they are a projection of r_t onto $Z_{t.}$, a subset of I_t" (1981:309), where I_t is the information set at t.

reject the null hypothesis of no relationship when in fact there might be none[32]. We therefore examine the time series properties of the variables; this is important for determining the order of integration of the variables. We use the standard unit root tests, the Dickey Fuller (DF) and Augmented Dickey Fuller tests (ADF) to test the stationarity of the variables, and we employ differencing to reduce them to stationarity.

The unit root tests are presented in Tables 2.4 (a)-(c) and a summary of the results is presented in Table 2.5. A detailed description of the tests are presented in Appendix A2.1, and plots of the data are presented in Appendix A2.2. The first row in each of the Tables 2.4(a)-(c) reports the DF test statistics for the data expressed in levels; the remaining two rows present the ADF test statistics for the data in levels and in first differences. The Akaike Information Criterion (AIC) is used to determine the lag length for the ADF[33][34]. The URADF.SRC procedure available in RATS is employed, and this procedure automatically determines the appropriate number of lagged differences using the AIC. Where the situation of conflicting or unclear results arise, we look to the observation of the time series plots of the original series and the first differences, to arrive

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[32] For example, the regression of two strongly trended nonstationary series, is virtually certain to produce a significant relationship, even if the two series, are in fact, independent. The significance would arise as a consequence of the underlying trend.

[33] It is important to ensure that the appropriate lag length is selected, as including too many lags results in a loss of efficiency; since additional parameters (nuisance parameters) result in a loss of degrees of freedom, and a reduction in the power of the test. On the other hand, including too few lags will not appropriately capture the actual error process, and may severely distort the test because the standard error will not be well estimated. In particular the standard error will be underestimated, leading to unrealistically high t-statistics and thereby a higher probability of committing a Type I error (that is, concluding the null hypothesis is false when it is true).

[34] The AIC selects the number of lags to minimise $\ln(RSS/n)+2k/n$, where RSS is the residual sum of squares, n is the sample size and k is the number of regressors. Based on Harris's(1992) findings that the size and power of the ADF tests are enhanced when a generous lag is used, we adopt the AIC, which tends to produce a less parsimonious model relative to other selection criteria such as BIC, the Ljung-Box test and the Lagrange multiplier test.

at a final conclusion. Finally, we also take note of Muscatelli and Hurn's observation in that "[o]ften when dealing with unit root tests, given their low power, the practice in the applied literature has been to rely on one's theoretical priors when constructing models with co-integrated variables..."(1995:178).

Clearly, for all three countries the following series are non-stationary processes: total consumption, consumption of nondurables and services, disposable income, exports, and government expenditure. Upon first differencing, however, these series become stationary. Thus we can say that their relative rates of change are integrated of order zero, so the original series (in logarithms) are integrated of order one. In general these results are supportive of the belief that such macroeconomic data are either non-stationary or strongly trended. We also find that the real interest rate, and the consumption income ratio are integrated of order zero. Furthermore, we note that for each country the unemployment rate underwent a structural change during the early 1990s, corresponding to one of the longest and deepest recessions of the post-war era, experienced by these countries. When we account for the structural breaks, we conclude that the unemployment rate is stationary (refer to Appendix A2.1 for further details).

For the remaining variables some contrasting results are obtained across countries. Consider first, the case of Finland. The results of the ADF tests suggest that of the remaining variables, the inflation rate is stationary, whilst business investment and net wealth are I(1) processes. Turning to Norway, we find that both the inflation rate and net wealth are integrated of order one. Finally, for Sweden, both the inflation rate and business investment are non-stationary, whilst we conclude that net wealth is stationary.

In general, the time series plots of the data provide further support for these overall conclusions (refer to Appendix A2.2).

One further data issue that needs to be considered is that of the use of aggregate data to estimate the Euler equation. As outlined in Section 2.2, the Euler equation is based on the intertemporal optimisation of a representative agent. Hence the most appropriate data to use to estimate and infer about structural parameters using the Euler equation is individual data. In the absence of individual level data, or concerns regarding sampling bias and measurement errors in existing cross-sectional/panel data sets, many of the empirical studies in this area employ the representative agent model with aggregate time series data. The assumption of an infinitely lived representative agent has been used to justify the use of such data.

One particular issue that has arisen in recent literature is aggregation bias, which could be a serious problem for those researchers who apply aggregate data to the estimation of the Euler equation. A number of studies including Deaton (1992), Muellbauer and Lattimore (1995), and Attanasio (1999) have outlined that to correctly draw inferences about micro behaviour from aggregate data a number of specific assumptions are assumed, some of which may not be met in practice. Deaton (1992) outlined that only under certain assumptions will the implications of the Euler equation be similar for individual and aggregate data. These are (i) an infinitely lived consumer, (ii) all consumers have the same set of knowledge, and (iii) the assumption of quadratic preferences (1992:167). Deaton does however note that "only the martingale version of the model is likely to aggregate to anything like its microeconomic form" (1992:43).

The key issue is that in studies using aggregate data, changes in demographic structure should appear in a fully specified model. If not, then aggregation bias may result, which could contribute to the common finding of excess sensitivity. For many of the empirical studies on the Euler equation that have employed aggregate data, demographic variables have not been included. Attanasio and Weber (1993) employing both UK aggregate and cohort data found however, that even when they corrected for aggregation bias arising from the omission of demographic factors, they still found excess sensitivity of consumption.

For those studies which have used household data (Attanasio and Weber (1993, 1994, 1995), Attanasio and Browning (1995)), the use of such data is not itself without problems. Issues such as the presence of measurement error (which disappears in aggregation), sample variation, and the availability and reliability of individual consumption data needs to be considered. These limitations can reduce the accuracy of the estimated Euler equations.

While noting the above issues, we employ aggregate data in this study for the following reasons. Firstly, even though the Euler equation is applicable to an individual consumer, it still serves as a useful approximation to aggregate data (in particular, if we assume an infinitely lived consumer). Secondly, in the absence of a comprehensive cross-sectional or panel data set for all three countries of Finland, Norway and Sweden, the application of time series aggregate data will provide fruitful results. Finally, the majority of Nordic studies to date have employed aggregate date (refer to Section 2.4.2), hence for this study to serve as a useful comparison with these previous studies, aggregate time series data is used.

Table 2.4(a): Finland - Augmented Dickey Fuller Tests of Unit Roots; 1970Q1-1995Q4 (refer to Key at end of Table 2.4(c))

Variable	Lag	τ_τ	Φ_3	τ_μ	Φ_1	τ
Dickey Fuller Test						
lcp	0	-0.855	0.455	-2.225	8.785	3.441
lcnd	0	-0.765	2.956	-2.441	14.977	4.733
lyd	0	-1.569	2.573	-2.084	8.747	3.529
r	0	-4.288	9.282	-3.389	5.759	-2.348
inf4	0	-3.304	7.687	-0.585	0.257	-0.654
ur	0	-0.228	2.121	1.305	4.768	3.024
lexpt	0	-2.944	4.375	-1.433	2.995	1.929
lgovt	0	0.219	11.193	-4.270	27.106	5.357
lbusinv	0	-0.988	0.672	-0.798	0.851	-1.053
lnw	0	-0.026	0.737	-0.909	0.902	0.965
lcy	0	-3.264	5.369	-3.199	5.134	-1.511
Lag length set by AIC						
lcp	8	-1.652	1.815	-1.372	2.102	1.490^{A}
lcnd	5	-2.768	3.463	-1.829	2.377	1.146^{A}
lyd	11	-2.436	4.711	-1.819	4.299	2.236^{A}
r	5	-3.292	5.629	-2.934^{*D}	4.435	-1.354
inf4	12	-3.989^{*C}	8.033	-1.507	2.598	-2.193
ur	8	-1.142	1.607	0.229	0.878	1.255^{A}
lexpt	1	-2.466	3.311	-1.646	6.350^{*D}	3.076
lgovt	3	-0.856	2.286	-2.152	3.679	1.573^{A}
lbusinv	5	-2.499	3.666	-2.265	2.574	-0.182^{A}
lnw	5	-1.663	1.722	-1.668	1.547	0.509^{A}
lcy	7	-2.757	4.154	-2.878^{*D}	4.170	1.378
Lag length set by AIC						
dlcp	7	-3.201	5.321	-3.126^{*D}	-	-
dlcnd	4	-2.838	4.041	-2.673	3.575	-2.399^{*D}
dlyd	10	-3.143	5.257	-2.985^{*D}	-	-
dr	1	-10.179^{*C}	-	-	-	-
dinf4	7	-3.655^{*C}	-	-	-	-
dur	7	-3.899^{*C}	-	-	-	-
dlex	1	-9.017^{*C}	-	-	-	-
dlg	1	-4.801^{*C}	-	-	-	-
dlbus	1	-5.063^{*C}	-	-	-	-
dlnw	4	-3.012	4.563	-2.916^{*D}	-	-
dlcy	7	-4.433^{*C}	-	-	-	-

Table 2.4(b): Norway - Augmented Dickey Fuller Tests of Unit Roots; 1969Q2-1994Q4 (refer to Key at end of Table 2.4(c))

Variable	Lag	τ_τ	Φ_3	τ_μ	Φ_1	τ
Dickey Fuller						
lcp	0	-2.305	2.975	-1.385	4.235	2.522
lcnd	0	-3.293	5.612	-1.251	3.925	2.477
lyd	0	-2.401	3.002	-1.163	4.686	2.805
r	0	-4.023	8.163	-2.923	4.274	-2.081
inf4	0	-2.579	4.334	-1.758	1.550	-1.255
ur	0	-1.393	1.513	0.168	2.221	1.800
lexpt	0	-5.348	14.349	-0.446	2.961	2.383
lgovt	0	-0.912	2.272	-2.063	21.673	6.062
lnw	0	0.395	2.304	-2.015	66.585	10.792
lcy	0	-3.293	5.462	-3.316	5.528	-2.594
Lag length set by AIC						
lcp	7	-1.873	2.098	-1.285	3.129	2.111^{A}
lcnd	7	-2.254	2.649	-0.876	3.009	2.273^{A}
lyd	7	-2.473	3.622	-1.763	3.627	1.973^{A}
r	1	-4.140^{*C}	8.586	-3.003	4.509	-2.011
inf4	8	-1.694	2.143	-0.712	0.542	-0.943^{A}
ur	2	-3.063	4.799	-1.149	0.886	-0.147^{A}
lexpt	1	-3.876^{*C}	7.562	-0.201	5.711	3.379
lgovt	4	0.204	8.861^{*B}	-4.085	22.995	4.753
lnw	5	-1.913	2.507	-1.449	3.252	1.876^{A}
lcy	1	-2.318	2.697	-2.327	2.735	-1.762^{**C}
Lag length set by AIC						
dlcp	6	-3.559^{*c}	-	-	-	-
dlcnd	6	-3.407	5.926	-3.427^{*D}	-	-
dlyd	6	-2.778	3.859	-2.578^{**D}	-	-
dr	4	-6.568^{*c}	-	-	-	-
dinf4	7	-5.554^{*c}	-	-	-	-
dur	7	-3.723^{*c}	-	-	-	-
dlex	8	-4.359^{*c}	-	-	-	-
dlg	3	-7.609^{*c}	-	-	-	-
dlnw	7	-2.994	4.513	-2.629^{**D}	-	-
dlcy	0	-14.381^{*c}	-	-	-	-

Table 2.4(c): Sweden - Augmented Dickey Fuller Tests of Unit Roots; 1970Q1-1995Q4 (refer to Key at end of Table 2.4(c))

Variable	Lag	τ_τ	Φ_3	τ_μ	Φ_1	τ
Dickey Fuller						
lcp	0	-2.511	3.653	-2.087	2.952	1.209
lcnd	0	-3.556	6.641	-1.790	3.079	1.688
lyd	0	-4.397	9.913	-2.564	3.612	0.767
r	0	-4.277	9.175	-2.872	4.172	-2.370
inf4	0	-2.467	3.292	-1.724	1.607	-1.063
ur	0	-0.189	1.824	0.991	2.563	2.259
lexpt	0	-3.723	6.934	-0.702	3.392	2.493
lgovt	0	-0.049	3.889	-2.669	10.102	3.468
lbusinv	0	-2.255	2.589	-1.901	2.476	1.105
lnw	0	-1.265	0.859	-1.313	0.931	0.362
lcy	0	-3.976	7.906	-3.996	7.984	-3.158
Lag length set by AIC						
lcp	0	-0.435	18.283^{*B}	0.048	47.158	0.439
lcnd	2	-1.975	2.471	-1.544	4.833^{*B}	2.669
lyd	7	-2.916	4.580	-1.969	2.359	0.889^{A}
r	4	-4.089^{*C}	8.437	-1.922	1.942	-2.370
inf4	4	-2.358	4.005	-0.963	0.565	-0.719^{A}
ur	4	-2.301	3.405	-1.194	0.901	-0.108^{A}
lexpt	9	-4.101^{*C}	8.487	-0.219	2.121	2.051
lgovt	9	0.979	6.548^{*B}	-2.853	4.407	0.744
lbusinv	9	-2.682	3.624	-1.857	1.979	0.675^{A}
lnw	12	-4.157^{*C}	8.691	-3.664	6.729	0.163
lcy	11	-3.701^{*C}	6.859	-3.529	6.229	-2.626
Lag length set by AIC						
dlcp	0	-13.727^{*C}	-	-	-	-
dlcnd	1	-10.394^{*C}	-	-	-	-
dlyd	7	-3.189	5.277	-3.062^{*D}	-	-
dr	8	-5.397^{*C}	-	-	-	-
dinf4	3	-8.160^{*C}	-	-	-	-
dur	1	-4.382^{*C}	-	-	-	-
dlex	0	-14.238^{*C}	-	-	-	-
dlg	8	-3.718^{*C}	-	-	-	-
dlbus	7	-4.005^{*C}	-	-	-	-
dlnw	8	-2.475	3.065	-2.475	3.062	-2.482^{*C}
dlcy	3	-7.337^{*C}	-	-	-	-

Key to Tables 2.4(a)-(c)

- 5% Critical Values for τ_τ, Φ_3, τ_μ, Φ_1, τ are -3.43, 6.34, -2.88, 4.63, and -1.95 respectively.
- *: Significant at the 5 percent level; **: Significant at the 10 percent level.
- A: Series contains a unit root with zero drift; B: Series contains a unit root with drift; C: Series has no unit root; D: Series stationary around a non-zero mean.

Table 2.5: Summary Table of Unit Root Tests

Country	Variable	Conclusion
Finland	lcp	Series contains a unit root
	lcnd	Series contains a unit root
	lyd	Series contains a unit root
	r	Series stationary around a non-zero mean
	inf4	Series has no unit root
	ur	Series has no unit root[1]
	lexpt	Series contains a unit root
	lgovt	Series contains a unit root with drift
	lbusinv	Series contains a unit root
	lnw	Series contains a unit root
	lcy	Series stationary around a non-zero mean
Norway	lcp	Series contains a unit root
	lcnd	Series contains a unit root
	lyd	Series contains a unit root
	r	Series has no unit root
	inf4	Series contains a unit root
	ur	Series has no unit root[1]
	lexpt	Series contains a unit root
	lgovt	Series contains a unit root
	lnw	Series contains a unit root
	lcy	Series contains no unit root
Sweden	lcp	Series contains a unit root
	lcnd	Series contains a unit root with drift
	lyd	Series contains a unit root
	r	Series has no unit root
	inf4	Series contains a unit root
	ur	Series has no unit root[1]
	lexpt	Series contains a unit root
	lgovt	Series contains a unit root
	lbusinv	Series contains a unit root
	lnw	Series has no unit root
	lcy	Series has no unit root

Key to Table 2.5

- 1: When a break in the series is accounted for, it is found that the unemployment rate is a stationary process - refer to Appendix 2.1 "Unit Root Tests" for an in-depth analysis.

2.5.2 ESTIMATION ISSUES

In order to empirically test the three questions outlined in the Section 2.4.1, equation (2.17) is estimated using instrumental variables (IV). The IV estimator is used for a number of reasons; firstly to account for the role of current income in signalling changes in permanent income[35]; and secondly, as a cautionary measure to guard against simultaneity bias and the parameter instability that could be manifest as a result of simultaneity bias. The IV provides consistent, asymptotically normal, estimates even in the presence of an endogenous regressor(s)[36].

Further, for each country, both the standard model, where $\lambda_t \Delta y_t$ is the explanatory variable (2.17) and an augmented model where $\lambda_t[\alpha\Delta y_t + (1-\alpha)\Delta y_{t-1}]$ is the explanatory variable are estimated, that is:

2.18 $$\Delta c_t = \mu + \lambda_t\left[\alpha\Delta y_t + (1-\alpha)\Delta y_{t-1}\right] + \theta r_t + \varepsilon_t$$

The augmented model includes lagged disposable income since 1) it is probable that current income consumers determine consumption by reference to both current and lagged income; 2) they may respond to income with delay; and 3) differences may exist in the times of measurement of income and consumption within a quarter (Campbell and Mankiw, 1991:732).

In order to obtain consistent estimates and valid inferences, the following estimation strategy is adopted for each country. Firstly appropriate instruments are

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[35] This can be related to measurement error in the level of income.

[36] An alternative estimator is the two stage least squares estimator (2SLS) which is a special case of the instrumental variable technique, but one which is not used in this study. The reason for not using this method is that even though both IV and 2SLS produce identical coefficient estimates, they do not yield the same estimates of the variance-covariance matrix. The method of 2SLS yields incorrect estimates of the variance-covariance matrix, as it uses estimated values of endogenous variables as regressors rather than as instruments in its second stage.

selected; the instrument selection procedure is discussed in more detail in the next section (2.5.2.1). Secondly, the most general specification of model 2.18 is then estimated using the appropriate IV estimator and the appropriate instruments. Based on these results, testing of more specific versions of the above model are conducted. For example, the statistical significance of lagged income and the real rate of interest are tested, and if they are found to be insignificant, they are excluded as regressors. The final stage in the estimation strategy, is to conduct a series of stability tests.

2.5.2.1 Instrument Selection

Two issues arise when using the method of IV, the choice of instrumenting variables and the dating of the instruments. We now discuss both of these issues.

Choice of Instrumenting Variables

The choice of appropriate instruments for predicting income growth is very important as it obviously affects the power of any tests used (Nelson and Startz (1990a,b)). The definition of an instrument is a variable that is fully independent of the equation residuals but is highly correlated with the endogenous regressor. If the instruments have these required properties, then the IV estimators are unbiased, consistent and efficient. In theory, the higher the correlation between the instruments and the regressors, the smaller the asymptotic variances of the IV estimators. However if the instruments have low relevance for the regressors, that is they are weak instruments, then the IV estimator will have poor finite-sample performance, there will be a loss in efficiency, which has consequences for interval estimation and hypothesis testing. For example, Nelson and Startz (1990a,b) showed that when the correlation between the regressor and instrument is very low, then standard statistical inference may be misleading[37]. Similar results have been reported by Maddala and Jeong (1992), Bound, Jaeger and Baker (1995) and Staiger and Stock (1997). The objective is therefore to obtain a set of instruments that are both sufficiently uncorrelated with the equation residuals yet are sufficiently correlated with the relevant explanatory variables.

Previous studies that have adopted the Campbell and Mankiw framework (including Campbell and Mankiw) have adopted an informal approach to selecting valid instruments. In general, they use up to three lags of each variable, assessing the predictive power of the instrument set using the basic R^2. However, a number of studies have demonstrated that the R^2 is not a suitable basis for discrimination in multivariate models. A number of alternative tests of instrument relevance have been suggested. For the one regressor-one instrument case, Nelson and Startz(1990a), suggested using the statistic TR^2, obtained from the first regression of the regressor on the instrument in 2SLS. For the one regressor-multiple instrument case, Bound, et al. (1995) suggested the use of the F-test, while for the multivariate regressor-multivariate instrument case, Shea (1997) promoted the use of the partial R^2, obtained from regressing each regressor on the instrument vector. However, Hall, Rudebusch and Wilcox (1996) argued that the use of these relevance statistics as screening devices may provide misleading results and may actually enhance the problems of inference as discussed above.

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[37] For example, Nelson and Startz (1990a,b) illustrated using a short sample and one instrument that the 2SLS estimator is biased in the direction of the OLS estimator, and the magnitude of bias approaches that of OLS as the R^2 between the instruments and the regressors tends to zero. Their findings were further supported by Bound, Jaeger and Baker (1995) who showed that even for large samples, the IV estimates may suffer from finite sample bias, and may be inconsistent.

Concerning the choice of instruments, rather than adopting the Campbell and Mankiw instrument selection, this work attempts to select an appropriate instrument set by explicitly estimating a marginal income process for each country; this method ensures that variables significant in predicting income growth are used. Previous studies, have not tended to look at the stability or robustness of the marginal process; more careful dynamic specification of the marginal income process should produce some gains in efficiency. The procedure has involved a country specific comprehensive search among a list of candidate variables to find the main determinants of income growth. The list of candidate variables from which the instrument sets are selected include lagged values of disposable income[38], consumption, consumption to income ratio, interest rate (nominal and real), inflation rate, unemployment rate, government expenditure, exports, and business investment.

In selecting the appropriate instruments, it is important to obtain an balanced income regression with good explanatory content. Potential problems that would occur if instruments with poor power and/or instruments from an unbalanced regression are used include non robust[39] and spurious results[40]. For obtaining a balanced regression, the unit root test results outlined previously are important in determining the order of integration of the variables. To obtain a regression with good explanatory content, a series of diagnostic tests are conducted. The search process for each country consists of a

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[38] Lagged values of the regressors may be appropriate instruments when using time series data.

[39] Nelson and Startz (1990a, b) note that an instrument which is only weakly correlated with the right hand side variables in a regression equation, can result in a large bias in the estimated coefficient relative to its calculated standard error.

[40] For models containing non stationary variables, the problem of spurious regression may arise, whereby the results obtained suggest that statistically significant relationships between the model variables exists, when in fact all that is obtained is evidence of contemporaneous correlations rather than meaningful causal relations (Harris 1995:14).

sequential reduction analysis which involves a general to specific search and proceeds along the following steps:

Step 1: Model income as a general dynamic specification. A general process of the following was estimated initially

$$\Delta y_t = \alpha + \sum_{i=1}^{j} \beta_i \Delta c_{t-i} + \sum_{i=1}^{k} \gamma_i \Delta y_{t-i} + \sum_{i=1}^{l} \delta_i (c/y)_{t-i} + \sum_{i=1}^{m} \eta_i r_{t-i} + \sum_{i=1}^{m} \theta_i \Delta \inf_{t-i} + etc.... + \varepsilon_t$$

Step 2:

(a) Conduct F tests for the joint significance of all lags of each individual variable; for example, a variable deletion F test of all lags of consumption, that is the null and alternative hypotheses would be specified as:

$$H_0: \beta_1 = \beta_2 = ... = \beta_j = 0$$
$$H_A: \text{at least one paramter is not zero}$$

(b) Conduct a simple exclusion restriction using the standard individual t-statistics. Continuing with the previous example relating to consumption, the null and alternative hypotheses would be specified as:

$$H_0: \beta_1 = 0; H_0: \beta_2 = 0; ... H_0: \beta_j = 0;$$
$$H_A: \beta_1 \neq 0; H_0: \beta_2 \neq 0; ... H_0: \beta_j \neq 0;$$

Steps 2a-2b are repeated for each variable included. If it is found that the individual t statistics are all insignificant and the F test is insignificant, then all lags of the variable concerned is excluded from the regression.

Step 3: From the evidence in Step 2 on the inclusion or exclusion of the variables, the next step in the procedure is to check the significance of the lags included; for example a variable deletion F test of all second lags (second lag of consumption, income etc.), that is the null and alternative hypotheses would be specified as:

$$H_0\!:\beta_2 = \gamma_2 = \delta_2 = \eta_2 = \theta_2 = \ldots = 0;$$
$$H_A\!:\text{at least one paramter is not zero}$$

Step 4: Individual t statistics are then used to guide further simplification, that is,

$$H_0\!:\beta_2 = 0; H_0\!:\gamma_2 = 0; H_0\!:\delta_2 = 0; etc.$$
$$H_A\!:\beta_2 \neq 0; H_0\!:\gamma_2 \neq 0; H_0\!:\delta_2 \neq 0; etc.$$

At each of these steps 1-4, checks are maintained on the following diagnostics, to ensure that a congruent model is obtained at each step - normality of residuals, residual serial correlation; functional form mis-specification and heteroscedasticity. The null hypothesis that the residuals of the model are normally distributed, is examined using a test proposed by Bera and Jarque (1981), which tests for the joint significance of skewness and kurtosis of the residuals. The Bera and Jarque test is very sensitive to the presence of outlying observations. So, non-normality which can potentially be explained by the presence of outliers, is addressed by introducing dummy variables. The specification of these dummy variables correspond to some change in the economy at the time; for example the introduction of VAT (or change in the rate of VAT). The dummies are restricted to taking values of 0, 1, -1, 0; that is they have no long run effects.

The hypothesis that the disturbances are serially uncorrelated is tested using the Lagrange multiplier (LM) statistic; specifically the Lagrange multiplier statistic is computed for serial correlation of order 1, 4 and 8. A functional form test, based on Ramsey's (1969) RESET test is carried out to detect the choice of an inappropriate functional form[41]. The test statistic is calculated as the t-ratio of the fitted values from the regression of the residuals on the regressors and the squares of the fitted values. Finally, the hypothesis that the disturbances are homoscedastic, is tested using the Breusch-Pagan test, which is calculated from the regression of the squared residuals on squared fitted values, and tests whether the squared fitted values in this regression are statistically significant. A test for an alternative form of heteroscedasticity, known as autoregressive conditional heteroscedasticity (ARCH), is also computed. An LM test due to Engle (1982), is computed for possible first and fourth order ARCH effects in the residuals.

Dating of Instruments

The second issue concerns the timing lag of instruments. Both Hall(1988) and Campbell and Mankiw (1991) suggested that a first order moving average process was likely to be present in the disturbance term of equation 2.17. Arguments which give rise to an MA(1) process include temporal aggregation, whereby adjustments to innovations can occur within the time period observed, (which here is a quarter; it is actually possible that consumers plan on say a monthly or weekly basis while we only have quarterly data; see Working (1960)). Serial correlation may also arise due to misspecification arising from an omitted variable, or from the possible existence of transitory consumption. Patterson and Pesaran (1992) pointed out that when the error term follows a first order

[41] This test is frequently referred to as a test of mis-specification, as it serves as a general indicator that something is wrong with the model.

moving average process, then instruments dated t-1 are invalid since these instruments could be correlated with the MA component of the disturbance term. Previous studies which employ the Campbell-Mankiw "excess sensitivity" model, have in general assumed that the error term is serially correlated, and addressed this problem by using instruments lagged an extra period (that is, lags of -2 onwards), and correcting the test statistics for serial correlation. Patterson and Pesaran actually also pointed out that if the MA process is actually not statistically significant then restricting the instruments in this way will lead to an unnecessary loss of efficiency; hence they test for an MA(1) process. Following Patterson and Pesaran, in this chapter, it is explicitly tested to determine if the error term follows a first order moving process or not, by employing IVMA estimation.

The IVMA estimation methodology allows the joint estimation of the MA process structural coefficients[42]. This has the advantage that in directly estimating the MA process, the correct lagging of instruments can be determined. If a significant MA(1) process is determined, then an instrument set restricted to second lagged variables onwards will be employed with IVMA. If an MA(1) process is not present then instrument sets containing first lagged variables are potentially valid instruments. In this latter case, IV will be the appropriate estimator, as the IVMA will result in inefficient estimates and potential bias from the use of poorer than necessary instruments (Nelson and Startz 1990a,b).

To deal with the potential presence of a MA(1) process in the disturbance term, three sets of instruments are obtained for each country. The first set contains instruments of lag length greater than -1, which is with IVMA estimation (that is when there is evidence of a

[42] The IVMA estimation method is described in detail in Pesaran (1990).

significant MA(1) process in the disturbance term). The second set contains instruments to be used for IV estimation when lagged income is included as a regressor; specifically this set is employed for the IV estimation of equation 2.18, when IVMA provides no evidence of a significant MA term). The third and final set contains instruments to be used for IV estimation when lagged income growth is not included as a regressor (that is if lagged income is found to be statistically insignificant).

2.6 EMPIRICAL EVALUATION

In Section 2.6.1 we empirically select the instruments sets for each country using the procedure outlined in the Section 2.5.2.1. Using these country specific instrument sets, the RE-LCPI Hypothesis as embodied in the Campbell-Mankiw framework is then empirically tested in Section 2.6.2. Finally, in section 2.6.3, a number of stability tests are conducted.

2.6.1 INCOME PROCESS ESTIMATION: SELECTION OF INSTRUMENTS

Tables 2.6 (a)-(c) provide the results of the income growth regressions showing the fit between the changes in income and alternative instrument sets, for Finland Norway and Sweden respectively; and as outlined in the previous section, three instrument sets are selected for each country. In order to examine the structural stability of the instruments sets, CUMSUM and CUMSUMSQ tests as proposed by Brown, Durbin and Evans (1975) are computed. Both the CUMSUM and CUMSUMSQ tests are generated from recursive residuals. The CUSUM test is based on a plot of the sum of recursive residuals, and is useful for detecting systematic movements in the regression coefficients. The

CUSUMSQ test plots the cumulative sum of squared residuals, and is aimed mainly at detecting haphazard and sudden changes in the regression coefficients. The CUSUM and CUSUMSQ plots of are presented in Figures 2.10(a-c) - 2.12(a-c), for Finland, Norway and Sweden respectively.

Finland

The results for Finland are presented in Table 2.6(a). In each regression, either the 5th and/or 6th lags of either income, consumption, and/or the consumption income ratio are required in order to avoid significant serial correlation. On the basis of the results of serial correlation, ARCH and heteroscedasticity tests the null hypothesis of no serial correlation, homoscedasticity and the absence of ARCH effects cannot be rejected. The joint hypothesis of zero slopes is significant in each case (F-test), and the F-test for the restrictions imposed on the general unrestricted form equation in order to arrive at the final specification (hereafter the F-test of reduction) is found to be insignificant[43]. For the instrument set 1 process (instruments for IVMA estimation), the income equation explains 42 percent of the variation in real income growth, with an equation standard error of 0.009. The corresponding figures for the instrument sets 2 (instruments for IV estimation) and 3 (instruments for IV estimation when lagged income growth is excluded as a regressor) are 46 percent (0.009) and 47 percent (0.009) respectively.

Figures 2.10(a)-(c) presents the following plots for instrument set processes 1, 2,

[43] The latter test is calculated by comparing the instrument set with that of the most general model, which contained up to 4 lags of each variable in the selected instrument set.

and 3 respectively: (i) a plot of the regression residuals, together with a standard error band; (ii) a plot of the CUSUM statistic; and (iii) a plot of the CUSUMSQ statistic. Visual inspection of the regression residuals for each process suggest increased volatility during the early 1990s, which possible reflects the bigger than normal cyclical downturn that was experienced by the Finnish economy at this time. There is no evidence of structural instability from the plots of the CUSUM test. However for instrument sets 1 and 3, the plots of the CUSUMSQ test show that the CUSUMSQ moves outside the boundaries, indicating evidence of a short-lived structural break during the early 1990s, which coincides with our earlier comments on the regression residuals.

Norway

The corresponding three instrument sets for Norway are presented in Table 2.6(b). D943 is a dummy variable which takes the value 1 in 1994Q3, -1 in 1994Q4, and zero otherwise. This dummy variable is included to deal with a non normality problem. Probable explanations for its inclusion relate to the severe recession and banking crisis that occurred in Norway at this time. It's inclusion in instrument sets 1 and 2 is statistically significant at the 5 percent level. Furthermore, the F test of zero restrictions for all slopes, with an unrestricted intercept and dummy effect cannot not be rejected (F-test(dummy) = 3.594 and 6.769 for instrument set processes 1 and 2 respectively). This test indicates that the regressors other than the intercept and the dummy variable provide significant explanatory power.

Analysis of the diagnostic tests indicate that for each process the null hypothesis of serial correlation cannot not be rejected (LM(1), LM(4) and LM(8)) at the 5%

significance level. In addition there is no evidence of significant ARCH or heteroscedasticity effects for the sets. The null hypothesis of zero slope coefficients is conclusively rejected in each case, hence a statistically significant relationship has been estimated (F-test = 5.617, 8.776, and 5.662 for instrument set process 1, 2 and 3 respectively). Finally, an F-test of reduction from the general to specific model cannot be rejected (F-test of reduction = 0.903, 0.877, and 0.787 for processes 1, 2 and 3 respectively).

Figures 2.11(a)-(c) present plots of the regression residuals, the CUSUM and CUSUMSQ test for the respective instrument set processes 1, 2 and 3. From a visual inspection of the latter plots, we conclude that there is no evidence of structural instability of the regression coefficients.

Sweden

The three separate sets of instruments selected to predict Swedish income growth are presented in Table 2.6(c). For the first set the eighth lag of income is included to deal with the problem of serial correlation. A dummy variable (d921) is also included to deal with non normality of residuals. This reflects the presence of an outlier relating to the timing of tax reform[44]. The dummy takes the value of 1 in 1992Q1, -1 in 1992Q2, and is zero otherwise; as mentioned before, this ensures that the inclusion of the dummy only has

[44] In 1991, the Swedish tax system underwent a radical change with the implementation of the tax reform act of 1991. The key reforms included a broadening of income tax bases, and cuts in the marginal tax rates on personal and corporate income. Refer to Agell, Berg and Edin (1995) for a fuller discussion on the tax reform and its implications for the Swedish economy.

a temporary effect in the regression. The F-test of zero slopes when the dummy variable d921 and a constant are only included, is found to be statistically significant at the 5 percent level, indicating that the excluded variables have a jointly significant effect on income growth (F-test(dummy) =6.483).

Turning to the diagnostics for Sweden, for the first and second instrument set processes, the null hypothesis of first, fourth and up to the eighth order serial correlation cannot not be rejected. None of the instrument sets possess statistically significant ARCH effects or any evidence of heteroscedasticity. The joint hypothesis of zero slopes for each instrument set is significant (F-test = 7.783, 8.613, and 9.662 for processes 1, 2, and 3 respectively). The F-test of reduction (general to specific model) is insignificant, indicating that the variables of the general model that are excluded from the selected model do not significantly contribute to predicting Swedish income growth (F-test of Reduction = 1.366, 1.182, and 0.310 for process 1, 2, and 3 respectively). Finally, the plots of the regression residuals, the CUSUM and CUSUMSQ tests are presented in Figures 2.12(a)-(c). Both tests suggest that the models are stable over time.

Summary of the Instrument Sets

The following provides a summary of the results for the marginal income process

Country	**Instruments**
FINLAND	Set 1: dlyd(-2, -3, -5), dlc(-3), lcy(-2, -6), dlg(-2) Set 2: dlyd(-2, -5), dlc(-1, -5), lcy(-2), dlg(-2) Set 3: dlyd(-1, -5), dlc(-1) dlg(-1, -2), dlex(-1)
NORWAY	Set 1: dlc(-2, -3), dlg(-2), dlnw(-2), dr(-4), dinf4(-3), d943 Set 2: dlyd(-3), dlc(-1), dlg(-2), dlnw(-1), dr(-5), dlex(-2), d943 Set 3: dlyd(-1, -4), dlc(-1), dlg(-2), dlex(-2), dlnw(-1, -2)
SWEDEN	Set 1: dlyd(-2, -8), dlc(-4), dlex(-3, -6), dlbus(-3), dr(-2), dinf4(-3), d921 Set 2: dlyd(-2, -3), dlcy(-1), dlbus(-1), dur(-2) Set 3: dlyd(-1, -5, -6), dlc(-2), dlbus(-1), dr(-1, -2), ur(-2, -3)

Table 2.6(a): Instrument Sets - Finland (1975Q1-1995Q4) [refer to Key for table at the end of Table 2.6(c)]

Regressors	Instrument Set 1			Instrument Set 2			Instrument Set 3		
	Coeff.	Std.Error	T-Ratio[Prob]	Coeff.	Std.Error	T-Ratio[Prob]	Coeff.	Std. Error	T-Ratio[Prob]
Constant	0.002	0.002	1.019[.312]	0.003	0.002	1.611[.111]	0.235E-3	0.001	0.186[.853]
dlyd(-1)							0.398	0.102	3.922[.000]
dlyd(-2)	0.510	0.115	4.417[.000]	0.359	0.092	3.908[.000]			
dlyd(-3)	0.234	0.131	1.782[.079]						
dlyd(-5)	-0.220	0.111	-1.982[.051]	-0.437	0.107	-4.103[.000]	-0.400	0.096	-4.193[.000]
dlc(-1)				0.219	0.091	2.408[.019]	0.179	0.095	1.894[.062]
dlc(-3)	-0.263	0.125	-2.111[.038]						
dlc(-5)				0.243	0.107	2.264[.027]			
lcy(-2)	0.428	0.127	3.359[.001]	0.070	0.037	1.899[.061]			
lcy(-6)	0.218	0.058	3.745[.000]						
dlg(-1)							0.286	0.116	2.469[.016]
dlg(-2)	-0.166	0.062	-2.659[.010]	0.347	0.124	2.792[.007]	0.296	0.125	2.376[.020]
dlex(-1)							-0.041	0.017	-2.386[.020]
$\bar{R}^2$	0.418			0.461			0.465		
SEE	0.009			0.009			0.009		
F-test	F(7, 73) = 9.001[.000]			F(6,74) = 12.417[.000]			F(6,74) 12.581[.000]		
F-test of Reduction	F(5, 66) = 1.439[.222]			F(7, 65) = 0.689[.682]			F(11, 61) = 1.177[.322]		
F-test(dummy)	n/a			n/a			n/a		
Serial Correlation (1)[a]	F(1, 72)=1.7728[.187]			F(1, 73)= 1.2210[.273]			F(1, 73)= 2.2316[.140]		
Serial Correlation (4)[a]	F(4, 69)=1.5343[.202]						F(4, 70)= .97505[.427]		
Serial Correlation (8)[a]	F(8, 65)=1.9570[.066]			F(4, 70)= .82356[.515]			F(8, 66)= 1.5676[.152]		
Functional Form	F(1, 72)=.26637[.607]			F(8, 66)= 1.8588[.082]			F(1, 73)= 2.2918[.134]		
Normality	CHSQ(2)= .22846[.892]			F(1, 73)= .0204[.887]			CHSQ(2)= 0.3273[.849]		
Heteroscedasticity	F(1, 79)=3.6494[.060]			CHSQ(2)= .3230[.851]			F(1, 79)= 1.3509[.249]		
ARCH(1)	F(1, 72)=.47787[.492]			F(1, 79)= 2.9083[.092]			F(1, 73)= 1.8602[.177]		
ARCH(4)	F(4, 69)=.99591[.416]			F(1, 73)= .27993[.598]			F(4, 70)= 1.1425[.344]		
				F(4, 70)= .72472[.578]					

Table 2.6(b): Instrument Sets - Norway (1967Q2-1994Q4) [refer to Key for table at the end of Table 2.6(c)]

Regressors	Instrument Set 1			Instrument Set 2			Instrument Set 3		
	Coeff.	Std.Error	T-Ratio[Prob]	Coeff.	Std.Error	T-Ratio[Prob]	Coeff.	Std. Error	T-Ratio[Prob]
Constant	0.010	0.003	3.422[.001]	0.003	0.003	1.061[.292]	0.006	0.003	1.755[.082]
dlyd(-1)							-0.268	0.104	-2.577[.011]
dlyd(-3)				0.191	0.094	2.047[.044]			
dlyd(-4)							0.186	0.096	1.936[.056]
dlc(-1)				-0.238	0.084	-2.824[.006]	-0.150	0.095	-1.581[.117]
dlc(-2)	0.264	0.099	2.665[.009]						
dlc(-3)	0.157	0.100	1.563[.121]						
dlg(-2)	-0.284	0.125	-2.271[.025]	-0.307	0.116	-2.652[.009]	-0.273	0.125	-2.177[.032]
dlex(-2)				0.109	0.039	2.763[.007]	0.082	0.041	1.987[.050]
dlnw(-1)				0.170	0.076	2.249[.027]	0.251	0.092	2.732[.007]
dlnw(-2)	-0.146	0.084	-1.739[.085]				-0.144	0.091	-1.588[.116]
dr(-4)	0.301	0.095	3.175[.002]						
dr(-5)				-0.214	0.088	-2.438[.017]			
dinf4(-3)	0.347	0.173	2.002[.048]						
d943	-0.053	0.014	-3.859[.000]	-0.066	0.013	4.928[.000]			
$\bar{R}^2$	0.242			0.352			0.236		
SEE	0.019			0.018			0.019		
F-test	F(7, 94) = 5.617[.000]			F(7, 93) = 8.776[.000]			F(7, 98) = 5.622[.000]		
F-test of Reduction	F(9, 85) = 0.903[.526]			F(18, 75) = 0.877[.607]			F(13, 80) = 0.787[.671]		
F-test(dummy)	F(6, 94) = 3.594[.003]			F(6, 93) = 6.769[.000]			n/a		
Serial Correlation (1)[a]	F(1, 93) = 2.543[.114]			F(1, 92) = 3.614[.060]			F(1, 97) = 2.989[.087]		
Serial Correlation (4)[a]	F(4, 90) = 1.474[.217]			F(4, 89) = 2.058[.093]			F(4, 94) = 1.705[.155]		
Serial Correlation (8)[a]	F(8, 86) = 1.299[.255]			F(8, 85) = 1.497[.170]			F(8, 90) = 1.287[.260]		
Functional Form	F(1, 93) = 2.655[.107]			F(1, 92) = 2.341[.129]			F(1, 97) = 1.604[.208]		
Normality	CHSQ(2) = 0.397[.820]			CHSQ(2) = 1.212[.546]			CHSQ(2) = 2.223[.329]		
Heteroscedasticity	F(1, 100) = 0.013[.911]			F(1, 99) = 0.655[.420]			F(1, 104) = 2.617[.109]		
ARCH(1)	F(1, 93) = 2.184[.143]			F(1, 92) = 0.031[.861]			F(1, 97) = 2.578[.112]		
ARCH(4)	F(4, 90) = 1.628[.174]			F(4, 89) = 0.734[.571]			F(4, 940 = 1.484[.213]		

Table 2.6(c): Instrument Sets - Sweden (1970Q1-1995Q4) [refer to Key for table at the end of Table 2.6(c)]

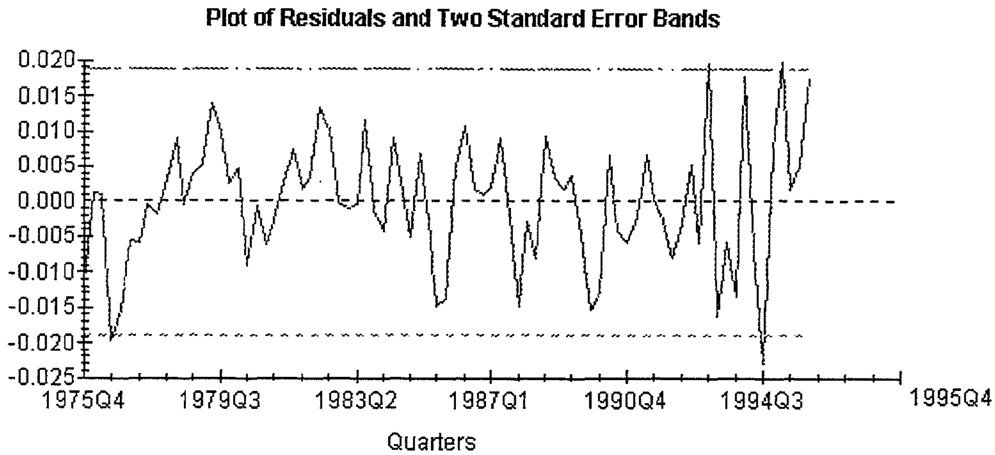
Regressors	Instrument Set 1			Instrument Set 2			Instrument Set 3		
	Coeff.	Std.Error	T-Ratio[Prob]	Coeff.	Std.Error	T-Ratio[Prob]	Coeff.	Std. Error	T-Ratio[Prob]
Constant	0.003	0.002	1.183[.240]	0.005	0.002	1.915[.059]	0.005	0.004	1.229[.222]
dlyd(-1)							-0.615	0.083	-7.397[.000]
dlyd(-2)	0.162	0.087	1.872[.065]	-0.214	0.110	-1.944[.055]			
dlyd(-3)				-0.191	0.101	-1.892[.062]			
dlyd(-5)							0.371	0.088	4.228[.000]
dlyd(-6)							0.331	0.092	3.589[.001]
dlyd(-8)	-0.379	0.084	-4.553[.000]						
dlc(-2)							-0.369	0.147	-2.525[.013]
dlc(-4)	0.415	0.149	2.793[.006]						
dlcy(-1)				0.503	0.090	5.565[.000]			
dlex(-3)	0.112	0.054	2.093[.039]						
dlex(-6)	-0.209	0.059	-3.518[.001]						
dlbus(-1)				-0.133	0.043	-3.064[.003]	-0.096	0.038	-2.522[.014]
dlbus(-3)	-0.093	0.039	-2.366[.020]						
dr(-1)							0.203	0.099	2.047[.044]
dr(-2)	-0.299	0.111	-2.697[.008]				0.139	0.101	1.369[.175]
dur(-2)				-2.007	0.814	-2.466[.015]			
ur(-2)							-2.870	0.782	-3.671[.000]
ur(-3)							2.849	0.814	3.499[.001]
dinf4(-3)	-0.334	0.175	-1.915[.059]						
d921	-0.081	0.015	-5.270[.000]						
$\bar{R}^2$	0.394			0.278			0.453		
SEE	0.021			0.024			0.020		
F-test	F(9, 85) = 7.783[.000]			F(5, 94) = 8.613[.000]			F(9, 85) = 9.662[.000]		
F-test of Reduction	F(16, 69) = 1.366[.168]			F(10.79) = 1.182[.316]			F(13, 72) = 0.310[.989]		
F-test(dummy)	F(8, 85) = 6.483[.000]			n/a			n/a		

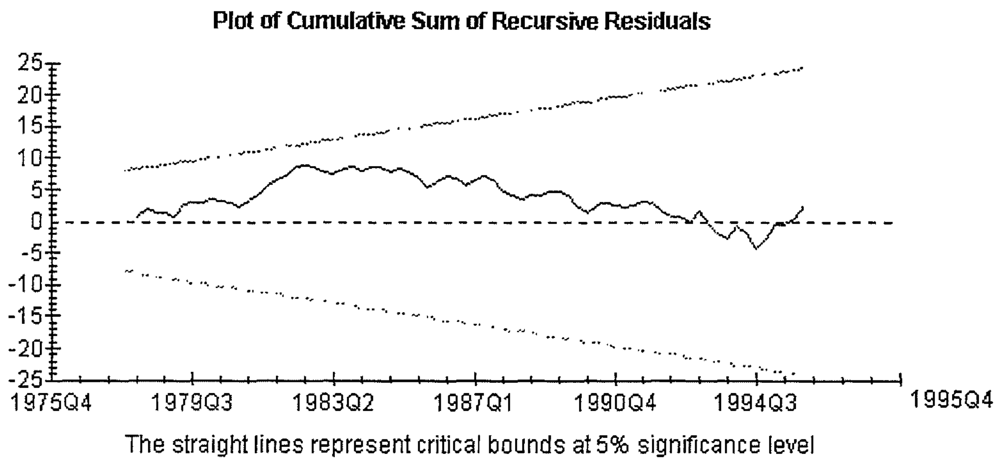
Serial Correlation (1)[a]	F(1, 84) = 1.623[.206]	F(1, 93) = 2.309[.132]	F(1, 84) = 0.406[.526]
Serial Correlation (4)[a]	F(4, 81) = 1.005[.410]	F(4, 90) = 1.005[.409]	F(4, 81) = 0.165[.955]
Serial Correlation (8)[a]	F(8, 77) = 0.843[.568]	F(8, 86) = 1.567[.147]	F(8, 77) = 0.292[.967]
Functional Form	F(1, 84) = 0.439[.509]	F(1, 93) = 0.445[.506]	F(1, 84) = 3.641[.060]
Normality	CHSQ(2) = 0.663[.718]	CHSQ(2) = 1.056[.590]	CHSQ(2) = 1.519[.468]
Heteroscedasticity	F(1, 93) = 2.207[.141]	F(1, 98) = 1.331[.252]	F(1, 93) = 1.799[.183]
ARCH(1)	F(1, 84) = 0.457[.501]	F(1, 93) = 0.413[.522]	F(1, 84) = 0.001[.973]
ARCH(4)	F(4, 81) = 0.346[.846]	F(4, 90) = 0.744[.565]	F(4, 81) = 1.029[.397]

Key to Tables 2.6(a)-(c)

1. The first column of each table (Instrument Set 1) contains the selection of instruments used in IVMA estimation (that is, instruments of lag length greater than 1); the second column (Instrument Set 2) contains the selection of instruments used in IV estimation; and the third column (Instrument Set 3) contains the selection of instruments for IV estimation when lagged income growth is excluded as a regressor.
2. n/a = not applicable
3. "a" - Lagrange multiplier test of residual serial correlation
4. Probability values are noted in square brackets

Figure 2.10(a): Finland - Instrument Set 1





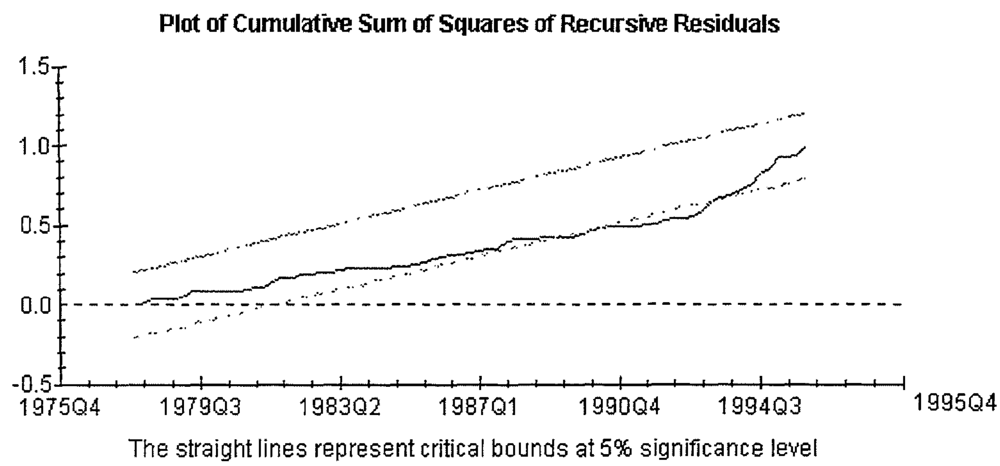
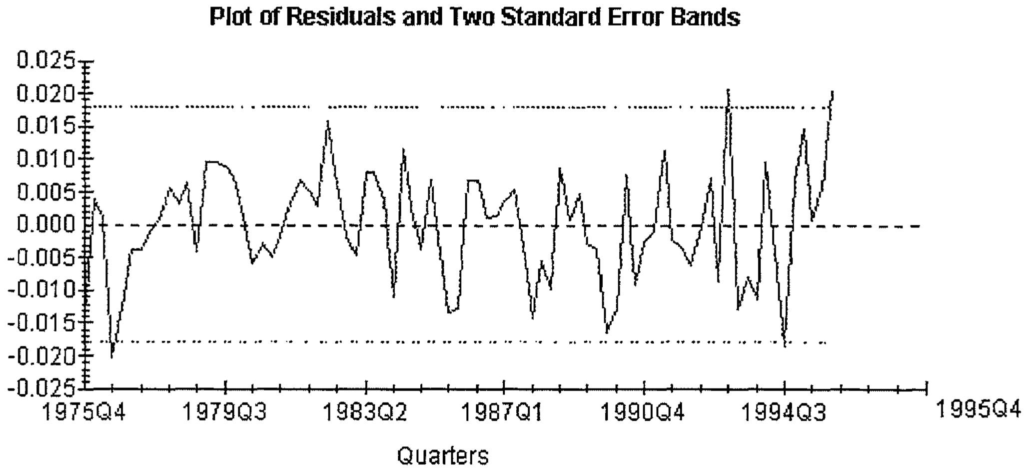
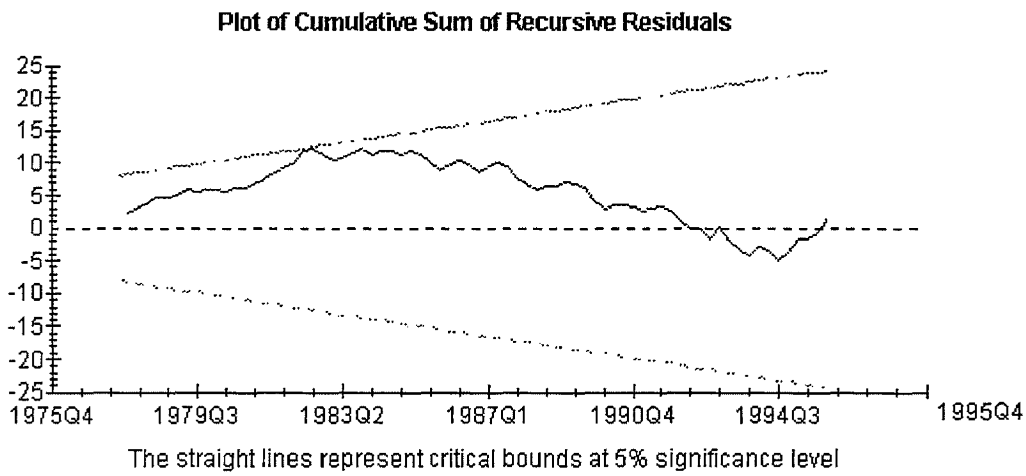


Figure 2.10(b): Finland - Instrument Set 2





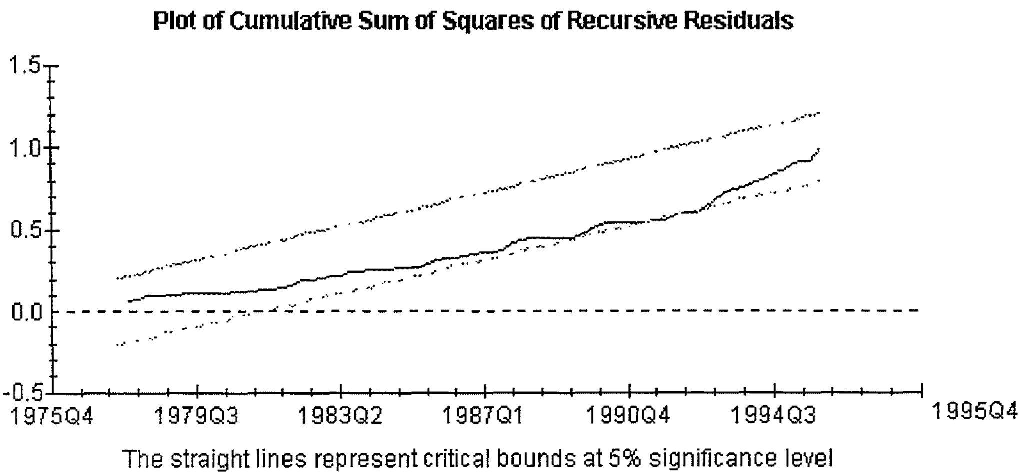
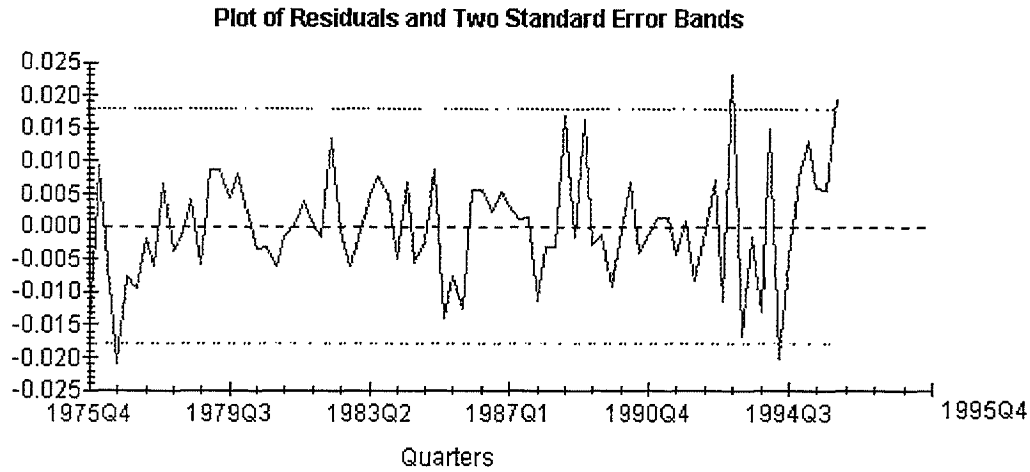
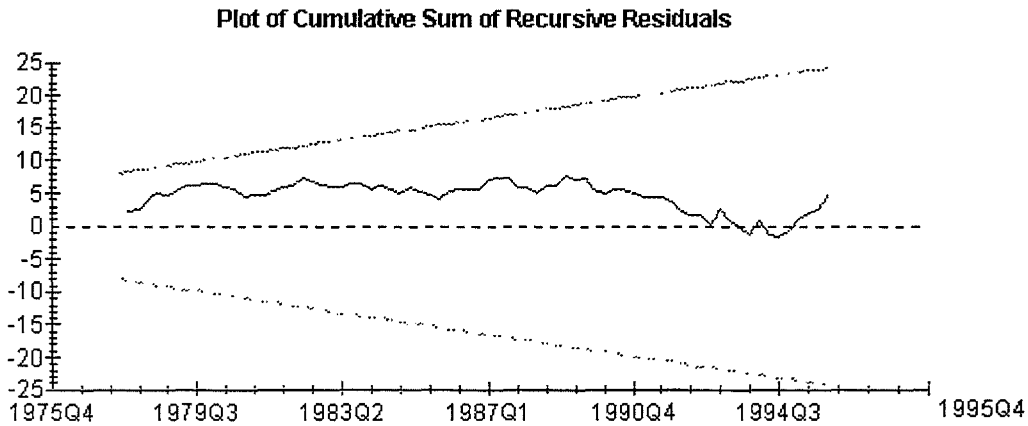
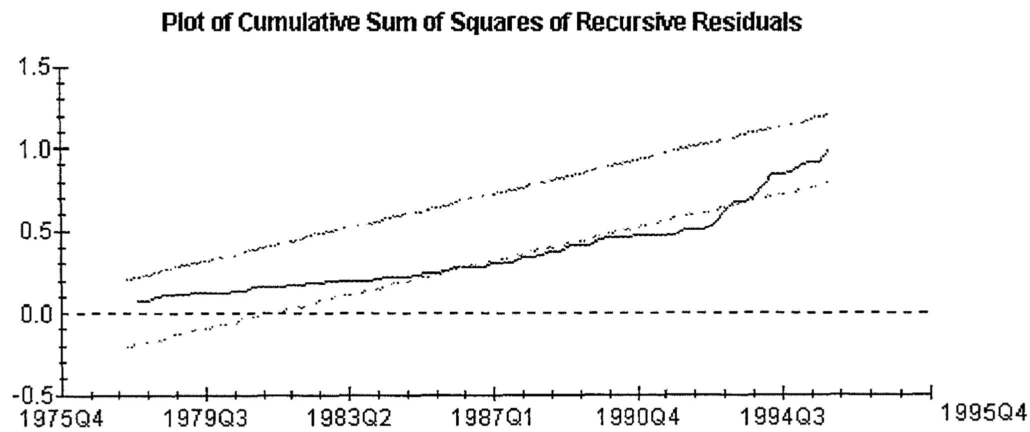


Figure 2.10(c): Finland - Instrument Set 3



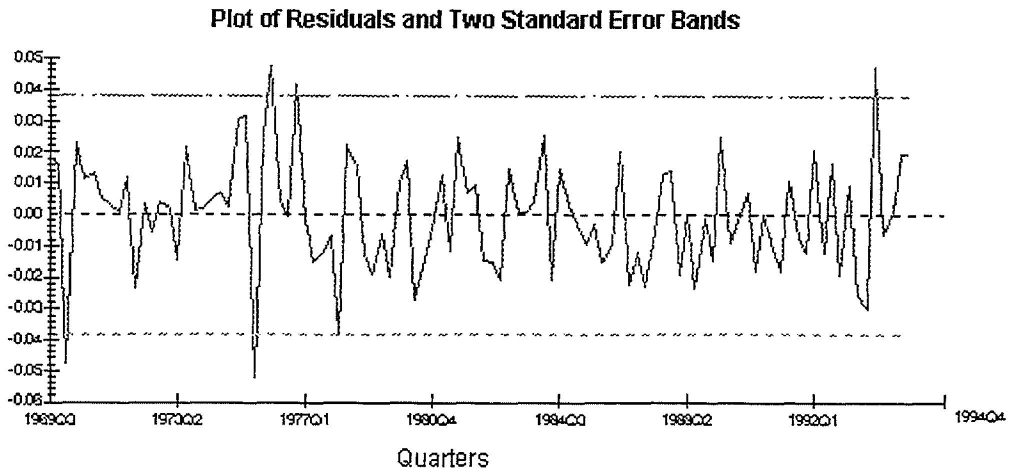


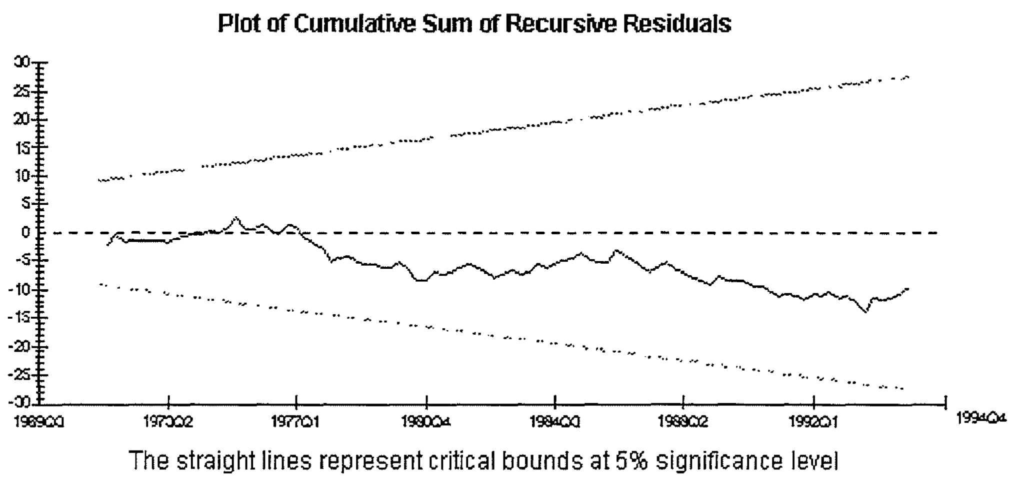
The straight lines represent critical bounds at 5% significance level



The straight lines represent critical bounds at 5% significance level

Figure 2.11(a): Norway - Instrument Set 1





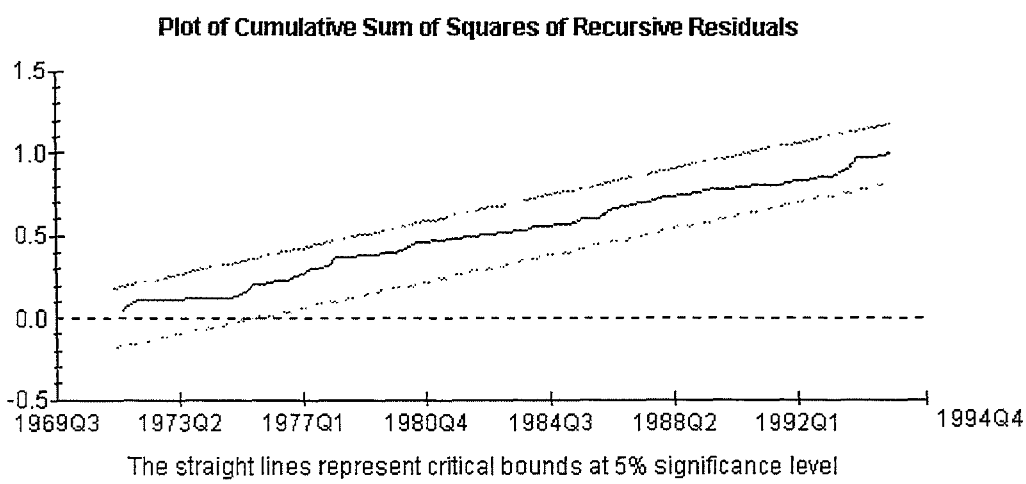
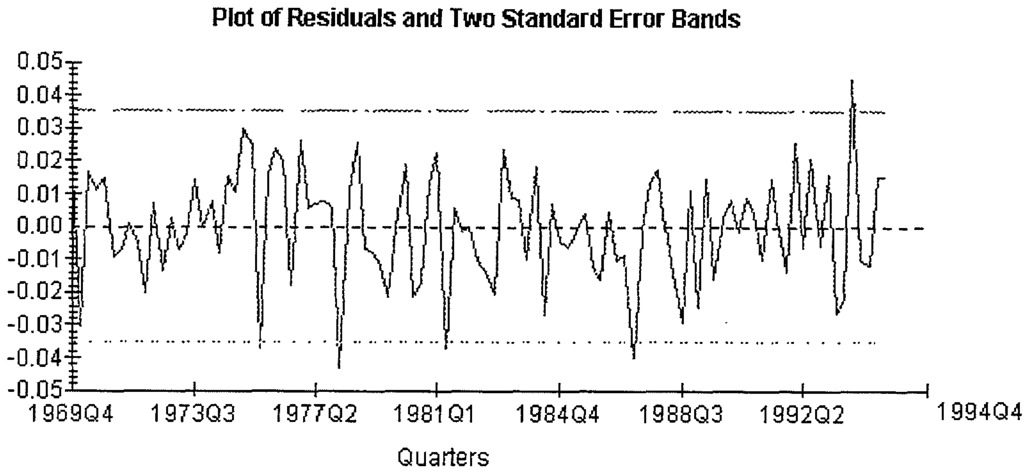
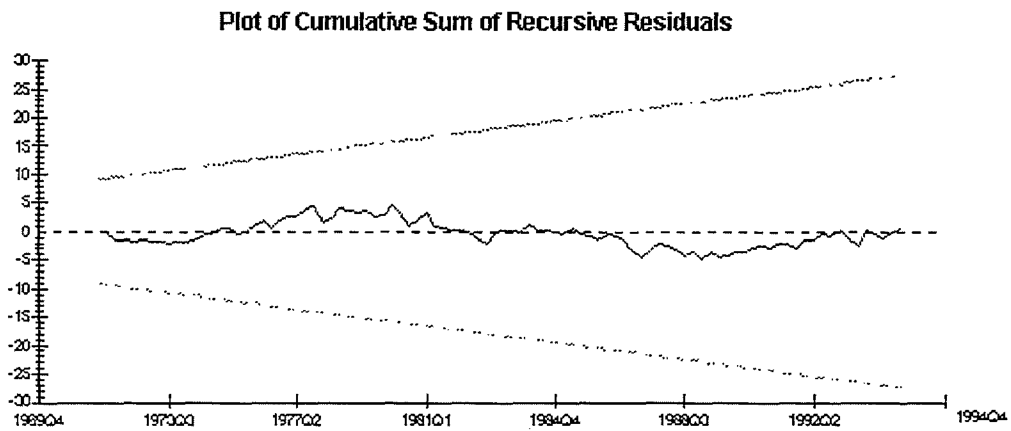


Figure 2.11(b): Norway - Instrument Set 2





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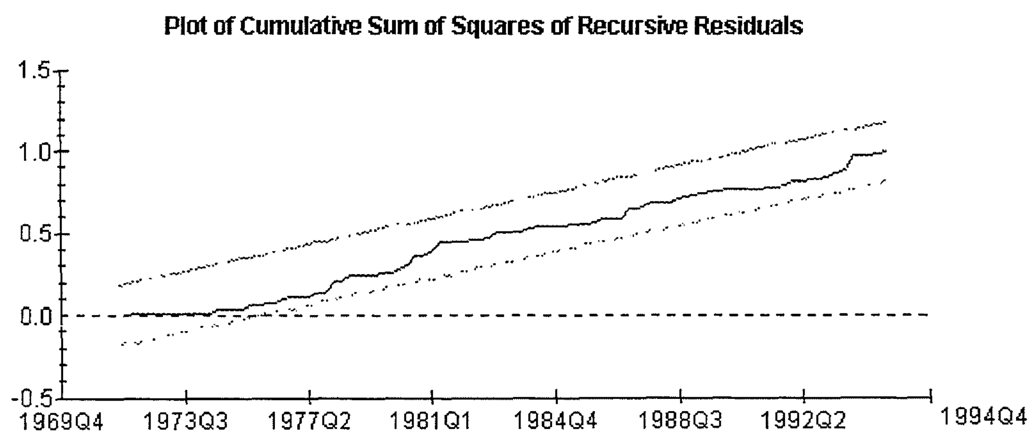
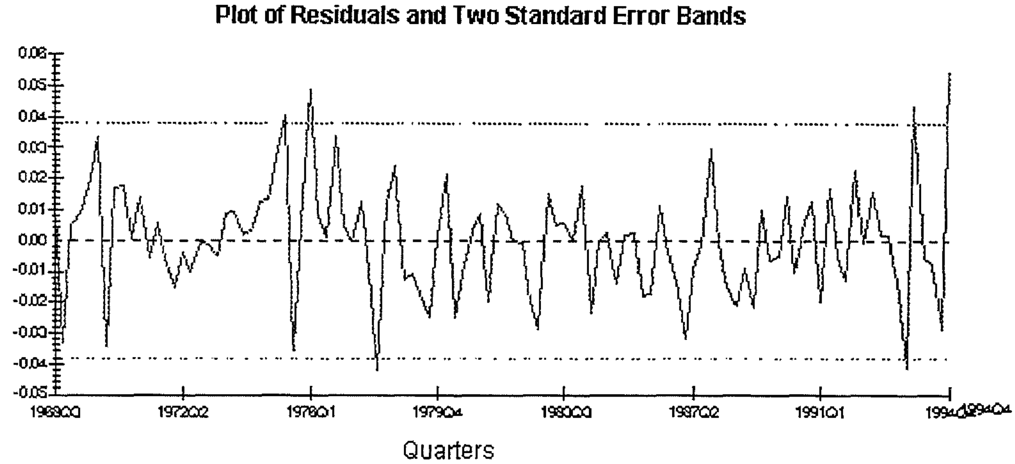
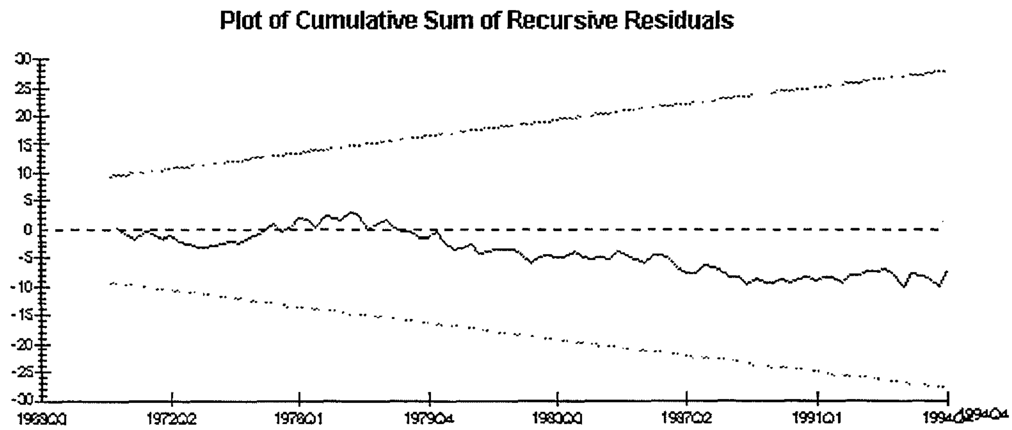


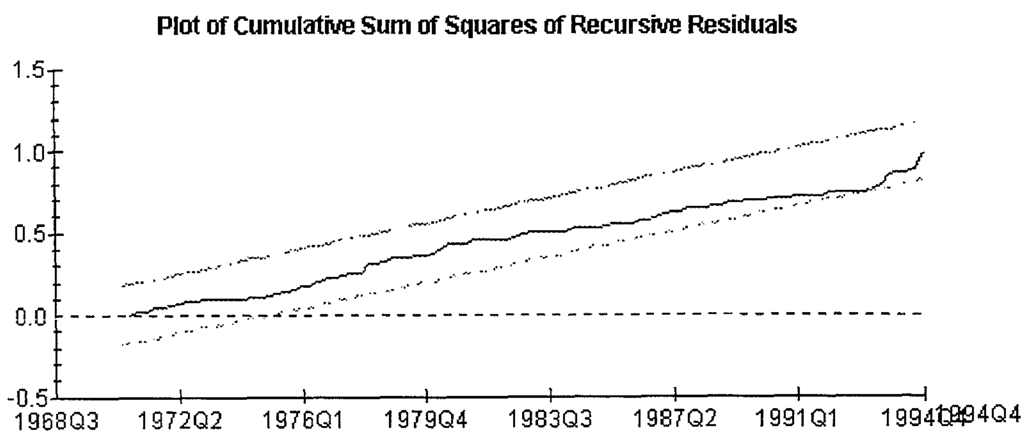
The straight lines represent critical bounds at 5% significance level

Figure 2.11(c): Norway - Instrument Set 3





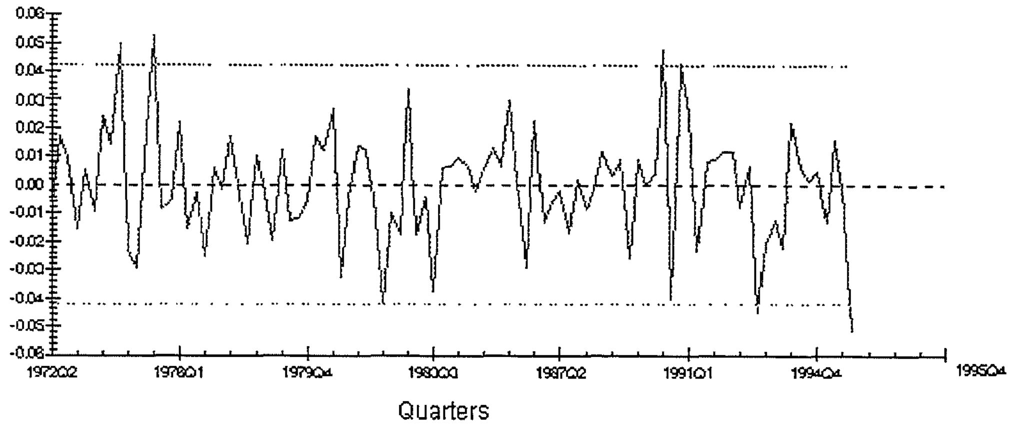
The straight lines represent critical bounds at 5% significance level



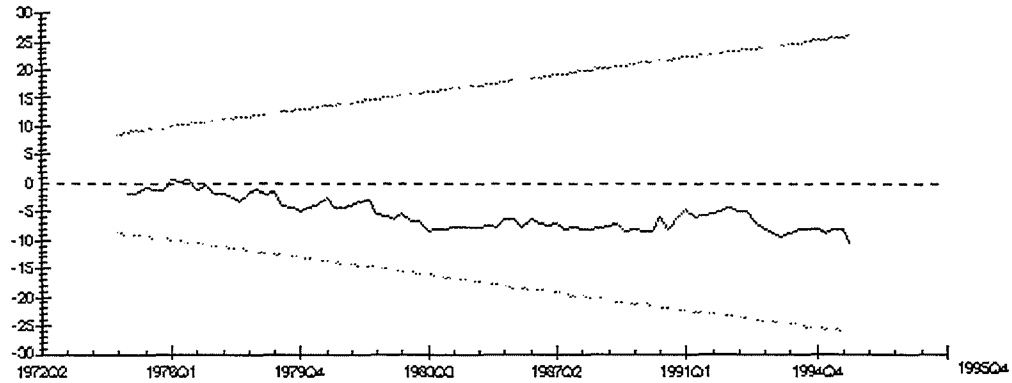
The straight lines represent critical bounds at 5% significance level

Figure 2.12(a): Sweden – Instrument Set 1

Plot of Residuals and Two Standard Error Bands

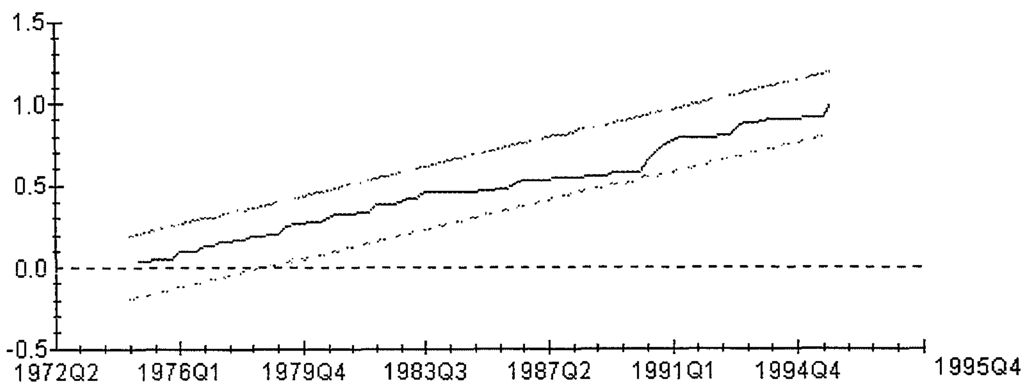


Plot of Cumulative Sum of Recursive Residuals



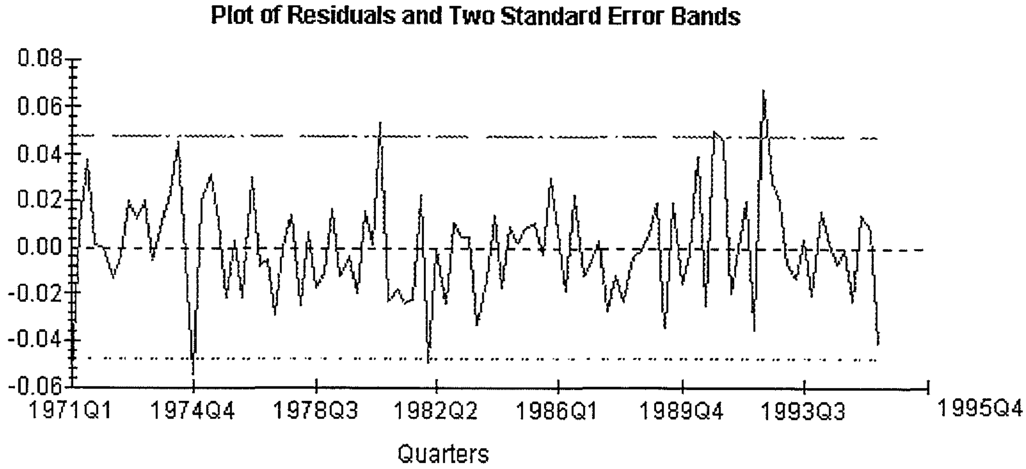
The straight lines represent critical bounds at 5% significance level

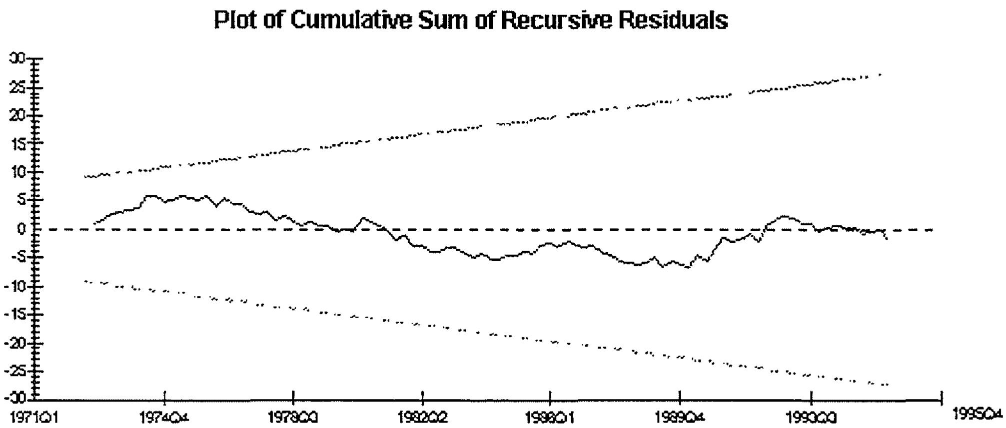
Plot of Cumulative Sum of Squares of Recursive Residuals



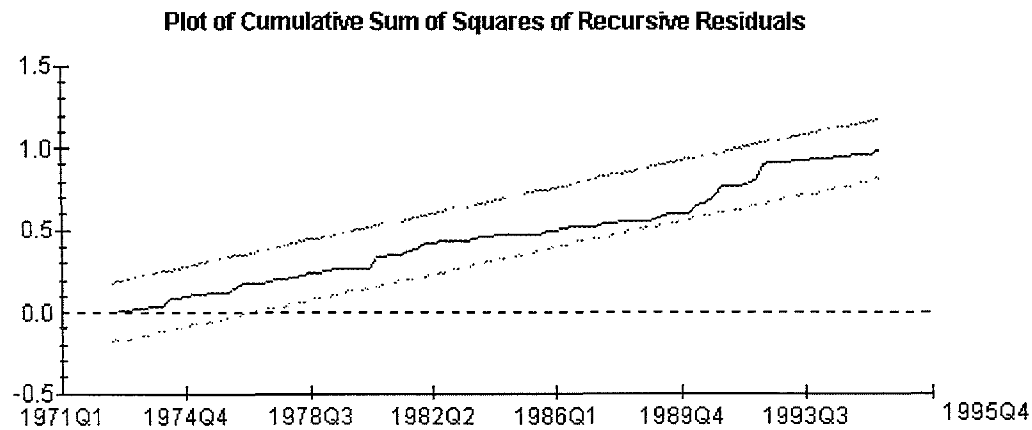
The straight lines represent critical bounds at 5% significance level

Figure 2.12(b): Sweden - Instrument Set 2



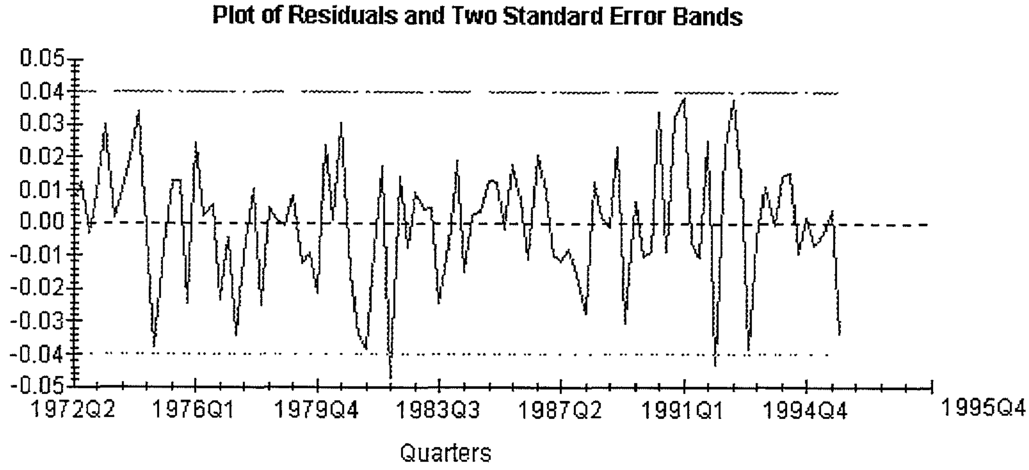


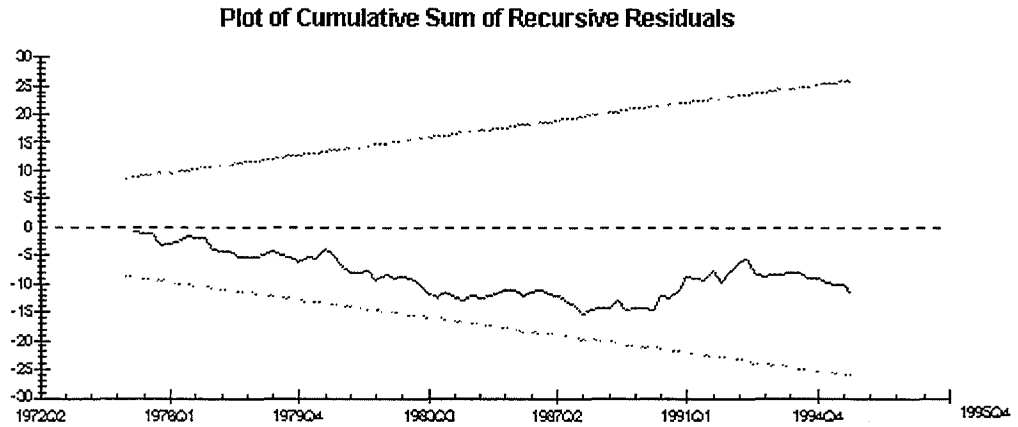
The straight lines represent critical bounds at 5% significance level



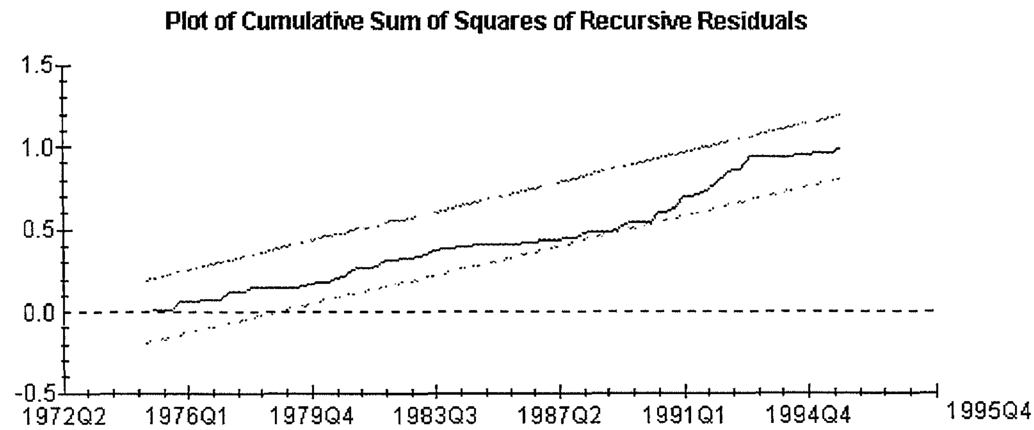
The straight lines represent critical bounds at 5% significance level

Figure 2.12(c): Sweden - Instrument Set 3





The straight lines represent critical bounds at 5% significance level



The straight lines represent critical bounds at 5% significance level

2.6.2 EXCESS SENSITIVITY - BASELINE RESULTS AND COMPARISON WITH PREVIOUS RESULTS

The results of the estimation of equation 2.18 for Finland, Norway and Sweden are presented in Tables 2.7 ((i), (ii) and (iii)) and 2.8((i), (ii) and (iii)). Table 2.7 presents results for the consumption of non-durables and services for both the full and pre-deregulation samples; table 2.8 presents the equivalent results for the total consumption measure. By concentrating on consumer behaviour in the period prior to financial deregulation, inference will not be effected by potential deregulation induced changes in consumption. For each country, the parameter estimates, and their asymptotic standard errors are reported. We provide an analysis of the results by country; as the results for the two consumption measures are similar, we focus our analysis on the consumption of non-durables and services, and where necessary highlight any differences that arise for the total consumption measure.

Finland

Following the estimation strategy outlined in Section 2.5, model (2.18) is initially estimated for each country using the IVMA procedure (with instrument set 1), to detect if the error term had a first order moving average structure. Referring to Table 2.7(i) and model 1, it is evident that for Finland the MA term is statistically insignificant at the 5% level (t-ratio of the ρ coefficient is 0.34; it is 1.37 for total consumption (Table 2.8(i))). This result implies that the error term does not have a first order MA structure, and that once lagged variables are potentially valid instruments. We therefore proceed to re-estimate equation 2.18 using IV with instrument set 2 (that is, instruments lagged once and earlier).

With respect to the IV results for Finland (Table 2.7(i), model 2), the standard t-ratio indicates that lagged income is statistically insignificant in the CM model for ΔC_t (t-ratio = -0.64). The interest rate is also found to be statistically insignificant (t-ratio = -1.48), but the coefficient on the contemporaneous change in income is found to be significant for Finland (t-ratio = 3.31). It is well known, that the inclusion of irrelevant variables will always reduce the efficiency of estimates, that is their presence inflates the standard errors. Consequently, lagged income is excluded as a regressor. With the exclusion of lagged income, for Finland, the coefficients on the contemporaneous change in income and the real rate of interest remain statistically significant and insignificant respectively (t-ratios = 4.23 and -1.53 respectively). It should be noted that the standard error on the coefficient of income is lower in the regression which excludes lagged income, indicating the possible inefficiency resulting from the inclusion of irrelevant variables.

The finding of a negative but insignificant coefficient on the real rate of interest, suggests that consumption growth is not significantly responsive to changes in the real rate of interest, that is the intertemporal elasticity of substitution is low. This finding is supported by the indeterminacy of the effect of interest rates on consumption noted by other researchers[42]. Clearly, this result has important implications for policies related to stimulating savings and thereby growth. For example it is often argued that favourable tax treatment of interest income would increase saving. Alternatively, increases in interest rates could be implemented to initiate a slow down in the economy, a mechanism intended

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[42] As outlined earlier in section 2.4.1, the indeterminacy arises due to changes in the interest rate affecting consumption in two different ways, that is the substitution and income effects.

to operate through the postponement of consumption. However such policies will be ineffective if consumption is relatively unresponsive to interest rate changes.

Based on the above results the real rate of interest is excluded as a regressor, and the consequent results are shown in Table 2.7(i), model 4. For Finland, the coefficient on contemporaneous income growth (hereafter, the excess sensitivity coefficient (λ)) is statistically significant, confirming that consumption is excessively sensitive to changes in current income (t-ratio = 4.18).

Our findings of excess sensitivity (λ=0.475) coincides with those obtained by Takala (1995a) and compare favourably on both the significance and degree of excess sensitivity. The implicit values of λ calculated from models 1 and 2 (0.383 and 0.449 respectively) also compare favourably[43]. Employing a number of instrument sets, Takala obtained significant point estimates of the excess sensitivity coefficient (λ) within the range of 0.29-0.49 (refer to Table 2.3). However our results are in contrast with Koskela and Viren (1992a) who obtained a statistically insignificant estimate of λ (0.272 with a t-ratio of 0.97). The authors comment that such an estimate is rather low (1992a:221). Such differences in results may be attributed to the use of a different sample period and instrument set. For example, Koskela and Viren's data set was shorter (1971Q2-1989Q4), and their instrument set included lags of the change in income, in consumption and the nominal interest rate (specifically, Δy_{t-1}, Δy_{t-2}, Δc_{t-1}, Δc_{t-2}, Δi_{t-1}, Δi_{t-2}).

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[43] The implicit values of λ calculated from models 1 and 2, when the dependent variable is total consumption are 0.456 and 0.512 respectively.

We also estimate equation 2.18 for the pre-deregulation period for each country. For Finland the regression estimated for the pre-deregulation period 1975q4 - 1985q2[44] finds that the excess sensitivity coefficient remains significant but has a much larger value compared to that obtained for the full sample (that is 0.689 compared to 0.475). So, for Finland, a comparison of the pre-deregulation sample period and the full sample period indicate that excess sensitivity is evident for both time periods, but that there has been a detectable decline in the estimate of λ. This result supports the idea that liquidity constraints have declined in importance over time. A similar conclusion is found when we calculate the implicit value of λ for model 1 for the pre-deregulation period (0.499). However the implicit value of λ from model 2 is lower for the pre-deregulation period (0.387) relative to the full-sample implicit value (0.449)[45].

We also compare the full-sample and pre-deregulation sample point estimates of λ using dummy variables. We incorporate both additive (intercept) and multiplicative (slope) dummies into equation 2.18, to allow for changes in both the intercept and slope coefficients from one period to another. The intercept dummy variable is formed such that it takes the value of 0 for each observation in the pre-deregulation period and a value of 1 otherwise; the slope dummy takes the value of the contemporaneous change in income in the deregulation period and is zero otherwise. The results are reported in Table 2.7(iii). For Finland the intercept and slope dummies are both individually insignificant (t-ratios = 0.02 and -0.65 respectively) and jointly insignificant as indicated by the

[44] The end period of the Finnish pre-deregulation period is assumed to be 1985:2 to coincide with the key deregulation changes that occurred in the Finnish economy during the mid 1980s (refer to section 2.3.1).
[45] The implicit values of λ calculated from models 1 and 2, when the dependent variable is total consumption are 0.528 and 0.42 respectively.

insignificant Wald statistic (χ^2 = 0.804, with a p-value of 0.67). When the intercept dummy is excluded, the slope dummy remains insignificant. These preliminary results indicate that the above noted reduction in the size of the excess sensitivity coefficient over time is not significant. This issue is examined further in section 2.6.3.

Norway

Turning to Norway, and referring to Table 2.7(i), model 1, there is evidence of a significant MA(1) process, suggesting that the IVMA is the appropriate estimator (the estimated parameter is -0.335 (t ratio = -3.88)). This result is further supported when the equation is re-estimated using IV with instrument set 1 for which results differed significantly from those obtained using IVMA. The differences between the results could be explained in that IV is an inefficient estimator when a MA(n) process is present in the disturbance term. When higher MA orders are tested for, there is no evidence to indicate same. The final results for the CM model (equation 2.18) are obtained using the IVMA estimator (and instrument set 1) for Norway.

Similar results are obtained for Norway as for Finland, in that neither lagged income nor the real interest rate are statistically insignificant. Given our earlier argument that the incorrect inclusion of a set of regressors produces inefficient estimates, we exclude both variables from the final regression (Table 2.7(i), model 4). It should be noted that the estimated MA coefficient remains statistically significant (model 4, t-ratio = -5.04).

We next consider the coefficient on the contemporaneous change in income, which is found to be statistically insignificant (the estimated parameter is 0.144 (t-ratio = 1.65)). A low value is also calculated for the implicit value of λ for model 1 (0.058). However, when the dependent variable is defined as total consumption, we obtain a significant point estimate of λ (0.216, t-ratio = 2.27; Table 2.8(i), model 4)[46]. The former result implies that in the case of Norway, there is no evidence to suggest excess sensitivity which at this stage is suggestive that Norwegian consumption behaviour can be characterised by the RE-LCPI Hypothesis.

Our finding of no excess sensitivity is comparable to Koskela and Viren's (1995) finding of an insignificant λ (-0.023 with a t-ratio = 0.03), but is in direct contrast to Boug, Mork and Tjemsland(1995). The latter obtained, using two alternative instrument sets, significant values of λ equal to 0.603 and 0.559 (t-ratios = 2.544 and 2.201 respectively). These estimates are not only larger in value than our estimates, but are also statistically significant. Differences in results could be related to two factors (i) the use of different instrument sets (refer to Table 2.3 for Boug *et als.* instrument lists) and (ii) the treatment of seasonality. With respect to the latter, Boug *et al.* follow Campbell and Mankiw(1991) who work with annual growth rates, measured at a quarterly frequency for unadjusted data. We work with seasonally adjusted data (adjusted using the X11 procedure). Campbell and Mankiw(1991) noted that their estimates of λ were sensitive to

[46] The implicit value of λ calculated from model 1, when the dependent variable is total consumption is 0.087.

the seasonal adjustment procedure. For example, using UK data, they estimated λ equal to 0.35 for seasonally adjusted quarterly data but obtained a significantly higher value of λ equal to 0.65 for annual differences of seasonally unadjusted data (1991:738)[47].

When we estimate equation 2.18 for the Norwegian pre-deregulation period (1969Q2-1984Q2)[48], the results are strikingly different, in that we obtain a statistically significant point estimate of the excess sensitivity coefficient of 0.567 (t-ratio = 5.45; Table 2.7(ii), model 4). This is obviously a significant and larger value than the full sample estimate (λ = 0.144), a result which is suggestive of financial deregulation effects on the excess sensitivity coefficient[49]. This result is in accordance with Boug *et als.*(1995) findings. Employing their first instrument set for their pre-deregulation period (1968Q2-1994Q4), they estimated a significant value of λ equal to 0.747 (t-ratios = 2.918). However when the second instrument list was used with the pre-deregulation sample period, they obtained an insignificant and lower value of λ equal to 0.369 (t-ratio = 1.387). They did note that the standard errors were slightly higher for the estimates obtained with the second instrument set list (1995:11).

Our result is further supported, when we analysis the sample split using dummy variables; the results are reported in 2.7(iii). It is evident that the coefficient of the slope dummy is statistically significant, and more importantly, is negative. This represents the decline in the excess sensitivity coefficient resulting from deregulation. For model 6, in

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[47] As noted in the literature review of Section 2.4.2, the majority of research done to date has been on Sweden; consequently there are fewer studies to serve as comparative aids in discussing results for Finland and Norway.
[48] For comparison, we adopted Boug *et als.* break point of 1984Q2.
[49] The implicit values of λ calculated from model 1 are 0.626 and 0.606, for the consumption of non-durables and services, and total consumption respectively.

Table 2.7(iii), this implies an estimate of λ of 0.018 (0.533-0.515). Overall our results suggest that for Norway, the excess sensitivity of consumption to current income has declined over time, providing some evidence of diminished liquidity constraints arising as a consequence of financial deregulation.

Sweden

Referring to Table 2.7(i), there is strong evidence of a significant MA(1) term for the Swedish data set (-0.412, t-ratio = -3.95), suggesting that potential valid instruments must be lagged more than one period. For subsequent regressions, the IVMA estimation procedure is used with instrument set 1. As for Finland and Norway, both lagged income and the real interest rate are statistically insignificant, and are thereby excluded from further regressions; it should be noted that for these regressions, the MA(1) remains statistically significant at the 5 percent level. For the full sample period, there is no evidence of excess sensitivity (Table 2.7(i), model 4). Such results suggest the Swedish consumer behaviour conforms closely with the RE-LCPI Hypothesis. The above results relate to regressions where consumption of non-durables and services is the dependent variable; although similar results are obtained when total consumption is used as the dependent variable (see Table 2.8(i)). The implicit values of λ for model 1 are 0.007 and 0.053, for the consumption of non-durables and services, and total consumption respectively.

Our finding of no excess sensitivity coincides with Bayoumi and Koujianou (1990) and Koskela and Viren(1992), both of who find small and insignificant point estimates of λ (0.33, t-ratio = 1.32; and -0.006, t-ratio = 0.07 respectively). Our results are also in accordance with the earlier findings of Jappelli and Pagano(1989) who obtained NLIV and FIML estimates of λ equal to 0.12 and -0.05 respectively (t-ratios = 1.1 and -0.04 respectively). Conflicting evidence is reported in Campbell and Mankiw(1991), Berg(1993) and Agell, Berg and Edin (1995)[50]. Campbell and Mankiw(1991) using non-seasonally adjusted data obtained a statistically significant estimate of λ equal to 0.357 (t-ratio = 2.064). Berg(1993) obtained significant estimates of λ equal to 0.19 and 0.23 for quarterly and annual data respectively. The former estimate was calculated for the consumption of non-durables and services, and the latter for a pure consumption measure. Agell *et al.* (1995) obtained point estimates of 0.132 (t-ratio = 2.86) and 0.185 (t-ratio = 2.13) for instruments dated t-1 and earlier, and instruments dated t-2 and earlier, respectively. As for Norway, such result differences could be related to (i) the use of alternative instrument sets (refer to Table 2.3), and/or (ii) the treatment of seasonality[51]. With respect to the latter, Agell and Berg(1996) noted that their decision to use annual data in their consumption study was determined by the extreme sensitivity of their model estimates to the method of seasonal adjustment. It should also be noted that our finding of a lack of significant intertemporal substitution effects in the Swedish regression is supported by Campbell and Mankiw(1991), and Agell and Berg(1996).

The estimation results for the pre-deregulation period are reported in Table 2.7(ii). The deregulation period is assumed to be the start of 1985 onwards for Sweden. A striking feature arises in that there is no evidence of excess sensitivity at the 5 percent

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[50] Refer to Table 2.3 for further details.

[51] We select an appropriate instrument set by explicitly estimating a marginal income process for each of the Nordic countries, whilst the above studies adopt a more informal approach. In general, they include a number of lags of a set of variables, which generally include lags of income and consumption growth

level for the pre-deregulation period. However, the estimated coefficient of λ is statistically significant at the 10 percent level (0.149, t-ratio = 1.98; model 4)[52]. It should be noted that the point estimates of λ are of a larger magnitude than for the full sample, albeit statistically insignificant at the 5 percent level. These results are further supported when we use dummy variables to reflect the effects of deregulation (Table 2.7(iii)). The coefficients on both the intercept and slope dummies are small and insignificant at conventional levels.

These findings are in line with Berg (1993), who, whilst he does not report the results in full, states that by shortening the sample time period and using dummy variables, he finds no evidence of a decline in the excess sensitivity coefficient as a result of financial deregulation. Further support is offered by Campbell and Mankiw (1991) who allowed λ to be a linear function of a time trend, and Agell and Berg (1996) who calculated recursive estimates of λ. For both studies, there was no evidence of a detectable decline in λ. Our results are in contrast with those of Bayoumi and Koujianou (1990), who, using dummy variables, found that financial deregulation did lower the importance of liquidity constraints (1990:202).

Summary of Excess Sensitivity Results

Overall the results suggest that the excess sensitivity parameter, λ_t, varies significantly across the Nordic countries. For Finland, the λ parameter falls from a significant value of 0.69 for the pre-deregulation period, to a statistically significant value

[52] The implicit values of λ for model 1 are 0.02 and –0.006, for the consumption of non-durables and services, and total consumption respectively.

of 0.48 for the full sample, which is consistent with reduced liquidity constraints[53]. For Norway, the magnitude of the estimated λ parameter is lower in value (0.14) and insignificant for the full sample, compared with a significant value of 0.57 in the earlier pre-deregulation period. For Sweden, the striking result is that there is no evidence of excess sensitivity for either sample (at the 5 percent level of significance). In all cases the magnitude of λ is much smaller for the full sample than in the earlier period. Overall these results are suggestive of a time varying λ parameter, which could be linked to the timing of deregulation and the subsequent reduction of liquidity constraints in the Nordic countries. The next section tests more rigorously whether the declines in λ are significant in a statistical sense.

[53] A similar conclusion can be stated when the total consumption measure is used as the dependent variable - refer to Table 2.8(i).

CONSUMPTION OF NON-DURABLES AND SERVICES

Table 2.7(i): Full Sample Estimates of λ
($\Delta c_t = \mu + \lambda[\alpha\Delta y_t + (1-\alpha)\Delta y_{t-1}] + \theta r_t + \varepsilon_t$, where $\varepsilon_t = e_t + \rho e_{t-1}$; t = 1...n, $e_t \approx NID(0, \sigma_e^2)$)

Country	Model	Constant Coef.(t-ratio)	Δy_t Coef.(t-ratio)	Δy_{t-1} Coef.(t-ratio)	r_t Coef.(t-ratio)	MA(1) Term (ρ) Coef.(t-ratio)
Finland 75Q4-95Q4	1	0.005(2.52)	0.384(4.02)*	-0.001(-0.01)	-0.049(-1.58)	0.044(0.34)
	2	0.005(2.27)	0.527(3.31)*	-0.078(-0.64)	-0.046(-1.48)	
	3	0.005(2.29)*	0.476(4.23)*		-0.047(-1.53)	
	4	0.002(1.91)	0.475(4.18)*			
Norway 69Q2-94Q4	1	0.005(2.73)*	0.049(0.53)	0.009(0.10)	-0.022(-0.66)	-0.335(-3.88)*
	2					
	3	0.006(3.16)*	0.067(0.74)		-0.023(-0.73)	-0.359(-4.46)*
	4	0.004(3.65)*	0.144(1.65)			-0.389(-5.04)*
Sweden 70Q1-95Q4	1	0.003(3.12)*	0.051(1.04)	-0.044(-0.89)	-0.021(-1.09)	-0.412(-3.95)*
	2					
	3	0.002(3.17)*	0.068(1.43)		-0.023(-1.23)	-0.439(-4.29)*
	4	0.002(2.88)*	0.065(1.35)			-0.426(-4.22)*

(a) Model 1: $\Delta c_t = \mu + \lambda[\alpha\Delta y_t + (1-\alpha)\Delta y_{t-1}] + \theta r_t + \varepsilon_t$ estimated using IVMA; Model 2: $\Delta c_t = \mu + \lambda[\alpha\Delta y_t + (1-\alpha)\Delta y_{t-1}] + \theta r_t + \varepsilon_t$ estimated using IV; Model 3: $\Delta c_t = \mu + \lambda\Delta y_t + \theta r_t + \varepsilon_t$ estimated using IVMA/IV; Model 4: $\Delta c_t = \mu + \lambda\Delta y_t + \varepsilon_t$ estimated using IVMA/IV;
(b) t-ratios in brackets;
(c) * = statistically significant at the 5 percent level; ** = statistically significant at the 10 percent level.

Table 2.7(ii): Pre-Deregulation Sample Estimates of λ
($\Delta c_t = \mu + \lambda[\alpha\Delta y_t + (1-\alpha)\Delta y_{t-1}] + \theta r_t + \varepsilon_t$, where $\varepsilon_t = e_t + \rho e_{t-1}$; t = 1...n, $e_t \approx NID(0, \sigma_e^2)$)

Country	Model	Constant Coef.(t-ratio)	Δy_t Coef.(t-ratio)	Δy_{t-1} Coef.(t-ratio)	r_t Coef.(t-ratio)	MA(1) Term (ρ) Coef.(t-ratio)
Finland 75Q4-85Q2	1	0.002(1.03)	0.057(0.41)	0.442(2.76)*	0.017(0.99)	-0.574(-1.32)
	2	0.003(1.52)	-0.119(-0.25)	0.506(1.49)	-0.005(-0.17)	
	3	0.002(0.92)	0.681(3.46)*		-0.007(-0.25)	
	4	0.002(1.04)	0.689(3.55)*			
Norway 69Q2-84Q2	1	0.001(0.78)	0.507(4.22)*	0.119(1.115)	0.374E-3(0.01)	-0.618(-2.70)*
	2					
	3	0.002(1.94)	0.523(5.46)*		-0.014(-0.44)	-0.715(-4.39)*
	4	0.002(1.55)	0.567(5.45)*			-0.638(-3.41)*
Sweden 70Q1-84Q4	1	0.002(2.48)*	0.079(1.20)	-0.059(-0.87)	-0.058(-1.52)	-0.429(-2.24)*
	2					
	3	0.002(2.31)*	0.079(1.21)		-0.049(-1.29)	-0.411(-2.01)*[C]
	4[A]	0.002(1.41)	0.149(1.98)**[B]			

(a) Model 1: $\Delta c_t = \mu + \lambda[\alpha\Delta y_t + (1-\alpha)\Delta y_{t-1}] + \theta r_t + \varepsilon_t$ estimated using IVMA; Model 2: $\Delta c_t = \mu + \lambda[\alpha\Delta y_t + (1-\alpha)\Delta y_{t-1}] + \theta r_t + \varepsilon_t$ estimated using IV; Model 3: $\Delta c_t = \mu + \lambda\Delta y_t + \theta r_t + \varepsilon_t$ estimated using IVMA/IV; Model 4: $\Delta c_t = \mu + \lambda\Delta y_t + \varepsilon_t$ estimated using IVMA/IV;
(b) t-ratios in brackets;
(c) * = statistically significant at the 5 percent level; ** = statistically significant at the 10 percent level.
(d) A = No evidence of MA(1) term, therefore estimate using IV; B = Borderline insignificant; p-value = 0.053; C = Borderline significant; p-value = 0.050

Table 2.7(iii): Test for Parameter Constancy between the Full-Sample and Pre-Deregulation Sample using Dummies

Country	Model	Constant Coef.(t-ratio)	Δy_t Coef.(t-ratio)	DUM.Δy_t Coef.(t-ratio)	DUM Coef.(t-ratio)	MA(1) Term (ρ) Coef.(t-ratio)	Wald Statistic $\chi^2(2)$ [p-value]
Finland 75Q4-95Q4	5 6	0.002(0.85) 0.001(1.09)	0.573(1.45) 0.835(2.35)*	-0.264(-0.65) -0.519(-1.45)	0.518E-4(0.02)		0.804[0.67]
Norway 69Q2-94Q4	5 6	0.002(1.33) 0.003(2.19)	0.486(4.40)* 0.533(4.89)*	-0.484(-2.86)* -0.515(-3.15)*	0.002(0.87)	-0.328(-3.87)* -0.281(-3.15)*	8.205[0.02]*
Sweden 70Q1-95Q4	5 6	0.002(2.43)* 0.002(2.64)*	0.035(0.52) 0.037(0.55)	0.004(0.05) 0.203E-3(0.00)	-0.971E-3(-0.67)	-0.372(-3.25)* -0.361(-3.17)*	0.451[0.79]

(a) Model 5: $\Delta c_t = \mu_1 + \lambda_1 \Delta y_t + \mu_2 DUM + \lambda_2 (DUM.\Delta y_t) + \varepsilon_t$ (where $\varepsilon_t = e_t + \rho e_{t-1}$; t = 1...n, $e_t \approx NID\left(0, \sigma_e^2\right)$) estimated using IVMA/IV;

Model 6: $\Delta c_t = \mu_1 + \lambda_1 \Delta y_t + \lambda_2 (DUM.\Delta y_t) + \varepsilon_t$, (where $\varepsilon_t = e_t + \rho e_{t-1}$; t = 1...n, $e_t \approx NID\left(0, \sigma_e^2\right)$) estimated using IVMA/IV.

(b) $DUM_t = 0$ for t =1 to t = breakpoint (The breakpoint for Finland = 1985Q2; Norway = 1984Q2; and Sweden = 1984Q4)
$DUM_t = 1$ for t = breakpoint + 1 to t = n (n = full sample size)

(c) t-ratios in brackets; p-values in square brackets.

(d) * = statistically significant at the 5 percent level; ** = statistically significant at the 10 percent level.

TOTAL CONSUMPTION

Table 2.8(i): Full Sample Estimates of λ

($\Delta c_t = \mu + \lambda[\alpha \Delta y_t + (1-\alpha)\Delta y_{t-1}] + \theta r_t + \varepsilon_t$, where $\varepsilon_t = e_t + \rho e_{t-1}$; t = 1...n, $e_t \approx NID(0, \sigma_e^2)$)

Country	Model	Constant Coef.(t-ratio)	Δy_t Coef.(t-ratio)	Δy_{t-1} Coef.(t-ratio)	r_t Coef.(t-ratio)	MA(1) Term (ρ) Coef.(t-ratio)
Finland	1	0.006(2.06)*	0.467(4.19)*	-0.011(-0.09)	-0.063(-1.58)	0.159(1.37)
75Q4-95Q4	2	0.005(2.11)*	0.583(2.99)*	-0.071(-0.48)	-0.064(-1.69)	
	3	0.005(2.03)*	0.572(4.11)*		-0.064(-1.69)	
	4	0.002(1.15)	0.570(4.05)*			
Norway	1	0.006(2.48)*	0.129(1.25)	-0.042(-0.39)	-0.034(-0.86)	-0.277(-3.30)*
69Q2-94Q4	2					
	3	0.005(2.59)*	0.159(1.62)		-0.031(-0.83)	-0.295(-3.65)*
	4	0.004(2.71)*	0.216(2.27)*			-0.301(-3.82)*
Sweden	1	0.002(1.79)	0.033(0.49)	0.020(0.29)	-0.034(-1.06)	-0.268(-2.91)*
70Q1-95Q4	2					
	3	0.002(1.87)	0.014(0.22)		-0.033(-1.03)	-0.271(-2.98)*
	4	0.002(1.50)	0.004(0.06)			-0.246(-2.67)*

(a) Model 1: $\Delta c_t = \mu + \lambda[\alpha \Delta y_t + (1-\alpha)\Delta y_{t-1}] + \theta r_t + \varepsilon_t$ estimated using IVMA; Model 2: $\Delta c_t = \mu + \lambda[\alpha \Delta y_t + (1-\alpha)\Delta y_{t-1}] + \theta r_t + \varepsilon_t$ estimated using IV; Model 3: $\Delta c_t = \mu + \lambda \Delta y_t + \theta r_t + \varepsilon_t$ estimated using IVMA/IV; Model 4: $\Delta c_t = \mu + \lambda \Delta y_t + \varepsilon_t$ estimated using IVMA/IV;

(b) t-ratios in brackets;

(c) * = statistically significant at the 5 percent level; ** = statistically significant at the 10 percent level.

Table 2.8(ii): Pre-Deregulation Sample Estimates of λ
($\Delta c_t = \mu + \lambda[\alpha \Delta y_t + (1-\alpha)\Delta y_{t-1}] + \theta r_t + \varepsilon_t$, where $\varepsilon_t = e_t + \rho e_{t-1}$; t = 1...n, $e_t \approx NID(0, \sigma_e^2)$)

Country	Model	Constant Coef.(t-ratio)	Δy_t Coef.(t-ratio)	Δy_{t-1} Coef.(t-ratio)	r_t Coef.(t-ratio)	MA(1) Term (ρ) Coef.(t-ratio)
Finland 75Q4-85Q2	1	0.002(1.42)	-0.096(-0.39)	0.624(2.89)*	0.016(0.73)	-0.559(-1.78)
	2	0.003(0.99)	-0.359(-0.48)	0.779(1.51)	0.003(0.07)	
	3	0.938E-3(0.31)	0.907(3.05)*		0.759E-3(0.02)	
	4	0.923E-3(0.44)	0.918(3.13)*			
Norway 69Q2-84Q2	1	0.002(1.32)	0.557(4.35)*	0.049(0.42)	-0.028(-0.70)	-0.569(-2.62)*
	2					
	3	0.003(2.04)*	0.554(4.64)*		-0.037(-0.96)	-0.622(-2.70)*
	4	0.002(1.44)	0.614(5.31)*			-0.583(-2.62)*
Sweden 70Q1-84Q4	1	0.002(1.44)	0.029(0.26)	-0.035(-0.31)	-0.081(-1.42)	-0.517(-3.39)*
	2					
	3	0.002(1.40)	0.005(0.05)		-0.073(-1.23)	-0.492(-3.29)*
	4	0.002(1.17)	0.005(0.04)			-0.349(-2.65)*

(a) Model 1: $\Delta c_t = \mu + \lambda[\alpha \Delta y_t + (1-\alpha)\Delta y_{t-1}] + \theta r_t + \varepsilon_t$ estimated using IVMA; Model 2: $\Delta c_t = \mu + \lambda[\alpha \Delta y_t + (1-\alpha)\Delta y_{t-1}] + \theta r_t + \varepsilon_t$ estimated using IV; Model 3: $\Delta c_t = \mu + \lambda \Delta y_t + \theta r_t + \varepsilon_t$ estimated using IVMA/IV; Model 4: $\Delta c_t = \mu + \lambda \Delta y_t + \varepsilon_t$ estimated using IVMA/IV;
(b) t-ratios in brackets;
(c) * = statistically significant at the 5 percent level; ** = statistically significant at the 10 percent level.

Table 2.8(iii): Test for Parameter Constancy between the Full-Sample and Pre-Deregulation Sample using Dummies

Country	Model	Constant Coef.(t-ratio)	Δy_t Coef.(t-ratio)	DUM.Δy_t Coef.(t-ratio)	DUM Coef.(t-ratio)	MA(1) Term (ρ) Coef.(t-ratio)	Wald Statistic $\chi^2(2)$ [p-value]
Finland 75Q4-95Q4	5 6	0.002(0.65) 0.851E-3(0.53)	0.712(1.45) 0.954(2.18)*	-0.304(-0.60) -0.545(-1.24)	-0.965(-0.28)		1.336[0.51]
Norway 69Q2-94Q4	5 6	0.002(0.90) 0.002(1.42)	0.615(5.09)* 0.672(5.64)*	-0.538(-2.93)* -0.583(-3.29)*	0.002(0.53)	-0.219(-2.51)* -0.179(-1.96)**	8.742[0.01]*
Sweden 70Q1-95Q4	5 6	0.002(1.13)* 0.002(1.42)	-0.043(-0.46) -0.042(-0.46)	0.051(0.39) 0.049(0.38)	-0.358E-3(-0.14)	-0.194(-1.98)** -0.195(-1.99)*	0.162[0.92]

(a) Model 5: $\Delta c_t = \mu_1 + \lambda_1 \Delta y_t + \mu_2 DUM + \lambda_2(DUM.\Delta y_t) + \varepsilon_t$ (where $\varepsilon_t = e_t + \rho e_{t-1}$; t = 1...n, $e_t \approx NID(0, \sigma_e^2)$) estimated using IVMA/IV;
Model 6: $\Delta c_t = \mu_1 + \lambda_1 \Delta y_t + \lambda_2(DUM.\Delta y_t) + \varepsilon_t$, (where $\varepsilon_t = e_t + \rho e_{t-1}$; t = 1...n, $e_t \approx NID(0, \sigma_e^2)$) estimated using IVMA/IV.

(b) DUM_t = 0 for t =1 to t = breakpoint (The breakpoint for Finland = 1985Q2; Norway = 1984Q2; and Sweden = 1984Q4)
DUM_t = 1 for t = breakpoint + 1 to t = n (n = full sample size)

(c) t-ratios in brackets; p-values in square brackets.

(d) * = statistically significant at the 5 percent level; ** = statistically significant at the 10 percent level.

2.6.3 TESTS OF STABILITY

To observe whether the λ coefficient has declined over time, the following equation is estimated by recursive instrumental variable estimation[54]:

2.19 $$\Delta c_t = \mu + \lambda \Delta y_t + \varepsilon_t$$

The recursive estimation procedure produces a time series of estimates of λ ($\hat{\lambda}$) from the successive application of IV estimation to equation 2.19. In each recursion, the sample period is increased successively by one period. If the equation is structurally stable then the variation in $\hat{\lambda}$ through time should be small and random and within ± 2 standard errors of full sample estimates. If financial deregulation diminished the effects of liquidity constraints on aggregate consumption, then we would expect to see a declining pattern in the point estimates of λ, as more observations are added from the 1980s.

Plots of the resulting recursive coefficients are given in Figure 2.9(a)-(f), for the time period 1979-1995 for Finland and Sweden, for 1978-1994 for Norway, and for both measures of consumption. For Finland, there is a noticeable decline in the point estimates of λ, which supports the spilt sample results obtained in the previous section. A similar pattern is observed for the Norwegian data set in Figures 2.9 (c)-(d). The fact that estimates of λ do decline and the timing of the decline are consistent with deregulation causing a reduction in liquidity constrained behaviour. This finding conforms to the pattern of $\hat{\lambda}$ in other countries. For example, Browne, et al. (1991) found that the magnitude of the excess sensitivity coefficient had declined over successive decades for all the countries in their sample, except for the United

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[54] Lagged income and the real rate of interest are not included as regressors as they were found to be statistically insignificant for all three countries - refer to Section 2.6.2. Furthermore, based on our findings of statistically significant MA(1) terms for the Norwegian and Swedish data sets, instruments lagged twice and earlier are used for the recursive IV estimation of these data sets (that is, instrument set 1).

Kingdom[55] (see also the evidence provided by Campbell and Mankiw (1989) and Bayoumi and Koujianou (1989)). Figures 2.9 (e)-(f) tell a different story for Sweden, which show that the point estimates of λ are small and have remained relatively stable over the 1980s. This finding is in line with the spilt sample results that we obtained in section 2.6.2, which showed no evidence of a decline in the estimated λ parameter. Agell and Berg (1996) obtained similar results using recursive estimation, and concluded that there was no evidence of decreasing excess sensitivity for Sweden in the 1980s.

A striking feature common to all three countries should be noted, that is the upward drift in the $\hat{\lambda}$ during the 1990s. This trend is particularly pronounced for the Finnish and Norwegian consumption measures. This could be related to a tightening of credit constraints in the wake of the severe recessions which affected these countries in the early 1990s. It could also be related to the expected increase in uncertainty during this time, which could be reflected in a decrease in current consumption, as prudent consumers increased their levels of precautionary savings.

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[55] The other countries in the sample were the United States, Japan, Germany, France, Italy, Canada and Australia.

Figure 2.13 (a): Finland - Plot of Recursive IV Coefficients; (1979Q1-1995Q4)
Dependent Variable: Consumption of Non-durables and Services

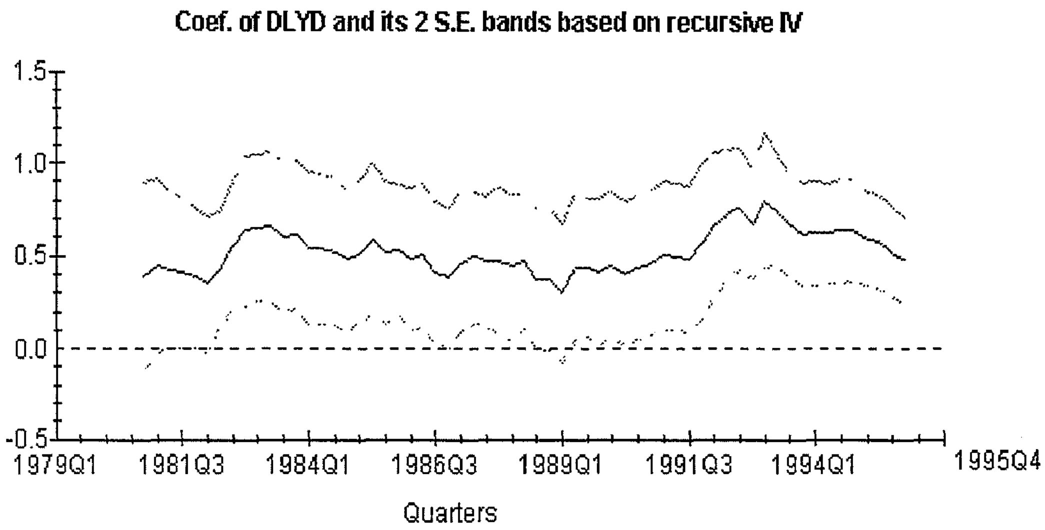


Figure 2.13 (b): Finland - Plot of Recursive IV Coefficients; (1979Q1-1995Q4)
Dependent Variable: Total Consumption

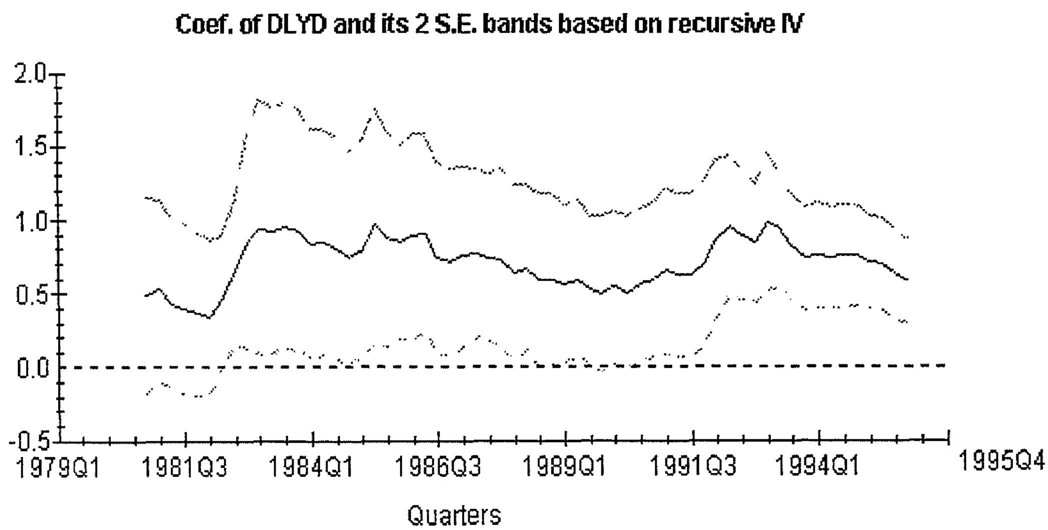


Figure 2.13 (c): Norway - Plot of Recursive IV Coefficients; (1978Q1-1994Q4)
Dependent Variable: Consumption of Non-durables and Services

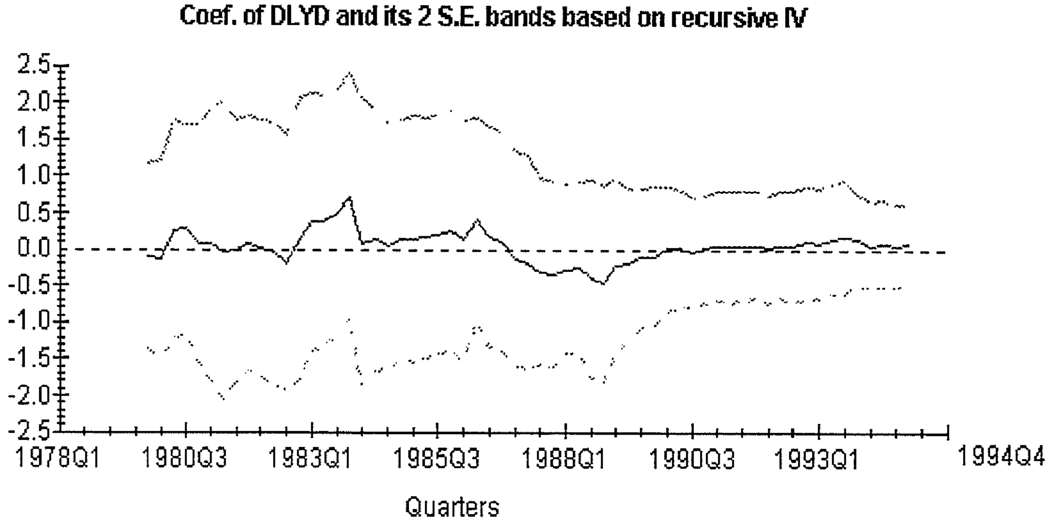


Figure 2.13 (d): Norway - Plot of Recursive IV Coefficients; (1978Q1-1994Q4)
Dependent Variable: Total Consumption

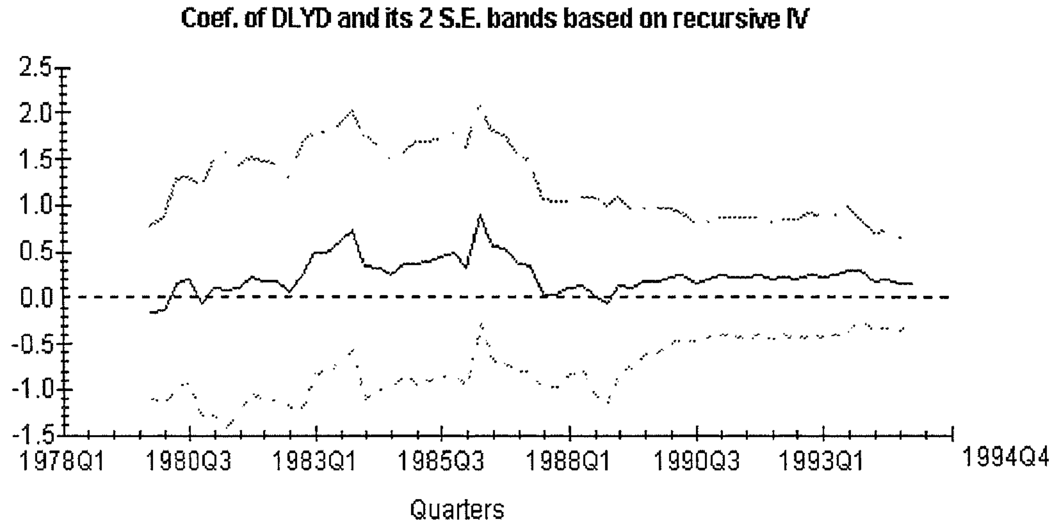


Figure 2.13 (e): Sweden - Plot of Recursive IV Coefficients; (1979Q1-1995Q4)
Dependent Variable: Consumption of Non-durables and Services

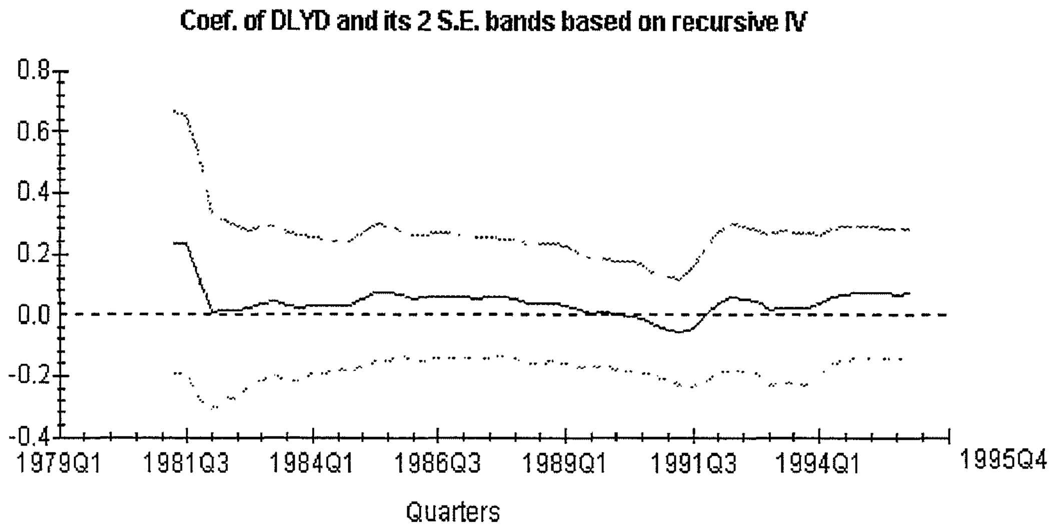
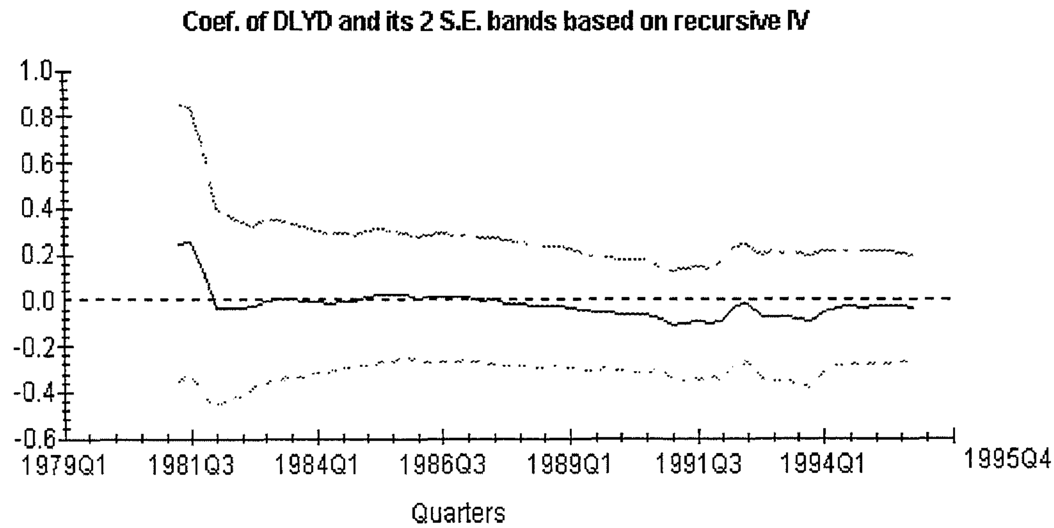


Figure 2.13 (f): Sweden - Plot of Recursive IV Coefficients; (1979Q1-1995Q4)
Dependent Variable: Total Consumption



We still need to test whether the observed decline is statistically significant. In order to address this question a number of formal stability tests are applied[56]. In each case the stability tests relate to a null hypothesis that the equation is stable, that is, the coefficient estimates obtained over sub-samples are not significantly different from each other. In this study the tests are used to determine whether the coefficient $\hat{\lambda}$ is the same between the earlier regulated period -when quantity rationing was prevalent - and the later deregulated period of the 1980s.

The best known and most widely used stability tests are the Chow tests. Both of these tests are based on F-distributions. When equations are estimated by IV, the standard Chow F-tests are invalid, although dummy based χ^2 Wald test analogues are available. The dummy based analogues are based on testing the null hypothesis of zero restrictions on the dummies. The Chow I analogue was popularised by Gujarati (1970). The analogue of the Chow predictive test was proposed by Salkever (1976). Details of both tests are provided in Godfrey (1988:136-143). We first describe the methodology of each test, and then present the results for each country.

Chow I Analogue - Wald Version[57]

This test is based on the following equation which allows for differential intercept and slope coefficients.

(2.20) $$\Delta C_t = \hat{u} + b_1 DUM + \lambda \Delta Y_t + b_2 DUM.\Delta Y_t + \varepsilon_t$$

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[56] As previously noted in the literature review on Nordic countries, a number of strategies have been adopted to examine the time varying properties of λ. This work contributes to the existing literature by adopting alternative methods.

[57]The validity of this test is conditional on the assumption of homoscedasticity.

The Wald statistic tests the joint hypothesis of b_1 and $b_2 = 0$. If the joint hypothesis cannot be rejected, this indicates that there is no evidence of structural change or parameter instability over the time period concerned. For this study, it would indicate that the decline in λ during the 1980s is not significant.

To implement the test, the dummy variable DUM is defined to be zero from the first observation in the sample (that is, 1975Q1 for Finland; 1967Q2 for Norway; and 1970Q1 for Sweden) up to a specified year during the 1980s, and 1 from the specified year to the last observation of the sample (that is 1995Q4 for Finland and Sweden, and 1994Q4 for Norway). The test is applied recursively with the dummy variable rolled forward one period, successively; the full sample period is used for estimation in each case.

Chow II Analogue - Predictive Test

A intuitive way to test the hypothesis of coefficient stability is by prediction. If the predicted values provided by a particular model are sufficiently different to the observed data, then evidence exists to suggest that the model specification is inadequate. It is likely that an underlying change which is not being accounted for by the existing model has occurred (for example, a move from a regulated to a less regulated regime). Salkever (1976) proposed a method to calculating the Chow predictive test which is applicable to IV regressions. A set of Salkever dummies (...0,1,0....) are added to the regression for j sub periods and the joint significance of the dummies is tested. This test is based on the estimation of the following equation

2.21 $$\Delta C_t = \hat{\mu} + \lambda \Delta Y_t + \sum_{i=n-j}^{n} b_i D_i + \varepsilon_t$$

where D_i equals unity in the ith period and zero elsewhere (D_i = 0,0,...0,1,0,0,...). A Wald statistic is computed to test the joint significance of the set of dummies. A significant Wald statistic indicates predictive failure of the model. As for the previous test the sub-periods under examination are those periods of financial deregulation, and the periods immediately following this. Once again, the test is applied recursively predicting i periods ahead over the full sample[58]. The estimated coefficient on each Salkever dummy (b_i) can be interpreted as the prediction error in the ith period, while the t-statistics on individual coefficients indicate those periods of significant prediction error, that is, errors in excess of that expected if the model is stable.

An additional test of stability is the one step ahead prediction test. This method begins by estimating the model over a specified sample period (smaller than the full sample size) plus one observation, and includes a Salkever dummy variable taking on the value of 1 in the final period and zero elsewhere. The first test in the sequence is a t-test on the significance of this dummy variable. The sample period is then increased by one, and the dummy variable moved to the new final period, and a second t-test is calculated; the sample period continues to increase by one, and the last test is applied over the entire sample period, with the dummy variable equal to one in the last period, and zero elsewhere. For each regression a significant t-ratio on the respective Salkever dummy would be indicative of predictive failure, again suggestive of a significant change in the λ parameter.

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[58]As with the Chow I analogue, the tests are based on IV estimates and to ensure the tests validity the same set of instruments is used under both the null and alternative hypotheses.

Test Results

We now turn to the estimates. For the Chow I analogue, the results of the Wald statistics with the corresponding p-values, and the t-ratios for the dummies are reported in the first panel of Tables 2.9-2.14 for both consumption measures; whilst the results of the N-step ahead predictive tests (Chow II analogue) and the 1-step ahead predictive tests with the corresponding p-values are reported in the second panel of Tables 2.9-2.14. We start by reviewing the results for Finland, and then consider Norway and Sweden. As similar results are obtained for both consumption measures, our results review will focus on the consumption of non-durables and services.

Finland

Considering the Chow I analogue test, the estimates in Tables 2.9(i)[59], show some instability for the years of 1989-91, 1993 and 1995, as indicated by the statistically significant χ^2 statistics ($\chi^2(2)$ = 9.083,11.060, 10.956, 7.699, and 7.255 respectively), which test for the joint significance of the slope and intercept dummy variables (that is, H_o:b_1=b_2=0; equation 2.20). Individually, the dummy variables are statistically insignificant at conventional levels, with the notable exception of the slope dummy for 1993 (t-ratio = -2.602). It should be noted that all coefficients of the slope dummy are negative as expected, albeit insignificant with the noted exception of 1993. Similar results are obtained for the total consumption measure.

The first column in Table 2.9(ii) reports the results for the Chow II analogue test. Once again, a χ^2 statistic and its corresponding p-value is presented, which tests for the joint significance of the Salkever dummies (that is, H_o:b_{i+1}=b_{i+2}=...=b_{i+j} =0, where i = n-j ...n;

[59] The corresponding results for total consumption are reported in Table 2.10(i).

equation 2.21). A statistically significant χ^2 provides evidence of predictive failure for a number of predictive sub-periods; specifically 1987-1995 (χ^2 =17.569), 1990-1995 (χ^2 =14.019), 1991-1995 (χ^2 =13.440), 1994-1995 (χ^2 =6.260), and 1995-1995 (χ^2 =6.241). The 1-step ahead predictive tests confirms some of these results, in that the t-statistics on the individual Salkever dummies for 1991 and 1995 are statistically significant, indicative of predictive failure.

Overall there is some tentative evidence of structural instability for the Finnish data set particularly during the late 1980s and early 1990s. These results do offer support for our earlier spilt sample findings of excess sensitivity in section 2.6.2.

Norway

Turning to Norway, the Chow I analogue test results reported in Table 2.11(i) provide strong evidence of a significant decline in the value of λ over time. The statistical significance of a number of the Wald statistics indicate that the hypothesis of no structural change (parameter stability) can be rejected at the 5 percent level. Furthermore, the majority of the slope dummy coefficients are negative and statistically significant at the 5 percent level, implying that the source of the instability can be attributed to changes in the slope coefficient (λ) over time, and in particular for the time periods of the mid to late 1980s and early 1990s. The former time period coincides with the implementation of the financial deregulation measures in Norway.

Additional evidence of parameter instability is provided by the N-step ahead predictive test statistics, with statistically significant χ^2 statistics for the predictive sub-periods 1980-1994 to 1988-1994. However, with the notable exception of the Salkever dummy for 1988 (t-ratio = -3.109), the 1-step ahead predictive tests are insignificant at the conventional levels.

Overall these results strongly support the hypothesis that through the effects of financial deregulation, liquidity constraints have declined in importance over time. These results are certainly in line with our earlier findings of excess sensitivity for the pre-deregulation period and lack of excess sensitivity for the full sample period (refer to Section 2.6.2).

Sweden

For Sweden, the Chow I analogue results are reported in Table 2.13(i). The insignificant Wald statistics indicate that there is no evidence of significant structural change during the 1980s. In addition, for each respective regression, the parameters attached to the dummy variables DUM and DUM.ΔY_t are individually statistically insignificant, confirming the results of the Wald statistics. This findings are further supported by the insignificant N-step ahead predictive test statistics reported in Table 2.13(ii). Furthermore, the t-statistics on all the individual Salkever dummies are statistically insignificant at the conventional levels, with the notable exception for the period 1980 (t-ratio = -2.498). Thus the null hypothesis of predictive failure cannot be rejected. One notable feature of the Swedish results is reported in Table 2.14(ii) for the total consumption measure. For the predictive sub-periods 1980-1995 to 1986-1995, there is evidence of predictive failure as indicated by the statistically significant χ^2 statistics for the N-step ahead predictive tests.

Overall the results show that there is no evidence to support a statistically significant shift in the λ parameter over time; that is financial deregulation does not appear to have caused a detectable decline in λ for the Swedish data set. These results are consistent with our earlier spilt sample findings reported in section 2.6.2, where we found no evidence of detectable changes in λ between the pre-deregulation and full-sample periods. Our findings are consistent with those obtained by Berg (1993), Agell and Berg (1995), and Campbell and Mankiw (1991), who also did not find any detectable decline in λ for Sweden.

Summary of Tests of Stability Results

For Finland, there is evidence of structural instability during the late 1980s and early 1990s. Stronger evidence of significant structural instability during the early to mid 1980s, exists for Norway; whilst no clear evidence is found Sweden. This pattern of results is consistent with those findings obtained in the Nordic study by Lehmussaari (1990) who found that deregulation did have a significant impact on consumption behaviour for Finland and Norway, but had little effect on Swedish consumption[60].

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[60] Lehmussaari(1990) estimated an error correction model using annual data for Denmark(1972-83), Finland(1971-85), Norway(1971-84) and Sweden(1971-85). The final period of the sample was chosen to correspond to when each country introduced its major deregulation measures. He then used remaining observations to 1987 for prediction. When he looked a the out-of-sample performance of each model, he concluded that only the model for Sweden predicated to a high degree of accuracy. He took this as evidence that deregulation had an impact on saving-consumption behaviour for Denmark, Finland and Norway.

FINLAND - CONSUMPTION OF NON-DURABLES AND SERVICES

Table 2.9(i) : Chow I Analogue - Wald Version (Instrumental Variable Estimation; n=81). Wald Statistic $\chi^2(2)$ presented; t-statistics and p-values for dummies presented

DUM_t t=80, ...,95	Wald Statistic $\chi^2(2)$ [p-value]	$DUM.\Delta y_t$ t-ratio [p-value]	DUM t-ratio [p-value]
DUM80	0.374[.829]	-0.564[.575]	0.295[.769]
DUM81	0.462[.794]	-0.672[.503]	0.397[.693]
DUM82	0.292[.864]	-0.529[.598]	0.439[.662]
DUM83	0.557[.757]	-0.635[.527]	0.159[.873]
DUM84	0.402[.818]	-0.606[.547]	0.291[.771]
DUM85	0.668[.716]	-0.650[.517]	0.086[.931]
DUM86	0.725[.696]	-0.478[.634]	-0.231[.818]
DUM87	1.534[.464]	-0.600[.550]	-0.423[.674]
DUM88	5.469[.065]	-1.099[.275]	-0.936[.352]
DUM89	9.083[.011]*	-1.295[.199]	-1.474[.145]
DUM90	11.060[.004]*	-1.359[.178]	-1.874[.065]
DUM91	10.956[.004]*	-1.699[.093]	-1.799[.076]
DUM92	5.694[.058]	-1.757[.083]	-0.809[.421]
DUM93	7.699[.021]*	-2.602[.011]*	-0.190[.849]
DUM94	3.782[.151]	-1.444[.153]	-0.403[.688]
DUM95	7.255[.027]*	-1.267[.209]	0.081[.936]

Table 2.9(ii): Salkever Method: (a) Chow II Analogue (N-step ahead Predictive Tests) - $\chi^2(q)$ presented; and (b) Recursive 1-step ahead Predictive Tests - t-statistics presented.

N-step ahead Predictive Tests D_i (i=80,...,95)		$\chi^2(q)$ [p-value]	1-step ahead Predictive Tests D_i (i=80,...,95)		t-ratio [p-value]
D80-D95[a]	*q=16*	18.379[.302]	D80	*n=21*	-0.101[.921]
D81-D95[b]	*q=15*	18.608[.232]	D81	*n=25*	-0.538[.596]
D82-D95	*q=14*	18.621[.180]	D82	*n=29*	0.312[.758]
D83-D95	*q=13*	18.199[.150]	D83	*n=33*	-0.656[.517]
D84-D95	*q=12*	17.929[.118]	D84	*n=37*	1.145[.260]
D85-D95	*q=11*	17.593[.092]	D85	*n=41*	0.846[.403]
D86-D95	*q=10*	17.487[.064]	D86	*n=45*	0.288[.775]
D87-D95	*q=9*	17.569[.041]*	D87	*n=49*	1.949[.057]
D88-D95	*q=8*	14.487[.070]	D88	*n=53*	1.202[.235]
D89-D95	*q=7*	13.943[.052]	D89	*n=57*	-0.721[.474]
D90-D95	*q=6*	14.019[.029]*	D90	*n=61*	-0.811[.421]
D91-D95	*q=5*	13.440[.020]*	D91	*n=65*	-2.982[.004]*
D92-D95	*q=4*	6.069[.194]	D92	*n=69*	0.073[.942]
D93-D95	*q=3*	6.726[.081]	D93	*n=73*	1.302[.197]
D94-D95	*q=2*	6.260[.044]*	D94	*n=77*	0.306[.760]
D95-D95	*q=1*	6.241[.012]*	D95	*n=81*	-2.498[.015]*

FINLAND - TOTAL CONSUMPTION

Table 2.10(i) : Chow I Analogue - Wald Version (Instrumental Variable Estimation; n=81). Wald Statistic $\chi^2(2)$ presented; t-statistics and p-values for dummies presented

DUM_t t=80, ...,95	Wald Statistic $\chi^2(2)$ [p-value]	$DUM.\Delta y_t$ t-ratio [p-value]	DUM t-ratio [p-value]
DUM80	0.304[.859]	-0.543[.588]	0.369[.712]
DUM81	0.372[.830]	-0.608[.545]	0.386[.700]
DUM82	0.172[.917]	-0.415[.679]	0.288[.774]
DUM83	1.173[.556]	-0.601[.550]	-0.230[.818]
DUM84	0.573[.751]	-0.575[.567]	0.053[.958]
DUM85	0.888[.641]	-0.579[.564]	-0.142[.887]
DUM86	1.433[.488]	-0.497[.620]	-0.512[.610]
DUM87	2.097[.351]	-0.611[.543]	-0.588[.558]
DUM88	5.347[.069]	-0.918[.362]	-1.094[.278]
DUM89	9.382[.009]*	-1.086[.281]	-1.710[.091]
DUM90	10.938[.004]*	-1.153[.253]	-2.037[.045]*
DUM91	8.847[.012]*	-1.151[.137]	-1.639[.105]
DUM92	4.346[.114]	-1.559[.123]	-0.672[.504]
DUM93	7.724[.021]*	-2.757[.007]*	0.441[.660]
DUM94	3.145[.208]	-1.588[.116]	0.113[.910]
DUM95	4.515[.105]	-0.969[.336]	0.029[.976]

Table 2.10(ii): Salkever Method: (a) Chow II Analogue (N-step ahead Predictive Tests) - $\chi^2(q)$ presented; and (b) Recursive 1-step ahead Predictive Tests - t-statistics presented.

N-step ahead Predictive Tests D_i (i=80,...,95)		$\chi^2(q)$ [p-value]	1-step ahead Predictive Tests D_i (i=80,...,95)		t-ratio [p-value]
D80-D95[a]	*q=16*	24.619[.077]	D80	*n=21*	0.056[.956]
D81-D95[b]	*q=15*	25.000[.050]	D81	*n=25*	-0.175[.862]
D82-D95	*q=14*	25.334[.031]*	D82	*n=29*	1.373[.182]
D83-D95	*q=13*	20.631[.081]	D83	*n=33*	-1.107[.277]
D84-D95	*q=12*	19.049[.087]	D84	*n=37*	0.746[.461]
D85-D95	*q=11*	19.033[.060]	D85	*n=41*	0.999[.324]
D86-D95	*q=10*	18.651[.045]*	D86	*n=45*	-0.283[.778]
D87-D95	*q=9*	18.956[.026]*	D87	*n=49*	1.218[.229]
D88-D95	*q=8*	16.822[.032]*	D88	*n=53*	1.241[.220]
D89-D95	*q=7*	16.013[.025]*	D89	*n=57*	-0.848[.400]
D90-D95	*q=6*	15.911[.014]*	D90	*n=61*	-1.575[.121]
D91-D95	*q=5*	13.103[.022]*	D91	*n=65*	-2.767[.007]*
D92-D95	*q=4*	5.794[.215]	D92	*n=69*	-0.725[.471]
D93-D95	*q=3*	5.369[.147]	D93	*n=73*	1.552[.125]
D94-D95	*q=2*	4.180[.124]	D94	*n=77*	0.522[.603]
D95-D95	*q=1*	3.943[.047]*	D95	*n=81*	-1.986[.051]

NORWAY - CONSUMPTION OF NON-DURABLES AND SERVICES

Table 2.11(i) : Chow I Analogue - Wald Version (Instrumental Variable Estimation; n=102). Wald Statistic $\chi^2(2)$ presented; t-statistics and p-values for dummies presented

DUM_t t=80, ...,94	Wald Statistic $\chi^2(2)$ [p-value]	$DUM.\Delta y_t$ t-ratio [p-value]	DUM t-ratio [p-value]
DUM80	2.320[.313]	-1.327[.187]	-0.149[.882]
DUM81	5.064[.080]	-2.186[.031]*	0.341[.743]
DUM82	4.621[.099]	-2.071[.041]*	0.236[.814]
DUM83	7.492[.024]*	-2.737[.007]*	0.985[.327]
DUM84	7.264[.026]*	-2.695[.008]*	0.996[.322]
DUM85	8.935[.011]*	-2.965[.004]*	0.674[.502]
DUM86	8.434[.015]*	-2.444[.016]*	-0.618[.538]
DUM87	10.416[.005]*	-2.553[.012]*	-0.897[.372]
DUM88	5.724[.057]	-1.336[.185]	-1.394[.167]
DUM89	3.995[.136]	-1.863[.065]	0.054[.957]
DUM90	12.076[.002]*	-3.453[.001]*	1.036[.303]
DUM91	10.764[.005]*	-3.267[.001]*	0.992[.324]
DUM92	12.560[.002]*	-3.541[.001]*	1.250[.214]
DUM93	7.698[.021]*	-2.751[.007]*	1.218[.226]
DUM94	5.198[.074]	-2.275[.025]*	0.431[.668]

Table 2.11(ii): Salkever Method: (a) Chow II Analogue (N-step ahead Predictive Tests) - $\chi^2(q)$ presented; and (b) Recursive 1-step ahead Predictive Tests - t-statistics presented.

N-step ahead Predictive Tests			1-step ahead Predictive Tests		
D_i (i=80,...,94)		$\chi^2(q)$ [p-value]	D_i (i=80,...,94)		t-ratio [p-value]
D80-D94[a]	*q=15*	128.923[.000]*	D80	*n=46*	-0.534[.596]
D81-D94[b]	*q=14*	363.630[.000]*	D81	*n=50*	0.696[.490]
D82-D94	*q=13*	371.512[.000]*	D82	*n=54*	-0.944[.349]
D83-D94	*q=12*	371.003[.000]*	D83	*n=58*	-0.421[.675]
D84-D94	*q=11*	133.709[.000]*	D84	*n=62*	0.257[.798]
D85-D94	*q=10*	134.291[.000]*	D85	*n=66*	0.257[.798]
D86-D94	*q=9*	26.832[.001]*	D86	*n=70*	1.128[.263]
D87-D94	*q=8*	19.725[.011]*	D87	*n=74*	-0.237[.814]
D88-D94	*q=7*	20.514[.005]*	D88	*n=78*	-3.109[.003]*
D89-D94	*q=6*	2.699[.846]	D89	*n=82*	1.509[.135]
D90-D94	*q=5*	0.995[.963]	D90	*n=86*	-0.310[.757]
D91-D94	*q=4*	1.101[.894]	D91	*n=90*	-0.435[.665]
D92-D94	*q=3*	1.057[.787]	D92	*n=94*	-0.772[.442]
D93-D94	*q=2*	0.308[.857]	D93	*n=98*	0.024[.981]
D94-D94	*q=1*	0.009[.930]	D94	*n=102*	-0.199[.843]

NORWAY - TOTAL CONSUMPTION

Table 2.12(i) : Chow I Analogue - Wald Version (Instrumental Variable Estimation; n=102). Wald Statistic $\chi^2(2)$ presented; t-statistics and p-values for dummies presented

DUM_t t=80, ...,94	Wald Statistic $\chi^2(2)$ [p-value]	DUM.Δy_t t-ratio [p-value]	DUM t-ratio [p-value]
DUM80	4.636[.098]	-2.031[.045]*	0.074[.942]
DUM81	7.557[.023]*	-2.669[.009]*	0.295[.768]
DUM82	6.968[.031]*	-2.554[.012]*	0.232[.817]
DUM83	8.919[.012]*	-2.956[.004]*	0.591[.556]
DUM84	8.313[.016]*	-2.865[.005]*	0.637[.526]
DUM85	9.711[.008]*	-3.045[.003]*	0.320[.749]
DUM86	10.450[.005]*	-2.548[.012]*	-1.084[.281]
DUM87	12.988[.002]*	-3.007[.003]*	-0.914[.363]
DUM88	7.199[.027]*	-1.997[.049]*	-1.082[.282]
DUM89	6.619[.037]*	-2.477[.015]*	0.185[.854]
DUM90	14.056[.001]*	-3.722[.000]*	0.882[.380]
DUM91	12.205[.002]*	-3.480[.001]*	0.895[.373]
DUM92	13.549[.001]*	-3.679[.000]*	1.188[.238]
DUM93	9.978[.007]*	-3.131[.002]*	1.293[.199]
DUM94	6.355[.042]*	-2.488[.015]*	0.765[.446]

Table 2.12(ii): Salkever Method: (a) Chow II Analogue (N-step ahead Predictive Tests) - $\chi^2(q)$ presented; and (b) Recursive 1-step ahead Predictive Tests - t-statistics presented.

N-step ahead Predictive Tests			1-step ahead Predictive Tests		
D_i (i=80,...,94)		$\chi^2(q)$ [p-value]	D_i (i=80,...,94)		t-ratio [p-value]
D80-D94[a]	*q=15*	124.153[.000]*	D80	*n=46*	-0.014[.989]
D81-D94[b]	*q=14*	528.719[.000]*	D81	*n=50*	0.399[.691]
D82-D94	*q=13*	547.034[.000]*	D82	*n=54*	-0.203[.840]
D83-D94	*q=12*	549.685[.000]*	D83	*n=58*	-0.589[.558]
D84-D94	*q=11*	139.412[.000]*	D84	*n=62*	0.323[.748]
D85-D94	*q=10*	139.412[.000]*	D85	*n=66*	0.323[.748]
D86-D94	*q=9*	18.639[.028]*	D86	*n=70*	-0.067[.946]
D87-D94	*q=8*	16.164[.040]*	D87	*n=74*	-0.763[.448]
D88-D94	*q=7*	15.007[.036]*	D88	*n=78*	-2.699[.009]*
D89-D94	*q=6*	1.886[.930]	D89	*n=82*	-0.932[.354]
D90-D94	*q=5*	1.031[.960]	D90	*n=86*	-0.392[.696]
D91-D94	*q=4*	0.939[.919]	D91	*n=90*	-0.411[.682]
D92-D94	*q=3*	0.749[.862]	D92	*n=94*	-0.677[.500]
D93-D94	*q=2*	0.218[.897]	D93	*n=98*	-0.097[.923]
D94-D94	*q=1*	0.057[.811]	D94	*n=102*	0.127[.899]

SWEDEN - CONSUMPTION OF NON-DURABLES AND SERVICES

Table 2.13(i) : Chow I Analogue - Wald Version (Instrumental Variable Estimation; n=95). Wald Statistic $\chi^2(2)$ presented; t-statistics and p-values for dummies presented

DUM_t t=80, ...,95	Wald Statistic $\chi^2(2)$ [p-value]	DUM.Δy_t t-ratio [p-value]	DUM t-ratio [p-value]
DUM80	2.686[.261]	-0.438[.662]	-1.438[.154]
DUM81	1.495[.474]	-1.148[.254]	-0.155[.877]
DUM82	0.822[.663]	-0.740[.461]	-0.373[.710]
DUM83	0.338[.845]	0.155[.887]	-0.576[.566]
DUM84	0.274[.872]	0.233[.816]	-0.496[.621]
DUM85	0.451[.798]	0.046[.964]	-0.670[.505]
DUM86	0.849[.654]	0.179[.858]	-0.919[.360]
DUM87	1.667[.435]	0.108[.915]	-1.290[.200]
DUM88	2.331[.312]	0.105[.916]	-1.523[.131]
DUM89	1.627[.443]	0.265[.791]	-1.269[.208]
DUM90	1.512[.470]	0.502[.617]	-1.174[.244]
DUM91	0.859[.652]	0.860[.392]	-0.329[.742]
DUM92	0.059[.971]	0.131[.896]	-0.198[.843]
DUM93	0.545[.762]	0.725[.470]	0.337[.737]
DUM94	0.166[.920]	0.398[.692]	-0.071[.943]
DUM95	0.117[.943]	0.192[.848]	0.333[.740]

Table 2.13(ii): Salkever Method: (a) Chow II Analogue (N-step ahead Predictive Tests) - $\chi^2(q)$ presented; and (b) Recursive 1-step ahead Predictive Tests - t-statistics presented.

N-step ahead Predictive Tests			1-step ahead Predictive Tests		
D_i (i=80,...,95)		$\chi^2(q)$ [p-value]	D_i (i=80,...,95)		t-ratio [p-value]
D80-D95[a]	*q=16*	18.412[.300]	D80	*n=35*	-2.498[.018]*
D81-D95[b]	*q=15*	10.261[.803]	D81	*n=39*	0.116[.908]
D82-D95	*q=14*	10.257[.743]	D82	*n=43*	0.531[.598]
D83-D95	*q=13*	9.929[.700]	D83	*n=47*	-0.135[.893]
D84-D95	*q=12*	9.725[.640]	D84	*n=51*	-0.237[.814]
D85-D95	*q=11*	9.323[.592]	D85	*n=55*	0.166[.869]
D86-D95	*q=10*	8.543[.576]	D86	*n=59*	0.523[.603]
D87-D95	*q=9*	7.971[.537]	D87	*n=63*	0.192[.848]
D88-D95	*q=8*	8.005[.433]	D88	*n=67*	-0.828[.411]
D89-D95	*q=7*	6.381[.496]	D89	*n=71*	-0.197[.844]
D90-D95	*q=6*	6.264[.394]	D90	*n=75*	-1.867[.066]
D91-D95	*q=5*	1.222[.943]	D91	*n=79*	-0.673[.503]
D92-D95	*q=4*	1.020[.907]	D92	*n=83*	-0.310[.757]
D93-D95	*q=3*	0.383[.944]	D93	*n=87*	0.569[.571]
D94-D95	*q=2*	0.095[.953]	D94	*n=91*	-0.105[.917]
D95-D95	*q=1*	0.058[.811]	D95	*n=95*	0.357[.722]

SWEDEN - TOTAL CONSUMPTION

Table 2.14(i) : Chow I Analogue - Wald Version (Instrumental Variable Estimation; n=95). Wald Statistic $\chi^2(2)$ presented; t-statistics and p-values for dummies presented

DUM_t t=80, ...,95	Wald Statistic $\chi^2(2)$ [p-value]	DUM.Δy_t t-ratio [p-value]	DUM t-ratio [p-value]
DUM80	2.659[.264]	1.116[.267]	-1.378[.172]
DUM81	0.039[.981]	0.104[.918]	-0.184[.854]
DUM82	0.158[.924]	0.315[.753]	-0.287[.775]
DUM83	0.245[.885]	0.434[.665]	-0.284[.777]
DUM84	0.236[.889]	0.485[.629]	-0.079[.937]
DUM85	0.162[.922]	0.391[.697]	-0.140[.889]
DUM86	0.267[.875]	0.386[.700]	-0.378[.706]
DUM87	1.579[.454]	0.348[.729]	-1.236[.220]
DUM88	3.219[.200]	0.347[.729]	-1.787[.077]
DUM89	3.396[.183]	0.419[.676]	-1.825[.071]
DUM90	4.078[.130]	0.625[.534]	-1.973[.052]
DUM91	2.338[.311]	0.753[.453]	-1.324[.189]
DUM92	2.805[.246]	0.624[.534]	-1.531[.129]
DUM93	1.565[.457]	1.190[.237]	-0.089[.930]
DUM94	0.273[.872]	0.519[.604]	0.082[.935]
DUM95	0.004[.998]	0.027[.979]	-0.044[.965]

Table 2.14(ii): Salkever Method: (a) Chow II Analogue (N-step ahead Predictive Tests) - $\chi^2(q)$ presented; and (b) Recursive 1-step ahead Predictive Tests - t-statistics presented.

N-step ahead Predictive Tests			1-step ahead Predictive Tests		
D_i (i=80,...,95)		$\chi^2(q)$ [p-value]	D_i (i=80,...,95)		t-ratio [p-value]
D80-D95[a]	*q=16*	58.714[.000]*	D80	*n=35*	-3.049[.005]*
D81-D95[b]	*q=15*	30.897[.009]*	D81	*n=39*	0.004[.997]
D82-D95	*q=14*	31.488[.005]*	D82	*n=43*	0.129[.898]
D83-D95	*q=13*	29.432[.006]*	D83	*n=47*	-0.307[.760]
D84-D95	*q=12*	28.222[.005]*	D84	*n=51*	-0.019[.984]
D85-D95	*q=11*	27.378[.004]*	D85	*n=55*	0.313[.755]
D86-D95	*q=10*	25.500[.004]*	D86	*n=59*	1.897[.063]
D87-D95	*q=9*	15.191[.086]	D87	*n=63*	0.799[.427]
D88-D95	*q=8*	12.789[.119]	D88	*n=67*	-0.349[.728]
D89-D95	*q=7*	12.523[.085]	D89	*n=71*	-0.057[.955]
D90-D95	*q=6*	12.499[.052]	D90	*n=75*	-1.909[.060]
D91-D95	*q=5*	7.501[.186]	D91	*n=79*	0.168[.867]
D92-D95	*q=4*	7.528[.111]	D92	*n=83*	-1.984[.051]
D93-D95	*q=3*	0.491[.921]	D93	*n=87*	-0.854[.396]
D94-D95	*q=2*	0.062[.970]	D94	*n=91*	0.295[.768]
D95-D95	*q=1*	0.009[.922]	D95	*n=95*	-0.137[.891]

Notes to Tables 2.9 to 2.14

(a) This is the joint significance test of b_0 to b_{15} in the following regression, where D80 is the Salkever dummy for 1980, D81 is the Salkever dummy for 1981 etc.:

$$\Delta C_t = \hat{u} + \lambda\Delta Y_t + b_0D80 + b_1D81 + b_2D82 + b_3D83 + b_4D84 + b_5D85 + b_6D86 + b_7D87 + b_8D88 + b_9D89 + b_{10}D90 + b_{11}D91 + b_{12}D92 + b_{13}D93 + b_{14}D94 + b_{15}D95 + \varepsilon_t;$$

(b) This is the joint significance test of b_1 to b_{15} in the following regression, where D81 is the Salkever dummy for 1981, D82 is the Salkever dummy for 1982 etc.:

$$\Delta C_t = \hat{u} + \lambda\Delta Y_t + b_1D81 + b_2D82 + b_3D83 + b_4D84 + b_5D85 + b_6D86 + b_7D87 + b_8D88 + b_9D89 + b_{10}D90 + b_{11}D91 + b_{12}D92 + b_{13}D93 + b_{14}D94 + b_{15}D95 + \varepsilon_t;$$

(c) p-values in square brackets;

(d) * = statistically significant at the 5 percent level.

Overall Summary of Results

In the case of Finland, evidence of excess sensitivity is found, in so far as we find a large and significant $\hat{\lambda}$, for the full sample. This is not the case for the full sample estimates of Norway and Sweden. When we look at the pre-deregulation sample period, we find evidence of excess sensitivity for Finland and Norway, but not for Sweden. In each country, recursive estimates show some decline in the estimated λ coefficient. In the cases of Finland and Norway, formal testing shows evidence of structural change and predictive failure during the 1980s. These latter results provide evidence of parameter instability. The statistically significant slope dummy coefficients for the Norwegian data set (Table 2.11(i)) suggest that the key source of instability is the λ parameter[61]. The evidence is not as clear cut for Finland (Table 2.9(i)).

Overall, for Norway, our findings are consistent with the idea that financial deregulation lowered the importance of liquidity constraints over time, and thereby the importance of current income for consumption (assuming that liquidity constraints are the key explanation of excess sensitivity). Possible explanations for the finding of excess sensitivity in both sample periods for Finland could include: (i) the increase in European unemployment in the late 1970s and 1980s, which was also a feature of Nordic unemployment, may have offset the impact and benefits of the financial deregulation process for previously liquidity constrained consumers[62]; and (ii) in other studies, other factors have been included to account for the excess sensitivity. For example potential wealth effects and consumers expectations could play a role in the Finnish model.

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[61] As opposed to an unstable constant term in the regression.

[62] For example, between 1981 and 1992, the Finnish unemployment rate increased from 4.9% to 13.1%.

Referring to Sweden, the findings of no excess sensitivity, and of no structural change since deregulation took place, could be explained by the fact that deregulation took place at an earlier stage than for the other two countries. For example, the implementation of the Swedish deregulation measures began in 1978 and continued during the early and mid 1980s, whilst the key deregulation measures for Finland and Norway primarily took place during the mid 1980s.

2.7 CONCLUSION

It has been argued that liquidity constraints facing consumers may become less important as financial deregulation has reduced imperfections in financial markets during the 1980s. One likely consequence is that consumers are then more forward looking. The objective of this chapter was to assess whether financial deregulation had a statistically significant effect on Nordic consumer behaviour. Specifically tests of one consequence of liquidity constraints, the diminishing excess sensitivity of current consumption to current income, were presented using Nordic data over the 1980s. A variety of stability tests were used, including the IV analogues of the Chow I and II tests of parameter stability, and the 1-step ahead predictive tests.

Some evidence was found for a decline in the excess sensitivity of consumption to current changes in income, and the decline was found to be statistically significant for Finland and Norway. This is itself consistent with diminished liquidity constraints. With respect to Sweden, neither evidence for excess sensitivity nor a decline in its degree was found. It should be noted, that in the case of Finland, even though evidence showed that the degree of excess sensitivity had declined over the deregulation period, excess sensitivity was still found to be significant for the full sample, leading to a rejection of the RE-LCPI hypothesis. Such results suggest that other sources of excess sensitivity should be investigated. In this chapter we assumed that liquidity constraints was one of the key sources of excess sensitivity. In the next chapter, we explore alternative explanations of excess sensitivity and employ discriminating tests to distinguish between these alternative explanations.

2.8 APPENDICES

A2.1 UNIT ROOT TESTS

As previously mentioned in Section 2.5.1, when we estimate a regression model containing non-stationary time series variables, spurious regression results can be obtained using conventional estimation methods. In particular, misleading values of R^2, DW and t-statistics can lead us to erroneously conclude that there is evidence of statistically significant relationships between variables in a regression equation, when in fact there might be none. Consequently it is strongly advised to undertake formal unit root tests. In this work, we employ the Dickey-Fuller approach to test the null hypothesis that a series is non-stationary (contains a unit root) against the alternative of stationarity.

Following Perron(1988), we adopt a sequential testing procedure as outlined in the Table A2.1.

Table A2.1: Sequential Testing Procedure for Unit Roots

Model			Null Hypothesis	Test Statistic
(A)	DF:	$\Delta Y_t = \phi Y_{t-1} + \alpha + \beta t + \varepsilon_t$	$\phi=0$	τ_τ
	ADF	$\Delta Y_t = \phi Y_{t-1} + \sum_{j=1}^{k} \eta_j \Delta Y_{t-j} + \alpha + \beta t + \varepsilon_t$	$\phi=\beta=0$	Φ_3
(B)	DF	$\Delta Y_t = \phi Y_{t-1} + \alpha + \varepsilon_t$	$\phi=0$	τ_u
	ADF	$\Delta Y_t = \phi Y_{t-1} + \sum_{j=1}^{k} \eta_j \Delta Y_{t-j} + \alpha + \varepsilon_t$	$\phi=\alpha=0$	Φ_1
(C)	DF	$\Delta Y_t = \phi Y_{t-1} + \varepsilon_t$	$\phi=0$	τ
	ADF	$\Delta Y_t = \phi Y_{t-1} + \sum_{j=1}^{k} \eta_j \Delta Y_{t-j} + \varepsilon_t$		

Key to Table A2.1

(i) Model A. General Model including a time trend t and a drift term α; Model B. General Model including drift term α;

(ii) Model C. General Model excluding time trend t and drift term α

(iii) DF: Dickey-Fuller; ADF: Augmented Dickey-Fuller where k is determined by AIC

We begin by estimating model A, which includes a time trend and a drift term. We select the ADF version of model A over the DF version, if there is evidence of auto-correlation in the regression residuals[63]. For the ADF regression, additional lags of the dependent variable are added to the DF regression, as are necessary to ensure that the regression has residuals that appear to be white noise. As outlined earlier in the chapter (section 2.5.1) the Akaike Information Criterion is used to select the appropriate number of lags (that is, k). We then proceed to test the significance of a unit root using a t-test (that is, H_o: $\phi = 0$), and also test the joint significance of a unit root and trend term using an F-test (that is, H_o: $\phi = \beta = 0$). The appropriate critical values are the Dickey-Fuller critical values for the test statistics, τ_τ and Φ_3 respectively (Column 3 of Table A2.1). If one fails to reject the null hypothesis of a unit root, but does not reject the null hypothesis H_o: $\phi = \beta = 0$, one can conclude that the trend is insignificant under the null of a unit root. We then proceed to estimate model B, which includes a drift term. At this stage, if one fails to reject the null of a unit root but does not reject the joint hypothesis H_O: $\phi=\alpha=0$, one can conclude that the constant is insignificant under the null of a unit root. Finally we estimate model C, which excludes both a time trend and a drift term, and test the null of a unit root.

This sequential testing procedure is applied to each variable in our data set, for both the level of the data and the first difference. For each variable the hypothesis testing stops at the stage where it is possible to reject the null hypothesis of a unit root. At each stage of the procedure it is important to use the appropriate Dickey-Fuller critical values; for example, when testing the significance of ϕ, the critical values for model A, B and C

[63] The same applies to models B and C

are τ_τ, τ_u, and τ; respectively. Similarly for the joint hypotheses, the appropriate Dickey-Fuller F-statistics for models A and B are Φ_1 and Φ_3 respectively. Table A2.2 displays the critical values for the 1%, 5% and 10% level, for sample size equal to 250. The values are those computed by McKinnon (1991) for sample size equal to 250 observations[64].

Table A2.2: Critical Values for Unit Root Tests (Sample Size = 250)

Test Statistic	1%	5%	10%
τ_τ	-3.99	-3.43	-3.13
τ_u	-3.46	-2.88	-2.57
τ	-2.58	-1.95	-1.62
Φ_3	8.43	6.34	5.39
Φ_1	6.52	4.63	3.81

Finland

On the basis of the DF test statistic (row 1, Table 2,4(a)), there is clear evidence that practically all variables are non-stationary at the 5% level (τ_τ critical value = -3.43). The notable exception is the real rate of interest which is found to be stationary (τ_τ = -4.288). These results based on the un-augmented DF test are all questionable, as there is evidence of serial correlation at the 5% significance level for all variables. Hence we focus on the ADF test results. The ADF test statistics (row 2, Table 2.4(a)) indicate that all series are nonstationary at the 5% significance level, except for the real rate of interest, the quarterly inflation rate, and the consumption-income ratio, which are all found to be I(0). This tends to be a common finding, particularly for the real rate of interest and

[64] MacKinnon(1991) simulated response surface regressions for several τ and Φ tests.

inflation rate. When we examine the results in more detail, we observe that the following variables contain a unit root with zero drift: consumption, the consumption of non-durables and services, disposable income, the unemployment rate, exports, business investment, and net wealth. The government expenditure variable contains a unit root with drift.

Plots of the Finnish data in levels (Figure A2.1) in general provide further support for these findings. However, there is one notable exception, that of the unemployment rate, which requires further investigation. The time-series plot of the unemployment rate suggests strong evidence of a structural break in the early 1990s. As a similar feature is also evident in the behaviour of both Norwegian and Swedish unemployment data, we discuss the relevant unit root tests in the presence of a structural break for all three countries in a later section ("Unemployment Rate"), subsequent to our general analysis for each individual country.

For Finland, to determine if the series are integrated of order 1, the ADF tests are next applied to the first differences of the data (row 3, Table 2.4(a)). The evidence suggests that we do not accept the null hypothesis of non-stationarity when the series are first differenced; hence we can conclude that all series are I(1) (except for variables noted above which are found to be I(0)). Once again, the plots of Finnish data in first differences support the empirical evidence (Figure A2.2).

Norway

As there is evidence of serial correlation at the 5% significance level, we concentrate on the ADF test results. We draw the following conclusions from the ADF test statistics applied to the data in levels (row 2, Table 2.4(b)). Firstly, total consumption, consumption of non-durables and services, disposable income, the quarterly inflation rate, the unemployment rate, government expenditure, net wealth, and the consumption-income ratio are all nonstationary at the 5 percent level. Secondly, both the real interest rate and exports are found to be stationary.

There are two notable features about these general conclusions. With respect to the consumption-income ratio, it is borderline non-stationary, as the null hypothesis of a unit root can be rejected at the 10 percent level. Based on this result, and our study of the time series plot of the consumption-income ratio, we conclude that it is stationary. The other notable finding, is the stationarity of exports. This is a surprising finding, even more so, when we study its time series plot in levels (Figure A2.3), which suggests evidence of a non-stationary series. Furthermore, if the presence of the deterministic trend is ignored, then a unit root is detected (τ_{μ}= -0.201). Given the low powers of unit root tests, we keep in mind Campbell and Perron's observations that in finite samples it can be shown that "...any trend stationary process can be approximated arbitrarily well by a unit process (in the sense that the auto-covariance structures will be arbitrarily close)"(Campbell and Perron, 1991:157). Similarly, an unit root process can be approximated by a trend stationary process. In this case, we err on the side of caution, and conclude that exports is non-stationary.

The third set of statistics in Table 2.4(b) correspond to the ADF values for the data expressed in first differences. For the majority of the non-stationary variables we can conclude that they are integrated of order one (at the 5 percent level). Notable exceptions include the first difference of income and of net wealth. However for both of these variables, the null of a unit root cannot be accepted at the 10 percent level. Therefore, in conjunction with their respective time series plots of their first-differences (Figure A2.4), we conclude that they are also I(1).

Sweden

As for Finland and Norway, we focus on the ADF statistics, based on the finding of significant serial correlation at the 5 percent level. The results suggest that the following variables are non-stationary (Table 2.4c, second row): consumption of non-durables and services, income, inflation rate, unemployment rate, government expenditure, and business investment. Supporting evidence is presented in the time series plots of the data in levels in Figure A2.5. The other variables are found to be stationary. Similar to Finland and Norway, evidence suggests that the Swedish real interest rate and the consumption-income ratio are stationary. Similar to Norway, we find evidence that Swedish exports are stationary; employing the above arguments used for Norway, it would seem reasonable to proceed on the basis that the level of exports is non-stationary. Finally, the results from using the ADF tests when applied to first differences of the data series are reported in the third row of Table 2.4c. The ADF tests suggest that all of the non-stationary series are I(1), since we are able to reject the null of non-stationarity when the series are first differenced. Consequently, these results suggest that by using first differences we can achieve stationarity. Corroborating evidence is shown in Figure A2.6, which shows the time series plots of first differences of the data.

Unemployment Rate

We noted for all three countries the finding that the unemployment rate was an I(1) process. However, this empirical evidence does not appear to coincide with the visual evidence from the time series plots of the unemployment rate. For each country, the respective time-series plot suggests strong evidence of a structural break in the early 1990s. Such a break could be related to the dramatic increase in Nordic unemployment at that time. All three Nordic countries enjoyed relatively low levels of unemployment in the decades prior to the 1990s, with the unemployment rate mostly hovering between 3-5 percent for Finland, and 2-4 percent for both Norway and Sweden. However, in the early 1990s, these countries headed into the most severe economic downturn since the 1930s, a fact which was reflected in a dramatic surge in the unemployment rate. For example, the Finnish unemployment rate increased from 4 percent in 1990 to a peak of 18 percent in 1994; unemployment in Norway rose from 1.6 percent in 1987 to 6 percent in 1993[65]; while Sweden's rate increased from 1.7 percent in 1990 to 8.2 percent in 1993[66].

Perron (1989) noted that a structural change in the mean of a stationary variable will tend to bias the ADF tests towards non-rejection of a null hypothesis of a unit root. That is, in the presence of a structural break, one may erroneously conclude that the process is I(1), whereas in fact it is I(0) with a change in the mean at some known point. We adopt

[65] The earlier date of 1987 is relevant for Norway, as it was hit by the recession much earlier than the other Nordic countries.
[66] Since then, the unemployment rate for these countries has continued to remain at a high level.

Perron's(1989), two stage procedure to test for a unit root in the presence of a structural change. In the first stage, we obtain the residuals (e_t) from the estimation of the following regression:

$$y_t = \alpha_0 + \alpha_1 trend + \alpha_2 Dummy + \mu_t$$

where y_t is the dependent variable (in this case the unemployment rate for each country), trend is a time trend, and Dummy represents a level dummy such that Dummy = 1 if t > break, and zero otherwise. The time breaks were estimated to occur approximately at 1991 for both Finland and Norway, with the structural break for Swedish unemployment data occurring at 1992[67]. Perron, argues that if there is evidence of a significant structural break, the residuals from this regression will have been purged of such an influence. Furthermore, he argues that evidence of stationary behaviour in the residuals is also evidence in favour that the variable we are looking at is actually an I(0) process with a structural break. Therefore in the second stage of Perron's procedure, an ADF test is conducted on the residuals.

We obtained the following results when we applied the first stage to the unemployment rate data, for all three countries (Table A2.3). For each country, the level dummy (Dummy) is statistically significant, providing additional support for the visual break in the time series plot of the unemployment rate. The results of Perron's second stage are shown in Table A2.4, and suggest that there is strong evidence for rejecting the null hypothesis of a unit root, after allowing for the possibility of a break in the series. We, therefore conclude that the unemployment rate for Finland, Norway and Sweden is stationary.

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[67] Visual evidence in conjunction with the Perron97 procedure in RATS, was used to approximate the structural break for each country. Refer to the Estima homepage (http://www.estima.com) for further information on the Perron97 procedure

Table A2.3: Perron's First Stage Results for the Unemployment Rate

Country	*Coef.*	*Std. Error*	*T-Ratio*	*P-value*
Finland				
Constant	0.025	0.005	5.265	0.000
Dummy	0.086	0.007	11.500	0.000
Trend	0.000	0.000	4.044	0.000
Norway				
Constant	0.263	0.146	1.804	0.074
Dummy	1.993	0.240	8.291	0.000
Trend	0.033	0.002	12.654	0.000
Sweden				
Constant	2.071	0.161	12.844	0.000
Dummy	4.791	0.261	18.312	0.000
Trend	0.005	0.003	1.425	0.157

Table A2.4: Perron's Second Stage Results for the Unemployment Rate

Country	*Lag*	τ_τ	Φ_3	τ_μ	Φ_1	τ
Finland	0	-2.086	2.193	-2.099	2.236	-2.110^{*C}
Norway	6	-4.329	9.372	-4.334	9.472	-4.335^{*C}
Sweden	0	-3.638^{*C}	6.616	-3.655	6.704	-3.674

Key to Table A2.4:
* = significant at the 5 percent level;
C - series has no unit root.

A2.2 TIME-SERIES PLOTS OF DATA

The first two sets of figures correspond to the Finnish data set expressed in levels and first differences respectively (Figure A2.1-A2.2). Figures A2.3-A2.4 correspond to the data in levels and first differences for Norway; whilst the remaining set of figures correspond to the Swedish data set (Figure A2.5-A2.6). All data are expressed in logarithms and in real per capita terms (except for the unemployment rate, the interest rate and the inflation rate). The following key applies to all figures.

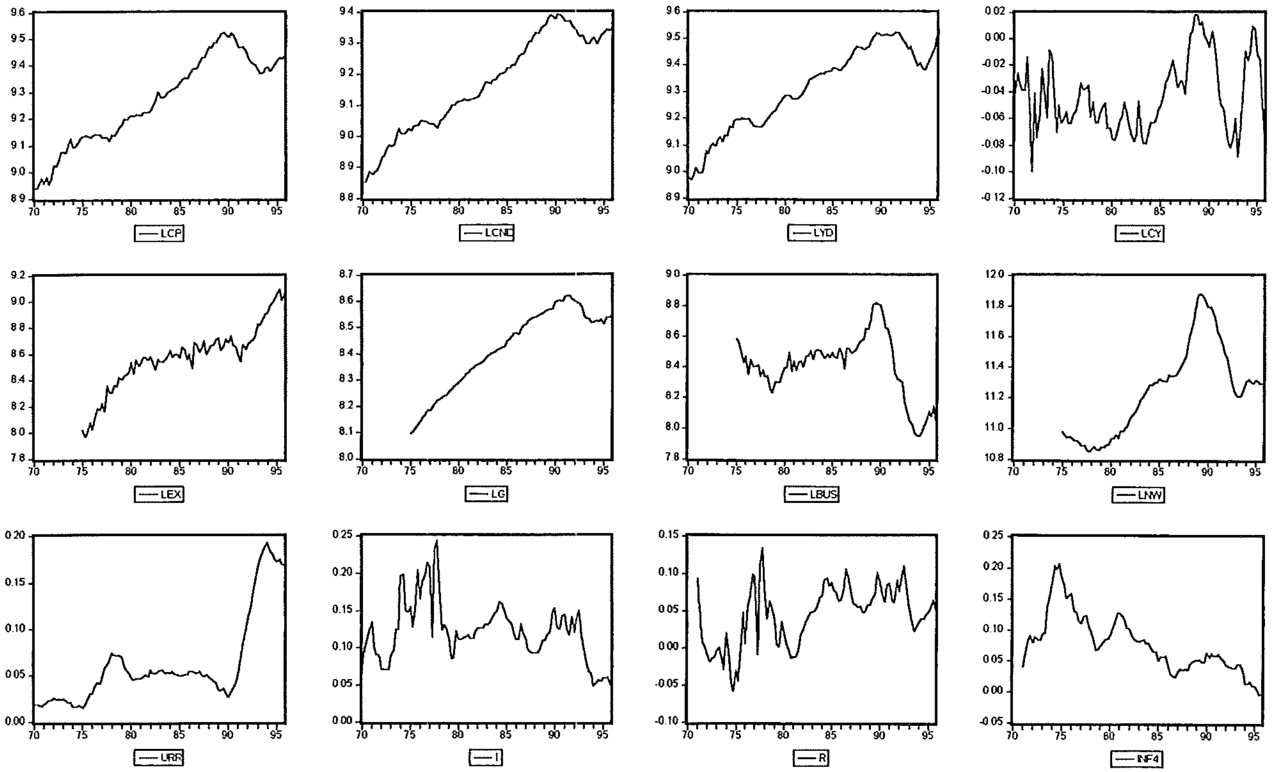
DATA IN LEVELS

LCP:	Total Consumption
LCND:	Consumption of non-durables and services
LYD:	Disposable income
LCY:	Consumption-income ratio
LEX:	Exports
LG:	Government expenditure
LBUS:	Business Investment
LNW:	Net Wealth
UR:	Unemployment rate
I:	Nominal Interest rate
R:	Real interest rate
INF4:	Inflation rate

DATA IN FIRST DIFFERENCES

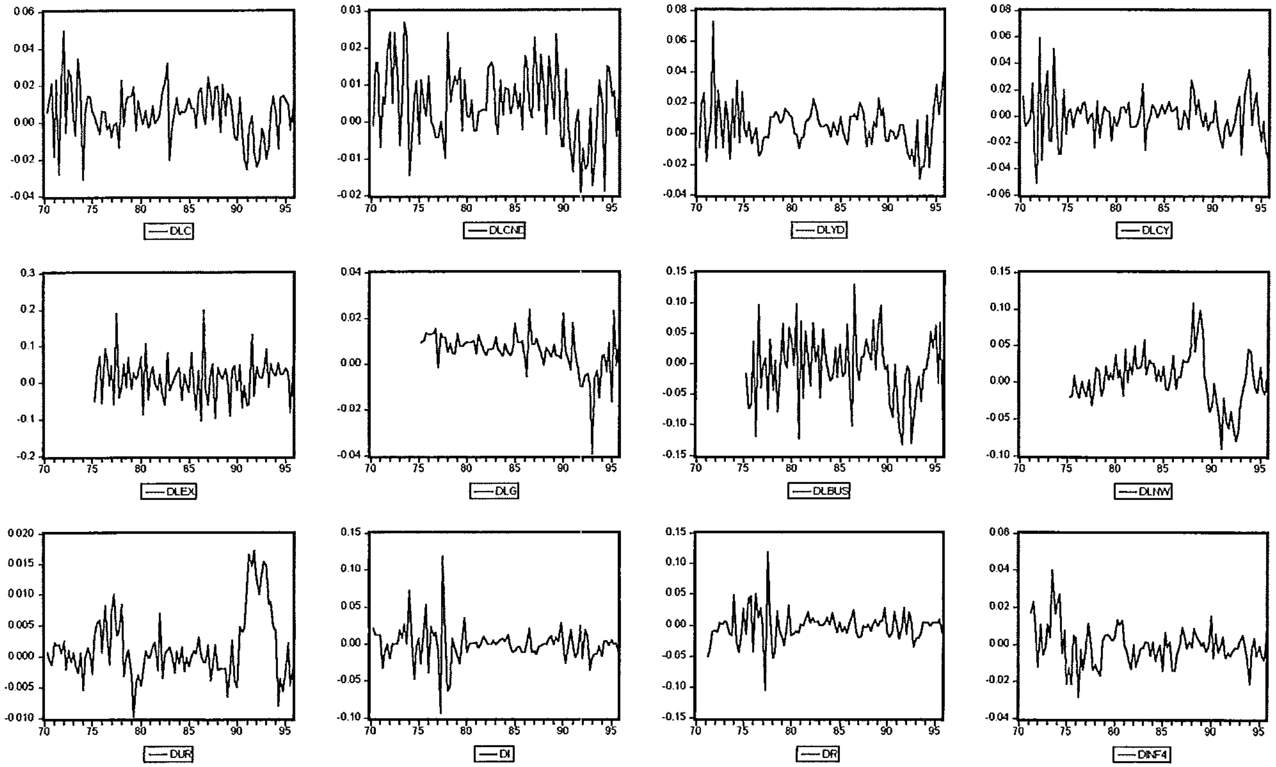
DLC:	ΔTotal Consumption (that is, expressed in first differences LCP_t - LCP_{t-1})
DLCND:	ΔConsumption of non-durables and services
DLYD:	ΔDisposable income
DLCY:	ΔConsumption-income ratio
DLEX:	ΔExports
DLG:	ΔGovernment expenditure
DLBUS:	ΔBusiness Investment
DLNW:	ΔNet Wealth
DUR:	ΔUnemployment rate
DI:	ΔNominal Interest rate
DR:	ΔReal interest rate
DINF4:	ΔInflation rate

Figure A2.1: Finland - Data in Levels; Time Period: 1970Q1 - 1995Q4



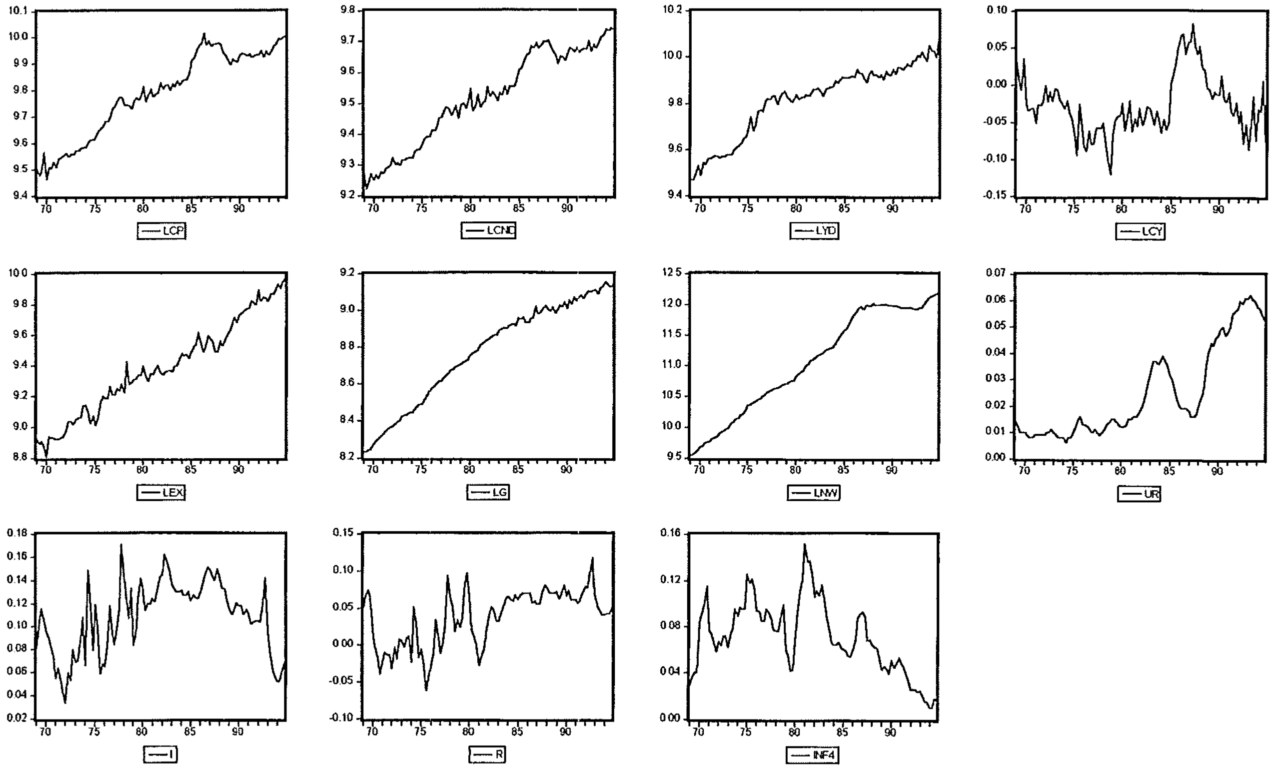
Note: All data are expressed in logs and in real per capita terms; Data for exports, government expenditure, business investment and net wealth are only available for the period 1975Q1-1995Q4. Refer to Key for variable definitions.

Figure A2.2: Finland - Data in First Differences; Time Period: 1970Q1 - 1995Q4



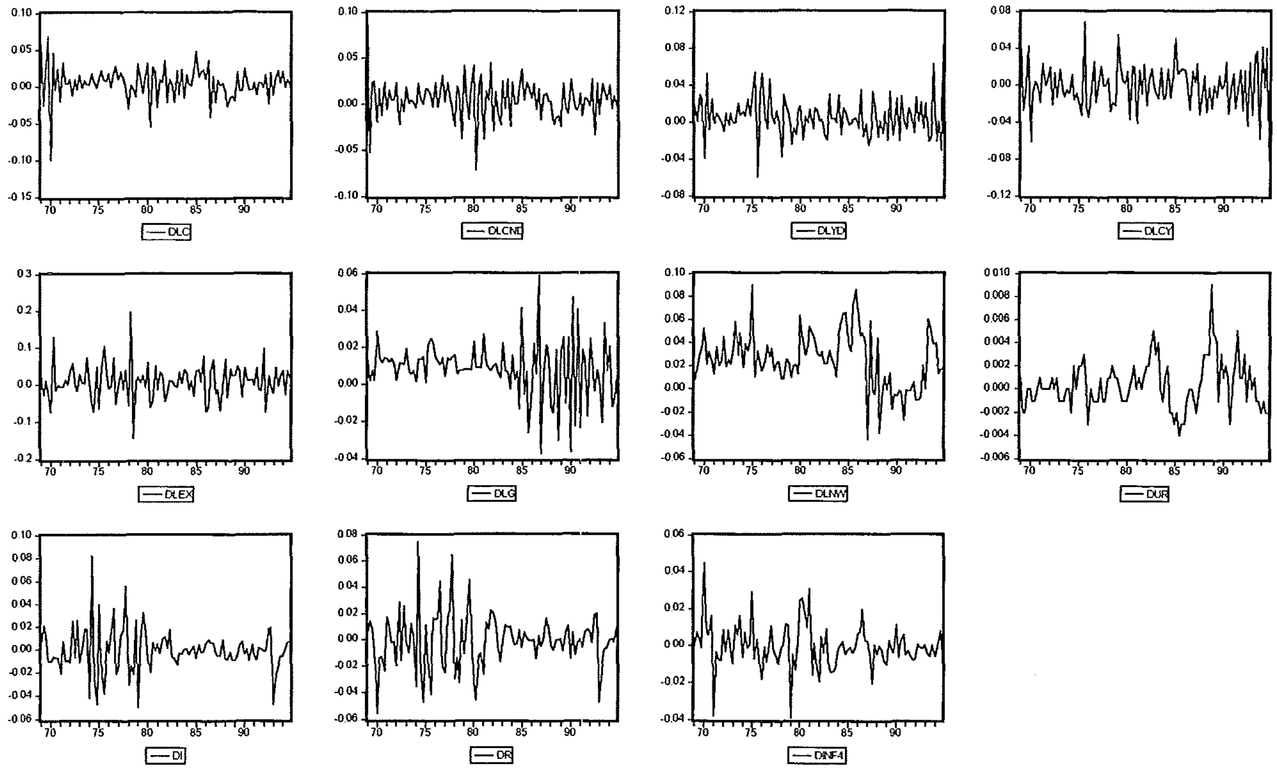
Note: All data are expressed in logs and in real per capita terms; Data for exports, government expenditure, business investment and net wealth are only available for the period 1975Q1-1995Q4. Refer to Key for variable definitions.

Figure A2.3: Norway - Data in Levels; Time Period: 1969Q1 - 1994Q4



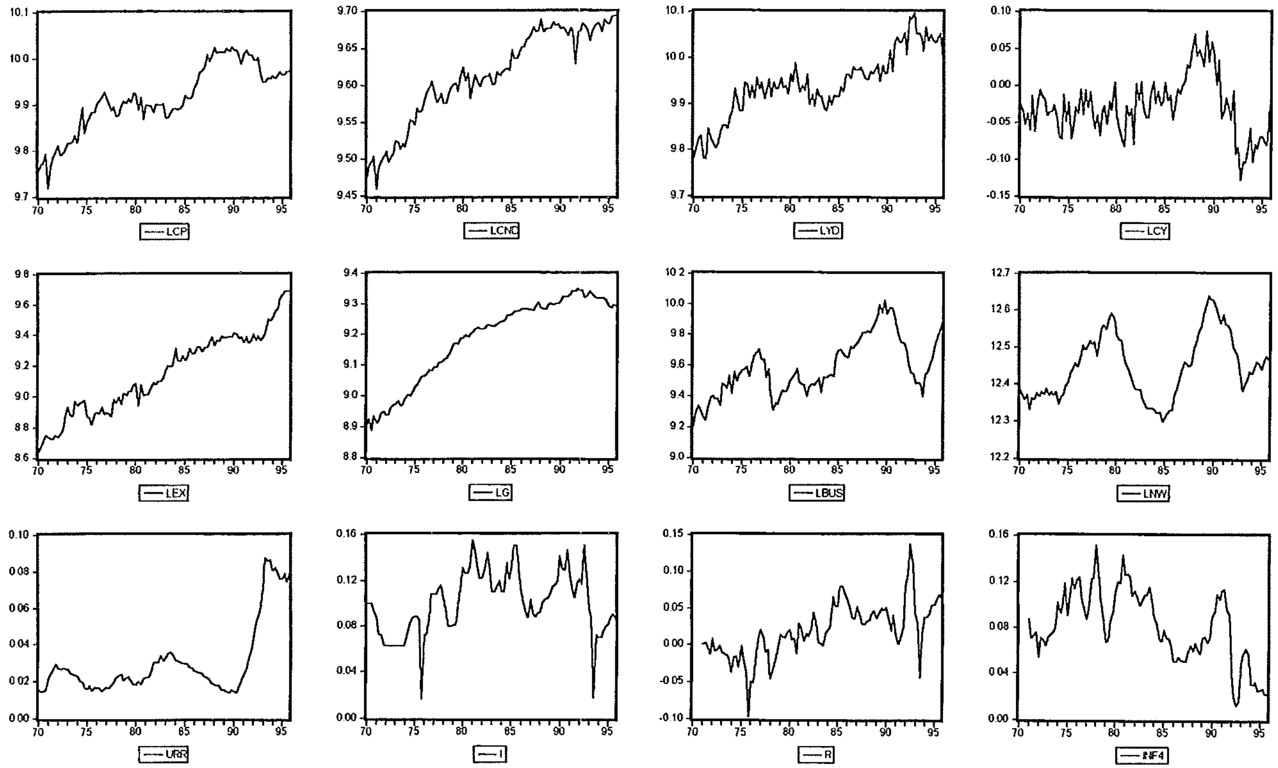
Note: All data are expressed in logs and in real per capita terms; Refer to Key for variable definitions.

Figure A2.4: Norway - Data in First Differences; Time Period: 1969Q1 - 1994Q4



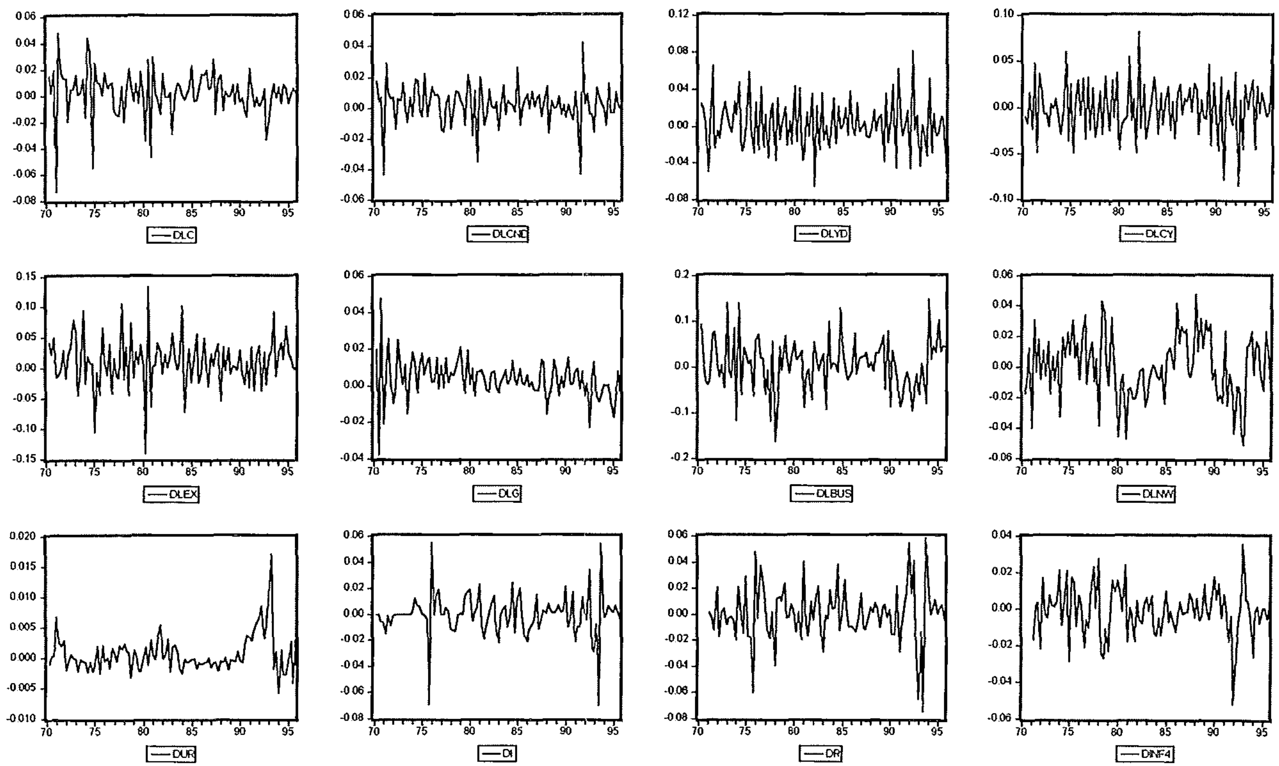
Note: All data are expressed in logs and in real per capita terms; Refer to Key for variable definitions.

Figure A2.5: Sweden - Data in Levels; Time Period: 1970Q1 - 1995Q4



Note: All data are expressed in logs and in real per capita terms; Refer to Key for variable definitions.

Figure A2.6: Sweden - Data in First Differences; Time Period: 1970Q1 - 1995Q4



Note: All data are expressed in logs and in real per capita terms; Refer to Key for variable definitions.

CHAPTER THREE

EXCESS SENSITIVITY AND ASYMMETRIES IN CONSUMPTION

3.1: INTRODUCTION

The rejection of the RE-LCPI Hypothesis, based on the finding of the "excess sensitivity" of consumption to current income is well established for both time series and cross sectional data (Flavin 1981, Campbell and Mankiw 1989, 1991, Deaton 1992, and Jappelli and Pagano 1989). The reasons for excess sensitivity however, are less well established. As outlined in the previous chapter, imperfections in the capital market, or liquidity constraints have frequently been cited as one of the main explanations for this sensitivity (Flavin 1985, Hayashi 1985a,b and Zeldes 1989a). Other explanations that have been postulated to account for the apparent discrepancy between theory and data include myopia (Flavin 1991) and precautionary savings behaviour (Skinner 1988, Cabellero 1990a, Blanchard and Fisher 1989)[1].

The objective of this chapter is to test for asymmetric dynamics in consumption with a view to distinguishing between these alternative explanations. In particular the study will look at whether the excess sensitivity arises because some consumers would like to smooth their consumption, but are prevented from doing so due to liquidity constraints, or whether consumers fail to smooth consumption even in the absence of liquidity constraints, because they are not forward looking (myopia). Chapter five will focus on the third explanation, precautionary savings.

[1] A myopic consumer is defined as one whose ith period consumption function depends only upon economic variables at time i; that is, there are no forward looking elements, such as future income streams, in the consumption function. Precautionary savings are defined as those additional savings that arise from perceived uncertainty about future income.

From a policy makers perspective, attempts to discriminate between alternative explanations for the excess sensitivity finding are important and the consequent results have significant implications for the effects of short term government policy with respect to its effectiveness and extent of its impact. According to the RE-LCPI hypothesis, changes in tax rates or government transfer payments, that are explicitly temporary, will not affect consumers' lifetime budget constraints, and therefore will not alter consumption decisions. However, using simulation methodologies, both Dolde (1978) and Mariger (1986, 1987) found that temporary tax changes did affect aggregate consumption in the presence of liquidity constraints. Mariger found that aggregate consumption was 3-4 times more responsive to temporary tax changes in the presence of liquidity constraints than if they were not in effect. A similar argument can be put forward for myopic consumers and their responsiveness to temporary tax changes. The consumption function of a myopic consumer depends only on economic variables at time t; that is it contains no forward-looking elements. Consequently, any changes (temporary or otherwise) in taxes will obviously affect current consumption.

The findings also have consequences for the choice of tax versus debt financing of government expenditure. As outlined in the introduction to Chapter 2, the Ricardian Equivalence proposition states for a given government budget constraint, the timing of taxes, or equivalently the accumulation and decumulation of government debt does not affect aggregate consumption. However, if consumers are liquidity constrained, and the government implements, for example, a debt-financed tax cut[2], then current taxes will be reduced, resulting in the easing of the impact of current liquidity constraints. Hence even though lifetime wealth has not changed, consumers current liquidity has increased,

[2] Assume the government budget constraint remains unchanged.

resulting in the stimulation of current consumption. For myopic consumers, it is the amount of taxes that they pay which affects their consumption decisions, and not the amount of real government expenditure. Hence a deficit financed tax cut will raise disposable income, thereby stimulating current consumption.

Tests for asymmetries in the response of aggregate consumption to expected income growth are conducted in a modified version of the Campbell and Mankiw two group model[3], and a subsequent discriminatory test of myopia and liquidity constraints is proposed based on the following argument. Under myopia, intertemporal substitution possibilities arising from an uneven income distribution are ignored by the consumer. Consumption tracks income; that is consumers simply spend their current income. Hence consumption should respond symmetrically to positive and negative real income growth. In contrast, in the case of liquidity constraints, Shea(1995b) suggests the response is likely to be asymmetric. Liquidity constraints impede borrowing when income is temporarily low; hence consumption should respond more strongly to income increases than income decreases. Shea(1995b) formally tested this hypothesis on US data. In this chapter, we adopt and expand Shea's methodology to test for asymmetries using data sets for Finland, Norway and Sweden. We also employ an alternative test for detecting asymmetries, based on Sichel's (1993) work on business cycle asymmetries.

The outline of the chapter is as follows. Section two outlines first, how myopic behaviour and liquidity constraints can contribute to consumption responding excessively to changes in current income; and second the reasons why the response of the myopic consumer to changes in income are symmetric, and why the responses of the liquidity constrained consumer would be asymmetric. In section three the tests for asymmetric

[3] The Campbell and Mankiw (1989, 1990, 1991) studies were discussed in Chapter 2.

dynamics in consumption based on Shea (1995) and Sichel (1993), are discussed. In addition a number of extensions to Shea's work are discussed. Section four presents and interprets the empirical results obtained from the tests outlined in section 3; and the conclusion provides a summary of the research.

3.2: MYOPIA AND LIQUIDITY CONSTRAINTS

3.2.1 EXCESS SENSITIVITY

One of the key assumptions underlying the joint RE-LCPI hypothesis is that consumers hold rational expectations; that is, their decision rules are influenced by information available at time t. As new information becomes available about future income, then plans are revised period by period. For example, consider the standard intertemporal optimisation problem where the consumer wants to maximise the life time utility function[4]:

$$\sum_{t=1}^{T} U_t(c_t)$$

subject to the life time budget constraint defined by

$$\sum_{t=1}^{T} \frac{c_t}{(1+r)^{t-1}} = \sum_{t=1}^{T} \frac{y_t}{(1+r)^{t-1}}$$

The solved out consumption function states that current consumption depends on both current and future income, that is:

$$c_t = f_t\left(\sum_{t=1}^{T} \frac{y_t}{(1+r)^{t-1}}\right)$$

[4] Assume that preferences are intertemporally additive.

In contrast, myopia, defined as short-sightedness, implies that some consumes may not form their expectations rationally; that is, they may not use all available information to make optimal forecasts about the future. Flavin (1985) defined myopic consumers as those who exhibited some degree of myopic behaviour in the sense that the marginal propensity to consume (MPC) out of transitory income was non-zero. They may base their expectations of future income excessively on current income (this can be re-interpreted as very high discount rates, that is heavily discounting the future); or they may relate to current income only (the latter corresponding to the Campbell and Mankiw's (1991) definition of rule of thumb consumers). Following Campbell and Mankiw(op.cit.), and Shea(1995) the latter definition is the one that is adopted in this chapter. Myopic behaviour, therefore arises when consumers do not optimise on the basis of current and expected future income. Instead they simply make consumption plans at time t on the basis of income available at time t, with no borrowing or saving done to smooth consumption. That is, the consumption function states that current consumption is a function of current disposable income, or more formally[5]:

$$c_t = f_t(y_t)$$

Using the familiar two period diagrams of Fisher's intertemporal framework, we now analyse how both the presence of liquidity constraints, and myopic behaviour may give rise to excess sensitivity. One of the assumptions underlying the pure RE-LCPI hypothesis is that of perfect capital markets which implies that consumers can borrow against expected future lifetime income, in addition to currently held assets. This implies

[5] This is equivalent to the Keynesian consumption function which states that current aggregate consumption depends upon aggregate income.

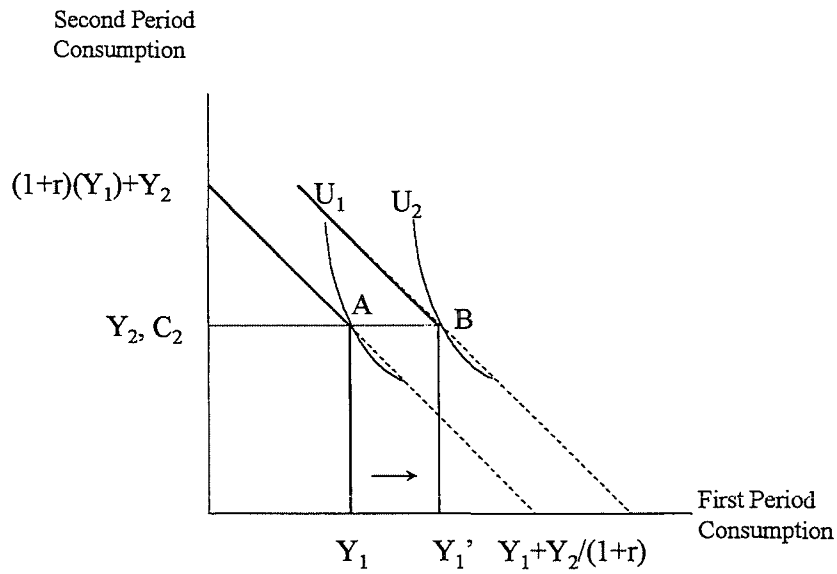
that the consumer has the ability to borrow against expected future income to allow current consumption to exceed current income, when current income is low. However capital markets tend to be imperfect, and a number of studies, including Fleming (1973), Heller and Starr(1979), Koskela and Viren(1984) and King(1986) have found that these imperfections have the effect of shortening the consumer's planning horizon[6].

When liquidity constraints are operative, consumers are prevented from realising their desired consumption paths and consequently consumption is more sensitive to contemporaneous income, than would be implied by the standard models without liquidity constraints[7]. For example, if consumers face high borrowing interest rates, they may choose not to borrow to smooth their consumption even when their current resources are low. If the consumer cannot borrow than consumption will be lower when current resources are low. Figure 3.1 illustrates the excess sensitivity of consumption to income, for a given credit constraint. We assume that the increase in current income is a one-off increase, where income increases in period 1, but falls back in period 2. The optimal consumption plan moves from A to B as current income increases from Y_1 to Y_1'; the MPC out of a current income increase is unity. This is in contrast to the response of a consumer who smoothes their consumption over time but who are not liquidity constrained. In this case, the MPC out of one-off income changes would be smaller.

[6] As noted in Chapter 2 (section 2.2.1), capital market imperfections or liquidity constraints can be defined as credit rationing (quantity constraints on the amount of borrowing available to the consumer) or price rationing operating through differential interest rates (differences between the borrowing and lending rate, where the former is higher).

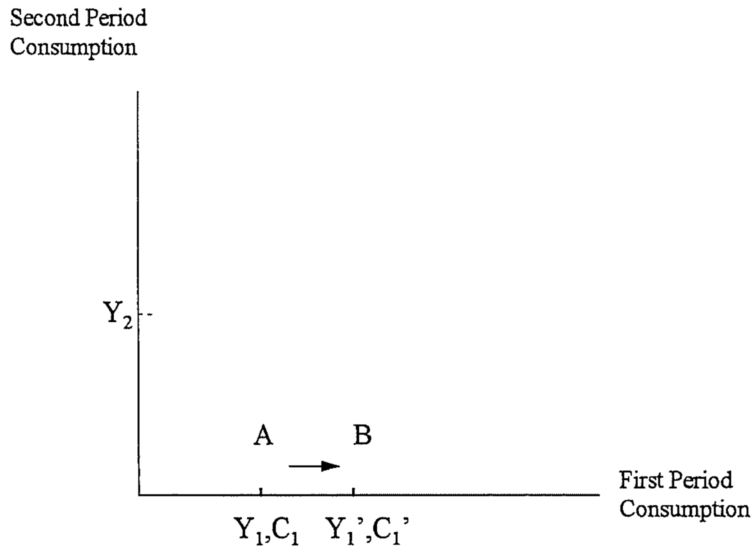
[7] We assume that liquidity constrained consumers have zero assets.

Figure 3.1: Liquidity Constrained Consumer - Response to a one-off increase in current income A $\rightarrow$ B. This shifts the budget line out so that the horizontal intercept increases by ΔY_1 (to Y_1'), while the vertical intercept increases by $\Delta Y_1(1+r)$.



As noted previously, the myopic consumer only considers current information (that is current income and the price of current consumption) in making his/her current consumption plans. Hence consumption will always follow any changes in actual income, implying that future income has obviously no influence (or a weak influence) on current consumption, with current income having a stronger influence than the pure RE-LCPIH predicts. Therefore, myopic consumers will be excessively sensitive to changes in income (and other variables) known at time t; as for the liquidity constrained consumer, the MPC out of the change in income will be equal to one (Figure 3.2). The results for both myopic and liquidity constrained behaviour generalise beyond the two period model.

Figure 3.2: Myopic Consumer - Response to a one-off increase in current income A → B. The consumption plans of the myopic consumer are dependent only on current income (Y_1) and the price of current consumption; that is they do not have a utility maximisation time horizon beyond the current period.



It is clear from Figures 3.1 and 3.2 that myopic and liquidity constrained consumers differ in their perceptions of future information, and yet they are treated as observationally equivalent in the context of the excess sensitivity model. Given that both myopia and liquidity constraints give rise to the observation of excess sensitivity, the next section outlines how the presence of significant asymmetries in consumption can be used to distinguish between the two alternative explanations.

3.2.2 ASYMMETRIES

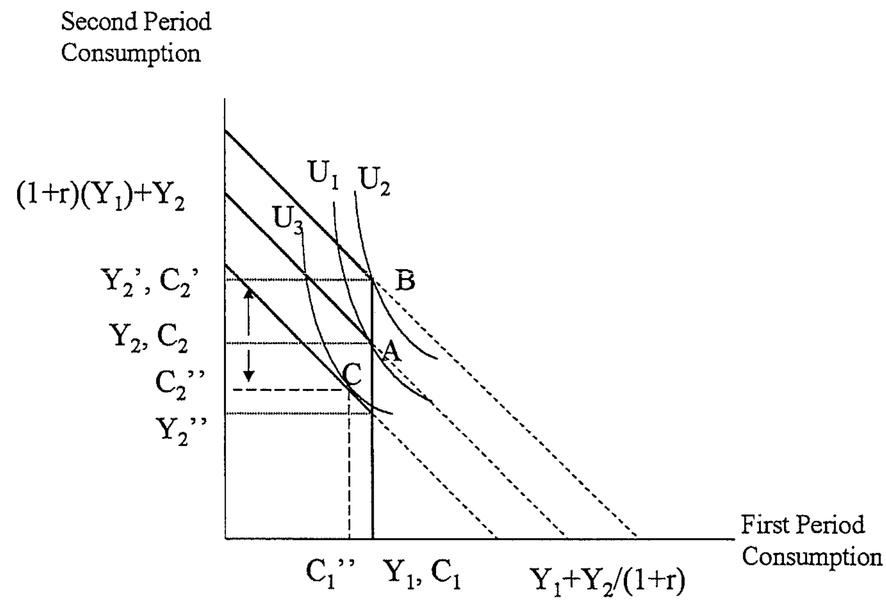
The idea that the response of consumption to predictable changes in income can differ depending on the direction of the change, that is the response may be asymmetric, has been put forward at various times and was first suggested by Dolde (1978) and taken up by Mariger (1987) who argued that the response of consumption to positive anticipated changes in income would be greater than a negative anticipated change.

The suggested source of the asymmetry lies in the response of consumers, who face binding liquidity constraints, to predicted future income growth. If consumers are prevented from borrowing against future income growth, consumption can only respond when the income growth materialises. Hence consumption is more sensitive to this previously predicted income growth than it would be if smoothing had been facilitated by the availability of borrowing.

On the other hand, predicted future decreases in income would necessitate (usually minor[8]) anticipatory cuts in consumption and would not be impeded by the presence of liquidity constraints; that is, consumers can smooth consumption by saving when future income is expected to fall. Hence if liquidity constraints are binding, excess sensitivity should be stronger in the presence of predictable increases in income and weaker, possibly insignificant, in the face of predictable declines. Alternatively expressed, the presence of a borrowing constraint creates a one sided violation of the Euler equation, because the consumer has the option of saving and accumulating assets but not of borrowing; hence the asymmetry - figure 3.3.

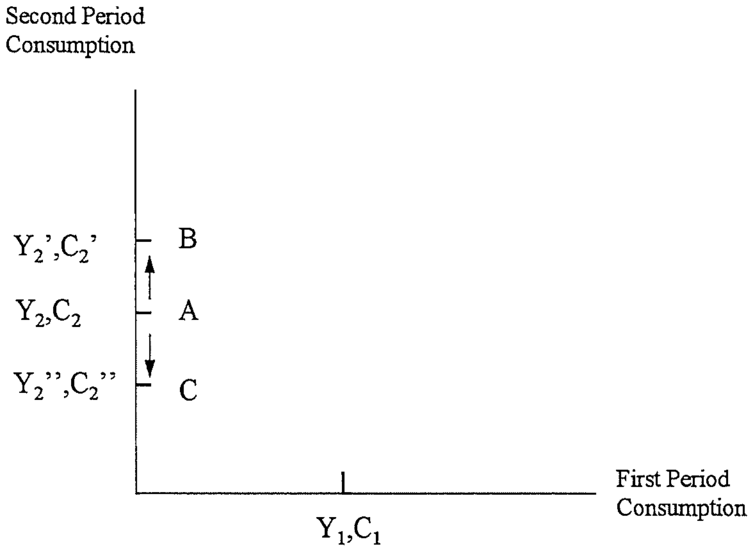
[8] If the decrease in income is likely to be reversed quickly or is small in relation to lifetime wealth.

Figure 3.3: Liquidity Constrained Consumer - Asymmetric responses to positive and negative income changes. For a predicted increase in future income (Y_2), period one consumption will not change but period two consumption will increase to C_2'; that is optimal consumption moves from A to B (the consumer remains currently constrained). For an equal predicted decrease in future income, the consumer's response is A to C, where the change in period two consumption is clearly smaller. That is, consumers reduce current consumption in order to save for the predicted future decrease in income (that is, smooth consumption).



For myopic consumers, consumption will always follow any change in actual income (Flavin(1991)). As they simply make plans on the basis of current income, they will respond to changes in future income as they arise, whether they are anticipated or not, and whether the income change is positive or negative. In contrast to the case of binding liquidity constraints, under myopia the response of consumption to changes in income will therefore be symmetric no matter what the direction of the income change - figure 3.4.

Figure 3.4: Myopic Consumer - Symmetric responses to positive and negative income changes. For either a predicted increase or decrease in future income (Y_2), the consumer's response is symmetric (A to B = A to C).



Summary

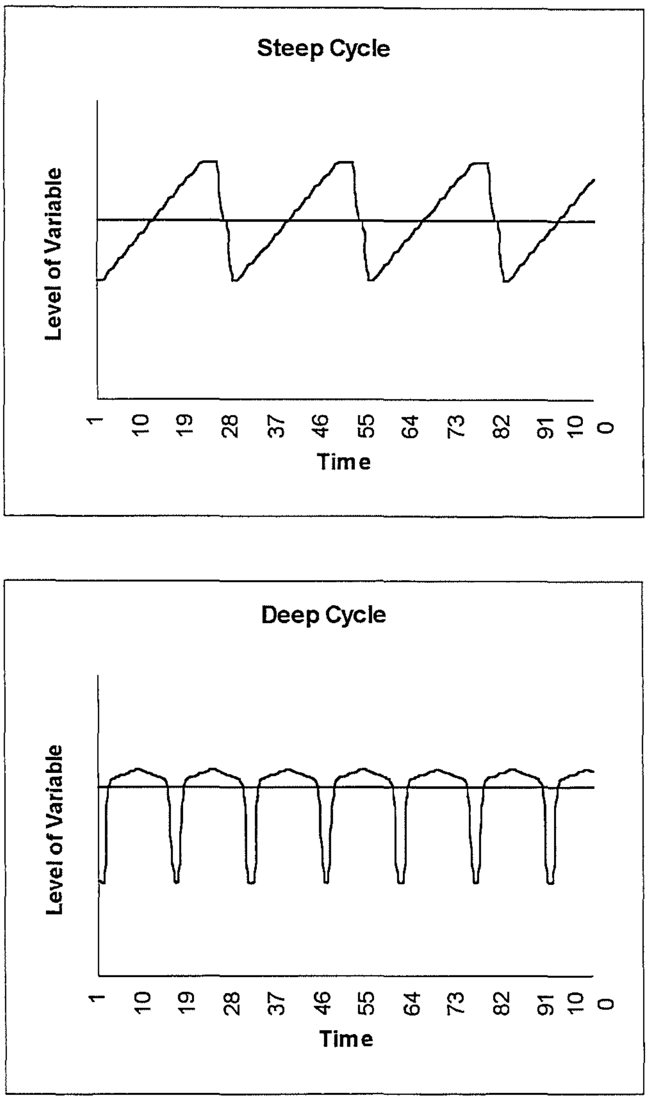
Both myopia and liquidity constraints have testable implications for asymmetry in consumption behaviour (Shea, 1995:799). Under myopia, consumption will respond symmetrically to positive and negative real income growth. Under liquidity constraints, which impede borrowing when income is temporarily low, the result is an asymmetric response, where consumption should respond more strongly to predicted increases in income than decreases. Prior to empirically testing these implications, a brief review of studies which examined asymmetries in consumption is outlined in the next section.

3.2.3 SURVEY OF EXISTING EMPIRICAL WORK

Many economists have found that economic recessions tend to involve steeper and more short lived departures from trend GDP than recoveries, that is, a pattern of slow ascents and rapid descents. This is a description of a simple asymmetric business cycle quality referred to as steepness by Sichel (1993) or equivalently as the negative growth rate asymmetry by Tinsley and Krieger (1997). Such asymmetric behaviour was first noted by Mitchell (1927). Possible explanations for such patterns include asymmetric costs of upward and downward adjustment (Chetty and Heckman (1985), and Baldwin and Krugman (1986)).

Another characterisation of cyclical asymmetry refers to deviations at troughs which are larger in absolute value but shorter lived than trend deviations at peaks. Such a description was termed deepness by Sichel (1993) and the negative gap asymmetry by Tinsley and Krieger (1997). Such asymmetry was first suggested by Hicks (1950) and his non-linear business cycle model. Hicks argued that capacity ceilings due to shortages of labour or fixed capital placed upper bounds on output growth in expansions. These upper bounds on output growth in expansions were not matched by comparable lower bounds on output contractions in recessions; hence asymmetries arise. Another explanation for deepness in the business cycle is that of asymmetric price adjustment (DeLong and Summers (1988)). Figure 3.5 illustrates Sichel's (1993) concept of deepness and steepness.

Figure 3.5: Steep and deep Cycles



The issue of asymmetry has frequently been addressed in empirical business cycle studies and in key aggregate variables such as GNP and the unemployment rate[9]. The present study is concerned with the issue of asymmetry in two key series: consumption of nondurables and services, and income. Empirical work to date in this area can be divided into two

[9] For example asymmetries in the unemployment rate have previously been addressed by Neftci (1984) who presented evidence of asymmetries in the aggregate rate of unemployment with unemployment rising faster during recessions but slower to fall during expansions. This result was confirmed by Falk (1986) and DeLong and Summers (1986). Negative asymmetry in growth rates was rejected for real GNP by DeLong and Summers (1986) and Sichel (1993).

categories: (i) studies which tested for asymmetries in consumption; and (ii) studies which tested for asymmetric responses of consumption to income changes[10].

Studies in the first category include Holly and Stannett(1995), and Speight and McMillan(1997, 1998) who all tested for asymmetries in UK consumption expenditure, and Dynarski and Sheffrin (1986a) who tested for asymmetric fluctuations in US consumption. The UK studies adopted tests designed by Sichel (1993)[11], and reached the conclusion there was evidence of asymmetries. In particular, Holly and Stannett found evidence of significant (inverse) deepness in consumption expenditure (that is tallness)[12]. Speight and McMillan confirmed Holly and Stannett's findings, but noted that the results were not robust to alternative detrending methods[13]. For the US, Dynarski and Sheffrin (1986a) also identified significant asymmetry (deepness) and argued that this could be related to unemployment[14]. Certainly some economists have argued that liquidity constrained behaviour can be often linked to unemployment (Flavin 1985, Malley and Moutos 1996). Hence since there is evidence that unemployment series are asymmetric (Dynarski and Sheffrin 1986, Sichel 1993), the possibility arises that unemployment fluctuations could induce asymmetric movements in income and thereby consumption spending. For example, consumers who are unemployed for a period of time, will typically have negative transitory income. If in addition they are liquidity constrained, than actual consumption and transitory income will be positively correlated. Hence asymmetries present in unemployment series could be reflected in consumption series.

[10] It should be noted, that to the best of the author's knowledge no work has been done to date in this area for the three Nordic countries of Finland, Norway and Sweden.
[11] Further details of Sichel tests are contained in Section 3.3.1.1
[12] Their data set contained quarterly, seasonally adjusted data for the time period 1965Q1-92Q4.
[13] Sichel's tests are calculated for the cyclical component which is obtained using detrending and filtering techniques. Speight and McMillan used quarterly, seasonally adjusted data for the time period 1955Q1-95Q1.
[14] They used quarterly data for the time period 1950Q2-1983Q4.

The second category of empirical studies focuses on those which explicitly test for asymmetries in consumption in response to income changes. Altonji and Siow (1987) test for asymmetric responses to positive and negative income changes. They constructed measures of positive and negative anticipated income changes and noted that the response of consumption to the positive changes was greater; however the asymmetry was not statistically significant. Following Altonji and Siow (1987), Shea (1995a,b) using both household and aggregate data, examined the testable implication of liquidity constraints that the response of consumption to changes in income should be asymmetric[15]. For his household study, he specifically focused on households with wage earners covered by long-term union contracts. Following Zeldes (1989a), he divided the households according to whether they held liquid assets or not, and then split the low wealth group according to whether the expected change in their real income was positive or negative. For the aggregate data set, he focused on positive and negative changes in expected aggregate income growth. For both studies, Shea argued that predictable income (wages) increases would produce predictable consumption increases, but predictable income (wages) decreases would not produce predictable consumption decreases. However for both studies, Shea found a 'perverse asymmetry' in which consumption responded more strongly to predictable income declines than to predictable increases.

More recent work by Garcia, Lusardi and Ng (1997), also considered asymmetric consumption responses to positive and negative changes in income. They used data from the US Consumer Expenditure Survey (CEX) and focused on the asymmetry in the response between a liquidity constrained consumer and a rule of thumb consumer to

[15] The household data was obtained from the Panel Study of Income Dynamics; and the aggregate data was US data.

lagged income and predicted changes in income. Anticipated changes in income were calculated as the predicted values from an auxiliary regression, in which income growth was regressed on household characteristics such as age, occupation, education, change in family size, sex, race, marital status and the interaction among these variables. They concluded that liquidity constraints appeared to be an important source of excess sensitivity

Blundell-Wignall *et al.*(1995) considered changes in the magnitude of asymmetry over time corresponding to financial liberalisation. Specifically, they argued that for large changes in income, reductions in income would be more constraining than increases in income, providing evidence of liquidity constraints. Furthermore, they argued that as liquidity constraints declined over time with financial liberalisation, then the magnitude of the asymmetry should also decrease. They obtained measures of positive and negative changes in disposable income by regressing disposable income on a set of exogenous variables including the second, third and fourth lags of itself, of consumption, the unemployment rate and total exports, as well as contemporaneous population and a time trend. They then examined whether asymmetry was present for the 1960s, 1970s, 1960s/70s and the 1980s/90s. They found evidence of significant asymmetries, consistent with their argument of liquidity constraints. They also found that the magnitude of asymmetry had declined between the earlier periods and the later decades of the 1980s/90s.

Conclusion

In this chapter, we examine the evidence of asymmetries in consumption data for Finland, Norway and Sweden, and use such evidence as a means of differentiating between the competing theories of myopia and liquidity constraints as sources of excess sensitivity. Specifically, we employ the tests proposed by Sichel(1993) and Shea(1995) to detect asymmetries. In the next section, a discussion of these tests is presented.

3.3: ECONOMETRIC METHODOLOGY AND DATA

Prior to undertaking the empirical testing of asymmetries, we discuss the tests used and related data issues in sections 3.3.1 and 3.3.2 respectively. We, firstly employ Sichel's (1993) tests of deepness and steepness to test for asymmetries in consumption. Secondly, we employ Shea's (1995b) method to test for asymmetries in consumption in response to positive and negative income growth changes. The former test can be viewed as a general test of asymmetries in consumption, whilst the latter can be viewed as a more specific test in that it examines asymmetries in consumption attributable to changes in income.

3.3.1 TESTS FOR ASYMMETRIES

3.3.1.1 Sichel's Tests of Deepness and Steepness

As noted in section 3.2.3 Sichel (1993) coined the terms deepness and steepness to describe asymmetries in business cycle variables. He tested for the cyclical asymmetries by examining the skewness coefficients of cyclical components of economic time series. Skewness is defined as the ratio of the third centred moment to the cube of the standard deviation. For a symmetric distribution, the estimate of skewness should be equal to zero.

His test for deepness is based on the calculation of the coefficient of skewness:

3.1 $$D(c) = \left[(1/T)\sum_t (c_t - \bar{c})^3 \right] / \sigma(c)^3$$

where $\bar{c}$ and $\sigma(c)$ are the mean and standard deviation of the cyclical component c_t, and T is the sample size. The cyclical component is obtained by removing a trend from the series and defining the cycle in terms of deviations from a trend. Methods of trend removal are outlined in the data section (3.3.2)

The test of steepness is based on the coefficient of skewness for the first difference of the variable concerned:

3.2 $$ST(\Delta c) = \left[(1/T)\sum_t (\Delta c_t - \Delta\bar{c})^3 \right] / \sigma(\Delta c)^3$$

where $\Delta\bar{c}$ and σ(c) are the sample mean and standard deviation of Δc (Δ is the first difference operator). As it is likely that the observations on c_t would be serially correlated, the formula for the asymptotic standard error of the coefficient of skewness is not applicable. Sichel suggests calculating the asymptotic standard error for both steepness and deepness using the Newey and West (1987) procedure, which produces an asymptotic standard error consistent in the presence of serial correlation. For the deepness test, this involves constructing a variable:

3.3 $$z_t = (c_t - \bar{c})^3 / \sigma(c)^3$$

which is then regressed on a constant, and the Newey-West standard error computed. The estimated intercept is identical to D(c). Furthermore, as the intercept term divided by its standard error is asymptotically normal, conventional critical values can be used to test for the significance of D(C). An asymptotic standard error for use in the steepness test can be calculated in a analogous way to the deepness test[16].

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[16] That is, $z_t = (\Delta c_t - \Delta\bar{c})^3 / \sigma(\Delta c)^3$

We apply Sichel's tests of deepness and steepness to consumption data for Finland, Norway and Sweden to detect if there is evidence of asymmetries in same data (the results are reported in the next section 3.4). Evidence of negative (positive) skewness in level data would indicate deepness (tallness), that is, larger trend deviations in absolute value occur at cyclical troughs than at peaks. Evidence of negative (positive) skewness in the distribution of growth rates or first differences will indicate contractionary (expansionary) steepness, that is, upturns are longer than downturns. Even though these tests are general tests of asymmetries, evidence of significant inverse deepness (tallness) in consumption could be loosely interpreted as evidence of asymmetric behaviour characterised by liquidity constrained consumers, namely, that the response of consumption to positive trend deviations in income (that is, increases in income) should be greater in magnitude than the response of consumption to deviations in income below trend.

3.3.1.2 Shea's Model

The second method applied in this study in order to test for asymmetries is that designed by Shea(1995b). He proposed a simple test to discriminate between liquidity constraints and myopia as explanations for excess sensitivity of consumption growth to income growth in a modified Campbell and Mankiw excess sensitivity model. His test was based on estimating the model:

3.4 $$\Delta c_t = \mu + \lambda_1 (NEG_t)\Delta\hat{y}_t + \lambda_2 (POS_t)\Delta\hat{y}_t + \beta\hat{r}_t + \varepsilon$$

where Δc, $\Delta\hat{y}$, $\hat{r}$ are consumption growth between t-1 and t, expected income growth between t-1 and t and expected real interest rate, respectively; and POS and NEG are dummy variables for periods in which $\Delta\hat{y} \rangle 0$ and $\Delta\hat{y} \langle 0$ respectively (Method 1). He argued that positive and significant estimates of the lambda coefficients would provide evidence of excess sensitivity. Under myopia, the lambda's are posited to have positive, significant and equal values ($\lambda_1 = \lambda_2 > 0$). Evidence of liquidity constraints would be reflected if $\lambda_2 > 0$ and significant, and where $\lambda_2 > \lambda_1$, that is, there is a greater predicted response to positive income changes than negative changes[17].

Extensions to Shea's Model

An extended version of Shea's methodology will used in this study to empirically test for asymmetries in the response of consumption to changes in income. Prior to outlining the extensions/developments, there are a number of particular issues which arise from Shea's analysis and remain to be addressed. First, Shea used 2SLS, but he did not modify the standard errors of the second-stage regression. As outlined in Gujarati(1995), incorrect estimates of the variance-covariance matrix are obtained when estimated values of endogenous variables are used as regressors, instead of instruments (1995:705)[18][19], thereby giving rise to misleading inference results. Hence, when employing 2SLS, the standard errors obtained using OLS in the second-stage regression of 2SLS must be modified.

Second, following Campbell and Mankiw(1989, 1990, 1991), he typically used a number of lags of disposable income growth, consumption growth, interest rates, and the log consumption-income ratio in his instrument sets, and assessed the predictive power of

[17] F-statistic is reported for testing the joint hypothesis $\lambda_1 = \lambda_2$.
[18] This occurs because estimates of the variance-covariance matrix are obtained using residuals calculated with estimated rather than actual values of these endogenous variables (Kennedy, 1998:172).
[19] Refer to Pagan, A.R. (1986) for further details.

the instrument sets by the partial R^2. Alternative instruments were not examined[20]. As outlined in chapter 2 (section 2.5.2.1), instrument relevance is of the essence for IV estimation, as IV estimators will have poor finite sample performance if the instruments have low relevance for the regressors[21]. Nelson and Startz (1990a,b) illustrated using a short sample and one instrument that the 2SLS estimator is biased in the direction of the OLS estimator, and the magnitude of bias approaches that of OLS as the R^2 between the instruments and the regressors tends to zero. Their findings were further supported by Bound, Jaeger and Baker (1995) who showed that even for large samples, the 2SLS estimates may suffer from finite sample bias, and may be inconsistent.

For the third and final issue, Shea used only one method to calculate whether predicted changes in income growth were positive or negative, that being whether the change in expected income growth was greater or less than zero.

In an effort to address these issues, we propose and implement a number of developments. Relating to the first issue discussed above, we employ the instrumental variables estimator (IV). When the orthogonality assumption is violated, this estimator provides unbiased, consistent and efficient estimates (once appropriate instrumental variables are found for each endogenous variable). In this study, instrumental variables deals with the problem that the error term ε_t (which contains news about income) is likely to be correlated with Δy_t in equation 3.4. Furthermore, even though 2SLS is a form of IV, and both will yield identical coefficient estimates, the IV technique will produce the

[20] Shea's study was on US quarterly consumption of non durables and services (1956:4-1988:4) and he employed two data sets. His first data set was taken form the standard NIPA accounts. Following Blinder and Deaton (1985), Shea's second data set contained the following modifications: the 1975:2 income tax rebate and interest payments were removed from households to businesses from disposable income; and shoes and clothing were removed from non durables. For estimation he experimented with five different instrument lists which included lags of income growth, consumption growth, interest rates, and the log consumption-income ratio.

[21] Instrument relevance is defined as the correlation between instruments and the regressors.

correct estimates of the variance-covariance matrix. Also the IVMA estimator has the distinct advantage over 2SLS in that it allows direct estimation of a MA process in the disturbance term. As outlined in chapter 2 a number of studies have suggested that a MA(1) process is likely to be present in the disturbance term, due for example, to time-averaging of data and durability of consumption goods. We refer the reader to Chapter 2, Section 2.5.2.1 for a discussion on both IV and IVMA estimation. Hence we firstly employ the IVMA estimator (with instruments lagged twice and earlier), and test for the significance of the MA term. If there is no evidence of a significant MA(1) process in the disturbance term, then the appropriate estimator to use is IV with instruments lagged once and earlier[22].

Concerning the issue of appropriate instruments sets, we obtain instruments by explicitly estimating a marginal income process for each country. The more careful dynamic specification of the marginal income process should produce some gains in efficiency. The income process also provides the estimates of expected income growth, $\Delta\hat{y}$, which are used in identifying positive and negative changes in same. Once again, we refer the reader to Chapter 2, section 2.5.2.1, for a detailed analysis of the instrument selection process and results. The instruments sets employed for each country are as follows:

Country	**Instruments**
FINLAND	dlyd(-1, -5), dlc(-1) dlg(-1, -2), dlex(-1)
NORWAY	dlc(-2, -3), dlg(-2), dlnw(-2), dr(-4), dinf4(-3), d943
SWEDEN	dlyd(-2, -8), dlc(-4), dlex(-3, -6), dlbus(-3), dr(-2), dinf4(-3), d921

[22] Following Campbell and Mankiw(1990), and to account for the possibility of a MA(1) process in the disturbance term, Shea did restrict his instrument sets to twice lagged variables and earlier.

With reference to the third issue discussed above, a number of alternative methods are employed in identifying different directions in the movement of income growth. Alternative methods provide a means of testing if our results are robust to different ways of calculating positive and negative changes in income growth. As well as Shea's method, we also employ other methods, including looking at changes in income growth by analysing fluctuations in income growth around a time trend; such a detection takes into account that income is generally strongly trended (Method 2).

Another method involves calculating the average growth in income for the previous year and comparing (the quarterly) observations for the current year to it (Method 3). In this case negative and positive values are identified as those less than or greater than the previous yearly average, respectively. This method takes into account the potential persistence of income shocks from year to year. Following Cabellero (1992), current income growth is also compared to the sample mean (Method 4). The sample mean is calculated by regressing income growth on a constant, with the coefficient on the constant providing an estimate of the sample average. Predicted growth is then compared to this estimate and positive and negative changes are identified. This final method provides a comparison of actual income growth values to the average level of income growth for the sample. This method is applicable when the sample mean is representative of the whole sample.

Finally, in addition to testing the Shea model as outlined in equation 3.4, estimates for a modified version of the model are also be reported, in which the above methods 1-4 for calculating the predicted increases and decreases in income growth are employed:

3.5 $$\Delta c_t = \mu + \lambda_2(POS_t)\Delta\hat{y}_t + \lambda_3(ALL_t)\Delta\hat{y}_t + \beta\hat{r}_t + \varepsilon_t$$

In this model only the positive changes in income are included, as well as the total changes in income, $(ALL_t)\Delta y_t$. If both coefficients, λ_2 and λ_3, are positive and significant, then this implies that changes in consumption are excessively sensitive to changes in income, but are even more sensitive to positive changes in income. This latter result implies asymmetric behaviour, characterised by liquidity constrained consumers. The advantages of including all changes in income and one category of changes (positive) are, firstly, the instrumenting should be more effective, and secondly, the test for asymmetry is a t-test of the λ_2 coefficient instead of a F test testing for a significant difference in the coefficients on $POS\Delta y_t$ and $NEG\Delta y_t$.

Summary

Our estimation strategy is as follows. Sichel's tests of deepness and steepness for detecting asymmetric behaviour in cyclical variables are first employed to detect if asymmetries exist in consumer expenditure for Finland, Norway and Sweden. Shea's original model (equation 3.4) and our modified version of it (equation 3.5) will then be estimated using IVMA/IV, to explicitly test if asymmetries exist in consumption responses with respect to changes in income[23].

For Sichel's tests, evidence of negative skewness relative to trend will indicate deepness; whilst evidence of negative skewness in growth rates will indicate steepness. Turning to Shea's test, for both models (3.4 and 3.5), evidence of a significant and positive λ_2 coefficient would indicate the presence of asymmetric behaviour characterised by liquidity constrained consumers, namely, that they respond more to predicted increases in income than predicted decreases.

Finally, it should be noted that even though Sichel's test is a more general test in that it is less strictly related to the cause of asymmetry, it complements Shea's tests in that the latter progresses a step further by employing the asymmetries in the response of aggregate consumption to expected income growth as a means of differentiating among competing explanations of excess sensitivity. The advantage of Sichel's test over Shea's, is that it is estimated independent of any instrument set(s).

3.3.2 DATA ISSUES

The individual country data sets are those used in Chapter 2[24]. Quarterly time series data is used in the empirical analysis; the data is seasonally adjusted throughout, and the natural log transformation is applied to each variable. The sample period for Finland and Sweden is 1970Q1-1995Q4, and 1967Q2-1994Q4 for Norway. The dependent variable in equations 3.4 and 3.5 is real consumption of nondurables and services per capita and the explanatory variables are real disposable income per capita, and the real interest rate. We refer the reader to Chapter 2, Section 2.5.1, and the appendices to Chapter 2 for a detailed analysis of the time series properties of the variables. The consumption measure used in calculating Sichel's tests is real consumption of nondurables and services per capita. As noted previously Sichel's tests are based on the cyclical component of a time series. We now discuss the methods used to extract this component.

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[23] The choice between the IVMA and IV estimators will be determined by the significance of an MA(1) process in the disturbance term.
[24] Refer to the Data Appendix 1 for more detailed information on each country's data set; also refer to Chapter 2, Section 2.5.1.

Trend Removal Methods

In order to analyse potential asymmetries, it is necessary to identify an appropriate measure of the cyclical component. A number of methods can be used to extract the cyclical component of each series. Those most commonly used include the removal of linear trends, the application of the first difference filter and/or alternatively, the Hodrick Prescott filter. Prior studies, for example Canova (1993), have indicated that the asymmetric evidence obtained can be dependent on the method of trend removal. Sichel (1993) employed a number of filters - the Hodrick-Prescott filter and the Beveridge-Nelson trend-cycle decomposition for the deepness test, and first differencing for the steepness test. He assumed that the sample mean was representative of the whole sample and he employed the detrending methods to illustrate that "[a]lthough detrending has been quite controversial in macroeconomics, ...any detrending filter that satisfies three requirements is appropriate for an analysis of asymmetry" (1993:228). The three requirements are: first a filter must render a filtered time series stationary; second, the filter should not induce a phase shift (that is, the filter should not change the timing of the turning points in the time series); and third a filter must extract the appropriate component for use in the asymmetry tests (that is, c_t and Δc_t for the deepness and steepness tests respectively) (1993:228-229).

The extraction of linear or log linear trends was once the standard method of trend removal (that is, detrending which entails regressing a variable on a polynomial time trend and saving the residuals). However, with the growing evidence that many macroeconomic time series contain unit root components, it is an inappropriate filter to apply as stochastic trended behaviour will not be removed. It should be noted that based on unit root tests conducted in Chapter 2, we concluded that for all three countries, the consumption of nondurables and services was nonstationary and could be approximated as an I(1) process. Based on this evidence, alternative methods to that of detrending are employed; in particular, the Hodrick-Prescott filter and the first differencing filter are used in this chapter. Assuming that a time series y_t can be decomposed into a stationary cyclical component c_t and a nonstationary trend component τ_t, these filtering techniques are now discussed.

The use of the business cycle filter designed by Hodrick and Prescott (1980), the Hodrick-Prescott filter (hereafter HP filter) has been popular in recent years. This is a linear filter that extracts a trend component that minimises the sum:

$$\min \sum_t \left\{ (y_t - \tau_t)^2 + \gamma \left[(1-L)^2 \tau_t \right]^2 \right\}$$

where L is the lag operator; γ is termed the smoothness parameter and penalises variation in the growth component, τ_t. The larger is γ, then the smoother is the growth component. For quarterly data, Hodrick and Prescott propose a value of $\gamma = 1600$.

The HP filter is widely used. It has several desirable features including: (i) it renders stationary time series that are integrated of order four or less, or that contain deterministic trends; (ii) as the HP filter is a linear symmetric filter, it does not alter the timing relationships between variables; that is, there is no phase shift for this filter. For our work, this implies that the use of this filter will not induce asymmetry, if none is present in the original data; and (iii) it provides an estimate of the cyclical component (c_t), which is the desired component for use in the deepness tests.

However a number of recent studies have pointed out that the mechanical application of the HP filter to series which are either integrated or driven by deterministic trends may induce spurious results (see Harvey and Jaeger(1993), King and Rebelo(1993), and Cogely and Nason(1995)). In particular, these studies have shown that the HP filter may induce spurious cyclical type behaviour, whereby it amplifies fluctuations at business cycle frequencies (broadly, it over estimates the cyclical component). Whilst this feature renders the use of the HP filter results unsuitable for some business cycle analysis, Sichel(1993) argues that it is actually desirable for business cycle asymmetry analysis. As noted above, the HP filter will not induce asymmetry, if none is present in the data. Hence if evidence of asymmetry is found in the filtered data, then asymmetry must be present in the original series. Sichel(1993) argues that the HP filter serves only to enhance any findings of asymmetry through the amplification of the cycles at business cycle frequencies in the filtered data.

Another frequently used filter is the first difference filter, which extracts the cyclical component from a time series as follows:

$$\Delta y_t = \Delta c_t + \Delta \tau_t$$

where Δ is the first difference operator, which takes differences between successive observations. This filter renders series which are first order integrated stationary, satisfying the first of the filter requirements discussed above. It is also a linear filter, and it extracts the appropriate component for use in the steepness test (Δc_t) but not for the deepness test[25]. It should be noted, that this filter tends to suffer the same drawback as that of the HP filter, in terms of over estimating the cyclical component, and thereby its first difference. Differencing data removes the low frequency components in the series (that is, long-term components or trend), whilst accentuating the high frequency components.

In summary, the HP filter provides an explicit expression for c_t, which is the appropriate measure for use in the deepness test (that is, c_t), whilst the first difference filter

[25]The steepness test focuses on growth rates. Given that our data is expressed in logs, the first differences are growth rates; hence the first difference of the cyclical component (Δc_t) is the appropriate component.

provides an explicit expression for Δc_t which is the measure used in the steepness test. We undertake the empirical work in the next section.

3.4: EMPIRICAL EVALUATION

In Section 3.4.1, we calculate and discuss the results for Sichel's deepness and steepness tests applied to data for the consumption of nondurables and services. We also discuss the trend removal estimates for the HP and first differencing filters. In Section 3.4.2, we empirically estimate the modified version of Shea's model.

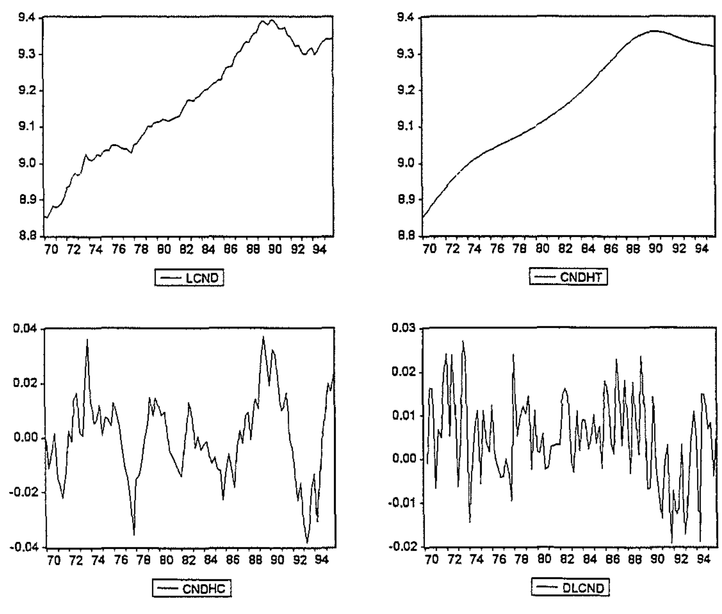
3.4.1 SICHEL'S APPROACH APPLIED: ASYMMETRY BY SICHEL

3.4.1.1 Trend Removal Estimates

This section presents the HP and first difference filter results obtained using the logarithms of seasonal adjusted quarterly data for the consumption of nondurables and services for Finland, Norway and Sweden. Time plots for the log of the data, their estimated HP trend and associated cyclical component, and their estimated first difference appear in Figures 3.6 to 3.8 for Finland, Norway and Sweden respectively.

A number of features of the plots of the data deserve comment. Plots of the log of the consumption of nondurables and services is shown in the graphs titled LCND in Figures 3.6-3.8 for Finland, Norway and Sweden respectively. As expected, it is strongly trended for all countries. Plots of the smoothed trend generated by the H-P filter appear in the graphs titled CNDHT, whilst plots of the estimates of the cyclical component of consumption of nondurables and services obtained using the HP filter appear in the graphs titled CNDHC. These latter plots indicate some visual evidence of steepness for Finland where the upswings appear to be longer and gradual, with rapid downswings (Figure 3.6, CNDHC). There is visual evidence of deepness for Sweden, where the troughs appear to be noticeably deeper than the peaks (Figure 3.8, CNDHC). In contrast the plot for Norway suggests evidence of inverse deepness, that is tallness, where the peaks are noticeably taller than the troughs (Figure 3.7, CNDHC). Overall though, the plots do not provide clear visual evidence supporting asymmetries of either kind in the consumption of non-durables and services for these countries. Plots of the first difference of the log of consumption of nondurables and services appears in the graphs titled DLCND.

Figure 3.6: Finland - Plots of the log of data (LCND), the HP Trend (CNDHT), the HP Cyclical component(CNDHC), and the First Difference (DLCND). Refer to Key at end of Figure 3.6 for variable definitions.



Key to Figures 3.6-3.8

LCND:	Consumption of non-durables and services, expressed in logarithms, constant prices, and in real per capita terms
CNDHT:	Hodrick-Prescott trend for consumption of non-durables and services (LCND)
CNDHC:	Cyclical Component from Hodrick-Prescott filter for consumption of non-durables and services (LCND)
DLCND:	First difference of consumption of non-durables and services (LCND)

Figure 3.7: Norway - Plots of the log of data (LCND), the HP Trend (CNDHT), the HP Cyclical component(CNDHC), and the First Difference (DLCND). Refer to Key at end of Figure 3.6 for variable definitions

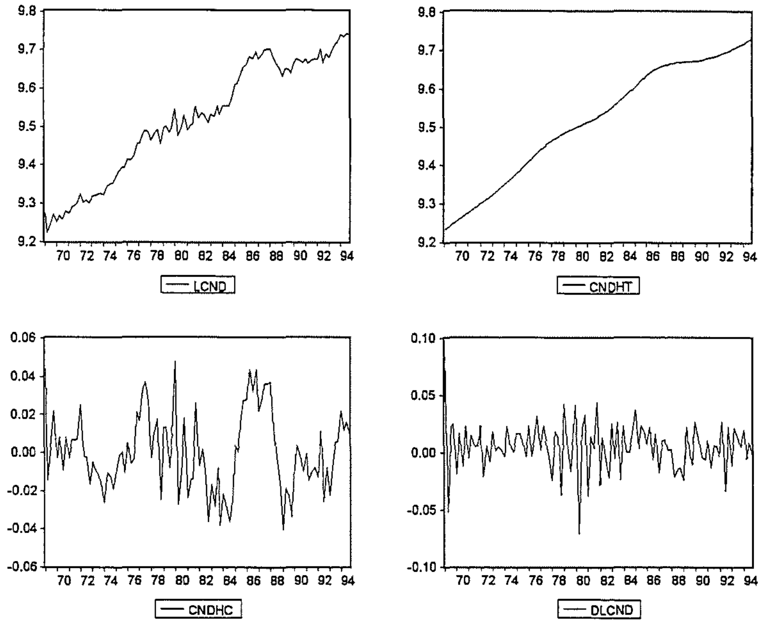
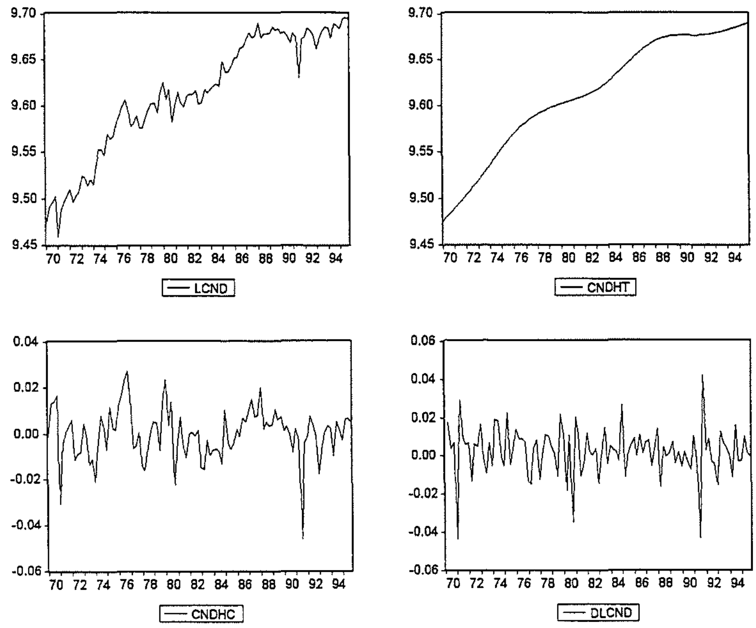


Figure 3.8: Sweden - Plots of the log of data (LCND), the HP Trend (CNDHT), the HP Cyclical component(CNDHC), and the First Difference (DLCND). Refer to Key at end of Figure 3.6 for variable definitions



3.4.1.2 Asymmetry by Sichel

Given some if limited visual evidence of asymmetries in the data, we now proceed to test explicitly for the existence of same, using Sichel's tests of deepness and steepness. The deepness and steepness statistics for consumption of nondurables and services are reported in Table 3.1. The first column displays asymmetries in the level of trend deviations (D(c)), while the second column displays the extent of asymmetry in the growth rate of consumption (ST(Δc)). For each test, values of the test statistics, standard errors and one-sided p-values are shown. The standard errors reported are the Newey-West (1987, 1994) asymptotic heteroscedastic and autocorrelation consistent standard errors[26]. The calculation of these standard errors is based on the weighted sums of estimated autocovariances of cross products of instruments and residuals, and the number of autocovariances included in the weighted sums depends on the degree of residual autocorrelation. Where the latter is not known, the window size (that is, the number of autocovariances included) has to be specified. The recommended procedure of using the Parzen window, with a window size equal to one-third of the sample size is adopted in this chapter[27,28]. The p-values reported in Table 3.1 are those associated with one sided significance levels at which the null of D(c) =0 and ST(Δc) =0 (that is no asymmetry) can be rejected[29].

The results suggest that Finnish consumption exhibits deepness and steepness at the 0.49 and 0.45 significance level respectively. This can be interpreted that there is no

[26] Reported Newey-West standard errors are obtained using MICROFIT version 4(1997, Oxford University Press).
[27] The Parzen window ways past autocovariances quadratically.
[28] Pesaran and Pesaran (1991) suggest not using more than one-third of the sample size, in their Microfit User's manual.
[29] We obtain the one-sided p-values using the CDF function in TSP which calculates and prints tail probabilities for several cumulative distribution functions including the normal distribution; refer to the TSP Version 4.3 reference manual(1995).

significant deepness or steepness in consumer's expenditure data, that is, that there is no evidence of significant asymmetric cycles within Finnish consumption. A similar conclusion can be stated for Norway where consumption exhibits deepness and steepness at the 0.15 and 0.32 significance levels respectively. Corroborating visual evidence of no clear deepness or steepness patterns is shown in Figures 3.6 and 3.7 for Finland and Norway respectively. In the case of Sweden there is no evidence of deepness but consumption does exhibit evidence of significant steepness at the 0.02 significance level. This can be interpreted as fairly strong evidence of contractionary (negative) steepness in Swedish consumption data; Figure 3.8 shows some visual evidence, confirming the strong empirical evidence of steepness.

In summary no evidence of significant asymmetries in consumption emerges for Finland or Norway. There is some evidence of asymmetric responses for Swedish consumption, and here, where steepness is exhibited. This suggests that Swedish consumption growth rates can be described by a pattern of slow ascents and rapid descents. As outlined earlier, evidence of inverse deepness in real consumption could be loosely interpreted as being indicative of the type of asymmetric response that Shea outlines for liquidity consumers, namely, that the response of consumption to predictable increases in income should be greater in magnitude than to the equivalent income decrease. However the Sichel tests provide no such evidence for any of our countries data sets.

To detect whether there are asymmetric consumption responses to predictable changes in income, Shea's asymmetry model is next estimated for each country. Even though Sichel's tests provide evidence of asymmetric responses for Swedish consumption only, Shea's model will be estimated on all data sets. This is based on the argument that

Shea's test is more specific than Sichel's, in that the sources of consumption asymmetries is explored further by analysing them with respect to changes in expected income growth; hence the test may be more powerful.

Table 3.1: Does Consumption Exhibit Deepness and Steepness? - Evidence for Finland, Norway and Sweden

Country (Sample period)	DEEPNESS D(c)	a.s.e.	p-value	STEEPNESS ST(Δc)	a.s.e.	p-value
Finland (70:1-95:4)	-0.0051	0.4556	0.4956	-0.0654	0.5639	0.4538
Norway (68:2-94:4)	0.2821	0.2740	0.1516	-0.2328	0.5096	0.3239
Sweden (70:1-95:4)	-0.7081	0.7183	0.1621	-0.6807	0.3315	0.0200*

Key to Table 3.1
1. D(c): Deepness test statistic; ST(Δc): Steepness test statistic.
2. a.s.e. = Newey-West asymptotic standard error (Parzen window with window size equal to 1/3 of the sample size)
3. p-value is the one-sided significance level at which the null of D(c)=0 or ST(Δc)=0 can be rejected.
4. * = significant at the 5 percent level

3.4.2 SHEA'S APPROACH APPLIED: ASYMMETRY BY SHEA

The results for both Shea's asymmetric model (equation 3.4) and the modified version (equation 3.5) are presented in Tables 3.2 - 3.4 for Finland, Norway and Sweden respectively. In these tables, we report the method used to identify positive and negative income growth changes (first column), and the estimates of λ_1, λ_2 and λ_3, from the estimation of equations 3.4 and 3.5 (second, third and fourth columns respectively). The fifth and sixth columns report estimates of the coefficients of the real interest rate and the MA(1) term respectively [30]. Tests

[30] This latter column is only reported for Norway and Sweden, as no evidence was found for a statistically significant MA(1) term for the Finnish data set, hence no MA(1) term results are reported for this country.

for asymmetric behaviour based on equation 3.4, carried out by a Wald χ^2 test of the joint null hypothesis, $\lambda_1 = \lambda_2$, are reported in the next column. The final column indicates the number of sample quarters for which income growth was positive, given the various methods of identifying such growth.

Prior to looking at the asymmetry results for each country, we first discuss some general results. We first estimated equation 3.4 employing the IVMA methodology for all three countries (with instruments sets containing twice lagged variables and earlier). Not surprisingly, given our findings in Chapter 2, a significant estimate of the MA(1) coefficient was found for both Norway and Sweden but not for Finland. This evidence indicates that IVMA is the appropriate estimator for Norway and Sweden. The finding of an insignificant MA(1) process in the disturbance term for Finland, indicates that IV is the appropriate estimator and that once lagged variables are potentially valid instruments. Consequently, our final results are obtained using IVMA for the Norwegian and Swedish data sets, and using IV for the Finnish data set.

Another general result for all countries is that there is no statistically significant interest rate effect at the 5 percent level, that is the elasticity of intertemporal substitution is insignificant; these results are reported in the fifth column of Tables 3.2-3.4 for Finland, Norway and Sweden respectively. Nor surprisingly, these findings are certainly in line with the low and insignificant interest rate effects reported in Chapter 2. Given that the inclusion of irrelevant variables leads to unbiased but inefficient results, we exclude the real rate of interest as a regressor to increase the power of tests on the remaining coefficients. It is these latter results, where we constrain the coefficient on the real interest rate to equal zero, which we focus on when discussing the asymmetry results by country.

Finland

We first estimated equation 3.4 (using IV), where positive and negative expected income growth was defined as being greater than or less than zero respectively. The results are reported in row 1 (line 2) in Table 3.2. The coefficient on positive income changes (λ_2) is positive, statistically significant (0.559 with p-value 0.003) and larger in value than the insignificant coefficient on negative income changes (estimated $\lambda_1 = 0.349$ with p-value = 0.168). Furthermore, we can formally reject the hypothesis $\lambda_1 = \lambda_2$ in favour of $\lambda_2 > \lambda_1$, based on a significant Wald statistic (18.131 with p-value = 0.000). These results are consistent with significant positive asymmetries, that is, consumption is more sensitive to predictable income increases than decreases. This is itself consistent with the existence of liquidity constraints.

We next consider our modified version of Shea's asymmetry model. When we employ positive income growth identified as expected income growth greater than zero in equation 3.5, the above findings are not supported (refer to row 2, line 2 of Table 3.2). The coefficients on positive income growth and on all income growth are statistically insignificant at conventional levels ($\hat{\lambda}_2$=0.210 with p-value 0.578 and $\hat{\lambda}_3$=0.349 with p-value = 0.168 respectively). When alternative methods are used to identify positive income growth (methods 2-4), the estimated coefficients of λ_2 are found to be statistically insignificant at conventional levels (p-values = 0.488, 0.863 and 0.748 for methods 2, 3 and 4 respectively). This indicates that our initial findings for Shea's original asymmetry model are not robust to alternative methods of classifying positive and negative income growth changes. These results of no asymmetries in consumption behaviour, corroborates those that we obtained using Sichel's asymmetry tests.

A possible explanation for the above findings could be related to the number of sample quarters for which $\Delta\hat{y}$ is positive. For example using Shea's classification of positive income changes, we obtained a total of 56 sample quarters which is approximately 69 percent of the total sample quarters. The greater the number of quarters where $\Delta\hat{y}$ is positive would obviously bias the results towards finding a significant coefficient on same variable. The other methods (methods 2-4) identified a smaller number of sample quarters for which income growth changes were deemed as positive; in particular, 54%, 57% and 52% of total sample quarters were identified as quarters of positive income growth using methods 2, 3 and 4 respectively.

One notable but expected feature of the Finnish results is the finding that the coefficient on all income growth ($\hat{\lambda}_3$) is statistically significant at the 5 percent level when method 2 is employed (0.384 with p-value = 0.026), and statistically significant at the 10 percent level when methods 3 and 4 are employed (0.440 with p-value = 0.059; and 0.414 with p-value = 0.058 respectively). These findings corroborate the findings of excess sensitivity for Finnish consumption in Chapter 2.

Finally it should be noted, that even though the evidence of no asymmetries suggests that liquidity constraints are not the key source of excess sensitivity for Finland, neither do the results support the idea that myopic behaviour is the source. Under myopia, consumption should respond symmetrically to predictable income increases and decreases, that is the coefficients λ_1 and λ_2 in equation 3.4 should be positive, significant and equal. As shown in Table 3.2, this is not the case. This would suggest that an alternative source underlies the excess sensitivity[31].

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[31] An alternative explanation for excess sensitivity is examined in chapter 5.

Norway

The results for Norway are reported in Table 3.3. As noted previously, IVMA estimation results are reported due to the finding of a statistically significant MA(1) term (refer to the sixth column "MA(1) Term"). As for Finland, we focus on those regression results for which the real interest rate is excluded as a regressor (as shown in the fifth column, the estimated θ coefficient is statistically insignificant in all cases).

The results for Shea's asymmetry model are reported in row one of Table 3.3. There is no evidence of asymmetry as indicated by the statistically insignificant coefficients on negative and positive expected income growth (-0.009 with p-value = 0.975; and 0.119 with p-value = 0.522 respectively). The null hypothesis $\lambda_1 = \lambda_2$ cannot be rejected at conventional levels (0.454 with p-value = 0.797), further supporting the above evidence of no asymmetries. When the alternate methods of classifying positive income growth are used in conjunction with the estimation of the modified version of Shea's asymmetry model (equation 3.5), no evidence is found of significant asymmetry (p-values = 0.825, 0.071 and 0.836 for methods 2, 3 and 4 respectively). It should be noted that the number of quarters for which $\Delta\hat{y}$ is positive ranges from a minimum of 42 percent using method 4 to a maximum of 78 percent for method 1. Yet given the larger than average proportion of periods of positive income growth as identified using method 1, no evidence is found of significant asymmetries. The finding of statistically insignificant $\hat{\lambda}_3$ coefficients is actually in line with our earlier findings of no excess sensitivity for Norway reported in Chapter 2. Overall then, we find no evidence of asymmetry in consumption behaviour for Norway.

Sweden

The results for Sweden are reported in Table 3.4 and show that a similar story to that of Norway can be told for Sweden. For all regressions, there is evidence of a significant MA(1) process in the disturbance term, hence IVMA is the appropriate estimator (with twice lagged and earlier variables as valid instruments). Once again, we focus on those regression results where the real interest rate is excluded as a regressor due to its insignificance.

Referring to row 1(line 2), we can see that the point estimates of $\hat{\lambda}_1$ and $\hat{\lambda}_2$ are far from significant (0.034 with p-value = 0.770, and 0.033 with p-value = 0.836 respectively). The Wald χ^2 statistic is also insignificant (0.576 with p-value = 0.750). These results suggest that there is no evidence of either negative or positive asymmetry in Swedish consumption behaviour in response to predicted changes in income. Similar findings are found for the point estimates of $\hat{\lambda}_2$ from the estimation of equation 3.5 and the various classifications of positive income growth. Values of $\hat{\lambda}_2$ range from -0.008 (method 2) to 0.033 (method 1), but all are statistically insignificant. The average number of quarters for which $\Delta\hat{y}$ is positive is approximately 50 percent for all methods.

Even though Sichel's tests provided some evidence of asymmetry in Swedish consumption behaviour (in particular evidence of steepness), the above results suggest that there is no evidence of asymmetries in Swedish consumption in response to predicted changes in income. Furthermore, the insignificance of $\hat{\lambda}_3$ indicates that consumption is not excessively sensitivity to anticipated changes in income. This supports our earlier findings of no excess sensitivity for Sweden, reported in Chapter 2.

Summary

The overall impression obtained from these results is that even though the RE-LCPI hypothesis is rejected for Finnish data based on the finding of excess sensitivity (Chapter 2), liquidity constraints are not a likely candidate as the source of the excess sensitivity. This is suggested by the lack of evidence of asymmetric responses, using either Sichel's tests or Shea's tests of asymmetries. Furthermore, no evidence exists either to suggest that myopic behaviour is the key source. With respect to Norway and Sweden, neither data set exhibits evidence of excess sensitivity, which supports our findings in Chapter 2. No evidence of significant asymmetries exists for either country using Shea's tests, but evidence of steepness is reported for Sweden using Sichel's steepness test.

Table 3.2: Finland - IV Estimates of Shea's Asymmetry Model (Equations 3.4 and 3.5); 81 observations used for estimation (1975Q4-1995Q4).

Breakdown of expected income growth using:	λ_1 Coef. [P-value]	λ_2 Coef. [P-value]	λ_3 Coef. [P-value]	θ Coef. [P-value]	$\chi^2(2)$ H_0: $\lambda_1=\lambda_2$ Coef. [P-value]	Quarters [POS=1] (% of Sample obs.)
Method 1 (Eq. 3.4)	0.334[0.180] 0.349[0.168]	0.573[0.002]* 0.559[0.003]*	-	-0.056[0.066]	18.995[0.000]* 18.131[0.000]*	56 (69%)
Method 1 (Eq. 3.5)	-	0.239[0.521] 0.210[0.578]	0.334[0.180] 0.349[0.168]	-0.056[0.066]		56 (69%)
Method 2 (Eq. 3.5)	-	0.228[0.313] 0.157[0.488]	0.346[0.043]* 0.384[0.026]*	-0.056[0.050]		44 (54%)
Method 3 (Eq. 3.5)	-	0.069[0.834] 0.058[0.863]	0.436[0.058]** 0.440[0.059]**	-0.055[0.069]		46 (57%)
Method 4 (Eq. 3.5)	-	0.124[0.686] 0.100[0.748]	0.403[0.062]** 0.414[0.058]**	-0.055[0.067]		42 (52%)

Key to Tables 3.2-3.4

1. * = significant at the 5 percent level; ** = significant at the 10 percent level.
2. Coef. = coefficient; Eq. = equation; obs. = observations.
3. Method 1: Asymmetric effect from predicted increases and decreases in income growth (Shea's breakdown of expected income growth).
4. Method 2: Asymmetric effect from predicted income greater than average of previous year.
5. Method 3: Asymmetric effect from predicted income growth greater than sample mean.
6. Method 4: Asymmetric effect from predicted income growth greater than trend.
7. Equation 3.4: $\Delta c_t = \mu + \lambda_t (NEG_t)\Delta\hat{y}_t + \lambda_2 (POS_t)\Delta\hat{y}_t + \beta\hat{r}_t + \varepsilon_t$, where $\varepsilon_t = e_t + \rho e_{t-1}$; t = 1...n, $e_t \approx NID\left(0,\sigma_e^2\right)$; the MA(1) term was found not to be statistically significant for the Finnish data set, hence (i) it is not reported in Table 3.2 and (ii) Equation 3.4 is estimated using IV for same data set.
8. Equation 3.4: $\Delta c_t = \mu + \lambda_2 (POS_t)\Delta\hat{y}_t + \lambda_3 (ALL_t)\Delta\hat{y}_t + \beta\hat{r}_t + \varepsilon_t$, where $\varepsilon_t = e_t + \rho e_{t-1}$; t = 1...n, $e_t \approx NID\left(0,\sigma_e^2\right)$; the MA(1) term was found not to be statistically significant for the Finnish data set, hence (i) it is not reported in Table 3.2 and (ii) Equation 3.4 is estimated using IV for same data set.

Table 3.3: Norway - IVMA Estimates of Shea's Asymmetry Model (Equations 3.4 and 3.5); 102 observations used for estimation (1969Q3-1994Q2). Refer to Key at end of Table 3.2.

Breakdown of expected income growth using:	λ_1 Coef. [P-value]	λ_2 Coef. [P-value]	λ_3 Coef. [P-value]	θ Coef. [P-value]	MA(1) Term Coef. [P-value]	$\chi^2(2)$ H_0: $\lambda_1=\lambda_2$ Coef. [P-value]	Quarters [POS=1] (% of Sample obs.)
Method 1 (Eq. 3.4)	0.036[0.900] -0.009[0.975]	0.129[0.513] 0.119[0.522]	-	-0.029[0.361]	-0.372[0.000]* -0.359[0.000]*	0.357[0.857] 0.454[0.797]	80 (78%)
Method 1 (Eq. 3.5)	-	0.094[0.789] 0.127[0.719]	0.036[0.900] -0.009[0.975]	-0.029[0.361]	-0.372[0.000]* -0.359[0.000]*		80 (78%)
Method 2 (Eq.3.5)	-	-0.058[0.842] -0.065[0.825]	0.143[0.561] 0.126[0.611]	-0.028[-0.368]	-0.373[0.000]* -0.360[0.000]*		53 (52%)
Method 3 (Eq. 3.5)	-	0.005[0.986] 0.022[0.071]	0.076[0.768] 0.044[0.865]	-0.028[0.373]	-0.371[0.000]* -0.358[0.000]*		49 (48%)
Method 4 (Eq. 3.5)	-	-0.026[0.932] -0.062[0.836]	0.097[0.706] 0.101[0.698]	-0.029[0.357]	-0.369[0.000]* -0.355[0.000]*		43 (42%)

Table 3.4: Sweden - IVMA Estimates of Shea's Asymmetry Model (Equations 3.4 and 3.5); 95 observations used for estimation (1972Q2-1995Q4). Refer to Key at end of Table 3.2

Breakdown of expected income growth using:	λ_1 Coef. [P-value]	λ_2 Coef. [P-value]	λ_3 Coef. [P-value]	θ Coef. [P-value]	MA(1) Term	$\chi^2(2)$ H_0: $\lambda_1=\lambda_2$ Coef. [P-value]	Quarters [POS=1] (% of Sample obs.)
Method 1 (Eq. 3.4)	0.033[0.773] 0.034[0.770]	0.079[0.434] 0.067[0.505]	-	-0.021[0.261]	-0.447[0.000]* -0.429[0.000]*	0.745[0.689] 0.576[0.750]	56 (59%)
Method 1 (Eq. 3.5)	-	0.046[0.775] 0.033[0.836]	0.033[0.773] 0.034[0.770]	-0.021[0.261]	-0.447[0.000]* -0.429[0.000]*		56 (59%)
Method 2 (Eq.3.5)	-	-0.006[0.968] -0.008[0.954]	0.077[0.472] 0.071[0.510]	-0.022[0.225]	-0.455[0.000]* -0.436[0.000]*		44 (46%)
Method 3 (Eq. 3.5)	-	0.025[0.874] 0.013[0.932]	0.053[0.639] 0.052[0.648]	-0.023[0.215]	-0.449[0.000]* -0.431[0.000]*		48 (51%)
Method 4 (Eq. 3.5)	-	0.022[0.890] 0.004[0.979]	0.054[0.638] 0.057[0.622]	-0.022[0.239]	-0.450[0.000]* -0.433[0.000]*		50 (53%)

3.5: CONCLUSION

In this chapter, we tested for asymmetric behaviour in consumption data with a view to distinguishing between myopia and liquidity constraints as potential explanations for excess sensitivity. The discriminatory test was based on the following argument. Under myopia, consumption tracks income, and thereby consumption should respond symmetrically to predictable income increases and decreases. Under liquidity constraints, which impede borrowing when income is temporarily low, the result is an asymmetric response, where consumption responds more strongly to income increases than decreases.

First, we employed Sichel's (1993) tests of deepness and steepness to investigate if there were significant asymmetries in consumption for Finland, Norway and Sweden. However, we only found evidence of steepness for Sweden, results which suggest that Swedish consumption growth rates can be described by a pattern of slow ascents and rapid descents. The lack of evidence for asymmetries using Sichel's tests could be related to a couple of factors. Firstly, asymmetries may not actually be present in the data, and therefore will not be detected. Secondly, it could be argued that Sichel's tests which are based on the measure of skewness would become sharper if a longer time series was available and used. Thirdly, DeLong and Summers(1986) noted that particulars features of quarterly data, such as it's need to be seasonally adjusted and it's high frequency movements, may render existing skewness undetectable (1986:170). This would suggest that an alternative periodicity of data, such as annual data may highlight asymmetries more when measures of skewness are employed.

Second, we employed Shea's(1995) asymmetry test; he analysed the response of consumption growth to positive and negative income growth, where the change in income growth was defined as positive or negative if it was greater or less than zero respectively. In this chapter we built upon the work of Shea in a number of ways, including: firstly, we used additional ways of distinguishing positive and negative changes in income growth; secondly, an alternative estimation method was employed, that of IV and IVMA; and thirdly, a modified version of Shea's model was estimated.

We found no evidence to reflect the importance of liquidity constraints over myopic behaviour as potential explanations for excess sensitivity. This result is of particular importance for Finland, given our finding of strong evidence of excess sensitivity reported in Chapter 2. This could be related to the fact that an alternative explanation underpins excess sensitivity for Finland. In chapter five, we focus on such an explanation, that of precautionary savings. The results for Norway and Sweden can be interpreted as being supportive of those already obtained in chapter 2 with respect to the excess sensitivity findings, but no evidence of significant asymmetries emerged for either country.

In the next chapter, we re-appraise the role of asymmetries in consumption, by considering the dis-aggregation of consumer expenditure into the broad categories of durable goods, and nondurables and services. Previous studies, including Speight and McMillan have found evidence of asymmetry in the category of durable goods, a result which was not found in other consumption categories such as total consumption expenditure or expenditure on consumption of nondurables and services. Hence we further explore the role of asymmetries in consumption by consumption category, and use this new information to provide an additional way of discriminating between the potential explanations of excess sensitivity.

CHAPTER FOUR

LIQUIDITY CONSTRAINTS AND DURABLE GOODS

4.1 INTRODUCTION

As outlined in the earlier chapters, the finding that consumption tracks current income more closely than is consistent with the RE-LCPI hypothesis (excess sensitivity) has frequently been attributed to the presence of liquidity constraints and the existence of myopic consumers. In the previous chapter, we looked at the role of asymmetries in consumption behaviour with the aim of discriminating between these two potential explanations of excess sensitivity. However the results obtained did not provide conclusive evidence in favour of either explanation. Overall asymmetries did not appear to be significant.

This chapter seeks to further explore the role of asymmetries in consumption; in particular we seek to analyse the cyclical behaviour of total consumption, income, consumption of durables, and consumption of non-durables and services. Tests for asymmetries in these broad categories of consumption, and income are conducted, and a subsequent discriminatory test of myopia and liquidity constraints is proposed based on the following argument.

Following Chah, Ramey and Starr(1995), we argue that consumers use durable expenditures to enable smoothing on non-durable expenditure in the face of liquidity constraints. Chah et al. put forward the idea that if credit is not available to the consumer, then the timing of durable expenditure can be used to help keep non-durable spending smooth. In particular when consumers experience negative transitory income, the first thing they will choose to do, is to postpone buying durables (for example, postpone buying a new car), so as to smooth out their level of consumption of non-durables and services (for example, such as food, heating etc.). Such a reaction should be reflected in the pattern of durable consumption growth in the following ways. Firstly, we would expect to see greater volatility in the consumption of durables relative to the consumption of non-durables and services. Secondly, the observed reductions of durable expenditure should be deeper than the reductions of non-durables and services expenditure. This latter reaction can be equated with Sichel's (1993) deepness effect.

This chapter is an extension of the work in chapter three and provides an alternative way of distinguishing between myopia and liquidity constraints as potential explanations of excess sensitivity. The plan of the chapter is as follows. The effects of liquidity constraints on durable goods expenditure has been the subject of a number of empirical studies. Section two contains a brief and selective review of the recent contributions to the literature. Our estimation strategy is reviewed in section three. Section four presents and analyses the empirical results obtained from these tests. Finally, the conclusion provides a summary of the research.

4.2 DURABLE GOODS, LIQUIDITY CONSTRAINTS AND ASYMMETRIES

Durable goods are defined as those which yield a flow of services into the future, and are the most cyclically volatile component of household spending. Research on durable goods is important, primarily because durable goods represent an important part of household wealth, and decisions to purchase and/or sell durable goods has a major impact on aggregate consumer expenditure. Yet most empirical work on consumption and saving decisions abstract from the existence of durable goods; however there are some notable exceptions, including Mankiw(1982), Bernanke(1985), Hayashi(1985b) and

Cabellero (1990b, 1993). Mankiw (1982) argued that expenditure on durable goods could be modelled as an ARMA(1,1), where the MA(1) term arose due to the fact that durables last for more than one period (in contrast to non-durables). However using quarterly U.S. post-war data, Mankiw rejected this hypothesis and found that the time series behaviour of durables expenditure exhibited the same behaviour as expenditures on non-durables. More recent work by Cabellero (1990b, 1993) showed support for Mankiw's initial ARMA(1,1) hypothesis, once it was taken into account that consumers seem to adjust their expenditures in durable goods slowly in response to shocks/news about the economic environment(1990b:728). Bernanke(1985) tested the RE-LCPI hypothesis for durable good expenditures but rejected the hypothesis for US quarterly data. Hayashi(1985) obtained a similar finding using Japanese panel data.

Liquidity Constraints and Durable Goods Expenditure

For this chapter, the interest lies in the effects of liquidity constraints on durable consumption expenditure. In particular, it is investigated how liquidity constraints affect the behaviour of both durable and non-durables expenditure, when consumers anticipate future changes in their income (income increases or decreases). Studies which have focused specifically on the effects of liquidity constraints on the decision to purchase consumer durables include Brugiavini and Weber (1992), Chah, Ramey and Starr (1995), and Alessie, Devereux, and Weber (1997)[1].

Both Brugiavini and Weber (1992) and Alessie, Devereux, and Weber (1997) used survey information for Italy and United Kingdom respectively to analyse the effect of

[1] As noted in the previous chapters, there have been numerous attempts to examine the effect of liquidity constraints on consumption and include Muellbauer (1983), Flavin (1985), Hayashi (1987), Zeldes (1989a), Jappelli (1990), Runkle (1991), Flavin (1994).

liquidity constraints on durables expenditure[2]. Brugiavini and Weber (1992) examined if the availability of consumer credit influenced the choice between durable goods (specifically the purchase of motor vehicles) and non-durable goods expenditure. In particular they regressed an estimate of the shadow price of the financial constraint facing consumers on both credit and demographic variables, to see what effect the constraint had on their durables-nondurables choice. For the credit variables, they constructed two credit market indicators. The first took on a value of 1 for those households who had been refused credit or who did not apply for credit in the expectation that their application would be denied. The second indicator took on a value of 1 for those households who did borrow funds when purchasing a motor vehicle. Their demographic variables included the age of the head of the household, their marital status, their educational status etc.

Based on these regression results, Brugiavini and Weber found that the trade-off between the consumption of durable and non-durable goods was influenced by credit availability, and that the trade-off was affected by the value of collateral owned by the consumer[3]; "[i]n particular if the extra credit made available for purchasing an extra unit of a durable good is less then the present value of its future resale value, then liquidity-constrained consumers will be induced to purchase less of that durable good and more non-durables (and *vice versa*, if the extra credit exceed that amount)"(1992:23).

Following Brugiavini and Weber(1992), Alessie, Devereux, and Weber (1997) employed a similar approach, but for survey information from the UK Family Expenditure Survey, to investigate the UK boom in consumer expenditure on durables in the 1980s. They concluded firstly, that prior to financial liberalisation in the UK, binding liquidity

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[2] Both papers assumed that the durable stock held by consumers acted as collateral for credit purchases.

[3] They showed that "if the borrowing limit facing forward looking consumers depends on the value of the collateral, i.e. on the resale value of the stock of durables, then the trade-off between the consumption of durable and non-durable goods is affected by liquidity constraints." (1992:23)

constraints mostly affected young households; and secondly, this in conjunction with the presence of high statutory down payment requirements up to 1982, implied that young British households were effectively discouraged from purchasing durable goods during the pre-liberalisation period.

Murphy (1997) investigated the role of the debt burden of households in helping to explain aggregate consumption expenditure, where the debt burden was measured as the ratio of household debt service to disposable personal income. He include lagged values of the debt-service ratio in a modified version of the Campbell and Mankiw(1989, 1990, 1991) model as follows:

$$\Delta c_t = \mu + \lambda_1 \Delta y_t + \sum a_i DS_{t-i} + \varepsilon_t$$

where Δc and Δy are consumption growth between t-1 and t, and expected income growth between t-1 and t respectively; and DS is the debt service to income ratio. He estimated this model using quarterly data on total real personal consumption expenditures and its components (durable goods, non-durables, and services), and tested for the joint significance of the lagged values of the debt-service ratio. Of particular interest to our work is his finding that lagged values of the debt-service ratio had a direct effect on the consumption of durables, but not on non-durables. He related this finding to the fact that households who face tighter lending conditions would more than likely reduce their consumption first in those categories that are considered discretionary. Purchases of durables are often deemed as discretionary in that they can be postponed if economic conditions are not favourable and vice versa (Weder (1998:3)).

Liquidity constrained behaviour has in previous studies been linked to unemployment (for example, Flavin(1985)). To the extent that unemployment proxies for liquidity constraints, we include in our literature review, those studies which have looked at the pattern of durable expenditures in response to changes in an individual's employment status; for example Browning and Crossley(1997) and Dunn(1998).

Browning and Crossley (1997) asked the following question "How do agents smooth consumption (if, indeed they do) or how do poor consumers smooth consumption during times of temporarily low income due to an unemployment spell" (1997:2). Using Canadian unemployment survey data, they investigated the effects of unemployment benefit levels on consumption. Specifically they estimated a demand system for total expenditure, expenditure on a non-durable good (food at home) and expenditure on a small durable (clothing). They concluded that consumers operate a smoothing mechanism whereby they adjusted the timing of the replacement of clothing and small durables to their income flow. That is, during periods of negative transitory income, they postponed the purchase of clothing and small durables rather than go hungry. Even though they did not explicitly focus on consumers who are liquidity constrained in their analysis, they did suggest that the presence of such constraints would make the postponing of clothes and small durables expenditures more likely.

Dunn(1998) addressed the effect of unemployment risk on the timing of durable expenditures. Using household level data from the 1983 and 1992 Survey of Consumer Finances (1983 and 1992), she estimated a probit model of the household's decision to purchase a durable good. Specifically, the dependent variable was an indicator of whether the household recently purchased a house, and one of the independent variables was a proxy for unemployment risk. The latter variable was calculated as the probability that a currently employed consumer would be unemployed in the next year. She concluded that if consumers perceived increases in unemployment risk, they postponed durable good expenditures in order to increase the precautionary buffer stock of liquid assets.

All of these studies highlight two important points for the work in this chapter. Firstly, the availability (or lack) of credit does have an effect on the choice between expenditure on durable and non-durable goods. Secondly, liquidity constraints (and unemployment as a proxy) do have an affect on durable consumption expenditure, and in particular consumers reactions to such constraints are to adjust this type of consumption before adjusting non-durables. Such findings could be related to the fact that durable expenditure often requires a sizeable initial down payment, or even payment in full[4].

Liquidity Constraints, Durable Goods Expenditure, and Predictable Changes in Income

Chah, Ramey, and Starr(1995)[5] expanded the analysis of durable expenditure further, by investigating the effects of credit availability on durable goods consumption, in the face of predictable changes in income. They were able to show that a distinctive relationship existed between household stocks of durables and consumption of non-durable goods, and that this relationship implied that lagged changes in durable expenditure relative to non-durable expenditure would have predictive power for the current change in non-durables goods consumption. They argued that if consumers could not borrow against future income to finance current expenditures for durable consumption, then predictable increases in income would be preceded by reductions in expenditures on durables. That is, if consumers anticipate increases in future income, but

[4] Obviously, the purchase of non-durables and services also requires payment in full, but in general require smaller amounts of cash.

[5] Studies such as those done by Brugiavini and Weber (1992) and Alessie, Devereux, and Weber (1997) examined liquidity constraints where the consumer could not borrow against currently held assets, whereas Chah, Ramey and Starr (1995) examine the issues when the consumer cannot borrow against expected future lifetime income.

cannot borrow against this, they will temporarily reduce purchases of durables and reallocate expenditures to current non-durable expenditures. Once the income increase is realised, consumers will undertake the desired augmentation of their durable goods stocks accordingly. For the opposite case where durable goods are fully financeable (but non-durables are not), then predictable increases in income would be preceded by increases in expenditures on durables, as consumers anticipate the increase in debt service capacity.

They estimated the following "liquidity constraint" model:

$$\Delta \ln C_{t+1} = constant + \theta_1 r_{t+1} + \theta_{2t+1} Z_t + \theta_3 \Delta \ln C_t + \theta_4 \Delta \ln K_t + \tau_{t+1}$$

where C_t is the consumption of non-durables during period t, r is the (constant) real interest rate, K_t is the stock of durables at the end of period t (they focused on motor vehicles and motor vehicle parts), and Z_t is an error correction term (which predicts future changes in non-durable consumption). All variables except the interest rate were expressed in logarithms. Chah et al. estimated two versions of the above model; firstly they assumed that θ_2 was constant, and secondly they assumed that it was significantly different from zero. They employed the IV estimator, where the instruments used were lags 1 through 5 of the log change in real disposable income; the commercial paper rate; the real interest rate; and the log change in the stock of cars. Using US monthly data for the period 1959M1 to 1989M12, they rejected the RE-LCPI hypothesis based on the finding that lagged values of the change in the stock of cars, and of non-durables were statistically significant in the "liquidity constraint" model.

They then estimated the Campbell and Mankiw(1989, 1990, 1991) rule-of-thumb (ROT) model, and found evidence of excess sensitivity. To detect whether this finding could be attributed to liquidity constraints or "Keynesian" rule-of-thumb behaviour, they included contemporaneous disposable income growth as a regressor in the above "liquidity constraint" model. Firstly, they noted, that the coefficient on income decreased and was no longer significant (compared to its estimate in the Campbell-Mankiw ROT model). Secondly, they noted that the liquidity constraints terms(the lagged stock of cars, etc.) remained significant. Hence they concluded that the excess sensitivity findings could be attributed to liquidity constraints.

Asymmetries in Durable Goods Expenditure

Finally, as previously noted in chapter three, a number of studies including Dynarski and Sheffrin (1986a), Holly and Stannett (1995), and Speight and McMillan (1997, 1998), have investigated asymmetries in consumption. Of particular interest to this chapter are the studies by Speight and McMillan who disaggregate consumers expenditure into the broad categories of durable and non-durable goods and services, and according to 13 specific consumption categories (food, beer, cars and other vehicles etc.), and tested for asymmetric dynamics in these categories. They concluded that durables exhibited significant asymmetric "steepness" while non-durables did not.

Conclusion

Speight and McMillan's (1997, 1998) finding of asymmetric behaviour in durables expenditure (which was not apparent in the consumption of non-durables and services), in conjunction with the evidence put forth by the other studies concerning the effects of liquidity constraints on durable expenditure (in particular, the Chah et al. study) provides a number of testable predictions. First, one of the obvious predictions is that we should see more volatility in expenditure on durables than we do for non-durables and services. Second, we should find that expenditure on durables should exhibit asymmetric patterns over time, and more specifically, that there should be a significant distinction in the asymmetric behaviour of durables versus the non-durables and services category.

Given these testable predictions, in this chapter we firstly examine the volatility of income and of consumption and its components. Secondly, deepness and steepness tests (as outlined in chapter 3) are employed to identify patterns in the growth on income, total consumption, consumption of durables, and the consumption of non-durables and services. More specifically we aim to test for comparative asymmetric behaviour in income and the consumption of durables. The methodology and related data issues are outlined in the next section.

4.3 METHODOLOGY AND DATA ISSUES

In this chapter, Chah et al.'s. hypothesis of the distinctive relationship between durable stocks and non-durables expenditure is adopted to investigate the underlying argument that the timing of durable expenditure is used to keep non-durable spending relatively smooth. Specifically the question as to whether durable consumption is used to enable smoothing on non-durable expenditure during periods of abnormally low income is investigated. It is argued that if deepness and steepness are evident for income growth (that is, asymmetric behaviour of income growth), but are not reflected to the same extent in consumption growth, this would suggest that consumers can smooth their consumption. This then leads to the question of how is the smoothing enacted? Possibilities include that the consumer can borrow, or alternatively that they can modify their durables expenditure. If credit is not available to the consumer (liquidity constrained), then adopting Chah et als (1995) argument, it can be argued that the timing of durable expenditure can be used to help keep non-durable spending smooth; that is during temporary spells of low income, the first thing the consumer will do is to cut their durable spending, and maintain their level of consumption of non-durables and services. Hence, such a reaction should be reflected in the pattern of durable consumption growth. In particular, comparative asymmetric behaviour should be evident in income and the consumption of durable goods.

4.3.1 ESTIMATION STRATEGY

Our estimation strategy proceeds as follows. Firstly, we calculate the volatility of income, total consumption and its components (durables, and non-durables and services). Volatility is measured by the time series standard deviation. Given the above arguments, we would expect income and the consumption of durables to be more volatile relative to total consumption and consumption of non-durables and services, a feature which would be consistent with durable goods volatility and consumption smoothing.

Secondly, we calculate Sichel's (1993) deepness and steepness tests to identify asymmetric/symmetric patterns in income, total consumption and its components. We first focus on asymmetries in income; evidence of deepness would reflect temporary bad news in income, while steepness would be reflected in the slow movement of income growth out of a recession. We then proceed to examine if similar cyclical characteristics are evident in the broad consumption categories. If we find that the cyclical characteristics of income and the consumption of non-durables and services are similar, this would suggest that consumption smoothing is not practised; that is consumption tracks current income. However if there are notable differences, in particular where income appears to be more asymmetric than the consumption of non-durables and services, the following question then arises: do changes in durable expenditure enable consumption smoothing. If this is the case, we would expect to see similar cyclical patterns evident in both income and consumption of durables data, but not (or at least not to the same degree) in the consumption of non-durables and services. A brief review of the Sichel tests is given in the next section.

4.3.2. SICHEL'S TEST OF DEEPNESS AND STEEPNESS

We recap in brief the essence of Sichel's tests of deepness and steepness; for further details we refer the reader to Chapter 3, Section 3.3.1.1 and to Sichel (1993). His test of deepness is based on the coefficient of skewness of a time series, where the data is expressed in levels:

$$D(c) = \left[(1/T)\sum_t (c_t - \bar{c})^3 \right] / \sigma(c)^3$$

where $\bar{c}$ and $\sigma(c)$ are the mean and standard deviation of the cyclical component c_t, and T is the sample size. If a series exhibits deepness, then it should be negatively skewed relative to mean or trend. Sichel's of steepness is based on the coefficient of skewness for the first difference of the variable concerned:

$$ST(\Delta c) = \left[(1/T)\sum_t (\Delta c_t - \Delta\bar{c})^3 \right] / \sigma(\Delta c)^3$$

where $\Delta\bar{c}$ and $\sigma(\text{c})$ are the sample mean and standard deviation of Δc (Δ is the first difference operator). Finally, as Sichel's tests are based on the cyclical component of a time series, we need to employ trend removal methods. Specifically, we adopt the HP filter to select the appropriate component for use in the deepness test and the first difference filter to select the appropriate component for the steepness test. We refer the reader to Chapter 3, Section 3.3.2 "Trend Removal Methods" for further details on both filters.

4.3.3. DATA ISSUES

The following data is examined, aggregate consumer expenditure, the consumption of non-durables and services, the consumption of durables, and disposable income, for Finland, Norway and Sweden. All data is expressed in quarterly and seasonally adjusted terms, and the natural log transformation is applied to each series. The data samples are 1970Q1 to 1996Q2, 1967Q2 to 1994Q4, and 1970Q1 to 1995Q4 for Finland, Norway and Sweden respectively. Plots of the data are shown in Figures 4.1 to 4.12 in the Appendix 4.1. As well as the original series (expressed in logarithms), the plots also show the smoothed trend generated by the HP filter, the corresponding cyclical component and the first differences of the data. Examining the plots of the data in levels (LCP, LCND, LCD, and LYD), all series appear to be strongly trended, which is confirmed by the test of the order of integration. We found in chapter 2, that the time series of income, total consumption and the consumption of non-durables and services were integrated of order one (refer to Chapter 2, Section 2.5.1). In Table 4.1, we show the ADF statistics for the consumption of durables in levels (lcd) and in first differences (dlcd). We can conclude that this series is also integrated of order one. Referring to the other plots of data (for example of the cyclical component etc.) additional features of these plots will be noted as we discuss the empirical results in the next section.

Table 4.1: Augmented Dickey Fuller Tests of Unit Roots for the Consumption of Durables for Finland, Norway and Sweden; Lag length is set by AIC.

COUNTRY	Lag	τ_τ	Φ_3	τ_μ	Φ_1	τ
FINLAND						
lcd	11	-3.279	5.383	-1.829	1.687	0.097^A
dlcd	1	-7.452^{*C}	-	-	-	-
NORWAY						
lcd	3	-1.754	2.390	-1.981	3.714	1.798^A
dlcd	1	-8.694^{*C}	-	-	-	-
SWEDEN						
lcd	1	-1.982	2.301	-1.962	2.113	0.523^A
dlcd	1	-9.025^{*C}	-	-	-	-

Key to Table 4.1
- 5% Critical Values for τ_τ, Φ_3, τ_μ, Φ_1, τ are -3.43, 6.34, -2.88, 4.63, and -1.95 respectively.
- *: Significant at the 5 percent level; **: Significant at the 10 percent level.
- A: Series contains a unit root with zero drift; B: Series contains a unit root with drift; C: Series has no unit root; D: Series stationary around a non-zero mean.

4.4 EMPIRICAL EVALUATION

4.4.1 VOLATILITY MEASURES

We present measures of volatility in Table 4.2 for the cyclical components of the following variables: real disposable income, consumption of durables, consumption of non-durables and services, and total consumption. As noted previously, volatility is measured by the time series standard deviation. As expected, durable consumption is the most volatile of all the consumption components (the standard deviation = 0.098, 0.044, and 0.049 for Finland, Norway and Sweden respectively). Corroborating evidence of durable volatility is shown in Figures 4.1-4.3 which plots the cyclical components of income (YDHC), total consumption (CPHC), consumption of non-durables and services (CNDHC) and consumption of durables (CDHC).

We also present another measure of volatility, "Relative Volatility", which is measured as the ratio of the standard deviation of each of the consumption measures to the standard deviation of income. A ratio greater than one implies that the consumption measure has greater volatility than does real income. A clear result emerges for all three countries. As expected, the durables expenditure category is more volatile than real income; the volatility ratio is greater than one for all countries, and is in the range of 2-4 (the durable volatility ratio = 4.132, 2.234 and 2.292 for Finland, Norway and Sweden respectively). The volatility ratio of both total consumption expenditure and consumption expenditure on non-durables and services are closer to one, actually for Finland and Sweden it is below one (0.684 and 0.5 respectively). This indicates that these series are relatively smooth, which may suggest consumption smoothing.

The next set of columns in Table 4.2 show cross-correlations of each variables with real income at a one period lead and lag as well as contemporaneous correlations. For Finland, all variables are highly correlated, in particular the measures of total consumption and the consumption of non-durables and services with real income (contemporaneous correlations = 0.597 and 0.664 respectively). The correlations for both Norway and Sweden are relatively lower. For Norway, the corresponding contemporaneous correlations are 0.427 and 0.381 respectively; whilst for Sweden, the figures are 0.189 and 0.223. Overall these results indicate that all variables are pro-cyclical and that there is evidence of the a priori co-movement between income and consumption (and its components).

Table 4.2: Cyclical Behaviour of Real Income, Consumption and its components for for Finland, Norway and Sweden.

Finland 1970Q1-1995Q4 Variable		**Std.Dev.**	**Relative Volatility**	**Correlation of A(t) with B(t-j) with j =**		
A	**B**	σ_B	σ_B / σ_A	**-1**	**0**	**1**
Income	Income	0.023	1.000			
Income	Durable Consumption	0.098	4.132	0.348	0.389	0.337
Income	Non-durable and Services	0.016	0.684	0.660	0.664	0.515
Income	Total Consumption	0.021	0.932	0.583	0.597	0.470

Norway: 1966Q1-1994Q4 Variable		**Std.Dev.**	**Relative Volatility**	**Correlation of A(t) with B(t-j) with j =**		
A	**B**	σ_B	σ_B / σ_A	**-1**	**0**	**1**
Income	Income	0.019	1.000			
Income	Durable Consumption	0.044	2.234	0.191	0.396	0.233
Income	Non-durable and Services	0.020	1.037	0.199	0.381	0.292
Income	Total Consumption	0.024	1.212	0.207	0.427	0.295

Sweden: 1970Q1-1995Q4 Variable		**Std.Dev.**	**Relative Volatility**	**Correlation of A(t) with B(t-j) with j =**		
A	**B**	σ_B	σ_B / σ_A	**-1**	**0**	**1**
Income	Income	0.022	1.000			
Income	Durable Consumption	0.049	2.292	-0.055	0.170	0.111
Income	Non-durable and Services	0.011	0.500	0.064	0.223	0.016
Income	Total Consumption	0.017	0.766	0.066	0.189	0.087

Key to Table 4.2

1. Std. Dev. = standard deviation (σ).

Figure 4.1: Finland - Cyclical Components

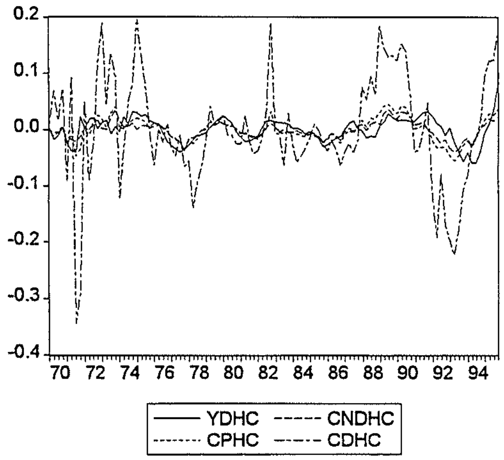


Figure 4.2: Norway - Cyclical Components

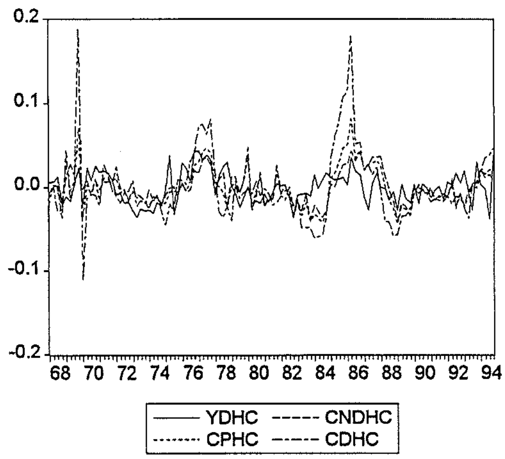
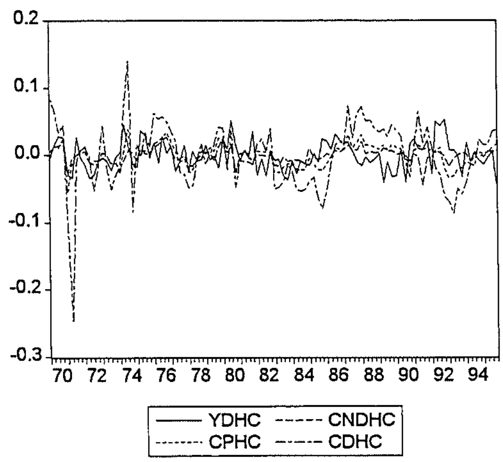


Figure 4.3: Sweden - Cyclical Components



4.4.2. SICHEL'S ASYMMETRY TESTS

The next stage is to test for deepness and steepness using Sichel's tests; the statistics are reported in Table 4.3. The column titled "Deepness" displays asymmetries in the levels of trend deviations; whilst the column titled "Steepness" indicates the extent of asymmetry in the growth rates of the various consumption categories and income. For each test, values of the test statistics, standard errors and one-sided p-values are shown. The standard errors reported are the Newey-West (1987, 1994) asymptotic heteroscedastic and autocorrelation consistent standard errors, obtained using the Parzen window, which weights the autocovariances quadratically[6]. To assess the robustness of the results to various window sizes (truncation lags of autocovariances), we report three window sizes up to approximately one third of the sample size. The p-values reported are for one sided significance levels at which the null hypothesis of zero deepness or zero steepness can be rejected.

For Finland there is no evidence of deepness in either income or consumption and its components. The steepness statistics show evidence of significant negative skewness at the 10 percent level in the first differences of consumers' durable expenditure relative to trend (for window size = 35, the p-value of the durable steepness test = 0.0676). This finding is robust to the selection of the window size. The finding of significant negative skewness in first differences suggests that durable expenditure behaviour can be characterised by sharp decreases which are large but less frequent than more moderate increases. Some corroborating visual evidence is shown in Figure A4.3 (in the appendix).

For Norway, there is evidence of asymmetric deepness in total consumption expenditure and in expenditure on durables. For the Parzen window size equal to one

[6] Refer to Chapter 3, Section 3.4.1.2 for further discussion on the Newey West method.

third of the sample size, the results suggest that total consumption and expenditure on durables exhibits significant positive deepness at the 0.04 and 0.02 significance level respectively. This finding suggests that the average deviation of observations above trend exceed the average deviation of observations below trend, that is inverse deepness (tallness). Figures A4.5 and A4.7 visual confirms these findings. Such asymmetry is not evident in either income or the consumption of non-durables and services. Turning to the steepness results, there is only evidence of asymmetric steepness at the 0.04 significance level for total consumption expenditure.

With respect to Sweden, there is no significant evidence of deepness in any of the data categories, but there is evidence of significant steepness in both total consumption expenditure, and in expenditure on non-durables and services. In particular the finding of significant negative skewness in first differences at the 0.02 significance level for both measures, indicates that both series can be characterised by sharp decreases followed by moderate increases. Such a pattern is clearly evident for total consumption expenditure in Figure A4.9; the pattern is not as visually clear for the consumption of non-durables and services in Figure A4.10.

Summary

Whilst there is evidence to suggest that our a priori expectations of the volatility of durable consumption are correct (as indicated by the time series standard deviations and relative volatility measures), there is no clear evidence to suggest that such fluctuations enable consumption smoothing (as indicated by the asymmetry tests). For Finland and Norway there is evidence of asymmetries in durable goods expenditure, but in contrast to our a priori results such a pattern is not apparent in income. Specifically, for Finland, there is evidence of significant asymmetric steepness in expenditure on durable goods, which suggests that expenditure on durable goods declines quickly during recessionary times and initially recovers slowly during expansionary periods. For Norway, there is evidence at the 5 percent level of deepness in the consumption of durables. Turning to Sweden, there is only evidence of asymmetries in the consumption of non-durables and services, and total consumption (specifically asymmetric steepness). Not surprisingly the former results coincides with that found in chapter three.

Table 4.3: Do Income and Consumption Exhibit Deepness and Steepness? - Evidence for Finland, Norway and Sweden

Country	Vari	Lag	DEEPNESS D(c)	a.s.e.	p-value[a]	STEEPNESS ST(Δc)	a.s.e.	p-value[a]
Finland 70.1-95.4	CP	25	-0.0032	0.5638	0.4978	-0.0530	0.4755	0.4556
		30	-0.0032	0.4994	0.4975	-0.0530	0.4712	0.4552
		35	-0.0032	0.4401	0.4971	-0.0530	0.4662	0.4547
	CD	25	-0.5016	0.6771	0.2272	-0.5816	0.4036	0.0748**
		30	-0.5016	0.6370	0.2133	-0.5816	0.3952	0.0705**
		35	-0.5016	0.6044	0.2009	-0.5816	0.3894	0.0676**
	CNDS	25	-0.0051	0.5799	0.4965	-0.0654	0.5588	0.4534
		30	-0.0051	0.5191	0.4961	-0.0654	0.5643	0.4539
		35	-0.0051	0.4599	0.4956	-0.0654	0.5639	0.4538
	YD	25	-0.1845	0.3702	0.3091	0.8677	1.0627	0.2071
		30	-0.1845	0.2995	0.2689	0.8677	1.0627	0.2071
		35	-0.1845	0.2426	0.2235	0.8677	1.0602	0.2066
Norway 68.2-94.4	CP	25	0.7523	0.5607	0.0898**	-0.9566	0.6153	0.0600**
		30	0.7523	0.4990	0.0658**	-0.9566	0.5921	0.0531**
		35	0.7523	0.4382	0.0430*	-0.9566	0.5708	0.0469*
	CD	25	1.6089	0.9223	0.0405*	-2.4305	2.0278	0.1153
		30	1.6089	0.8615	0.0309*	-2.4305	2.0048	0.1127
		35	1.6089	0.8007	0.0223*	-2.4305	1.9837	0.1103
	CNDS	25	0.2821	0.3776	0.2275	-0.2328	0.5207	0.3274
		30	0.2821	0.3262	0.1936	-0.2328	0.5159	0.3259
		35	0.2821	0.2740	0.1516	-0.2328	0.5096	0.3239
	YD	25	0.2459	0.4298	0.2836	0.4432	0.5066	0.1908
		30	0.2459	0.3949	0.2666	0.4432	0.5096	0.1922
		35	0.2459	0.3583	0.2462	0.4432	0.5110	0.1929
Sweden 70.1-95.4	CP	25	-0.3388	0.4396	0.2204	-1.0700	0.5576	0.0275*
		30	-0.3388	0.4219	0.2109	-1.0700	0.5579	0.0276*
		35	-0.3388	0.3975	0.1970	-1.0700	0.5614	0.0283*
	CD	25	-1.0669	1.1582	0.1785	0.1291	0.8039	0.4362
		30	-1.0669	1.1247	0.1714	0.1291	0.7304	0.4299
		35	-1.0669	1.0939	0.1647	0.1291	0.6701	0.4236
	CNDS	25	-0.7081	0.7664	0.1777	-0.6807	0.3835	0.0379*
		30	-0.7081	0.7428	0.1702	-0.6807	0.3592	0.0290*
		35	-0.7081	0.7183	0.1621	-0.6807	0.3315	0.0200*
	YD	25	0.2388	0.3078	0.2189	0.2224	0.2607	0.1968
		30	0.2388	0.2574	0.1768	0.2224	0.2549	0.1915
		35	0.2388	0.2222	0.1413	0.2224	0.2491	0.1859

Key to Table 4.3

(1) D(c): Deepness test statistic; ST(Δc): Steepness test statistic. (2) a.s.e. = Newey-West asymptotic standard error (Parzen window with window size up to 1/3 of the sample size). (3) p-value is the one-sided significance level at which the null of D(c)=0 or ST(Δc)=0 can be rejected. (4) * = significant at the 5 percent level; ** = significant at the 10 percent level.

4.5 CONCLUSION

Chah, Ramey and Starr(1995) hypothesised that changes in non-durable consumption expenditure are forecastable from corresponding prior changes in durable goods expenditures. They used this hypothesis to distinguish between a liquidity constrained and a "Keynesian" rule-of-thumb model of consumption behaviour, and concluded that liquidity constraints dominated myopia as an explanation of the excess sensitivity of consumption. We adopted their argument in this chapter with a view to distinguishing between myopia and liquidity constraints as potential explanations for excess sensitivity for the data sets of Finland, Norway and Sweden.

We used the following methods to aid our investigation: (a) volatility measures; and (b) Sichel's deepness and steepness tests. The volatility results strongly suggested, and as expected, that consumption of durables was the most volatile component of consumption. Sichel's test provided some noteworthy results. Firstly there was evidence of significant asymmetries in the consumption of durables for both Finland and Norway but not for Sweden. In particular there was evidence of steepness and deepness for Finland and Norway respectively. Secondly, there was evidence of significant steepness in both total consumption expenditure and expenditure on non-durables and services for Sweden. Thirdly, despite the above evidence of asymmetries present in some categories of consumption data, no such asymmetries were apparent in the disposable income measure for any of the countries. This would suggest that the observed asymmetries in the consumption categories, noted above, are not driven by fluctuations in income.

The lack of evidence suggesting comparable asymmetric behaviour for income and durables expenditure, indicates that the results do not necessarily reflect the importance of liquidity constraints or myopic behaviour as potential explanations for the Finnish excess sensitivity results observed in Chapter 2. Such evidence is certainly in line with our findings in chapter 3. Consequently, another explanation of excess sensitivity is sought. In the next chapter we investigate such an explanation, that of precautionary savings.

4.6 APPENDICES

A4.1 TIME-SERIES PLOTS OF INCOME AND CONSUMPTION DATA

Key to Figures A4.1-A4.12

LCP:	Total consumption, expressed in logarithms, constant prices, and in real per capita terms
CPHT:	Hodrick-Prescott trend for total consumption (LCP)
CPHC:	Cyclical Component from Hodrick-Prescott filter for total consumption (LCP)
DLC:	First difference of total consumption (LCP)
LCND:	Consumption of non-durables and services, expressed in logarithms, constant prices, and in real per capita terms
CNDHT:	Hodrick-Prescott trend for consumption of non-durables and services (LCND)
CNDHC:	Cyclical Component from Hodrick-Prescott filter for consumption of non-durables and services (LCND)
DLCND:	First difference of consumption of non-durables and services (LCND)
LCD:	Consumption of durables, expressed in logarithms, constant prices, and in real per capita terms
CDHT:	Hodrick-Prescott trend for consumption of durables (LCD)
CDHC:	Cyclical Component from Hodrick-Prescott filter for consumption of durables (LCD)
DLCD:	First difference of consumption of durables and services (LCD)
LYD:	Disposable Income, expressed in logarithms, constant prices, and in real per capita terms
YDHT:	Hodrick-Prescott trend for disposable (LYD)
YDHC:	Cyclical Component from Hodrick-Prescott filter for disposable income (LYD)
DLYD:	First difference of disposable income (LYD)

Figure A4.1: Total Consumption - Finland

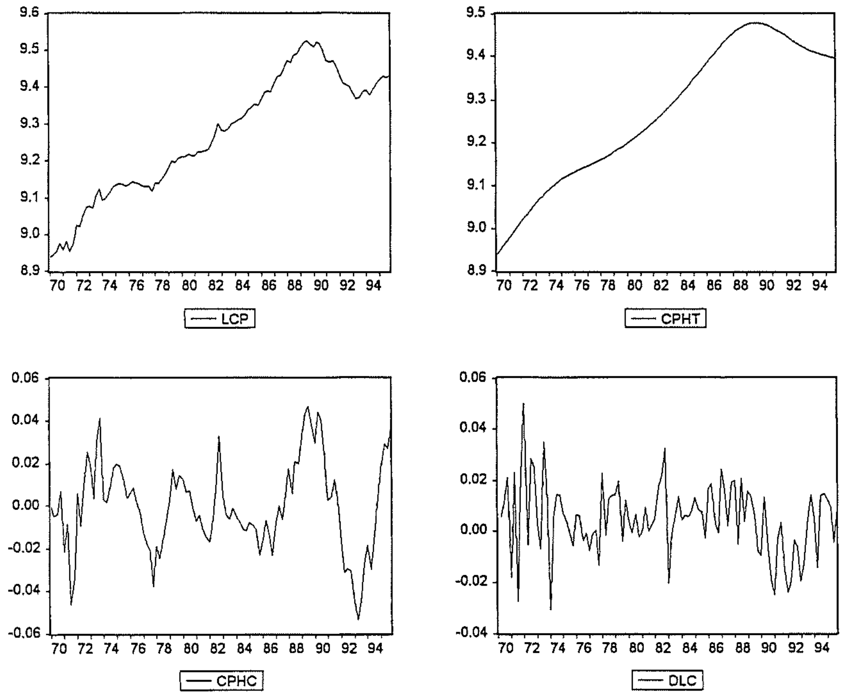


Figure A4.2: Consumption of Non durables and Services - Finland

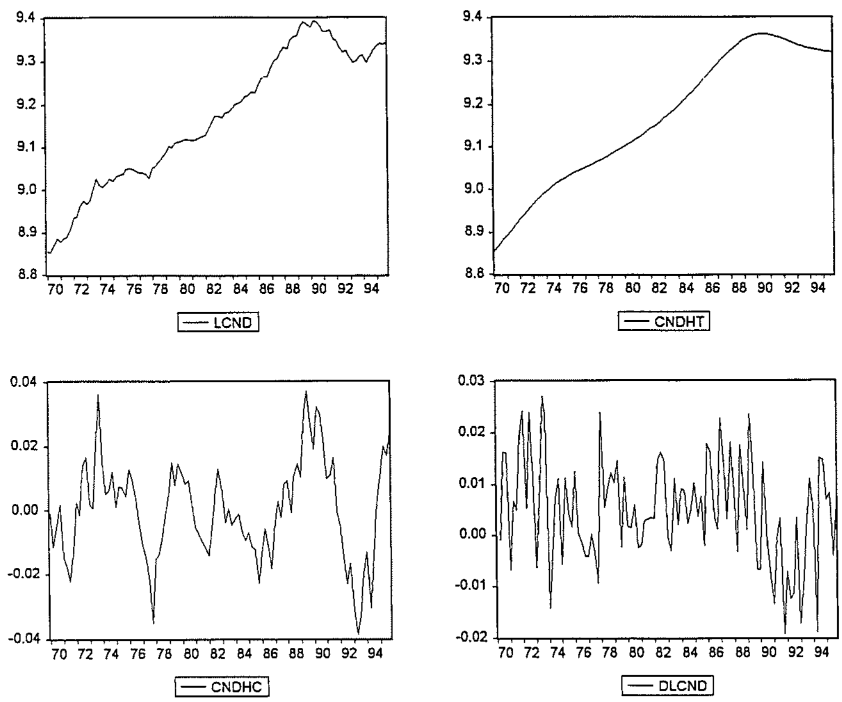


Figure A4.3: Consumption of Durables - Finland

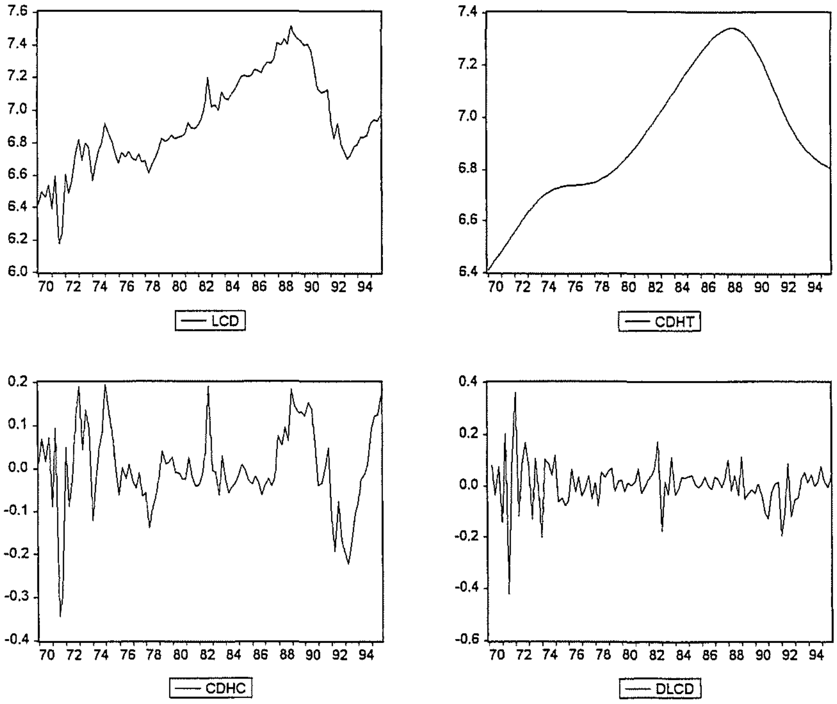


Figure A4.4: Disposable Income - Finland

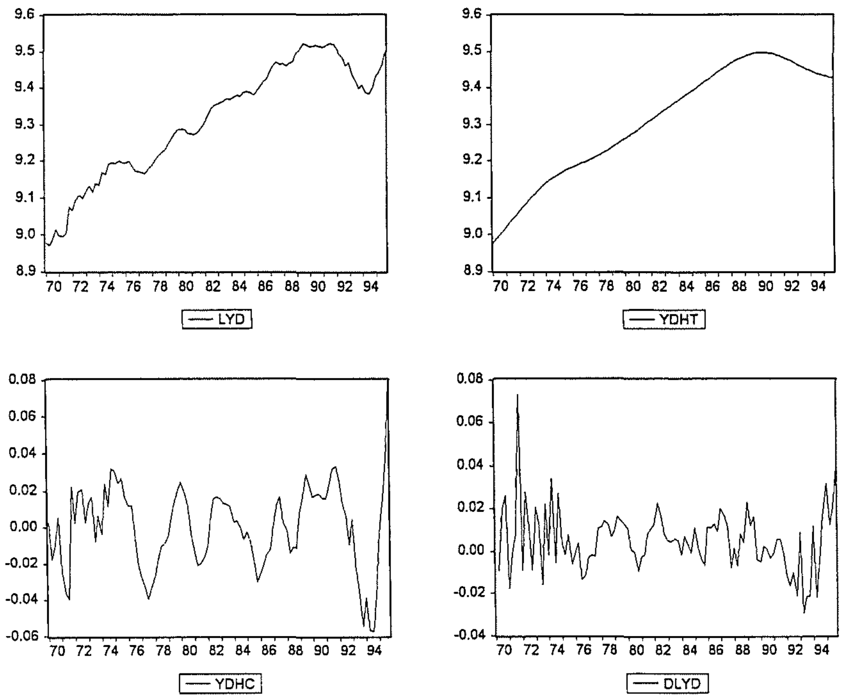


Figure A4.5: Total Consumption - Norway

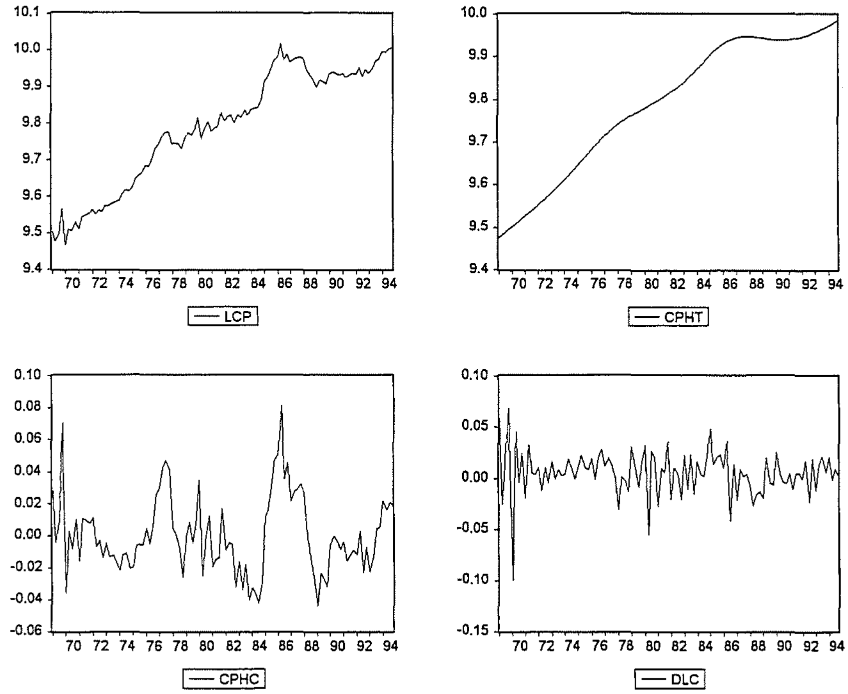


Figure A4.6: Consumption of Non-durables and Services - Norway

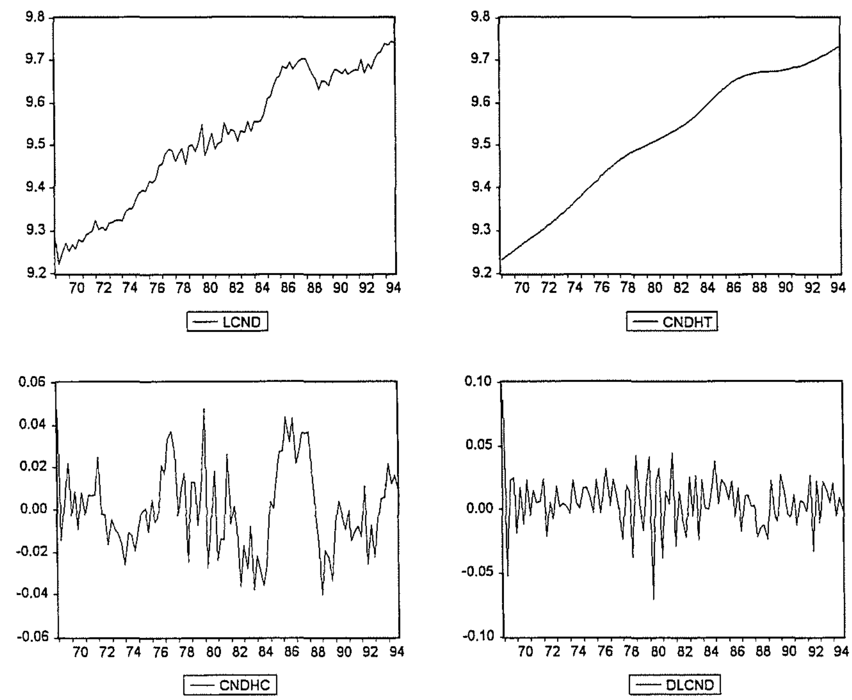


Figure A4.7: Consumption of Durables - Norway

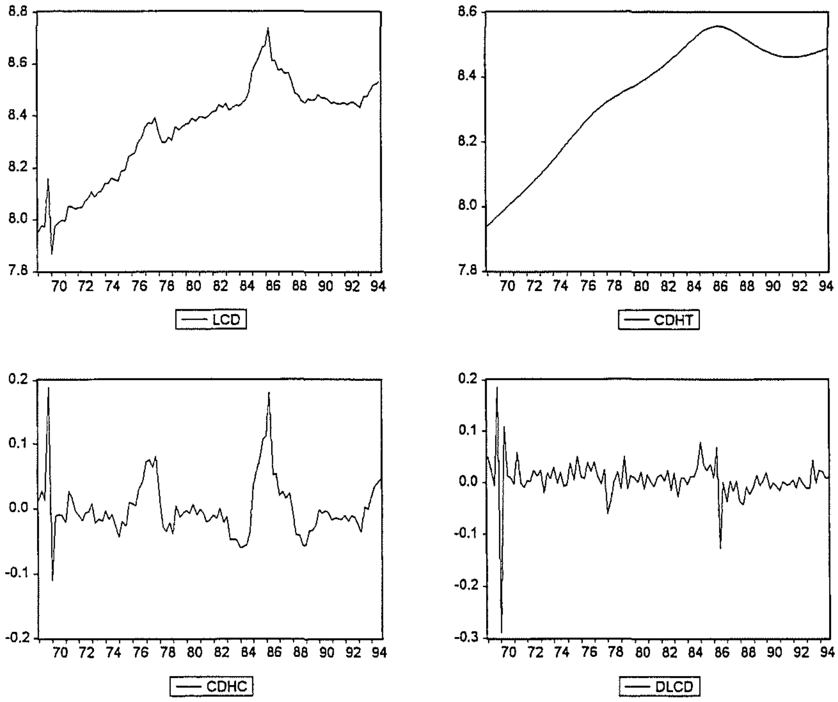


Figure A4.8: Disposable Income - Norway

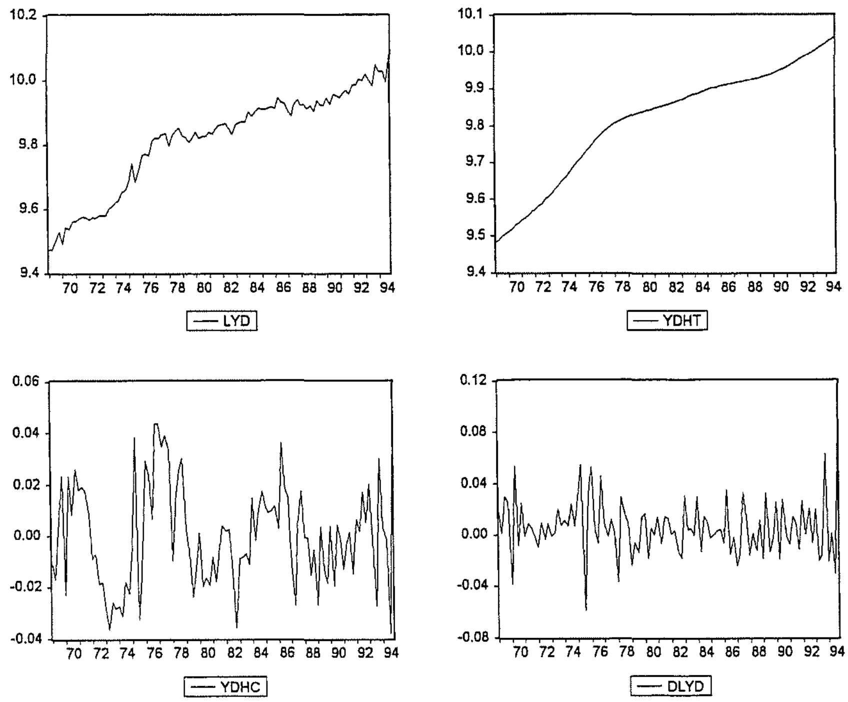


Figure A4.9: Total Consumption - Sweden

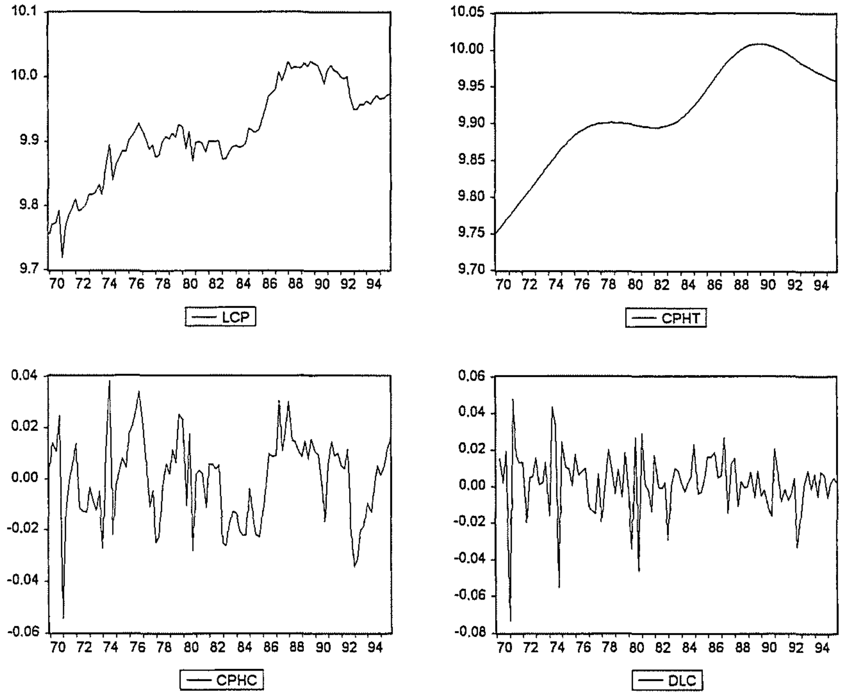


Figure A4.10: Consumption of Non-durables and Services - Sweden

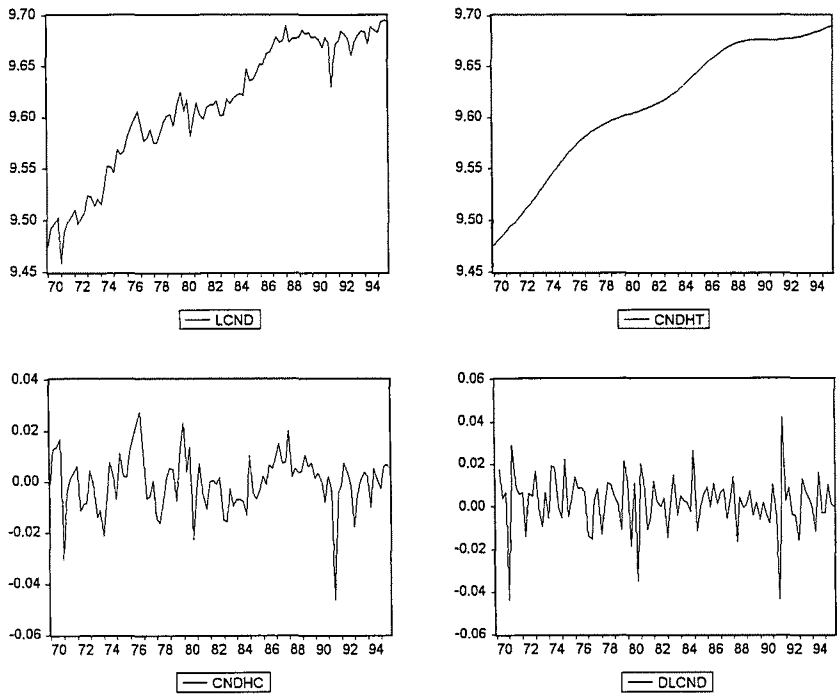


Figure A4.11: Consumption of Durables - Sweden

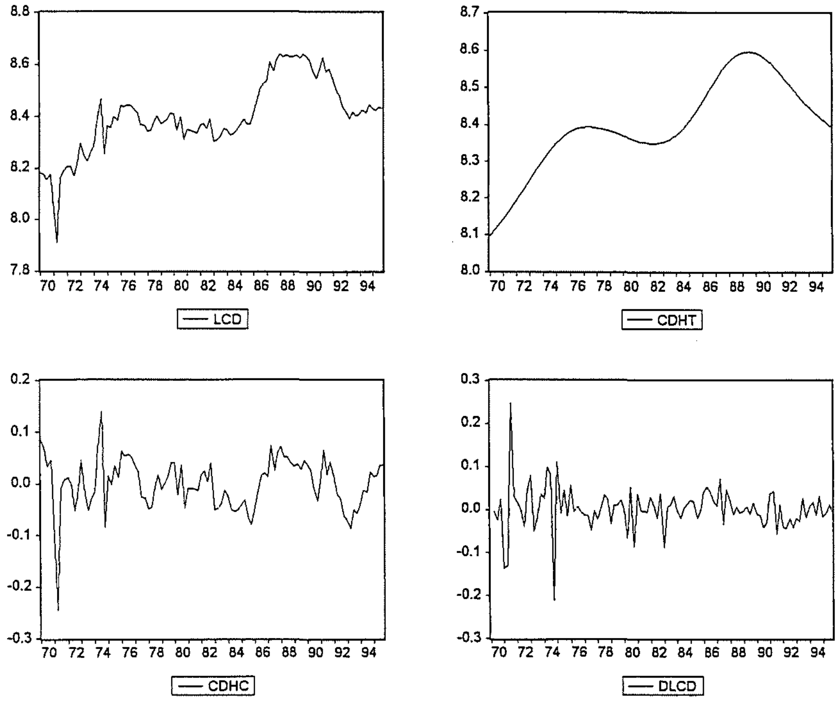
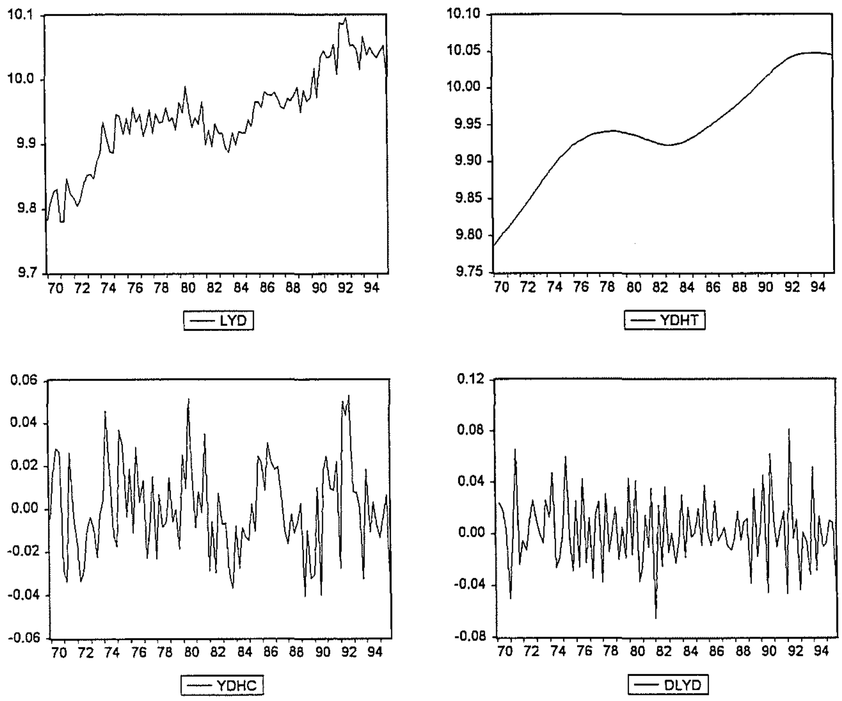


Figure A4.12: Disposable Income - Sweden



CHAPTER FIVE

CONSUMPTION IN THE PRESENCE OF INCOME UNCERTAINTY

5.1 INTRODUCTION

The prediction of the pure RE-LCPI Hypothesis that consumption should be a martingale was rejected for the Finnish data set in Chapter Two based on the finding of the excess sensitivity of consumption to anticipated changes in income. Chapters Three and Four aimed to clarify the cause of the excess sensitivity identified in Chapter Two. Specifically, we attempted to discriminate between the failure of two of Hall's assumptions (that of perfect capital markets and rational expectations) by seeking to identify asymmetric behaviour of a kind consistent with optimising behaviour in the presence of liquidity constraints, or the absence of asymmetry which would be consistent with myopia. In contrast, a particular alternative explanation will be examined in this chapter: possible mis-specification arising from the assumption of certainty equivalence. Specifically, we examine the role of uncertainty about future income in generating precautionary saving.

The focus on income uncertainty as a possible stimulus to precautionary saving is important since a number of key empirical and policy implications follow. Firstly, when consumers are risk averse, income uncertainty gives rise to a precautionary motive for saving over and above the life-cycle motive. Several studies have shown that, for reasonable parameter values, standard models can generate precautionary saving upto 60% of total savings (Skinner(1988), and Cabellero (1990a, 1991)).

Secondly an impact of future uncertainty is that consumption streams are shifted forward, implying a lower level of current consumption but an increase in its growth rate. This feature is called excess sensitivity. If consumers face uncertainty about future labour income, they will consume less in the current period; that is, they will save to protect against potentially lower income in the future. When future income is revealed it is all spent satisfying the intertemporal budget constraint, hence future consumption growth is higher than under certainty equivalence.

Thirdly, income uncertainty has implications for portfolio allocation, whereby an increase in perceived uncertainty may lead prudent consumers to reduce their holdings of risky assets in order to cut their overall exposure to risk (see Elmdorff and Kimball (1991), Kimball (1992,1993) and Guiso et al. (1996)). As additional savings are channelled into riskless or liquid assets, the demand for risky assets decreases as income uncertainty increases.

Fourthly, income uncertainty has implications for the relevance of Ricardian Equivalence[1]. Specifically, Chan (1983), Barsky, Mankiw and Zeldes (1986) and Kimball and Mankiw (1989), argue that government debt may alter consumers' perceptions of the risks they face. Assuming that future income is uncertain, and that taxes levied are a function of income, these authors argue that for a current tax cut associated with future income taxes, current consumption will be stimulated. This is in contrast to the certainty equivalent model, which predicts that temporary tax cuts which by their nature will be reversed and have a neutral impact on government debt, are inconsequential. Barsky et al. (1986) argue that the tax cut induced increase in current consumer spending arises from the fact that even though consumers expected lifetime income remains unchanged, there is a reduction in the variance of future income (induced by the government's use of counter cyclical fiscal policy aimed at smoothing GDP), and thereby a reduction in precautionary savings.

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[1] Refer to Chapter 2 for a definition of Ricardian Equivalence (pages 8-10)

This analysis can be extended to the general conclusion that if uncertainty affects consumer behaviour, and if government policy is directed at decreasing the volatility of income (that is, decreasing uncertainty), then the response of consumers to government tax policies and insurance programs, may significantly differ from the proposed responses set out by the benchmark, the certainty equivalent model. Feldstein (1989) offered further support for this line of analysis by showing that when future income is uncertain, bequests are also uncertain; hence the consumer will not in general be indifferent between receiving an increase in current disposable income and an equivalent present value increase in the disposable income of the next generation. Therefore he predicts that a debt financed tax cut, for which the debt will be serviced by future generations, will increase current consumption.

Given these implications, understanding income uncertainty and its impact on consumption (saving) is crucial with respect to the designing of policy interventions but also with respect to understanding the determinants of aggregate consumption. In this case we are specifically focusing on the possibility that rational behaviour of consumers reacting to uncertainty may offer a reason for the frequent rejection of the RE-LCPI Hypothesis.

Failing to account for income uncertainty as a potential determinant of consumption (saving), is econometrically equivalent to mis-specification of the model, which could manifest itself in terms of the omission of a relevant independent variable or the use of an incorrect functional form (that is, some form of non-linearity could be ignored). For example, with respect to the former, improperly omitting an uncertainty term in the consumption function may result in biased and inefficiently estimated coefficients; unless of course the omitted variable is orthogonal to other regressors in which case the estimates are unbiased but inefficient. Leland (1968) noted that the omission of a measure of income uncertainty from the consumption function would lead to the least squares estimates of the coefficients on current income, discounted expected future income and assets, to be downward biased (1968:471).

Income uncertainty is unlikely to be entirely random and might reasonably be expected to be related in part to the level of income or the interest rate. For example, in periods of high interest rates, there is a greater chance of business failure, as more risky but potentially lucrative projects are undertaken. More business failures are likely to result in job losses and so are likely to be associated with greater increased income volatility. By omitting any influence of income uncertainty, the estimated variance of the interest rate coefficient is likely to be biased upwards. This will have implications for interval estimation and hypothesis testing; specifically inferences will be invalid. It should be noted that the above arguments could also be reflected as heteroscedastic disturbances, the consequences of which are also unbiased but inefficient estimates.

Many of the empirical studies of the life-cycle permanent income model of consumption (LC-PIH) under income uncertainty have been carried out with the implicit assumption of certainty equivalence, whereby the expected value of future income is treated as if it were certain (Hall (1978), Campbell and Mankiw (1989, 1990)). In this chapter, it is argued that the assumption of certainty equivalence offers an implausible description of consumers behaviour given the presence of uncertainty. Most consumers will experience some degree of uncertainty with respect to their future income[2]. Moreover it is unlikely to be entirely random; it is more likely to be linked to economic and other factors e.g. company performance etc., and hence is likely to affect future consumption plans.

For some time it has been known that optimisation of utility functions which have a positive third derivative with respect to current consumption will result in consumers opting to make precautionary savings; that is, savings which arise in the form of insurance against future

[2] In this chapter, we focus on income uncertainty. Additional sources of uncertainty include uncertainty about length of life (Hubbard and Judd (1987) and Hubbard et al. (1993)); uncertainty about medical expenses (Hubbard et al. (1993)); and interest rate uncertainty (Skinner (1988)).

potential volatility in income (for example, Leland(1968) and Sandmo(1970)). In other words, in the presence of income uncertainty, consumers will defer consumption, and so become more prudent. In this chapter the case for augmenting the pure RE-LCPI Hypothesis to allow for precautionary saving will be investigated. Specifically our analysis focuses on two distinct groups of consumers, each characterised by differing degrees of income uncertainty[3]. Through adopting this approach our objective is to highlight the importance of income uncertainty for the consumer's decision making process and to allow for differing levels of income uncertainty facing distinct groups of consumers. As such, this chapter extends upon the consideration of liquidity constraints and myopia as explanations for the failure of the pure RE-LCPI Hypothesis, which have been investigated in previous chapters.

The current work also contributes to the existing literature on consumer behaviour in the presence of uninsurable labour income (see for example, Skinner 1988, Carroll 1992 and Flacco and Parker 1990, 1992)[4]. Firstly, various measures of income uncertainty are reviewed and a number of empirical estimates of income uncertainty are provided. Secondly, a two group model which allows those from differing occupations to be subject to differing degrees of income uncertainty is derived and empirically estimated. To the best of the author's knowledge this characterisation of consumption data by modelling on the basis of two groups differing in the degree of uncertainty they face has not been undertaken in prior research.

Thirdly, the empirical work is conducted on Finnish data[5]. There are a number of reasons for using the Finnish time series data in this study: (i) the empirical findings of chapter two clearly reject the pure RE-LCPI Hypothesis for Finnish data, while the

[3] Our approach contrasts with Campbell and Mankiw (1989, 1990, 1991), in that our aim is to distinguish two groups of consumers both of which follow optimising behaviour, but who differ in the extent of income uncertainty they face.

[4] These studies are discussed in Section 5.3

[5] The data sets of Norway and Sweden which were used in Chapters Two-Four, are not included in the empirical analysis of this chapter.

empirical findings presented in chapters three and four do not support the extension of the RE-LCPI model to incorporate either liquidity constraints or myopic behaviour on the part of some consumers; (ii) Finland serves as an appropriate case study to examine the effects of income uncertainty, given the severe banking crisis and recession which Finland suffered during the early 1990s, and which presumably would contribute to considerable uncertainty about future incomes[6]; (iii) finally, to date, there has been a relative scarcity of empirical work on Finnish consumption and precautionary savings; the exceptions include Koskela and Viren (1992) and Takala (1995). Hence this work will significantly contribute to the existing Finnish consumption literature.

The outline of the chapter is as follows; section (5.2) provides a discussion on the theoretical effects of income uncertainty on consumption via precautionary savings (5.2.1). In this section we also derive the model specification of our two group consumption function incorporating income uncertainty (5.2.2). A review of existing empirical work is given in section (5.3). The next section (5.4) outlines the data and methodology used in the estimation of the model outlined in section 5.2.2. The empirical results are presented and analysed in section 5.5, and the final section summarises and concludes.

5.2 THE EFFECT OF INCOME UNCERTAINTY ON CONSUMPTION

The idea that there is a precautionary element in consumers consumption (saving) decisions dates back to Keynes (1936), who argued that people accumulate wealth because of an innate desire to insure against potential bad contingencies, such as particularly bad draws in

[6] See Brunila and Takala (1993) for an analysis of the banking crisis. They review the Finnish financial deregulation process of the 1980s, and its role in the onset of the recession of the early 1990s and the high indebtedness of Finnish households at this time.

earnings[7]. The theoretical basis for the effect of income uncertainty on consumption behaviour was initially explored by Leland (1968), Sandmo (1970), and Dreze and Modigliani (1972) in the context of two period models. Multi-period models were subsequently examined by Sibley (1975), Miller (1976), Skinner (1988), Zeldes (1989) and Kimball (1990). The general conclusion of these theoretical studies was that when income risk is uninsurable, for any given level of wealth and income, an increase in uncertainty will reduce current consumption and increase saving. In the next section (5.2.1) we review the general theoretical framework used by these studies to illustrate the effects of income uncertainty on consumption.

5.2.1 THE THEORETICAL FRAMEWORK

The standard consumer optimisation problem holds that the consumer maximises the sum of discounted lifetime utility

5.1 $$E_t\left[\sum_{i=0}^{T}\frac{u(C_{t+i})}{(1+\delta)^i}\right]$$

subject to the standard lifetime budget constraint

5.2 $$\sum_{i=0}^{T}\frac{C_{t+i}}{(1+r_t)^i} = A_t + \sum_{i=0}^{T}\frac{Y_{t+i}}{(1+r_t)^i}$$

where E_t represents the conditional expectation operator, u is the period utility function, δ is the subjective rate of time preference, (1+r) is the discount rate in period t where r is the non stochastic interest rate, C_t is consumption in period t, Y_t is disposable income in period t, and A_t are net assets held at the beginning of period t.

Assuming that the individual has time separable preferences and has access to perfect capital markets, then the Euler condition takes the form:

[7] Additional motives for saving include the finance of future consumption; the maintenance of consumption after the consumer has stopped working; and/or to leave a bequest.

5.3 $$u'(C_t) = E_t\left[\frac{1+r_t}{1+\delta}\right]u'(C_{t+1})$$

with $u'>0$ and $u''<0$ and where u' and u'' denote first and second order partial derivatives of u with respect to C_t. Equation 5.3 states that marginal utility in period t, denoted by $u'(C_t)$ equals expected marginal utility in period t+1, $u'(C_{t+1})$. This is a standard result which intuitively means that the present discounted value of a unit of future consumption is equal to its current consumption value.

Leland (1968) was the first to demonstrate that uncertainty will affect optimal consumption if and only if it affects expected marginal utility. When the property of certainty equivalence (hereafter CEQ) is assumed, in effect this implies that $u'(C_{t+1})$ is known. Hence the consumer's consumption path is affected only by the mean of future income, and the present discounted value of consumption will be equal in period t and t+1. However without the assumption of certainty equivalence (hereafter this absence is denoted NCEQ), Leland demonstrated that the variance of future income will also impact upon the consumer's consumption path; this is reflected in the convexity of marginal utility (i.e. $u'''>0$), which gives rise to precautionary savings.

Consider once again equation 5.3, if marginal utility is convex, then increased uncertainty about future income and thereby future consumption, will affect optimal consumption behaviour since it increases expected marginal utility in period t+1; that is increased uncertainty makes future consumption more desirable. To maintain the equality in equation 5.3, expected future consumption must increase compared to current consumption; that is current consumption will be reduced and current saving increased. In other words, uncertainty leads consumers to be more prudent (Leland (1968), Sandmo (1970) and Dreze and Modigiliani (1972)). The strength of the precautionary motive to save can be defined using Kimball's (1990) theoretical measures of prudence, which are analogues to Arrow-Pratt measures of risk aversion. The coefficient of absolute prudence and the coefficient of relative prudence are defined as $-u'''/u''$ and $-u'''C/u''$ respectively (Kimball (1990:68)). Kimball(1990) defined prudence as "the propensity to prepare and forearm oneself in the face of uncertainty" (1990:54). In the context of the consumer's decision making process, prudence represents the extent of precautionary saving to uncertainty. Arrow (1965) and Pratt's (1964) measures of absolute and relative risk aversion therefore study the degree to which consumers dislike uncertainty; whilst Kimball's measures of absolute and relative prudence study the intensity of the precautionary saving motive.

The preceding analysis of equation 5.3 applies to a general specification which does not require any assumptions concerning preferences. In order to demonstrate uncertainty effects it is required to be more specific on the precise form of the felicity functions. As outlined in chapter two, in the case of quadratic preferences, with additional assumptions that r is constant and equal to δ, then $E(C_{t+1}) = C_t$. Using the fact that under rational expectations $C_{t+1} = E(C_{t+1}) + \xi_{t+1}$, then Hall's (1978) martingale process can be derived $C_{t+1} = C_t + \xi_{t+1}$. The corresponding optimal consumption decision rule function takes the form

5.4 $$C_t = \left(\frac{r}{(1+r)-(1+r)^{-T}}\right)\left(A_t + \sum_{i=0}^{T}(1+r)^{-i}E_t\left[Y_{t+i}\right]\right)$$

In the infinite life case (that is, as $T \to \infty$), we obtain

5.4' $$C_t = \left(\frac{r}{1+r}\right)\left(A_t + \sum_{i=0}^{\infty}(1+r)^{-i}E_t\left[Y_{t+i}\right]\right)$$

However, the condition of a positive third derivative is not satisfied when quadratic preferences are assumed, since under such preferences marginal utility is linear in consumption and so $u''' = 0$. The assumption of quadratic preferences is the equivalent to assuming that consumers' utility is independent of labour income uncertainty. Other specifications do allow marginal utility to be non-linear in consumption. A frequently used specification which does involve a positive third derivative is the exponential or constant absolute risk aversion (CARA) utility function. In terms of the standard consumers optimisation problem, in the CARA case, the consumer maximises

5.5 $$E\left[\sum_{i=0}^{\infty}\left(-\frac{1}{\theta}\right)\beta^{i}e^{-\theta C_t}\right]$$

subject to the standard life time budget constraint. Here, θ is the risk aversion parameter[8], β is the discount factor $1/(1+\delta)$, where δ is the subjective rate of time preference, and r is the real rate of interest. The corresponding Euler (or first order) condition of the optimisation problem is:

5.6 $$e^{-\theta c_t} = E_t[e^{-\theta c_{t+1}}]$$

Following Cabellero (1990a), it can be shown that when utility is exponential with exponent $-\theta C_t$, and when income can be described by a general ARMA process with innovations(ε_t) that are normally distributed with zero mean and standard deviation σ, then the resulting stochastic process for consumption will satisfy the Euler equation:

5.7 $$C_{t+1} = C_t + \Gamma_t + e_t$$

where

$$\Gamma = \frac{1}{\theta}\ln E_t\left[e^{-\theta u_t}\right]$$

Substituting the stochastic processes of consumption and income into the intertemporal budget constraint yields the following consumption decision rule:

5.8 $$C_t = (1-R)\left(A_t + \sum_{i=0}^{\infty}R^{i}E_t[Y_{t+i}]\right) - (1-R)\sum_{i=1}^{\infty}R^{i}\sum_{j=1}^{i}\Gamma_{t+j-1}$$

[8] This is the degree of curvature of the utility function, and describes the consumers attitude to risk. In general, the more curved the function, then the more the consumer would be willing to pay to insure against uncertainty, and the greater is θ.

where R is $(1+r)^{-1}$. This equation states that consumption is a function of net assets, income and uncertainty. The first two terms are identical to those appearing in the earlier derivation for optimal consumption when the form of utility function implies certainty equivalence (equation 5.4'). The additional (negative) term reflects income uncertainty, and basically the more uncertainty, the more precautionary balances the consumer will accumulate given a constant level of risk aversion[9].

In a later paper, Cabellero(1991) considered the finite life version of this model with an exponential utility function. His objective was to demonstrate how precautionary savings contributed to wealth accumulation. He derived the closed form solution for a finite-life version of the model with an exponential utility function, under the combined assumptions that labour income followed a random walk and that shocks to income (u_t) were normally distributed with zero mean and standard deviation σ; he derived the following expression[10]:

5.9 $$C_t = \frac{1}{T-t+1} A_t + Y_t - \frac{\Gamma(T-t)}{2} + e_t$$

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[9] Variations of Cabellero's models have been used; for example, Guiso et al (1992) present their theoretical model based on work done by both Cabellero (1990a) and Weil (1990). They assume that income follows the stochastic process:

$$Y_t = \gamma Y_{t-1} + (1-\gamma)\bar{Y} + \varepsilon_t$$

that is that income is the sum of a deterministic component $\bar{Y}$ and a stochastic component ε_t, with a degree of persistence determined by γ. The resulting consumption function solution to the standard intertemporal optimisation problem (assume that interest rate is equal to the discount rate) is:

$$C_t = \frac{R-1}{R-\gamma}\left(Y_t + \frac{1-\gamma}{R-1}\bar{Y} + W_t\right) - \frac{\Pi}{R}$$

where

$$\Pi = \frac{R-\gamma}{\theta R}\log\left[E\exp\left(-\frac{\theta R}{R-\gamma}\varepsilon\right)\right]$$

Note that when $\varepsilon \sim N(0,\sigma^2)$, then $\Pi = \frac{\theta R}{R-\gamma}\sigma^2$.

Even though they used a different specification of the stochastic process generating income, to that of Cabellero(1990a), Guiso et al.(1992) derived a general consumption function incorporating income uncertainty, similar to that of Cabellero(1990a). The first component in their consumption function is equivalent to the solution under CEQ. The latter term reflects the precautionary element of saving, and is a function of the innovation to income ε, the degree of risk aversion θ, and the degree of income persistence γ.

[10] The interest rate and the discount rate by assumption are set equal to zero

where

$$\Gamma = \frac{1}{\theta} E\left[e^{-\theta u_t}\right] \rangle 0$$

If $u \sim N(0,\sigma^2)$, then $\Gamma = \frac{\theta}{2}\sigma^2$

If it is assumed that the interest and discount rates are equal, but not to zero, the consumption function is as follows:

5.10 $$C_t = \left[\left(\frac{1-R}{R(1-R)^{T-t}} \right) A_t + Y_t - R\left[\frac{1}{1-R} - \frac{(T-t+1)R^{T-t}}{(1-R)^{T-t+1}} \right] \Gamma \right]$$

Once again, as in the case of the infinite life version, this consumption function shows that uncertainty lowers the optimal level of consumption and increases the level of savings that individuals choose to hold.

While analytically convenient, the CARA utility function is restrictive in that it implies a constant degree of prudence, that is the effect of uncertainty on consumption is independent of lifetime resources. In addition it is possible to generate negative consumption because the marginal utility of consumption is finite and positive even at zero consumption. However, closed form solutions for optimal consumption can be obtained only for exponential utility; therefore the CARA function is useful for showing the effects of labour income uncertainty on the level of consumption[11].

The attractiveness of the closed form solution over the more frequently used Euler equation, is that the latter is only informative about consumption changes over time and

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[11] An additional specification for preferences which can take on board income uncertainty via a positive third derivative, is the isoelastic or constant relative risk aversion (CRRA) utility function. A key disadvantage of the CRRA utility function is that a closed form solution for consumption, that is, a decision rule equivalent to 5.9, cannot be obtained. It does have some advantages over the CARA specification, in that it implies decreasing absolute risk aversion, and the marginal utility of consumption goes to infinity as consumption goes to zero.

does not say anything about the levels of consumption and thereby saving (Attanasio (1997) and Muellbauer and Lattimore (1995)). Muellbauer and Lattimore (1995) also cite the "drawn out procedure needed to make the Euler approach useful for policy analysis" as a significant disadvantage compared to the solved out consumption function (1995:225). Even though as previously noted there are certain disadvantages to the use of the CARA utility function, its specification yields the predictions of precautionary savings theory; it implies that uncertainty reduces the optimal level of current consumption, and increases the level of saving. In addition, the assumption of CARA utility combined with the assumption that shocks to income are additive and distributed normally with a variance of σ^2, implies an exact linear relationship between consumption and uncertainty.

5.2.2 DEVELOPMENT OF THE EMPIRICAL MODEL

We adopt Cabellero's finite-life version of the exponential utility model (equation 5.10) as the starting point of our analysis to represent consumption in the aggregate as comprised by the aggregation of two distinct groups of consumers. Specifically, two groups of optimising consumers facing different degrees of income uncertainty, will be nested within an aggregate consumption function. The first group is characterised as facing little uncertainty with respect to future income and certainly less uncertainty than the second group.

This work differs from previous studies in this area, in that such studies examined the impact of uncertainty about aggregate income on aggregate consumption (these studies are reviewed in the next section (Section 5.3)). They did not aim to distinguish how income uncertainty and its impact would differ for distinct groups of consumers. Some work, including Skinner (1988), did look at saving rates by occupation, but our work investigates whether a good characterisation of the data can be obtained by modelling on the basis of two groups differing in the degree of income uncertainty they face.

It is assumed that one group of consumers face more income uncertainty (Group 1) and the other group face relatively less income uncertainty (Group 2). This characterisation can be motivated using the arguments, put forth by the hypotheses of permanent income, and segmented labour markets[12]. In particular, that for certain groups/sectors within the economy, income uncertainty is relatively more important. The following outlines the proposed model to be estimated. Total consumption is defined as the sum of the two groups of consumers as follows:

$$C_t = C_{ut} + C_{ct}$$

where C_t is total consumption, and C_{ut} and C_{ct} represent the consumption of the more uncertain and less uncertain groups (Group 1 and 2) respectively. The specification of the aggregate consumption function is:

5.11 $$C_t = \left[\beta_1(A_{t,1} + Y_{t,1} - \Gamma_{t,1}) + \beta_2(A_{t,2} + Y_{t,2} - \Gamma_{t,2})\right]\left[1 + \mu_t\right]$$

where β_1 and β_2 are propensities to consume out of lifetime resources for group 1 and 2 respectively, and depend on the real rate of interest and rate of time preference. A_1 and A_2 are the non human wealth of group 1 and 2, with Y_1 and Y_2 representing the human wealth of group 1 and 2; Γ_1 and Γ_2 are the income uncertainty terms for groups 1 and 2; and μ_t is the disturbance term with the standard assumption of zero mean and constant variance.

We make the following additional assumptions. The interest rate is constant and equal to the rate of time preference; intertemporal preferences are represented by the CARA utility function for Groups 1 and 2; and the income processes for both groups

[12] Both hypotheses are discussed in the literature review, Section 5.3.4.

follow random walks. Given these assumptions, then the above general consumption function can be outlined as follows:

$$5.12 \qquad C_t = \begin{bmatrix} \left[\left(\dfrac{1-R}{R(1-R)^{T-t}}\right)A_{t,1} + Y_{t,1} - R\left[\dfrac{1}{1-R} - \dfrac{(T-t+1)R^{T-t}}{(1-R)^{T-t+1}}\right]\Gamma_{t,1}\right] + \\ \left[\left(\dfrac{1-R}{R(1-R)^{T-t}}\right)A_{t,2} + Y_{t,2} - R\left[\dfrac{1}{1-R} - \dfrac{(T-t+1)R^{T-t}}{(1-R)^{T-t+1}}\right]\Gamma_{t,2}\right] \end{bmatrix} [1+\mu_t]$$

where $R = (1+r)^{-1}$, and $Y_{t,1}$ and $Y_{t,2}$ are approximated as random walks, where $\xi \sim N(0, \sigma^2)$:

$$Y_{t,1} = Y_{t-1,1} + \xi_t$$
$$Y_{t,2} = Y_{t-1,2} + \xi_t$$

Equation 5.12 can be rewritten as:

$$5.13 \qquad C_t = \left[\alpha_1 A_{t,1} + Y_{t,1} - \alpha_2 \Gamma_{t,1} + \alpha_3 A_{t,2} + Y_{t,2} - \alpha_4 \Gamma\right][1+\mu_t]$$

where

$$\alpha_1 \approx \alpha_3 \approx \left(\frac{1-R}{R(1-R)^{T-t}}\right)$$

$$\alpha_2 \approx \alpha_4 \approx R\left[\frac{1}{1-R} - \frac{(T-t+1)R^{T-t}}{(1-R)^{T-t+1}}\right]$$

The model is expressed in terms of levels of the raw series C_t, Y_t, and A_t. However, with respect to the functional form of aggregate consumption functions, it is argued that it is likely that the stochastic error term in a consumption function grows with the scale of consumption leading to heteroscedasticity (Campbell and Mankiw (1989), and Muellbauer and Lattimore (1995)). This problem can be overcome through the use of a logarithm transformation. Muellbauer and Lattimore(1995) illustrate that "[i]f $C_t = f(W_t, \ldots)(1+\varepsilon_t)$ then, to a close approximation, $\ln C_t = \ln f(W_t, \ldots) + \varepsilon_t$, since, if ε is small, ln(1+ε) ≈ ε" (1995:277). Thereby aggregate log consumption is approximately given by

$$\ln C_t = \alpha_1 \ln A_{t,1} + \ln Y_{t,1} - \alpha_2 \ln \Gamma_{t,1} + \alpha_3 \ln A_{t,2} + \ln Y_{t,2} - \alpha_4 \ln \Gamma_{t,2} + \mu_t$$

or alternatively expressed as

$$5.14 \qquad c_t = \alpha_1 a_{t,1} + y_{t,1} - \alpha_2 \Gamma_{t,1} + \alpha_3 a_{t,2} + y_{t,2} - \alpha_4 \Gamma_{t,2} + \mu_t$$

where lowercase letters indicate logarithms.

Γ_t is the precautionary component of saving, reflecting income uncertainty. It is defined as:

$$\Gamma_t = \frac{1}{\theta} \ln E_t\left[e^{-\theta \xi_t}\right]$$

where θ is the coefficient of constant absolute risk aversion, and ξ_t are income innovations. Cabellero (1990) shows that Γ_t is positively dependent on the level of riskiness and the persistence of labour-income shocks (1990:120). When the labour income innovations are normally distributed with zero mean and constant variance, σ^2, then:

$$\Gamma_t = \frac{\theta}{2} \sigma^2$$

Income uncertainty is measured by the variance of income over time, denoted σ^2 above.

Summary

On the basis of the CARA utility function and the consequent solved out consumption function, we have derived a regression which can be estimated on time series data. The next step is to determine how each variable included in the model is potentially measurable, and then proceed to the empirical estimation and evaluation of the model as portrayed in equation 5.14.

However, prior to estimating the above model, we conduct a literature review in the next section, which serves three purposes. Firstly, we review previous works that have studied income uncertainty and its impact on consumption and saving. Secondly, part of the review will focus on research in the area of different groups experiencing differing degrees of income uncertainty. Such an analysis provides the motivation for our two group model. Thirdly, the review provides information on the various methods that have been employed to calculate income uncertainty directly, or to obtain proxies for it. Given the objective of our work, we have decided to highlight those studies which required an explicit measure of uncertainty, and hence this component of the chapter will include a review of measures used in estimation.

5.3 LITERATURE REVIEW OF EMPIRICAL AND SIMULATION STUDIES

To date, relatively few studies have examined the empirical relevance of the theoretical models outlined above. In part this scarcity of empirical analysis relates to the unobservable nature of some of the driving variables (e.g. ex ante measures of uncertainty) and the non-existence of closed form solutions for optimal consumption under some functional form specifications (as noted by Hayashi (1982), Blanchard and Mankiw (1988), Skinner (1988), and discussions above). The unobservable variable problem has led to some popularity of simulation approaches. In the following review, we first consider what has been learnt from simulation evidence (Section 5.3.1), and subsequently we focus on existing empirical work (5.3.2). As shown in the previous section, the appropriate measure of uncertainty is income uncertainty (human wealth uncertainty), hence throughout the review particular attention will be paid to the measures of income uncertainty employed.

As outlined in the previous section, our model deals with two groups of consumers who face differing degrees of uncertainty. In the final part of this literature review (section 5.3.3), we look at studies which provide some insight into the stability of labour income for some or all consumer groups. In particular we will examine two hypotheses, the permanent income hypothesis and the segmented labour market hypothesis.

5.3.1 Key Results from Simulations and Dynamic Programming Techniques

A number of studies have employed simulation techniques[13] to assess the likely effect of income uncertainty on consumption, and include Skinner (1988), Zeldes (1989b), Cabellero (1990a, 1991), and Deaton (1991). These studies used calibration to paramterise their models on the basis of previous empirical work. For example Cabellero (1990a, 1991), produced a number of simulations of equations 5.8 and 5.9 using different estimates of Γ obtained from a number of different but plausible estimates of income uncertainty (σ^2) and the coefficient of risk aversion (θ).

Cabellero took the coefficient of risk aversion to be identical with the reciprocal of the coefficient of the intertemporal elasticity of substitution[14]. From the many studies which have produced estimates of the intertemporal elasticity[15], he selected a baseline value of 0.3, which implies a coefficient of risk aversion of 3. Cabellero's primary source of measures of income

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[13] Simulation techniques are primarily used for policy evaluation and forecasting, and involve the use of calibrated models with alternative parameters values. The objective of simulation exercises is to determine (or simulate) the behaviour of the model system under different conditions or assumptions.

[14] It is the case for intertemporally separable homogenous utility functions, that the coefficient of relative risk aversion is the reciprocal of the elasticity of intertemporal substitution (Ottanasio and Weber (1989:59)).

[15] Many of the recent studies which have produced estimates of the intertemporal elasticity of substitution have been on the Euler equation of the RE-LCPI Hypothesis; for example Hall (1988), Campbell and Mankiw (1989) and Zeldes (1989).

uncertainty were obtained from previous work done using the panel data set, Michigan Panel Study of Income and Dynamics (hereafter PSID). Specifically he adopted MaCurdy's (1982) and Hall and Mishkin's (1982) specifications of the earnings process to obtain measures of the variance of income innovations (σ^2). Hall and Mishkin (1982) divided earnings into a permanent component which followed a random walk and a transitory component which followed a second order moving average process. Using PSID data they obtained a measure of income uncertainty from the residuals of the estimation of the above specification for the earnings process. They concluded that households experienced substantial variation in their earnings. Also employing PSID data, MaCurdy (1982) found that the earnings process could be described by an ARIMA(0,1,2) process, again, suggestive of large income variability.

Combining the estimates of income uncertainty with those of the coefficient of risk aversion, Cabellero (1991) concluded that approximately 60 percent of US wealth could be attributed to the accumulation of precautionary saving (1991:868). Cabellero (1990a) also proceeded to judge the sensitivity of inference on the extent of precautionary saving to changes in the parameters (within plausible ranges). For example, he found that an exponential utility function with a coefficient of risk aversion equal to 9, generated savings that were 6 times higher than that obtained if the coefficient of risk aversion equalled 1 (1990:125). He also looked at various simulations in which he varied the degrees of persistence in the income process, and concluded that the more persistent income shocks were, the more significant were precautionary savings.

For his work, Skinner (1988) considered isoelastic utility (CRRA)[16]. Similar to Cabellero, he also used the baseline value of 3 for his estimate of the coefficient of risk

[16] Skinner (1988) provided approximations to the closed form solution for consumption, with stochastic labour income and constant relative risk aversion utility (CRRA). He derived a closed form approximation of life-cycle consumption subject to both income uncertainty and interest rate uncertainty by taking a second-order Taylor expansion of the Euler equation (5.3) around $U'(C_t)$. Assuming that the distribution of earnings was log-

aversion, and used MaCurdy's (1982) ARIMA(0,1,2) structure for the log of earnings to obtain estimates of income uncertainty. Skinner found that precautionary saving could account for 56% of total life-cycle saving. When he assessed the sensitivity of the precautionary motive to changes in the underlying parameters, he found that an increase in the measure of risk aversion to 6, increased precautionary savings to 76% of aggregate savings, while reducing it to 1 led to 18% of savings being contributed by precautionary savings; that is, the extent of precautionary balances was highly sensitive to assumptions about the parameters.

Zeldes(1989b) also constructed a numerical example with isoelastic utility. As mentioned previously, one of the advantages of this utility function over the exponential function is that it exhibits decreasing absolute prudence. Put differently, the sensitivity of

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normal, and that contemporaneous correlation between random asset yield and earnings was assumed to be constant, Skinner obtained the general difference equation (Euler equation) for period i optimal consumption:

$$C_i = \left[\frac{1+\bar{r})(1+v_i)}{1+\delta}\right]^{\frac{1}{\gamma}}\left[\frac{L_i}{\bar{L}_i}\right]C_{i-1}$$

where

$$L_i \equiv W_i + \sum_{j=i+1}^{D} E_i(Y_j R_j^i)$$

and the uncertainty premium v_i

$$v_i = \theta_{1i}\sigma_y^2 + \theta_{2i}\sigma_r^2 + \theta_{3i}\sigma_{ry}$$

This expression was simplified by dividing both sides by C_{t-1} and then taking logarithms. He provided an explicit relation between consumption growth and its variance as follows:

$$\ln\left[\frac{C_i}{C_{i-1}}\right] = \frac{1}{\gamma}[\bar{r} - \delta + v_i] + \ln\left[\frac{L_i}{\bar{L}_i}\right]$$

where γ is the coefficient of relative risk aversion; L_i is the level of permanent income defined as the present value of lifetime resources at the end of the ith period. In a model with no uncertainty this expression would be:

$$\ln\left[\frac{C_i}{C_{i-1}}\right] = \frac{1}{\gamma}[\bar{r} - \delta]$$

When income is uncertain there are two additional terms; first, v_i represents the uncertainty premium, which is expressed as a linear combination of the constant variance of both the log of earnings and real returns, and their covariance. The second term, $\ln\left[L_i/\bar{L}_i\right]$, represents the revision of lifetime resources following the realisation of innovations to interest rates and earnings.

consumption to uncertainty is dependent on the level of consumers' wealth. Zeldes showed numerically that for a coefficient of risk aversion equal to 3, the level of precautionary savings was larger for those with low levels of financial wealth. Specifically, he showed that precautionary saving represented 20 percent of consumption, when wealth was twice as large as labour income. This value fell to 7 percent, when wealth was five times larger than labour income. Finally, as in Skinner (1988), he found that the more persistence in earnings shocks, the greater the precautionary balances which were accumulated.

5.3.2 Key Results from Empirical Work

Guiso et al (1992), noted that one of the key disadvantages of the results derived via simulation was that they relied on the maintained assumptions underlying preferences and the income generating processes rather than estimating parameters and explicitly testing for the significance of the relationships and mechanisms proposed. They summed up their conclusion in the following statement: "simulations do not test whether people actually respond to risk as predicted by the theoretical models" (1992:308).

More recent studies have focused on obtaining some empirical measure of the impact of uncertainty. Clearly in contrast to the simulation studies, these studies have to face the issue of how the unobservable perceived degree of ex ante uncertainty can be proxied. Empirical studies have had to address the problem of finding direct proxies such as the variance of income or indirect proxies such as the (change in the) unemployment rate, survey indicators of consumer confidence or the ex post variance of consumption growth. The measures used can be distinguished according to the type of data set used in estimation; that is, time series, cross sectional or panel. This distinction is used to structure the following review of empirical work. First, we will review those studies which employed time series measures of uncertainty. This will be followed by a discussion of studies which used measures calculated from household cross-sectional and panel data sets[17].

5.3.2.1 Time Series Measures

Studies which used a proxy of income uncertainty based on time series data include Flacco and Parker (1990, 1992) and Price (1993). Flacco and Parker (1990, 1992) used the estimated ex post variance of disposable labour income to proxy income uncertainty. They calculated estimates using the methodologies of autoregressive conditional heteroscedastic (ARCH) and linear moment (LM) models.

The linear moments model was developed by Antle (1983) and it specifies that both the mean and variance (and higher moments) of a variable are a linear function of the same set of independent variables. In their case Flacco and Parker specified the income process as a random walk with drift:

$$Y_t = a + Y_{t-1} + \xi_t$$

which would imply the ith moment function as:

$$\xi_t^i = \alpha_i + \beta_i Y_{t-1} + v_{ti}$$

They were interested in estimating the second moment, that is the variance of income, Var $(Y_t) = E(\xi^2_t) = \sigma^2$. Using US quarterly data on real per capita disposable labour income for 1953:2-1988:2 they estimated a random walk with drift model from which they obtained estimates of the first moment of income as follows (1990:657):

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[17] There are a number of alternative ways in which authors have attempted to capture the impact of uncertainty on consumption which do not involve parameters of the utility function. These are not discussed in any detail here, but include Hayashi (1982) who allowed for income uncertainty by letting the discount rate of future labour income to be different to the to the real rate of interest earned on non human capital Hayashi argued that households will incorporate future labour income uncertainty by discounting the expected value of uncertain future after-tax labour income at a higher rate than the interest rate (risk premium).

$$\hat{Y}_t = -9.7 + 1.0Y_{t-1}$$
$$(-0.35) \quad (210.19)$$

where the t-values are in parentheses. The squared residuals from this regression were then regressed on lagged income, with the resulting fitted values serving as an estimate of the second moment of income (that is the variance of income) (1990:658):

$$\hat{\sigma}_t^2 = -10298.8 + 2.42Y_{t-1}$$
$$(-2.69) \quad (3.39)$$

Flacco and Parker (1992) also employed Engle's (1982) ARCH model which specifies the conditional variance of a variable as a linear function of past errors. Maintaining the assumption that income is modelled as a random walk with drift, the pth order ARCH process can be described as (1992:704):

$$\xi_t^2 = \alpha_0 + \sum_{j=1}^{p} \alpha_j \xi_{t-j}^2 + u_t$$

where ξ_t are the disturbance terms from the income process. Using the same data set as in their 1990 study, they estimated ARCH models for lag 1 through to lag 8, and concluded that the ARCH(5) specification produced the best fit for the variance of income.

To assess the effect of income uncertainty on consumption Flacco and Parker (1992) included their ARCH and LM estimates of the variance of income as explanatory variables in the consumption function, similar to that estimated by Blinder and Deaton (1985):

$$\Delta c_t = f(t, c_{t-1,} y_t, y_{t-1}, w_t, w_{t-1}, \sigma_t)$$

where t is a time trend, c is the level of consumption, y is real disposable labour income, w is household net worth and σ is the standard deviation of income as proxied by either the LM or ARCH measure[18]. On the whole, their results indicated that income uncertainty

[18] All variables except the time trend were expressed in per capita terms and natural logarithms.

affected consumption in the direction predicted by theory. However, they did conclude that while both measures significantly improved the specification of the consumption function (as tested by Hausman mis-specification tests), only the LM estimates had a statistically significant effect on consumption.

Price (1993) proxied the variance of income, σ^2, by estimating the conditional variance of UK GDP for the period 1956-1991. Price estimated his conditional uncertainty measure in two stages. Firstly, he regressed the log of GDP on a set of exogenous variables which included the level of World trade, the real dollar price of oil, population, US short interest rates, and North Sea oil production. He also included a linear and quadratic trend to proxy technical progress, population growth and any other excluded secularly trending social factors. Secondly, in two separate regressions, using the residuals from the model in the first stage, he regressed (i) the square of the residuals and (ii) the absolute values of the residuals on a set of exogenous variables incorporating the initial list from the first stage. The fitted values from these second stage regressions provided time series estimates of the extent of income uncertainty over the time period.

The reasoning behind Price's methodology was that heteroscedasticity may be present in the original regression. This heteroscedasticity may reflect a particular relationship to the independent variable(s). In particular he argued that it was likely that the diagonal elements of the variance covariance matrix would vary in size with the independent variable(s). On including the uncertainty measure in a VAR estimation which additionally incorporated consumers expenditure, real personal disposable income, real net wealth, real short interest rates and inflation, he found that the uncertainty term was statistically significant and had the appropriate negative sign in the consumption function (after correcting for autocorrelation)[19].

Other studies have suggested that income uncertainty is a function of the unemployment rate or the change in the unemployment rate; see Flavin(1985), Muellbauer and Murphy(1994), Berg and Bergstrom(1996), and Malley and Moutos(1996). The argument here is that if consumers face greater uncertainty with respect to their employment status, they will reduce their expenditure to build up precautionary saving balances. This effect is being captured to the extent that perceived income uncertainty reflects changes in the unemployment rate. For example, Malley and Moutos (1996) included the unemployment rate as a proxy for income uncertainty in a consumption function to model consumer expenditure on motor vehicles. The parameter on the unemployment rate term was found to be significant and negatively signed in their equation for consumer expenditure on motor vehicles. They also reported that both the level and the change in the unemployment rate were significant in predicting the variance of income and income growth. For Finnish data, both Koskela and Viren (1992) and Takala (1995a) included the unemployment rate in savings regressions to explain the time series development of Finnish household savings ratios over the 1970s to the early 1990s. Both studies found that as predicted by theory, the unemployment rate serving as a proxy for income uncertainty, had a positive effect on the households savings ratio.

Other time series measures include Muellbauer and Murphy (1994) who calculated a short run measure of income volatility defined as $|\Delta \ln y - MA5\Delta \ln y|$ where Δlny is the current income change and MA5 denotes the 5 year moving average from t to t-4. They

[19] Price (1993) applied the Newey West correction for autocorrelation to ensure standard errors are robust to autocorrelation and heteroscedasticity.

expected consumption to be lower when this measure took a larger value reflecting greater income uncertainty perceived by consumers.

Turning to survey data, survey measures based on regular surveys can also be used to construct time series estimates of uncertainty. For example where researchers have had access to survey data information on the level of consumer confidence, these data have been used to indicate consumption and income growth over time. Such researchers include Acemoglu and Scott (1994) (using UK data), and Berg and Bergstrom (1996) (using Swedish data). The consumer confidence indicator used by Acemoglu and Scott (1994) was based on the Gallup[20] monthly survey which is available from 1974. They investigated the performance of the confidence indicator as a coincident and/or leading indicator of income growth, and concluded that such an indicator was useful in predicting future income. The consumer confidence indices employed by Berg and Bergstrom (1996) related to consumers expectations regarding the general economic situation and personal financial situation for the next 12 months (that is, the indices attempt to gauge forward looking attitudes). The source surveys come from HIP and are available from 1973:4 onwards. Berg and Bergstrom examined the potential role of these consumer confidence indices in explaining consumption growth in Sweden during 1975:1-1994:4. They concluded that the estimated parameter attached to the index was statistically insignificant if seasonally unadjusted data was employed, but found it to be statistically significant after a seasonal adjustment had been applied.

[20] Every month a representative group of people are asked a set of twelve questions, some of which relate to their opinions on the general economic situation and to their own financial situation.

5.3.2.2 Cross-Sectional and Panel Study Measures of Income Uncertainty

A number of other studies, where possible, have used panel data and consumer expenditure surveys to calculate estimates of uncertainty (see, for example, Hall and Mishkin (1982), Carroll (1992, 1994), Guiso, Jappelli, and Terlizzese 1992, and Dynan (1993)). Hall and Mishkin (1982) obtained a measure of income uncertainty from the squared residuals from a regression of PSID income data on demographic and life-cycle variables. Guiso et al. (1992) used Italian household survey data, and calculated a measure of income uncertainty based on responses to questions regarding the probability distribution of the rate of growth of nominal earnings and inflation for the year following the survey. Their measure of income uncertainty was approximated by the variance of real earnings. To obtain a measure of this variance, they used the following identity:

$$z = x + \pi$$

with the corresponding expression for the variance of z:

$$\sigma_z^2 = \sigma_x^2 + \sigma_\pi^2 + 2\rho\sigma_x\sigma_\pi$$

where z is the percentage growth rate of nominal earnings, π the rate of inflation, and x the growth rate of real earnings. Given the survey information on the former two variables, they were able to calculate an estimate of σ_x^2, that is the variance of real earnings. When this measure was included in a number of specifications of the consumption function, which included the case of constant absolute risk aversion and constant relative risk aversion, on the whole Guiso et al. found a small but statistically significant precautionary savings motive, which explained approximately 2% of Italy's wealth accumulation.

Carroll (1994) constructed several measures of income uncertainty using a combination of cross-sectional and panel data from the Consumer Expenditure Survey (hereafter CES) and the PSID data set respectively. He obtained traditional measures such as the variance of income across individuals, in addition to the equivalent precautionary premium (hereafter EPP) as proposed by Kimball (1990)[21]. Not surprisingly, he concluded that "farmers and self-employed businessmen had the highest income uncertainty, while professionals and highly educated workers had low income uncertainty"(1990:137). Carroll included these measures of uncertainty in regressions of consumption on current and future income in his "uncertainty augmented consumption model":

$$C_t = \alpha_1 + \alpha_2 Y_i + \alpha_3 H_i + \alpha_4 W_i + \alpha_5 S_i + e_t$$

where Y_i is current labour income, W_i is physical assets, H_i is human wealth and S represents uncertainty. He found that more uncertainty resulted in significantly less consumption, thereby offering support for the precautionary savings hypothesis (1994:140). More specifically, he noted that on average, a one-standard-deviation increase in uncertainty would decrease consumption by 3-5 percent (1994:113).

Carroll and Samwick (1997, 1998) using PSID data, constructed measures of labour income uncertainty to investigate the relationship between income uncertainty and wealth. In both studies, restricting their sample to those households younger than 50 years of age, they obtained instrumental variables regressions of wealth on uncertainty and found a statistically significant positive relationship between wealth and their measures of uncertainty. In their 1997 paper, the measures of uncertainty were calculated as the variances of the permanent and transitory shocks to income. In their 1998 study, they calculated three measures of uncertainty: a normalised version of Kimball's EPP, known as the Relative Equivalent

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[21] Kimball's (1990) equivalent precautionary premium is given by an amount φ such that

$$u'(w-c-\varphi) = Eu'(w-c+y^*)$$

where u is the utility function, w is the consumer's wealth, c is consumption, E an expectation operator, and y* a random error term in income (Kimball (1990:59)).

Precautionary Premium (hereafter REPP), the variance of income (VARY), and the variance of the log of income (VARLY)[22].

Dynan's (1993) measure of uncertainty was the variance of quarterly consumption growth, based on the argument that those who face greater uncertainty should have greater consumption growth. Using data from the 1985 CES, she calculated quarterly consumption growth and the variance of quarterly consumption growth, and then regressed the former on the latter, which was instrumented by occupation, industry, education, the number of earners in a household etc. However, she found no evidence of a precautionary motive.

Dardanoni (1991) using data from the 1984 UK Family Expenditure Survey (hereafter FES) calculated a measure of income uncertainty for each occupational group in his sample. He assumed that the riskiness of future labour income was group specific and constructed a measure of the ex-post variability in each group's labour income as a proxy for ex-ante uncertainty. He concluded that precautionary savings constituted a significant proportion of total savings[23].

5.3.3 SUMMARY

In summarising the first part of this literature review (that is sections 5.3.1 and 5.3.2), Table 5.1 lists a number of the main studies, the measure(s) of uncertainty used, and the main conclusions. Measures of income uncertainty in previous work can essentially be divided into two categories. The first category contains time series

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[22] The REPP measure was obtained by dividing the EPP by the mean of consumption, to obtain a scale-less measure of relative uncertainty.

[23] Other studies include Kuehlwein(1991) who derived a measure of consumer uncertainty based on the expectational errors from the Euler equation and found no evidence of a precautionary motive.

measures (Flacco and Parker (1990, 1992), Price (1993)), while the second contains measures calculated from panel household studies (Hall and Mishkin (1982), Carroll (1992, 1994), Guiso, Jappelli, and Terlizzese (1992)).

We should highlight some important points concerning the use of one type of measure over another. For example, a disadvantage of time series proxies for uncertainty is that aggregate data may not reflect individual risk/uncertainty. Kimball (1990) and Guiso et al (1992) note that individual risks are probably the main determinants of precautionary savings, but that such risks will be washed out in aggregation. So it is generally the case, that when the appropriate data is available, one should use cross sectional data. However, against this, it should be noted that a key disadvantage to the use of cross sectional measures, as pointed out by Guiso et al (1992) is that cross sectional level "proxies for risk are almost invariably correlated with other consumer attributes, and it is impossible to distinguish whether they are truly measuring risk or capturing some other effect" (1992:308). That is, even with cross-sectional data, the obtained measures are not perfect. In addition, the problem of self selection has to be kept in mind (Skinner (1988)); that is consumers in risky occupations may have chosen to belong to that occupation because they are less risk averse. Finally, with regard to simulations, they do not test whether consumers actually respond to uncertainty about future income as predicted by theoretical models[24].

For our work, we want to look at the time dimension of income uncertainty and its predicted effect on consumption. Consequently, we will be employing time series measures in our study. As outlined in Section 5.2.2., our empirical model deals with two groups of consumers who face differing degrees of uncertainty. In the second part of the

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[24] One further point is that where panel data is available, the problem arises that the time series component is in general too short on individuals.

this literature review (section 5.3.4), we look at those studies which provide us with some insight into the stability of labour income for some or all consumer groups.

Table 5.1: Summary of Empirical and Simulation Work for Precautionary Saving

Authors	Data Source	Measure of Uncertainty	Main Finding
Skinner (1988)	US CES	(a) Simulation exercise with isoelastic utility; (b) Occupational dummies to classify households in different risk categories.	(a) 56% of total savings were of a precautionary nature; (b) No evidence of precautionary motive as those in risky occupations appeared to save less than average.
Dardamoni (1991)	UK FES (1984)	Calculated variance of labour income levels within each occupational group	Approx. 60% of savings in the sample arose as a precaution against future income risk.
Carroll (1994)	CES and PSID	Variance of income constructed for each household; Kimball's (1990) equivalent precautionary premium (EPP).	(i) Farmers and self-employed business people had the highest rate of uncertainty, while professionals and highly educated workers had low uncertainty. (ii) Evidence of precautionary saving motive based on the finding that the EPP estimates are statistically significant and have a negative influence on consumption.
Flacco and Parker (1992)	US Time Series	Variance of disposable income as estimated using ARCH and LM models.	Evidence of a statistically significant and negatively signed LM measure in the consumption function supports the theory of precautionary savings.
Guiso, Jappelli and Terlizzese (1992)	SHIW (1989)	Household's subjective assessment of uncertainty	Find a small but significant precautionary motive, accounting for 2 percent of households' wealth.
Dynan (1993)	US CES (1985)	Quarterly consumption growth variance	No evidence of precautionary savings motive.
Price (1993)	UK Time Series	Conditional variance of UK GDP	Measure of uncertainty is statistically significant and has a negative effect on consumption.
Malley and Moutos (1996)	US Time Series	Unemployment rate	Unemployment rate is a "good" proxy of aggregate income uncertainty.

CES: Consumer Expenditure Survey (US)
FES: Family Expenditure Survey(UK)
PSID: Panel Study of Income Dynamics (US)
SHIW: Survey of Household Income and Wealth (Italy)

5.3.4 GROUP UNCERTAINTY

In this section we review the hypotheses of permanent income and segmented labour markets, both of which provide valuable insight into how different working groups may experience differing degrees of income uncertainty.

5.3.4.1 Permanent Income Hypothesis

Friedman's (1957) permanent income hypothesis was one of the earlier works that examined the implications of the dispersion of income between consumers. He treated income as the sum of two components: a permanent component (Y_P) and a transitory component (Y_T): $Y = Y_P + Y_T$ (1957:21). He suggested that the response of consumption will differ according to the composition of income changes, because some components would be regarded as more being more "transitory" than others. Friedman used the specific examples of farm and non farm income, and profit and non-profit income.

Hall and Miskin (1982) also worked along the lines of permanent and transitory income with some consumers having a larger transitory component than others. Quah (1990, 1992) looked at permanent and transitory shocks to income to explain the "excess smoothness" of consumption or the "Deaton Paradox" (Deaton(1987), and Campbell and Deaton (1989)). Excess smoothness of consumption relates to the finding that consumption responds less than the RE-LCPIH predicts to unexpected changes in income. According to the RE-LCPIH, consumption innovations should equal innovations in permanent income, and if we maintain the standard assumption that income has a unit root, this implies that permanent income innovations should correspond strongly to current income innovations; consumption should thereby be at least as volatile as income. However a number of studies including Deaton (1987) and Campbell and Deaton (1989) argued that consumption appeared to be excessively smooth. Quah (op.cit.) explained that different kinds of disturbances can affect the income stream; specifically disturbances can have either a permanent impact or transitory impact on labour income. He concluded that those disturbances that have a permanent impact on labour income, will also have a large impact on consumption. In his (1992) study he argued that the permanent element was relatively smooth compared to the transitory element, hence the finding of excess smoothness. For this study, however, the works of Hall and Miskin (1982) and Quah (1990, 1992) did not distinguish between groups of consumers, so did not demonstrate whether permanent or transitory elements could be relatively more important for one group than another group.

Work by Kennedy and Dowling(1970), Kelleher(1970), Arestis and Driver(1980), and Holbrook and Stafford(1971)) decomposed income according to the employment/self employment/unemployment split, based on the argument that those who are self employed face greater income uncertainty. Using data from the Consumer Expenditure Survey of 1972-73, Skinner (1988) looked at saving rates by occupation. Firstly, he presented the average of the savings to net income ratio by occupation. Secondly, he presented results for saving regressions which included as independent variables, dummy variables for each occupation, as well as income, family size and age. For both sets of results, his findings did not correspond with his prior expectation that those in riskier occupations would save more. However, Skinner noted that his results could reflect self selection; that is that the less risk averse tend to seek and therefore be employed in the relatively risky jobs.

Using a self-reported measure of income uncertainty from the 1989 Italian Survey of Household Income and Wealth (SHIW), Guiso et al. (1992) did find evidence to support the assumption that certain groups of workers could be classified as high risk groups; specifically those who were self-employed[25].

[25] In the 1989 SHIW, households were asked two questions "regarding the probability distribution of the rate of growth of nominal earnings and inflation for the year following the survey" (Guiso et al. (1992:

5.3.4.2 Segmented Labour Markets

A second approach that can provide some insight into groups facing distinct perceived income uncertainty is that of segmented labour markets (hereafter SLM)[26]. One of the earliest developments in SLM theory is the dual labour market theory. Labour market duality views all jobs as belonging to either the primary sector or the secondary sector. Jobs in the primary sector exhibit characteristics such as high negotiated wages, good working conditions, good promotion possibilities and, employment security and stability. On the other hand, jobs in the secondary sector are characterised by competitive conditions, low wages, poor working conditions, little possibility of career development, and high labour turnover.

Doeringer and Piore(1971) argued that the primary sector is composed of a series of internal labour markets (hereafter ILM)[27], of which a key feature is the stability of employment. Leontaridi(1998) notes that, in general, firms that foster primary conditions for employment are those which face a stable demand for their products, and can afford investment in technological development and labour enhancing schemes such as on-the-job training, promotion systems etc. On the other hand, she noted that firms who face a variable product demand "will tend to engage in labour intensive production techniques, avoiding sunk costs of capital investment and labour training"(1998:72). Further distinction between the segments is illustrated by Osberg, Apostle and Clairmont(1987) who argued that the secondary (low wage) sector will consist of those workers employed in the "marginal manufacturing" sectors and in "personal services". Marginal

312). The responses to these questions were then used to obtain a measure of "subjective uncertainty of real earnings in 1990" (1992:312).

[26] For excellent surveys of the literature on segmented labour markets, see Cain(1976) and more recently Leontardi(1998).

[27] Internal labour market theory states that such markets are governed by institutional rules (e.g. trade unions are involved in the negotiation of wages etc.) as opposed to market processes (e.g. wages determined competitively).

manufacturing firms tend to be "highly exposed to third world competition"(1987:1610), while personal services such as retail shops and restaurants, "implicitly compete with unpaid household labour"(1987:1610)[28].

A related approach to distinguishing between economic groups was put forward by Spann (1977) and Skolka (1977), both of whom employed Baumol's (1967) two sector model of unbalanced growth. The essence of this model was that two sectors would experience different productivity growth rates, because sector one would be technologically progressive and experience high productivity growth, whilst sector two would have lower productivity growth. Both Spann (1977) and Skolka (1977) applied the Baumol model to the case of the public and private sectors of the economy, and argued that the former sector could be described as the non-progressive sector (Dean (1981:63). Dean (1981), using UK public and private sector pay and employment data, extended this analysis by noting that public sector expenditure (of which public sector payment is a significant proportion) and public sector employment tended to be relatively insensitive to general economic conditions. So public sector employment tended to fluctuate less than the private sector. In terms of income uncertainty, such a feature could be reflected in public sector employees facing less uncertainty than their private sector counterparts.

In summary, the segmented labour markets hypothesis suggests that given the particular features which characterise the primary sector, its' workers would face less income uncertainty than workers in the secondary sector. Some corroborating evidence is provided by Carroll and Samwick (1997). They used data from the Panel Study of Income

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[28] That is, where market produced goods can be substituted for home production or vice versa.

Dynamics (PSID) for the years 1981 to 1987 to construct estimates of labour income uncertainty for industry and occupational groups[29]. With respect to industry groupings, Carroll and Samwick concluded that workers in the manufacturing and utilities sectors faced less uncertainty than those in the trade or professional services (1997:49). They also noted that workers in the public administration sector, faced comparatively little income uncertainty (1997:49), which would support Dean's (1981) arguments concerning the public versus private sector. With respect to occupation groupings, they concluded that "Farmers, Service Workers, and Self-Employed Managers have high uncertainty; Labourers, Clerical Workers, and Managers have average uncertainty; Professionals and Craftsmen have the least uncertainty"(1997:46).

Summary

In conclusion, both the permanent income, and the segmented labour market hypotheses provide insights into the implications of the relative stability of earnings for different occupations. The permanent income hypothesis suggests that for certain occupations, the level of transitory income can be a large component of income, and that workers will experience high variances of transitory income relative to the variance of permanent income. For these workers we would expect to find relatively high volatility in their income streams. The SLM hypothesis suggests that, given the general characteristics of the primary and secondary sectors, workers in primary sector jobs will experience less income uncertainty relative to those in secondary sector jobs.

So, with respect to our two group consumption model, the above analysis would suggest the division of consumers according to (i) a permanent-transitory spilt; (ii) a

[29] They also provided estimates of income uncertainty for education. With respect to education, they noted that uncertainty declines with higher levels of education (1997:49).

primary-secondary sector spilt; or (iii) a private-public sector spilt. For example, with respect to (i) our Group 1 consumers would be those with higher levels of transitory income relative to Group 2 consumers. With respect to (ii), our Group 1 consumers would be defined as those with jobs in the secondary sector, and Group 2 consumers as those with jobs in the primary sector. Finally, for the latter spilt (iii), our Group 1 consumers would be defined as those employed in the private sector, and Group 2 as those employed in the public sector. The particular division selected in this work is primarily determined by the availability of data, as shown in the next section (5.4).

Prior to concluding the second part of this literature review (that is section 5.3.4), we will briefly examine some particular features of the Finnish labour market which will provide us with some insight into the applicability of the above characterisations for Finnish consumer groups.

5.3.4.3 Finnish Labour Market

In this section, we outline a number of distinct features of the Finnish labour market. Firstly, as a consequence of strict labour legislation for the protection of employees, the number of people with fixed term work contracts is high. In 1993, this group accounted for 13.5% of the total labour force (OECD (1996)). Petajaniemi (1996) noted that of all the OECD countries, only Holland and Spain surpassed Finland in this trend (1996:5). In terms of income uncertainty, a fixed term contract can be perceived as having a degree of certainty and security attached to it for a specified time period. It should also be noted that there is a higher percentage of employees on fixed term contracts in the public than in the private sector (see Table 5.2).

Table 5.2: Fixed-term employment contracts by employer (as percentage of total employees, aged 15-64), 1982-1993

	1982	1989	1993
Current Contracts:			
Total	11.3	11.9	13.5
Central Government	14.9	13.2	17.7
Local Government	19.5	21.6	19.4
Private Sector	8.3	8.6	10.2

Source: The Finnish Labour Market Institute for Economic Research report on The Labour Market in Finland (1996:114), and Statistics Finland: Supplementary Labour Force Survey.

Secondly, over 57% of private sector employment is accounted for by small and medium size firms (Petajaniemi (1996:5)). Thirdly since 1990, Finland has gone through a long and severe recession which has created mass unemployment. The sectors most severely affected were construction and finance, the primary reason being that the recession followed a property-related financial crisis. The core manufacturing sector also suffered, but primarily through increased international competition and technological progress. According to the Statistics Finland Labour Force Survey, between 1991 and 1995 there was a drop of over 16 percent in total employment (see Table 5.3). While both the private and public sectors registered drops in employment, the extent of their declines reflects their different degrees of susceptibility to general economic conditions. In the public sector, employment fell by approximately 5 percent over the period 1991-1995, whilst in the private sector, employment fell by 20 percent over the same time period. The overall decline in the private sector was primarily driven by the construction sector where employment fell by almost 50 percent, and by the manufacturing sector where employment fell by approximately 18 percent. These factual points highlight that the private sector, and in particular some of its sub sectors, are more susceptible to the economic business cycle, and consequently face relatively more uncertainty.

Table 5.3: Developments in Finnish Employment (percent change), 1991-1995

Industries	1991	1992	1993	1994	1995
Primary	-4.3	-5.6	-7.0	-4.0	-5.4
Manufacturing	-9.7	-9.8	-6.4	0.5	6.6
Construction	-12.7	-16.8	-14.1	-10.9	5.3
Other private	-4.4	-6.6	-5.0	0.2	1.7
Total Private	-6.8	-8.4	-6.4	-1.1	2.5
Public	1.1	-2.6	-5.1	0.0	1.0
Total	-5.1	-7.1	-6.1	-0.8	2.2

Source: OECD Country Survey: Finland (1996:53) and Statistics Finland Labour Force Survey.

5.3.5 CONCLUSION

We now conclude this literature review by noting a number of key points. Firstly, relative to the wealth of work done in other areas of consumption (for example the Euler equation approach), empirical work on precautionary saving is still in its early stages. This is partly explained by the difficulties in obtaining closed form solutions for the consumption function and the unobservable nature of income uncertainty. Of the work that has been done, while theoretical literature clearly illustrates that income uncertainty reduces current consumption and increases savings, the empirical work produces conflicting results. Furthermore, the simulation studies show that the relationship between uncertainty and consumption depends on the nature of the stochastic process generating income and the risk attitudes of consumers. As noted previously, we refer to Table 5.1 which provides a summary account of the main simulation and empirical studies.

Secondly, some of the studies have dealt with the issue that income uncertainty varies across consumer groups. For example, Skinner (1988) incorporated occupational dummy variables as explanatory variables into the consumption function, while others calculated the variance of labour income for each occupational group (for example, Guiso et al. (1992) and Carroll and Samwick (1997)). From the above literature review and to the best of the author's knowledge, no study has been undertaken to empirically examine differing income uncertainty across two groups, within a consumption function. Hence our work should contribute to and complement the existing literature.

Thirdly, it is notable that various measures of income uncertainty have been calculated and employed in empirical work. Of particular relevance to this study are the time series measures, since these offer the ability to focus on aggregate consumption behaviour over time (for example, Flacco and Parker (1990, 1992) and Price (1993)). In the next section we address a number of issues concerning the empirical estimation of equation 5.14, one of which will include the methods used in our work to estimate the time series measures of income uncertainty.

5.4 DATA AND METHODOLOGY CONSIDERATIONS

The estimation of equation 5.14 is conducted using quarterly Finnish time series data. The data are obtained from the following sources: Kari Takala of the Bank of Finland; Hannu Siitonen (Statistician, Finnish Labour Force Survey) and Jari Tarkoma (Statistician, Department of Employment), both of Statistics Finland. These data are seasonally adjusted, and expressed in logarithms. The sample period is 1975:1 - 1995:4[30].

Prior to the empirical work, it is necessary to address several issues which arise with respect to the estimation of equation 5.14. Firstly, in the derivation of the model we assumed that measures of financial wealth and post tax non property income are available for each consumer group (that is A_1, A_2, Y_1, Y_2). In fact we have data on total disposable

[30] Further details on data collection and variable definitions are provided in the Data Appendices (Appendix 2).

income and wealth, but not income and wealth for individual groups. In order to estimate the model we therefore have to make certain assumptions about the allocation of human and non human wealth between the two groups. In section 5.4.1 the available decomposition of income (5.4.1.1) and wealth (5.4.1.2) are examined. We then discuss measures of income uncertainty and their calculation (5.4.2). Potential estimation methods for equation 5.14 include instrumental variables, IVMA and GMM. In section 5.4.3 we outline the factors which will allow us to decide which estimator is most appropriate in practice. Finally, other data considerations such as time series analysis of all series is examined in section 5.4.4.

5.4.1: INCOME AND WEALTH

5.4.1.1: Decomposition of Income

The measure of income used in the theoretical model is labour income. We also have the objective of decomposing this figure between two groups of consumers where the groups are distinguished by their respective degrees of uncertainty. We use data for total non property disposable income, in conjunction with sectoral wages and salaries (the manufacturing sector, non-manufacturing sector and public sector) to arrive at the appropriate decomposition. The former will be used as an approximation to labour income. This is the only income data available to the researcher.

In order to segregate groups of consumers according to the degree of uncertainty they face, we initially look to the existing literature: as seen in section 5.3.4, previous work has decomposed income according to whether the receiver is employed/self employed/unemployed, based on the argument that those who are self employed and/or unemployed face greater income uncertainty. However, due to the non-availability of data such a breakdown is not feasible with Finnish data. An alternative way would be to spilt income using a statistical approach; for example, dividing income into its permanent and transitory components. However in practice, all consumers' income streams are likely to have permanent and transitory components and the distinction is likely to be blurred in aggregation.

The approach adopted in our work follows the earlier work of Friedman(1957), Skinner(1988) and the dual labour market hypothesis. Income is decomposed according to various groups by industry, and it is assumed that some groups of wage earners expect greater income uncertainty than other groups. In theory, the ideal situation would be to obtain data at a relatively high level of disaggregation, for example, employment and wages for the agricultural and forestry sector, construction sector, manufacturing sector, etc. However, data are not available for such a detailed analysis of the sectors taken individually; in practice our choice of groups is determined by the available data.

We have been able to collect wages and salaries for the private and public sectors. The private sector is further disaggregated into the manufacturing and non-manufacturing sub-sectors. The manufacturing category includes the standard classification of manufacturing, as well as mining and quarrying, and electricity, gas and water. The non-manufacturing private sector includes financing, insurance, real estate and business services; transport, storage and communication; trade, restaurants and hotels; construction; and agriculture, hunting and fishing.

Based on the arguments advanced in section 5.3.4 (that is, the permanent income hypothesis and the dual labour market hypothesis), we argue that it is likely that those employed in the private sector would experience more variation in their income over time, and consequently face greater income uncertainty. For example, it is likely that both the manufacturing and non-manufacturing private sectors are more susceptible to downturns in the economy (at least in the short run) compared to the public sector. This was clearly evident in Finland during the recessionary period of the early 1990s, where the decline in the employment in the private sector was four times greater than that in the public sector[31]. Similarly for the recession of 1977-1978, when unemployment peaked at 7.3 percent, its rise was dominated by a 20 percent and 19 percent rise in the sectors of manufacturing and construction respectively. The corresponding figure for the public sector was only 3.5 percent (Statistics Finland, Labour Force Survey).

Looking at the subsectors within the private sector, service industries in general tend to comprise of small industries, and do not have the ability to cope with downturns in the economy. Petajaniemi (1996) noted that of private sector employment (which employs approximately 70 percent of the Finnish labour force), small and medium sized enterprises accounted for 57 percent of its employment (1996:5). With respect to the manufacturing sector, work generally tends to be on the basis of contracts, and hence in the short term [that is, during contract periods] the sector would tend to be more secure/stable than non-manufacturing private sector; in the medium term, a recession would affect this sector[32]. The dual labour market hypothesis also suggests that of the non-manufacturing private sector, many of its subsectors would predominately be included in the secondary sector (for example retail. restaurants, hotels etc.), in which jobs

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[31] Details of labour market developments during the recessionary period of the 1990s were provided in section 5.3.4 "Finnish Labour Market".

[32] Becker's (1975) theory of the allocation of time and goods over time states that, for example, if there was a positive shock to consumers wages and salaries, then their time overall becomes valuable, and hence they will seek non working activities which are less time intensive. Such an increase in wages and salaries should be reflected in the substitution of market-produced goods for home production, in particular the increased purchase of more service type products. A change in wages and salaries will therefore have a greater (initial) effect on non-manufacturing private sector, and then on manufacturing.

are generally characterised on average by lower wages, poorer working conditions, employment instability and more part-time work relative to the primary sector[33].

In order to ascertain which of these sectors in fact experience the least and most income uncertainty, we present some statistical evidence[34]. A number of descriptive statistics are presented in Tables 5.4 and 5.5. Table 5.4 reports figures for the absolute level of earnings in each sector, and the corresponding ratio of private to public sector earnings. The time period is 1975-1995, and we focus on the long term movement in the relative earnings of the two sectors. This follows from Dean(1981) who noted that "[t]he absolute levels of pay in the two sectors will be affected by the industrial, occupational and age distributions of the respective work-forces. Attention should thus be focused on broad movements of pay over several years rather than on precise details."(1981:46).

[33] This statement obviously relates to the average experience, as clearly some of those in the private sector, for example in finance, do rather well for themselves. But given that we cannot dis-aggregate further due to data limitations, we refer to the average experience.

[34] Time plots of the wage and salary data are provided in Appendix A5.1.

Table 5.4. Index of Relative Wages and Salaries of the Private and Public Sectors: 1975-1995 (refer to notes at end of Table 5.4)

	1975	*1976*	*1977*	*1978*	*1979*	*1980*	*1981*	*1982*	*1983*	*1984*
Private	64.07	67.72	66.68	69.06	71.79	72.46	75.09	75.82	76.90	78.26
Public	64.26	70.66	68.28	69.82	71.10	69.67	71.61	70.78	70.44	70.80
Ratio	**99.71**	**95.84**	**97.65**	**98.91**	**100.96**	**104.00**	**104.86**	**107.12**	**109.17**	**110.54**

	1985	*1986*	*1987*	*1988*	*1989*	*1990*	*1991*	*1992*	*1993*	*1994*	*1995*
Private	80.85	84.14	88.38	91.65	98.61	100.00	100.14	91.95	91.66	90.63	94.12
Public	72.49	75.79	77.19	79.37	94.59	100.00	102.97	94.71	92.20	87.03	87.20
Ratio	**111.53**	**111.01**	**114.49**	**115.47**	**104.25**	**100.00**	**97.25**	**97.09**	**99.41**	**104.14**	**107.93**

Notes to Table 5.4

(1) Ratios are expressed as private sector earnings divided by public sector earnings; the base year is 1990=100. An upward movement in the ratio indicates a relative improvement in private sector earnings, and vice versa.

(2) The data are annual averages (derived from quarterly data), seasonally adjusted, and are expressed in real (base year = 1990) per worker terms. Per worker calculations are obtained using the number of people employed in the respective sector[35].

Two key features appear evident. Firstly, earnings in the two sectors have moved in the same direction throughout much of the period, but the mid to late 1980s provide an exception, in that there was a significant increase in the earnings of the private sector. The latter was a period of rapid expansion in Finland, where the OECD reported an average annual Finnish output growth about 1.5 percent higher than that recorded for OECD Europe (1991:11). This coincides with Spann's (1977) and Skolka's (1977) arguments that the private sector could be regarded as a higher productivity sector relative to the public sector. Hence we would expect during a period of high growth, increased productivity in the private sector, which in turn would be reflected in increased

[35] The data are seasonally adjusted using the US Census of Bureau X11 method, as computed using the package Econometric Views (Version 2.0, Quantitative Micro Software). The variables are deflated by the implicit deflator for the consumption of non durables and services.

wages and salaries. Secondly, a cyclical pattern is evident for both sectors but this is more pronounced for the private sector. This is particularly evident when we look at the ratio figures, expressed as private sector earnings divided by public sector earnings. This ratio shows that (relative to the base year) private sector earnings increased relatively faster during expansions (e.g. during the period of strong economic growth of the mid to late 1980s), but rose relatively less in recessionary times (e.g. during the recession of 1977-1978 and the deep recession of the early 1990s).

We also present summary descriptive statistics for each sector for the period 1975-1995 in Table 5.5. As we would expect, average earnings for the private sector are higher than that of the public sector; however earnings dispersion (given by the standard deviation) is lower for the private sector. This is a surprising result, and one which is further supported by the coefficient of variation (measure free) statistics (0.0149 and 0.0155 for the private and public sector respectively)[36]. This feature of the data can be partly attributed to the changes in industrial classification in 1989, which mainly affected the division between the following categories: (i) trade, restaurants and hotels; (ii) finance, insurance, real estate and business services; and (iii) community, social and personal services. For 1989, the difference between the SIC 1979 and SIC 1988 for these groups was an additional 19300 workers in category (i), an additional 40500 in (ii), and a reduction of 62100 in (iii)[37]. This new classification meant a decrease in the public sector (category (iii)) official employment figures of approximately 8 percent, with proportionate increases in the private sector. This reclassification obviously affects the calculation of the per worker/sectoral figures.

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[36] The coefficient of variation (CV) is a measure of relative dispersion or variability; it is calculated as the standard deviation(s) as a percentage of the mean, that is:

$$CV = \left(\frac{s}{\bar{x}}\right) * 100$$

where s = the standard deviation and $\bar{x}$ is the mean.

As a comparative aid, the diagnostics are calculated for the two periods 1975-1988 and 1989-1995, and are presented in the second and third rows of Table 5.5. Noting the coefficients of variation for the former period (second row), they are consistent with our earlier argument that the public sector would experience relatively less volatility (0.0112 and 0.0071 for the private and public sectors respectively). With respect to the period of 1989-1995, we observe that all sectors experienced a similar rate of volatility (once again shown by the respective coefficients of variation). This can be explained by the fact that the recession during this period affected all sectors within the Finnish economy.

For the full sample period, if we look at the disaggregation of the private sector into it's manufacturing and non-manufacturing components, the figures suggest that average income and income dispersion are higher for the non-manufacturing private sector than the manufacturing sector. From these descriptive statistics we can conclude that there is some evidence to suggest greater variation in earnings for the private sector relative to the public sector. This statistical evidence in conjunction with the theoretical arguments outlined in 5.2.4., suggest the following decomposition of income amongst consumer groups. The first group of consumers in equation 5.14, that is Group 1 will be characterised by those working in the private sector. Group 2 will be defined as those working in the public sector.

Table 5.5. Descriptive Statistics of Sectoral Wages and Salaries per Worker (refer to notes at end of Table 5.5)

	TOTAL	PRIVATE Total	Nonmanu	Manu	PUBLIC
1975:1-1995:4					
Maximum	9.6688	9.6809	9.6954	9.7036	9.6552
Minimum	9.1718	9.1508	9.0597	9.2734	8.9564
Mean	9.4408	9.4650	9.4483	9.4952	9.3730
Std.Dev.	0.1374	0.1414	0.1578	0.1175	0.1448
Skew.	0.0942	-0.1107	-0.1851	0.1237	0.3605
Kurto. -3	-1.2178	-1.2109	-1.0335	-1.3169	-0.4539
Coef. of Var.	**0.0146**	**0.0149**	**0.0167**	**0.0124**	**0.0155**
1975:1-1988:4					
Maximum	9.5500	9.6090	9.6312	9.5677	9.3947
Minimum	9.1718	9.1508	9.0597	9.2734	8.9564
Mean	9.3607	9.3877	9.3670	9.4241	9.2818
Std.Dev.	0.0885	0.1049	0.1255	0.0704	0.0656
Skew.	0.2491	0.2207	0.1458	0.2316	-1.9050
Kurto. -3	-0.4502	-0.5651	-0.4960	-0.3729	9.1262
Coef. of Var.	**0.0095**	**0.0112**	**0.0134**	**0.0075**	**0.0071**
1989:1-1995:4					
Maximum	9.6688	9.6809	9.6954	9.7036	9.6550
Minimum	9.5295	9.5479	9.5093	9.5825	9.4540
Mean	9.6010	9.6196	9.6108	9.6376	9.5555
Std.Dev.	0.0458	0.0428	0.0583	0.0287	0.0625
Skew.	0.1932	0.0337	0.0866	0.2994	0.0304
Kurto. -3	-1.4457	-1.4301	-1.4741	-0.3374	-1.0160
Coef. of Var.	**0.0048**	**0.0045**	**0.0061**	**0.0029**	**0.0065**

Notes to Table 5.5

(1) The table reports the descriptive statistics for total wages and salaries, and by sector. Total = total wages and salaries; Private = wages and salaries of the private sector; Nonmanu = wages and salaries of the non-manufacturing private sector; Manu = wages and salaries of the manufacturing private sector; Public = wages and salaries of the public sector.

(2) The statistic Std. Dev. is the standard deviation, Skew. is the coefficient of skewness, the statistic 'Kurto' is the coefficient of kurtosis, and Coef. of Var. is the coefficient of variation. For a normally distributed random variable, the value of the coefficient of skewness is 0 and the value of the coefficient of kurtosis is 3.

(3) All variables are expressed in constant 1990 prices, in logarithms and in per worker terms.

Adopting the public-private sector division, we now turn to the allocation of income and wealth between them. We first look at income. Data are available for total disposable income and for the wages and salaries for each sector. However the sum of all wages and salaries does not provide disposable income. We have to deduct current transfers per capita[38] from total disposable (non-property) income per capita. This measure of aggregate disposable income exclusive of transfer payments (in levels) is divided proportionately between the two groups of consumers. The proportion will relate to real wage and salaries per sector as a percentage of total real wage and salaries.

The deduction of transfer payments must also be considered in relation to the dependent variable in equation 5.14, that is, the measure of consumption employed (consumption of non durables and services per capita)[39]. Now, obviously, the consumer population consists of those who are employed and unemployed. The uncertainty augmented model (equation 5.14) deals with the explanation of consumption behaviour for the employed labour force. However the unemployed are responsible for a part of total consumption; to take account of this within the model, we work with aggregate consumption exclusive of transfer payments. In obtaining these measures we assume that the unemployed (on average) receive purely transfer income, and that it is spent immediately and in full. This assumption can be attributed to Muellbauer and Murphy (1994) and Darby and Ireland (1994)[40]; it is a simplifying assumption but quite a useful one.

[38] Current transfers are proxied by unrequited current transfers to households and own profit institutions (BOF5 model variable YTRH).

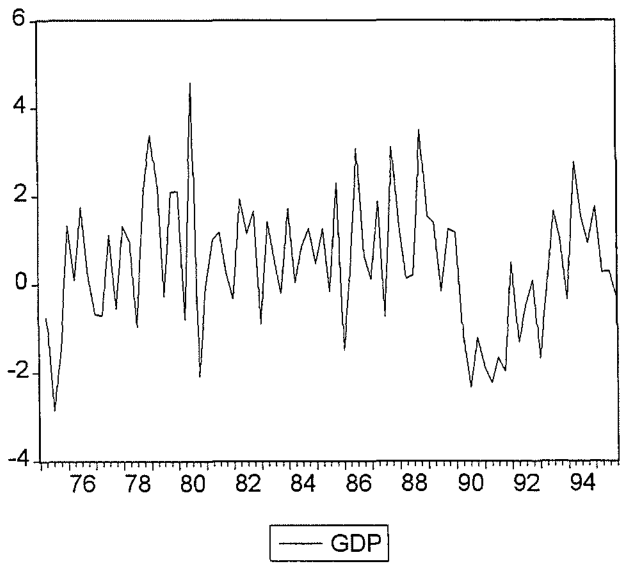
[39] Per capita estimates obtained by dividing each variable by the total Finnish population.

[40] Muellbauer and Murphy (1994), using quarterly data for the UK and US, observed that their results suggested that most of income paid in current transfers was spent in each quarter (1994:14).

5.4.1.2: *Decomposition of Wealth*

The wealth variable (A_t) is defined in equation 5.14 as net non human wealth of households that is, housing wealth plus financial wealth less debt. It is not possible to allocate net non human wealth by sector from published data. Instead we have to adopt a rule of thumb to divide total net non human wealth between the two groups. Wealth is essentially a proportion of income accumulated over time. Consequently we apply a moving average process to the real wages and salaries of each sector. We refer to the Finnish business cycle to obtain an indication of the length of the moving average period. Figure 5.1 presents a time series plot of quarterly GDP growth over the period in question. A moving average of 5 periods is calculated. Five periods are selected as it approximates the average duration of a period of contraction and expansion in the Finnish business cycle (defined as a period of a decline and an increase in the growth rate of GDP respectively).

Figure 5.1. Quarterly Growth Rate of Finnish GDP: 1975Q1-1995Q4



The moving average period of length 5 is applied to the real wage and salary per worker data for the private sector and the public sector. Then the moving average data for each sector are summed, and proportions are obtained of the total. These latter proportions are used to decompose net wealth amongst the sectors[41][42]. Our measures of sectoral wealth are presented in Figure 5.2. Similar to Muellbauer and Murphy's (1989) findings for the UK, we find that the importance of wealth increased during the 1980s. This is more clearly evident when we look at the ratio of total consumption to net wealth (C/W), as shown in Figure 5.3[43]. We can see that wealth increased dramatically during the late 1980s (reflected in a decreasing C/W ratio), but decreased sharply from 1990 onwards (an increasing C/W ratio). The increase in household wealth can be partly attributed to the rapid increase in asset prices during the mid to late 1980s, the period of financial liberalisation. As outlined in chapter two, financial liberalisation resulted in an increased demand for various assets, which contributed to increased asset prices and thereby greater capital gains. The increased demand can also be partly attributed to the favourable tax treatment of investments in shares (Englund (1990)).

[41] We also looked at the sensitivity of proportions when different lengths of the moving average period were used, for example, a moving average period of order 3 and 7 were calculated. In all cases similar proportions to the moving average period of order 5 were obtained.
[42] Net wealth is expressed in real and per capita terms.
[43] Both variables are expressed in real and per capita terms.

Figure 5.2. Measures of Sectoral Wealth (calculated using a moving period of length 5). Total = Net Wealth; Pubwealth = proportion of wealth allocated to the public sector; and Privwealth = proportion of wealth allocated to the private sector.

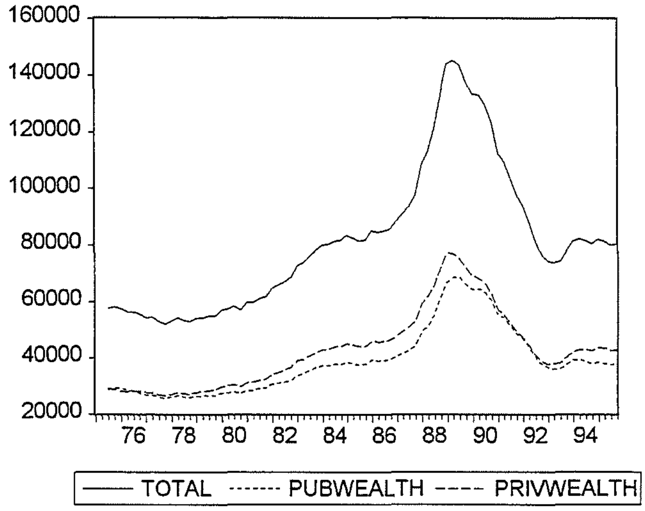
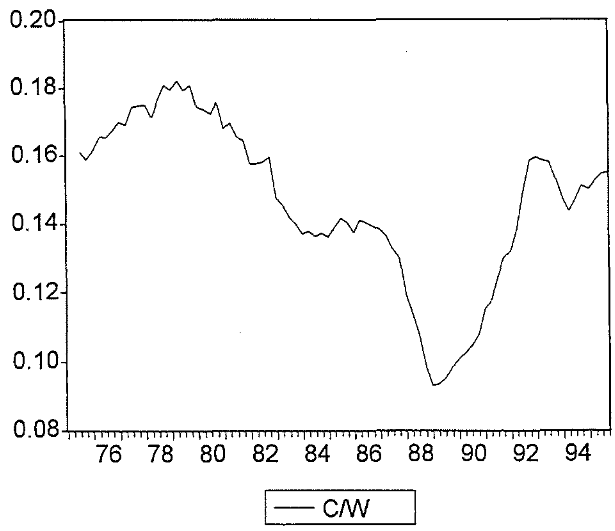


Figure 5.3. Consumption to Net Wealth ratio (C/W).



5.4.2 MEASURES OF INCOME UNCERTAINTY

The theoretical measure of income uncertainty in our model is the variance of income. In this section we outline the methodologies used to obtain the estimates of income uncertainty, which are used in the estimation of equation 5.14. The results are presented in the Empirical Evaluation section (Section 5.5). As noted in section 5.4.1.1 income per sector is not available to the researcher, consequently we have to use an alternative data source to obtain an approximation of the variance of income per sector. One option would be to use the allocation of total non-property disposable income to each sector to obtain such measures. However in this case, any change in the volatility could be attributed to changes in the relative weights. Another option is to use the wage and salary data for each sector. In this work we adopt this latter option. Obviously, the variance of sectoral wage and salaries does not fully reflect the level of income uncertainty experienced by workers in each sector. However, it should serve as a good approximation, in particular, when for many consumers, wages and salaries contribute a significant proportion to their overall income.

The following methods are employed to obtain time series measures[44] of income uncertainty, (a) the ARCH techniques as initiated by Engle(1982); (b) the LM method as demonstrated by Flacco and Parker(1992); and (c) the modelling of the conditional variance of income following Price (1993). These methods have already been mentioned in the literature review; each will now be discussed in more detail. A measure of the change in the sectoral employment rate is also used to approximate uncertainty. This latter measure is clearly different from the former ones, since it focuses on

[44] The focus in this work is on time series measures, as (i) the objective of this work is to examine the effects of income uncertainty on aggregate consumption over time; and (ii) cross sectional and panel data are unfortunately not available to the researcher, thereby excluding the use of this data.

employment/unemployment and not income from employment. We include it as a comparative measure based on the argument that it is likely that wage growth moderates when unemployment in a sector rises, primarily due to the fear of being unemployed.

5.4.2.1 ARCH and GARCH Methodologies

Conventional time series and econometric models operate under the assumption of constant variance. In practice, however, a number of economic time series exhibit periods of relative tranquillity followed by periods of high volatility. Engle(1982) introduced the Autoregressive Conditional Heteroscedastic (ARCH) process to allow a series with changing volatility to be represented. He noted that in many economic time series, particularly in financial data, there was a clustering of large and of small residuals, suggesting that the magnitude of the error of the preceding period would provide information about the current error. He represented this pattern of behaviour as an ARCH process which allows the conditional variance (hereafter h_t) to change over time as a linear function of the square of past error terms (hereafter ε_t). He developed the p^{th} order autoregressive conditional heteroscedasticity, the ARCH(p):

$$h_t = \omega + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2$$

where α_1, ..., α_p and ω are constant parameters.

Since the introduction of ARCH processes, a number of variations and extensions have been developed. The ARCH(p) process is restrictive in that volatility is a determinant of past errors only. Bollerslev(1986) generalised the ARCH(p) model to the GARCH(p,q) model, in which the conditional variance is also a function of past conditional variances, such that:

$$h_t = \omega + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{q} \beta_i h_{t-i}$$

where $\alpha_1, \ldots, \alpha_p, \beta_1, \ldots, \beta_q$, and ω are constant parameters. The particular advantages of the GARCH model for modelling income uncertainty over the standard ARCH model, is that it allows the observed persistence of income shocks to be incorporated. This is important as previous studies such as Skinner(1988) and Zeldes(1989b) have indicated that the precautionary saving motive is stronger, the higher the degree of persistence in income shocks. As we are working with quarterly data, we specify an ARCH(4) process; while with respect to the specification of the GARCH model, a GARCH(4,4) is selected.

The residuals required for estimation of the family of ARCH models can be obtained from a standard autoregresion (AR) model, an ARMA model or a single dynamic multivariate regression, of the wage and salary process for each sector. For this study the latter model is adopted, whereby a sequential reduction procedure is adopted in order to obtain a base regression for modelling the sectoral wage and salary processes (Muellbauer 1995). This base regression serves as the conditional mean equation when testing for potential ARCH and GARCH effects. The sequential reduction procedure commences with a general to specific search modelling of wage and salary growth, whereby wage and salary growth is regressed on lagged values of wages and salary growth along with lags of the growth rates of government expenditure, exports, business investment, total consumption, net wealth allocated to the private and public sectors, and the real interest rate and the inflation rate (all variables are expressed in logs except for the real interest and inflation rates). Using individual significant tests (t-statistics), joint significant tests (F-statistics) and other diagnostics, we obtain a more parsimonious specification of the process for the wage and salary growth for each sector.

5.4.2.2 Price Methodology

Our second method of measuring income uncertainty follows that of Price (1993). Price modelled the conditional variance of GDP, and employed it as a proxy for income uncertainty. He conditioned both the mean and the variance of GDP on a set of exogenous variables. A similar exercise is conducted here, where we condition the mean and variance of sectoral earnings on a set of exogenous variables. The modelling processes for sectoral wage and salaries which are selected for the ARCH and GARCH modelling are also used here, as the conditional regressions. First, we obtain the residuals from each mean income regression, and second, we regress both the square of these residuals and their absolute values on the explanatory variables of the mean equations. The resultant fitted values from these latter regressions provide estimates of the variance of income conditional on the explanatory variables.

5.4.2.3 LM Methodology

The previous two methodologies are dependent on the previously specified wage and salary generating process obtained through a general to specific modelling procedure. An alternative method for modelling a measure of income uncertainty, and one which specifies a different process underlying the dynamics of income, is the linear moments (LM) model as developed by Antle (1983). This method specifies that both the mean and variance (and potentially higher moments) of a variable (Y_t) are linear functions of the same set of independent variables. In the derivation of equation 5.14, we made the assumption that income follows a random walk with normally distributed errors; we maintain this assumption here,

$$Y_t = Y_{t-1} + \xi_t$$

Thereby, according to the LM methodology, the first and higher moments of Y_t are also modelled as linear functions of Y_{t-1}

$$\xi_t^i = \beta_i Y_{t-1} + v_{ti}$$

Hence the second moment, that is the variance of Y_t can be modelled as

$$E(\xi_t^2) = \sigma^2 = \beta_2 Y_{t-1}$$

In this work, we apply the random walk model to sectoral earnings, to obtain measures of uncertainty.

5.4.2.4 Labour Market Based Measures of Uncertainty

The final estimate of income uncertainty is based on a labour market based measure, and its use is motivated by the following facts. Firstly, as outlined in the literature review, the unemployment rate has frequently been used as a proxy for uncertainty (Flavin(1985), Muellbauer and Murphy(1994)). Secondly, a labour market based measure is completely independent of any particular income generating process as in the previous calculations, and thereby will serve as a useful comparative measure. We represent uncertainty for each group with a measure based on changes in sectoral employment, as direct sectoral unemployment figures are not available. Even though we only have figures for sectoral employment, its change should give us an indication of the general movement in sectoral unemployment. Specifically we calculate a measure of uncertainty based on the change in sectoral employment as a proportion of the total labour force in each quarter; for example, the change in private sector employment as a proportion of the total labour force for 1985Q1 is calculated using the following formula:

$$\frac{private_{t-2} - private_{t-1}}{total_{t-1}}$$

where private = private sector employment (for 1985Q2 and 1985Q1 in the above example) and total = total labour force.

In conclusion, the following methodologies are used to obtain estimates of income uncertainty: ARCH and GARCH modelling; Price's (1993) model; the LM model; and finally a measure of sectoral employment. The results are presented later in the empirical evaluation section (5.5.1).

5.4.3 ESTIMATION METHODOLOGY

We now turn to the process of the estimation of equation 5.14, and in this we must address the problem of endogenity of the regressors in equation 5.14. A number of estimators can be used to deal with the issue of endogenous regressors, e.g. instrumental variables and GMM. In this study we employ the IVMA estimator, and this decision is motivated by the following arguments. An instrumental approach needs to be used since the assumption made by OLS that income is weakly exogenous is potentially invalid and without instrumenting could manifest itself into simultaneity bias and parameter instability. In addition, IVMA is preferred to IV as there are a number of arguments to indicate the presence of a moving average process. It may arise due to the time averaging of data (Working (1960)), the timing of consumption decisions and to the possible existence of transitory consumption, all of which can lead to adjustments to innovations occurring within the time period observed. The argument for using instruments, in conjunction with the fact that the error term in equation 5.14 may potentially have a first order moving average structure (MA(1)), suggest that the use of standard IV procedure is not appropriate, as even though the coefficient estimates will be consistent, the standard errors will not[45]. Hence we employ the IVMA; further details of the IVMA methodology are presented in Chapter 2, Section 2.5.2.1.

5.4.4 OTHER DATA CONSIDERATIONS:

In this section time series properties of the model variables are examined using unit root tests. This is motivated by a number of reasons. First, estimation of ARCH and GARCH effects must be applied to stationary series. Second, the use of non-stationary variables in estimation leads to a number of problems including spurious results etc. Based on the non-stationarity of the variables, the possible co-integration of the variables is also examined.

Unit root tests are applied to the variables used in the estimation of equation 5.14 (that is consumption of nondurable and services and income (both exclusive of transfers), and net wealth). Furthermore, unit root tests are also applied to those variables which could serve as potential instruments for the IVMA estimation, and as potential explanatory variables in the mean regressions of sectoral wage and salary growth. Unit root tests for a number of the aforementioned variables (for example, net wealth, etc.) have been previously calculated and are reported in chapter 2, section 2.5.1. In Table 5.6, we report the results of the augmented Dickey Fuller tests for those variables not included in our earlier analysis in Chapter 2; specifically the consumption and income measures exclusive of transfers (lcndt and lydt respectively), total wages and salaries (ltotal), wages and salaries of the private sector (lprivate), and wages and salaries of the public sector (lpublic). The ADF results suggest that all series expressed in levels are non-stationary

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[45] This will have consequences for hypothesis testing procedures and confidence interval construction.

(refer to row 1 of Table 5.6). On further investigation of the data expressed in first differences, it was found that all variables were integrated of order 1 (refer to row 2 of Table 5.6)[46].

Table 5.6: Augmented Dickey Fuller Tests of Unit Roots.

Variable	Lag	τ_τ	Φ_3	τ_μ	Φ_1	τ
Levels						
ltotal	2	-0.944	0.813	-1.149	3.096	2.185^{A}
lprivate	0	-0.013	0.004	0.074	36.132^{B}	-
lpublic	2	-2.321	2.792	-0.849	0.638	0.735^{A}
lydt	0	-0.074	0.003	-0.152	38.547	-0.242^{A}
lcndt	5	-2.666	3.648	-2.620	3.445	-0.179^{A}
First Differences						
dltotal	1	-7.866^{*C}	-	-	-	-
dlprivate	0	-4.146^{*C}	-	-	-	-
dlpublic	1	-6.881^{*C}	-	-	-	-
dlydt	1	-6.419^{*C}	-	-	-	-
dlcndt	10	-3.691^{*C}	-	-	-	-

Key to Table 5.6

- The URADF.SRC procedure in RATS is employed, and the Akaike Information Criterion (AIC) is used to determine the lag length for the ADF (refer to footnotes 31 and 32 in Chapter 2 for further details).
- 5% Critical Values for τ_τ, Φ_3, τ_μ, Φ_1, τ are -3.43, 6.34, -2.88, 4.63, and -1.95 respectively.
- *: Significant at the 5 percent level; **: Significant at the 10 percent level.
- A: Series contains a unit root with zero drift; B: Series contains a unit root with drift; C: Series has no unit root; D: Series stationary around a non-zero mean.

Given the above findings of non-stationarity, we must now consider the issues that arise when estimating equation 5.14, where the data is expressed in levels. Non-stationarity can be a problem when estimating with levels, because it can give rise to a spurious relationship among the variables. The parameter estimates from a regression of

[46] A detailed description of the augmented Dickey-Fuller tests is presented in Chapter 2, Appendix A2.1.

the dependent variable on the regressors, can produce inconsistent parameter estimates, which may even be non-convergent. Proposed estimates to deal with the stationarity include specifying the model in levels and then proceeding to remove a deterministic trend from the data to obtain stationarity (Flavin 1981, 1985 and Hayashi 1982). However Mankiw and Shapiro(1985) showed that such detrending can lead to spurious excess sensitivity of consumption to income innovations. Alternatively one could transform the data into first difference form or following Campbell and Deaton(1989), all variables could be divided by the lagged level of income. Such transformations, however, are not required if the variables are co-integrated[47].

If the non-stationary variables are co-integrated, then West(1985) and Sim, Stock and West(1990) show that conventional inference and estimation is correct and no adjustment for non-stationarity is necessary. Johansen's (1988) estimation procedure[48] is used to test for co-integration and the results are presented in Table 5.7 for the variables and the instruments used in the estimation of equation 5.14 (that is, consumption, income and wealth). The λ_{trace} and λ_{max} are displayed for the null hypotheses r=0, 1 and 2, along with the critical values for the 95 and 90 percent significance level. Using the λ_{trace} statistic (λ_0), we can reject the null hypothesis of no cointegrating vectors (r=0), and accept the alternative of one or more cointegrating vectors (r>0), since 30.30 exceeds the critical the 90 percent critical value of 28.71. However, with the 95 percent critical value it is not possible to reject the null hypothesis of no cointegrating vector. Using the λ_{max}

[47] A group of non-stationary time series is co-integrated if there is a linear combination of them that is stationary; that is, the combination does not have a stochastic trend. The linear combination is called the co-integrating equation. Its normal interpretation is as a long-run equilibrium relationship. Formally co-integration is defined as follows: a vector X_t is said to be co-integrated of order d,b, if all components of X_t are integrated of order d and there exists at least one vector α, such that $Z_t = \alpha' X_t$ is integrated of order d-b, for b>0.

[48] The results are obtained using the Johansen methodology for CATS in RATS (Version 1, 1995 CATS Partnership, Estima)

statistic, the null hypothesis of no cointegrating vectors against the specific alternative of one cointegrating vector is clearly rejected at the 95 and 90 percent significant levels (23.86 > 21.07 and 23.86 > 18.90 respectively).

The preceding results indicate at least one cointegrating vector. To determine if there are more, we use the $\lambda_{trace}(1)$, $\lambda_{trace}(2)$, $\lambda_{max}(1)$ and the $\lambda_{max}(2)$ statistics. In all cases, the respective null hypotheses (as outlined in the table) cannot be rejected either at the 90 or 95 percent significance levels. We can therefore conclude that the variables are cointegrated and specifically that there is evidence of one cointegrating relationship. Hence it is possible to estimate equation 5.14 in levels. The final row in Table 5.7a presents the Ljung-Box test for serial correlation; the result suggests that the first 20 residuals are serially uncorrelated[49].

Table 5.7a: Tests of the Cointegration rank for Equation 5.14.

Null Hypothesis	Alternative Hypothesis		95% critical value	90% critical value
λ_{trace} tests:		λ_{trace} value		
r=0	r>0	30.30	31.52	28.71
r≤1	r>1	6.44	17.95	15.66
r≤2	r>2	2.45	8.18	6.50
λ_{max} tests:		λ_{max} value		
r=0	r=1	23.86	21.07	18.90
r=1	r=2	3.99	14.90	12.91
r=2	r=3	2.45	8.18	6.50
Ljung-Box test (20)	Chi-sq(162) = 183.312		p-value = 0.12	

Key to Table 5.7a

Critical values are obtained from Osterwald-Lenum (1992: Table 1.1*). A constant is included in the cointegrating vector. A lag length of 2 was used to remove serial correlation in the residuals.

[49] Johansen's cointegration tests were also applied to the variables as explicitly expressed in Equation 5.14; that is consumption, public and private sector income, and public and private sector wealth. We found that the variables expressed in this form (that is where income and wealth were allocated to each sector) were cointegrated.

Table 5.7b shows the estimates of the cointegrating coefficients and their asymptotic errors, where the coefficient on consumption is normalised to one. The coefficient on income, estimated at -0.906(0.0594) with its asymptotic error in brackets is statistically significant. However, the coefficient on wealth, estimated at -0.009(0.023) is statistically insignificant.

Table 5.7b: ML Estimates of Restricted Cointegrating Relations (Order of VAR =2; r =1)

Variable	ML estimates (s.e.s. in brackets)
	Vector 1
LCNDT	1.0000 (*NONE*)
LYDT	-0.906 (.0594)
LNW	-0.009 (0.023)
Intercept	-0.484 (0.489)
LL subject to exactly identifying restrictions= 557.1509	

5.5 EMPIRICAL EVALUATION

In this section we present the empirical results of our work. In section 5.5.1, we obtain the empirical estimates of income uncertainty, using the methodologies outlined in section 5.4.2. We then proceed to empirically test the uncertainty augmented consumption model as embodied in equation 5.14 (Section 5.5.2).

5.5.1 MEASURES OF INCOME UNCERTAINTY

The estimates of income uncertainty serve two purposes. Firstly, the estimates are included as independent variables in the estimation of equation 5.14; secondly, they are used in a comparative analysis to confirm that uncertainty varies across consumer groups and provide further support for the suggested group decomposition of income, put forward in the sub-section 5.4.1.1.

5.5.1.1 ARCH and GARCH Methodology Results

We employ a general to specific approach to model the wage and salary growth process for each sector which are then used as the conditional mean regressions in the estimation of the ARCH and GARCH effects. The results of the final specification of the wage and salary growth process for both the private and public sectors are presented in Tables 5.8a and b. The first row of Table 5.8a presents the results for the private sector. The lagged change in private sector wage and salaries (first lag), and the unemployment rate (first and third lags) are relevant for predicting current private sector wages and salaries (p-values = .005, .000, and .000 respectively)[50]. These results are plausible with a priori results - for example, we would expect the rate of unemployment to be relevant for private sector wages and salaries. Even though the coefficient on the real rate of interest is insignificant, it is included in order to avoid significant heteroscedasticity.

The second row of Table 5.8a presents results for various diagnostic tests which test the adequacy of the proposed wage and salary process. On the basis of the results of serial correlation, ARCH and heteroscedasticity tests the null hypothesis of no serial correlation, homoscedasticity and the absence of ARCH effects cannot be rejected. The joint hypothesis of zero slopes is significant in each case (F-test=5.687), and the F-test for the restrictions imposed on the general unrestricted form equation in order to arrive at the final specification (F-test of reduction=1.807) is found to be insignificant[51]. Finally, the wage and salary growth process explains 20 percent of the variation in real wage and salary growth of the private sector, with an equation standard error of 0.017.

With respect to obtaining an income process for the public sector, the general to specific modelling strategy in this instance did not produce as parsimonious a specification as in the case of the private sector. The final results are presented in Table 5.8b. All variables are statistically significant at the 5% significance level with the exception of the constant term and the coefficient on the fifth lag of the unemployment rate. This latter regressor is included, since its exclusion results in heteroscedasticity. A dummy variable (dum89) is also included to capture an outlier in the residuals which would otherwise lead to non-normality; it takes the value of 1 in 1989Q1, -1 in 1989Q2 and 0 elsewhere. It is

[50] The constant coefficient is statistically insignificant at the 5% level of significance.

[51] The latter test is calculated by comparing the final selected set of variables with that of the most general model, which contained up to 4 lags of each variable (for example, unemployment rate, real interest rate, government expenditure, exports, etc.; all variables were expressed in real and logarithmic terms, and first differences).

notable that this dummy variable coincides with the reclassification of sectoral employment in 1989.

Analysis of the diagnostic tests (second row of Table 5.8b) indicate that the null hypothesis of serial correlation cannot not be rejected (LM(1), LM(4) and LM(8)) at the 5% significance level. In addition there is no evidence of significant ARCH or heteroscedasticity effects. The null hypothesis of zero slope coefficients is conclusively rejected, hence a statistically significant relationship has been estimated (F-test = 7.194). An F-test of reduction from the general to specific model cannot be rejected (F-test of reduction = 1.704). Finally, the F test of zero restrictions for all slopes, with an unrestricted intercept and dummy effect is found to be statistically significant at the 5 percent level (F-test(dummy) = 4.348). This test indicates that the regressors other than the intercept and the dummy variable provide significant explanatory power.

Table 5.8a. Estimation results and diagnostics for the Mean Regression for the Private Sector: 1975Q1-1995Q4 (refer to notes at end of Table 5.8a).

$$\Delta private_t = \underset{\substack{(0.005)\\ [.555]}}{0.003} - \underset{\substack{(0.107)\\ [.005]}}{0.313}\,\Delta private_{t-1} - \underset{\substack{(0.189)\\ [.000]}}{0.825}\,ur_{t-1} + \underset{\substack{(0.198)\\ [.000]}}{0.821}\,ur_{t-3} + \underset{\substack{(0.059)\\ [.079]}}{0.104}\,r_{t-2}$$

$\bar{R}^2$	0.196
SEE	0.0166
F-test	F(4, 73) = 5.687[.000]
F-test of Reduction	F(8, 63) = 1.807[.092]
Serial Correlation (1)[a]	F(1, 72)=0.216[.644]
Serial Correlation (4)[a]	F(4, 69)=0.956[.437]
Serial Correlation (8)[a]	F(8, 65)=1.202[.312]
Functional Form[b]	F(1, 72)=0.392E-3[.984]
Normality[c]	CHSQ(2)= 2.239[.326]
Heteroscedasticity[d]	F(1, 76)=0.486[.488]
ARCH(1)[e]	F(1, 72)=3.011[.087]
ARCH(4)[e]	F(4, 69)=0.789[.536]

Notes to Table 5.8a and b

1. Δprivate = ln(private$_t$/private$_{t-1}$) where private refers to the wages and salaries of the private sector; Δpublic = ln(public$_t$/public$_{t-1}$) where public refers to the wages and salaries of the public sector; ur = unemployment rate; r = real rate of interest; $\Delta r = r - r_{t-1}$; dum89 = Dummy variable which takes on the value of 1 in 1989:1 and -1 in 1989:2, and zero elsewhere; Δpubwealth = ln(pubwealth$_t$/pubwealth$_{t-1}$) where wealth is the wealth holdings of the public sector; Δgovt = ln(govt$_t$/govt$_{t-1}$) where govt is government expenditure; Δexpt = ln(expt$_t$/expt$_{t-1}$) where expt is exports; $\Delta c = \ln(c_t/c_{t-1})$ where c is total consumption.
2. a: Lagrange multiplier test of residual serial correlation; b: Ramsey's RESET test using the square of the fitted values; c: Based on a test of skewness and kurtosis of residuals; d: Based on the regression of squared residuals on squared fitted values. e: Test for ARCH effects;
3. Standard errors are in parentheses, and significance levels or p-values are in square brackets.

Table 5.8b Estimation results and diagnostics for the Mean Regression for the Public Sector: 1975Q1-1995Q4 (refer to notes at end of Table 5.8a).

$$\begin{aligned}\Delta public_t = \; & \underset{[.367]}{\underset{(0.007)}{0.007}} + \underset{[.014]}{\underset{(0.118)}{0.301}}\,\Delta public_{t-1} - \underset{[.014]}{\underset{(0.777)}{1.965}}\,ur_{t-1} + \underset{[.046]}{\underset{(0.968)}{1.975}}\,ur_{t-2} + \underset{[.090]}{\underset{(0.893)}{1.541}}\,ur_{t-5} - \underset{[.008]}{\underset{(1.162)}{3.195}}\,ur_{t-6} + \underset{[.018]}{\underset{(0.716)}{1.744}}\,ur_{t-7} \\ & + \underset{[.000]}{\underset{(0.017)}{0.112}}\,dum89 + \underset{[.000]}{\underset{(0.090)}{0.374}}\,\Delta pubwealth_{t-2} - \underset{[.002]}{\underset{(0.096)}{0.305}}\,\Delta pubwealth_{t-3} + \underset{[.005]}{\underset{(0.094)}{0.278}}\,\Delta pubwealth_{t-5} + \underset{[.003]}{\underset{(0.094)}{0.288}}\,\Delta r_{t-5} \\ & + \underset{[.046]}{\underset{(0.308)}{0.627}} \bullet \Delta govt_{t-1} - \underset{[.038]}{\underset{(0.048)}{0.101}} \bullet \Delta expt_{t-1} - \underset{[.003]}{\underset{(0.049)}{0.151}} \bullet \Delta expt_{t-2} - \underset{[.002]}{\underset{(0.224)}{0.737}} \bullet \Delta c_{t-1} - \underset{[.002]}{\underset{(0.252)}{0.816}} \bullet \Delta c_{t-3} - \underset{[.015]}{\underset{(0.271)}{0.680}} \bullet \Delta c_{t-5}\end{aligned}$$

$\bar{R}^2$	0.591
SEE	0.018
F-test	F(17, 56) = 7.194[.000]
F-test of Reduction	F(33, 21) = 1.704[.101]
F-test (Dummy)	F(16, 56) = 4.348[.000]
Serial Correlation (1)[a]	F(1, 55)=0.129[.721]
Serial Correlation (4)[a]	F(4, 52)=0.389[.815]
Serial Correlation (8)[a]	F(8, 48)=0.394[.918]
Functional Form[b]	F(1, 55)=11.725[.001]
Normality[c]	CHSQ(2)= 2.615[.271]
Heteroscedasticity[d]	F(1, 72)=3.124[.081]
ARCH(1)[e]	F(1, 55)=0.456[.502]
ARCH(4)[e]	F(4, 52)=0.398[.809]

The processes describing real wage and salary growth for both sectors serve as the conditional mean regressions in the estimation of ARCH(4) and GARCH(4,4) effects. The estimation results and diagnostic tests relating to these models are presented in Tables 5.9a and b for the private and public sectors respectively. Firstly, looking at the private sector (Table 5.9a), the estimation results indicate that the coefficients on the lagged variance in the ARCH(4) model are insignificant (h_t), and both the lagged variance and the lagged squared residuals (ξ_t) terms are also statistically insignificant in the GARCH(4,4) model. The diagnostic results shown in the second row of Table 5.9a confirm these results of no significant ARCH or GARCH results. The adequacy of the models are checked using the sign bias, the negative size bias, and the positive size bias tests, as well as the commonly used Ljung-Box test for serial correlation in the squared normalised residuals. The sign bias test, negative size bias test and the positive size bias test, each examine whether the squared normalised residuals can be predicted by some variables observed in the past but not included in the volatility model being used. All are statistically insignificant for both the ARCH and GARCH cases. The LB statistic for 8th order serial correlation in the squared normalised residuals is also insignificant at the 5% level for the two models, indicating that the null of homosecdastic conditional variance cannot be rejected.

The results for the public sector are reported in Table 5.9b. As for the private sector, the coefficients on the lagged variance terms in both the ARCH(4) and GARCH(4,4) model, and the coefficients on the lagged squared residual terms in the GARCH(4,4) model are all statistically insignificant. Furthermore the diagnostic tests are all statistically insignificant, emphasising the lack of ARCH or GARCH effects. A possible explanation for the insignificant ARCH and GARCH effects may be due to the low frequency of the data. In general, the family of ARCH model are more suitable to high frequency data sets (daily, and weekly)[52].

Even though there is no empirical evidence of significant conditional variance, we present some visual evidence in Figures 5.4 and 5.5, which show plots of the conditional variance over the sample period, produced by both the ARCH(4) and GARCH(4,4) models; the plots suggest that there is some volatility, even if it is statistically insignificant. The highest peaks for the conditional variance which occur in the early 1990s, correspond to the severe recession that Finland experienced at this time. The volatility measures for the public sector are still clearly affected by the reclassification of the employment data, which took place in 1989Q1, even when a dummy variable is included in the mean regression to account for it (dum89).

[52] No data are available at a higher frequency, consequently we are unable to offer results based on data of a frequency which might allow easier discovery of ARCH and GARCH effects.

Table 5.9a. ARCH and GARCH Models - Estimation and Diagnostic Results for the Private Sector: 1975:1-1995:4 (refer to notes at end of Table 5.9b).

Estimation Results for the Private Sector

ARCH(4)

$$h_t = \underset{\substack{(0.000)\\ [.016]}}{0.000} + \underset{\substack{(0.149)\\ [.429]}}{0.119}\, h_{t-1} + \underset{\substack{(0.125)\\ [.568]}}{0.072}\, h_{t-2} - \underset{\substack{(0.085)\\ [.989]}}{0.001}\, h_{t-3} + \underset{\substack{(0.095)\\ [.704]}}{0.036}\, h_{t-4}$$

GARCH(4,4)

$$h_t = \underset{\substack{(0.000)\\ [0.814]}}{0.000} + \underset{\substack{(0.161)\\ [0.346]}}{0.151}\, h_{t-1} + \underset{\substack{(0.655)\\ [0.919]}}{0.066}\, h_{t-2} + \underset{\substack{(0.609)\\ [0.944]}}{0.042}\, h_{t-3} + \underset{\substack{(0.442)\\ [0.915]}}{0.047}\, h_{t-4} + \underset{\substack{(4.489)\\ [0.959]}}{0.231}\, \varepsilon^2_{t-1} + \underset{\substack{(4.263)\\ [1.000]}}{0.000}\, \varepsilon^2_{t-2} - \underset{\substack{(3.456)\\ [0.999]}}{0.004}\, \varepsilon^2_{t-3} + \underset{\substack{(2.108)\\ [0.959]}}{0.106}\, \varepsilon^2_{t-4}$$

Diagnostic Test Results

Model	Ljung-Box(4)[a]	Ljung-Box(4)[b]	Sign Bias	Negative Sign Bias	Positive Sign Bias	Joint Test
ARCH(4)	2.112[.715]	0.223[.994]	-0.713[.478]	-0.834[.407]	-0.994[.324]	0.616[.607]
GARCH(4,4)	1.176[.882]	0.371[.984]	0.145[.885]	-0.316[.753]	-0.476[.636]	0.365[.778]

Table 5.9b. ARCH and GARCH Models - Estimation and Diagnostic Results for the Public Sector: 1975:1-1995:4 (refer to notes at end of Table 5.9b).

Estimation Results for the Public Sector

ARCH(4)

$$h_t = \underset{\substack{(0.000)\\ [.000]}}{0.000} + \underset{\substack{(0.094)\\ [.936]}}{0.007}\, h_{t-1} - \underset{\substack{(0.123)\\ [.991]}}{0.001}\, h_{t-2} - \underset{\substack{(0.077)\\ [.914]}}{0.008}\, h_{t-3} - \underset{\substack{(0.080)\\ [.621]}}{0.039}\, h_{t-4}$$

GARCH(4,4)

$$h_t = \underset{\substack{(0.001)\\ [0.546]}}{0.000} + \underset{\substack{(0.276)\\ [0.687]}}{0.111}\, h_{t-1} + \underset{\substack{(0.282)\\ [0.785]}}{0.076}\, h_{t-2} + \underset{\substack{(0.295)\\ [0.792]}}{0.078}\, h_{t-3} + \underset{\substack{(0.246)\\ [0.718]}}{0.089}\, h_{t-4} - \underset{\substack{(2.387)\\ [0.999]}}{0.000}\, \varepsilon^2_{t-1} + \underset{\substack{(1.288)\\ [0.911]}}{0.143}\, \varepsilon^2_{t-2} - \underset{\substack{(1.295)\\ [0.986]}}{0.022}\, \varepsilon^2_{t-3} + \underset{\substack{(0.881)\\ [0.815]}}{0.206}\, \varepsilon^2_{t-4}$$

Diagnostic Test Results

Model	Ljung-Box(4)[a]	Ljung-Box(4)[b]	Sign Bias	Negative Sign Bias	Positive Sign Bias	Joint Test
ARCH(4)	3.785[.436]	0.338[.987]	1.049[.299]	0.630[.531]	-0.085[.932]	0.451[.717]
GARCH(4,4)	2.752[.600]	0.313[.988]	1.091[.279]	0.701[.486]	-0.065[.949]	0.468[.706]

Notes to Table 5.9a and b

(1) These tables report the estimation and diagnostic test results of the of the ARCH(4) and GARCH(4,4) models for the private and public sector. h_t is the conditional variance, and ε^2_t is the squared residuals obtained from the mean regressions in Table 5.8. The estimation is performed by the method of quasi maximum likelihood using the BHHH numerical optimisation algorithm.

(2) (a) Ljung-Box(4)[a] - the Ljung-Box Q test for serial correlation in the normalised residuals (that is, residuals divided by the square root of the conditional variance). (b) Ljung-Box(4)[b] - the Ljung-Box Q test for serial correlation in the squared normalised residuals (that is, residuals divided by the square root of the conditional variance)

(3) Asymptotic standard errors are in parentheses, and significance levels or p-values are in square brackets.

Figure 5.4 Conditional Variance for the Private and Public Sectors: calculated using the ARCH(4) model.

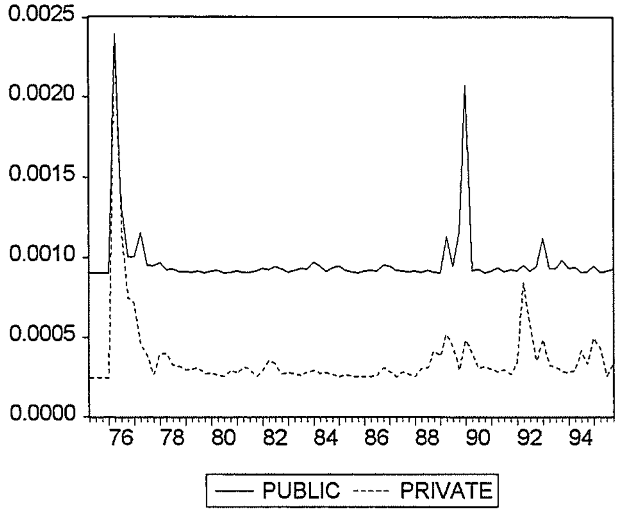
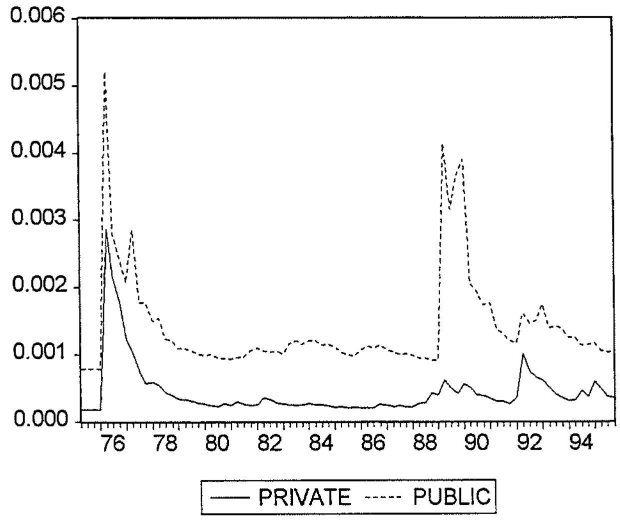


Figure 5.5 Conditional Variance for the Private and Public Sectors: calculated using the GARCH(4,4) model.



5.5.1.2 Price Methodology Results

The processes for real wage and salary growth per sector also serve as the mean regressions in the application of Price's methodology. As outlined in section 5.4.2.2., we obtain the residuals from these mean regressions, and regress both the square and absolute values of the residuals on the explanatory variables from the mean regressions. The results are presented in Tables 5.10(a,b), while Figures 5.6(a,b) presents plots of the resulting conditional variance estimates.

The first row in Table 5.10a reports the results for the regression when the square of the residuals is the dependent variable. As indicated by the insignificant p-values (in square brackets), all regressors have statistically insignificant and numerically small effects; the exception is the intercept term (p-value = .037). Furthermore, the adjusted R^2 is very low in value. Similar results are obtained when the absolute values of the residuals serve as the dependent variable; these results are reported in the second row of Table 5.10a.

The results for the public sector are reported in Table 5.10b. For both regressions, all the coefficients are statistically insignificant (except for the intercept term in the second regression where the absolute value of the residuals serves as the dependent variable (p-value = .011)). Overall the results for both sectors, indicate that the explanatory variables which explained the growth in wages and salaries of each sector, do not contribute significantly to explaining the variance of same. This suggests that if there was evidence of heteroscedasticity, it is not a linear function of the above set of explanatory variables.

Table 5.10a. Estimation results and diagnostics for the Price methodology: Private Sector (refer to notes at end of Table 5.10b).

Dependent variable is the squared residuals obtained from the mean regression outlined in Table 5.8a

$$\underset{\substack{(0.127E\text{-}3)\\[.037]}}{res^2 = 0.270E\text{-}3} \; - \underset{\substack{(0.003)\\[.437]}}{0.002\,\Delta private_{t-1}} + \underset{\substack{(0.005)\\[.301]}}{0.005\,ur_{t-1}} - \underset{\substack{(0.005)\\[.385]}}{0.005\,ur_{t-3}} - \underset{\substack{(0.002)\\[.430]}}{0.001\,r_{t-2}}$$

$\bar{R}^2 = -0.009$

Dependent variable is the absolute values of the residuals obtained from the mean regression outlined in Table 5.8a

$$\underset{\substack{(0.003)\\[.000]}}{|res| = 0.013} \; - \underset{\substack{(0.068)\\[.207]}}{0.086\,\Delta private_{t-1}} + \underset{\substack{(0.119)\\[.486]}}{0.084\,ur_{t-1}} - \underset{\substack{(0.125)\\[.591]}}{0.068\,ur_{t-3}} - \underset{\substack{(0.037)\\[.296]}}{0.039\,r_{t-2}}$$

$\bar{R}^2 = 0.004$

Table 5.10b. Estimation results and diagnostics for the Price methodology: Public Sector (refer to notes at end of Table 5.10b).

Dependent variable is the squared residuals obtained from the mean regression outlined in Table 5.8b

$$\begin{array}{lllllll} res^2 = 0.238E\text{-}3 & + 0.002\ \Delta public_{t-1} & - 0.010\ ur_{t-1} & + 0.015\ ur_{t-2} & + 0.005\ ur_{t-5} & - 0.005\ ur_{t-6} & - 0.005\ ur_{t-7} \\ (0.182E\text{-}3) & (0.003) & (0.019) & (0.024) & (0.022) & (0.029) & (0.018) \\ [.196] & [.433] & [.609] & [.549] & [.822] & [.852] & [.801] \end{array}$$

$$\begin{array}{lllll} + 0.218E\text{-}3\ dum89 & - 0.842E\text{-}3\ \Delta pubwealth_{t-2} & + 0.002\ \Delta pubwealth_{t-3} & + 0.613E\text{-}3\ \Delta pubwealth_{t-5} & + 0.004\ \Delta r_{t-5} \\ (0.415E\text{-}3) & (0.002) & (0.002) & (0.002) & (0.002) \\ [.602] & [.708] & [.427] & [.794] & [.126] \end{array}$$

$$\begin{array}{llllll} + 0.003\ \Delta govt_{t-1} & - 0.307E\text{-}3\ \Delta expt_{t-1} & + 0.596E\text{-}3\ \Delta expt_{t-2} & - 0.004\ \Delta c_{t-1} & - 0.006\ \Delta c_{t-3} & - 0.777E\text{-}3\ \Delta c_{t-5} \\ (0.008) & (0.001) & (0.001) & (0.006) & (0.006) & (0.007) \\ [.707] & [.795] & [.626] & [.530] & [.369] & [.909] \end{array}$$

$\bar{R}^2 = -0.124$

Table 5.10b (contd.): Estimation results and diagnostics for the Price methodology: Public Sector

Dependent variable is the absolute values of the residuals obtained from the mean regression outlined in Table 5.8b

$\lvert res \rvert =$	0.012	$+\ 0.079\ \Delta public_{t-1}$	$-\ 0.324\ ur_{t-1}$	$+\ 0.449\ ur_{t-2}$	$+\ 0.067\ ur_{t-5}$	$-\ 0.234\ ur_{t-6}$	$+\ 0.043\ ur_{t-7}$
	(0.005)	(0.073)	(0.479)	(0.597)	(0.551)	(0.717)	(0.442)
	[.011]	[.281]	[.501]	[.455]	[.904]	[.745]	[.923]

$+\ 0.007\ dum89$	$-\ 0.017\ \Delta pubwealth_{t-2}$	$+\ 0.059\ \Delta pubwealth_{t-3}$	$+\ 0.021\ \Delta pubwealth_{t-5}$	$+\ 0.091\ \Delta r_{t-5}$
(0.010)	(0.056)	(0.059)	(0.058)	(0.058)
[.480]	[.759]	[.314]	[.720]	[.121]

$+\ 0.035\ \Delta govt_{t-1}$	$-\ 0.002\ \Delta expt_{t-1}$	$+\ 0.009\ \Delta expt_{t-2}$	$-\ 0.137\ \Delta c_{t-1}$	$-\ 0.143\ \Delta c_{t-3}$	$-\ 0.053\ \Delta c_{t-5}$
(0.189)	(0.029)	(0.030)	(0.138)	(0.155)	(0.167)
[.856]	[.955]	[.771]	[.327]	[.362]	[.752]

$\bar{R}^2 = -0.131$

Notes to Table 5.10a and b

(1) Refer to Notes to Table 5.8(a,b) for variable explanations. res^2 = squared residuals; $|res|$ = absolute values of the residuals.

(2) Standard errors are in parentheses, and significance levels or p-values are in square brackets.

Figure 5.6a Conditional Variance for the Private and Public Sectors: calculated using Price's Methodology for the Squared Residuals.

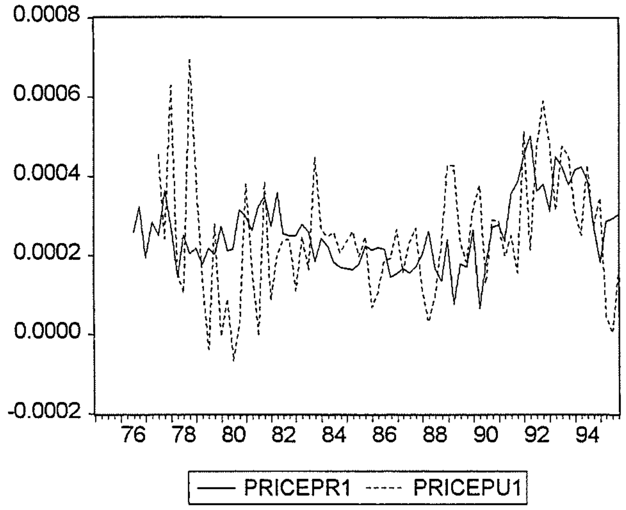
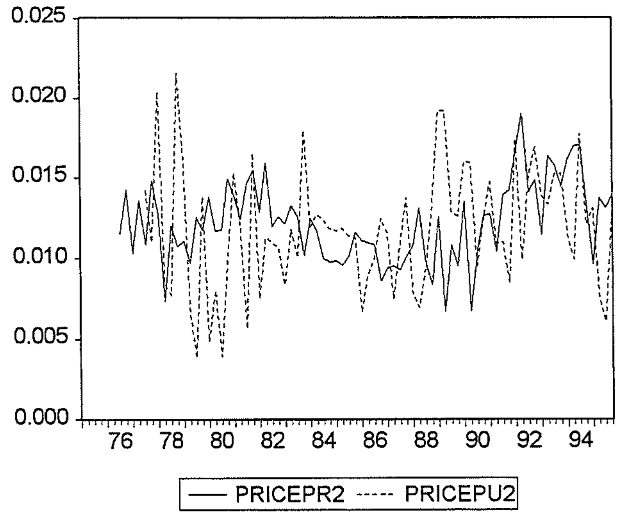


Figure 5.6b Conditional Variance for the Private and Public Sectors: calculated using Price's Methodology for the Absolute Residuals.



5.5.1.3 LM Methodology Results

Using quarterly data on real per capita wages and salaries, we estimate a random walk model for both the private and public sectors. The squared residuals from this regression ($\hat{\sigma}_t^2$) are then regressed on lagged wages and salaries, and a set of consistent estimates of the variance of wage and salaries is then obtained from the set of predicted values from this equation. The results are presented in Tables 5.11a and b. There was evidence of heteroscdasticity in the estimated equations for both sectors, hence the standard errors should be corrected. White's heteroscedasticity-consistent correction was applied to the standard errors.

There are a number of interesting results here. Firstly, the coefficient on the Y_{t-1} term is positive and statistically significant at the 5% level of significance for both sectors. We test to see if it is significantly different from 1, and obtain the following t-statistics, 1.729 and 1.598 for the private and public sector respectively. We conclude that the estimated coefficients are insignificantly different from 1, providing strong empirical support for the maintained assumption of a random walk process. The adjusted R squared is high for both sectors (0.967 and 0.925 respectively). The null hypotheses of no first, fourth or eighth order serial correlation are not rejected. The second rows of Tables 5.9a and 5.9b, present the results of the second stage regression, where the squared residuals from the random walk model are regressed on Y_{t-1}, and a plot of the resultant conditional variance is given in Figure 5.7. The second stage regressions represent poor fits as indicated by the low values of the adjusted R^2. From the plots we observe that the estimated conditional variance for the public sector is higher than that of the private sector.

Table 5.11a. LM Models: Estimation Results and Diagnostics for the Private Sector (refer to notes at the end of Table 5.11b)

$$\underset{\substack{(0.000)\\[.000]}}{private_t = 1.000\ private_{t-1}}$$

$\bar{R}^2$	0.967
SEE	0.025
Serial Correlation (4)[a]	F(4, 78)=2.113[.087]

$$res^2 = \underset{\substack{(0.198E\text{-}4)\\[.001]}}{0.655E\text{-}4}\ private_{t-1}$$

$\bar{R}^2$	-0.003
SEE	0.002
Serial Correlation (4)[a]	F(4, 78)=5.749[.000]

Table 5.11b. LM Models: Estimation Results and Diagnostics for the Public Sector (refer to notes at the end of Table 5.11b)

$$\underset{}{public_t} = \underset{\substack{(0.000)\\[.000]}}{1.000}\ public_{t-1}$$

$\bar{R}^2$	0.925
SEE	0.038
Serial Correlation (4)[a]	F(4, 78)=1.424[.234]

$$res^2 = \underset{\substack{(0.590E\text{-}4)\\[.013]}}{0.149E\text{-}3}\ public_{t-1}$$

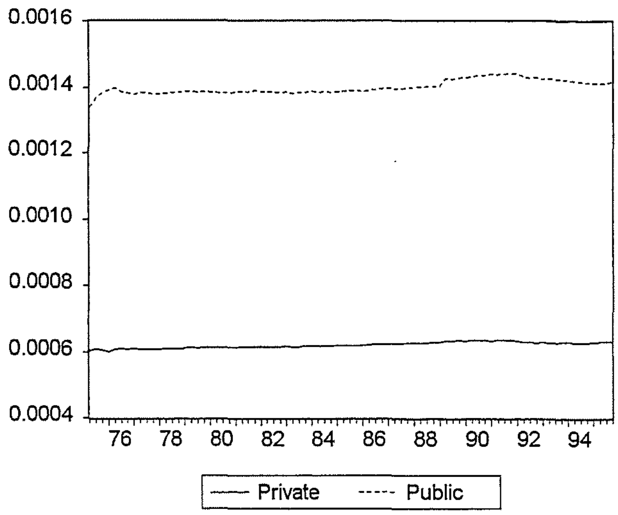
$\bar{R}^2$	-0.002
SEE	0.005
Serial Correlation (4)[a]	F(4, 78)=0.502[.734]

Notes to Table 5.11a and b

(1) private = log of wages and salaries for the private sector; public = log of wages and salaries for the public sector; res = residuals.

(2) White-heteroscedasticity-consistent standard error's are in parentheses, and significance levels or p-values are in square brackets.

Figure 5.7 Conditional Variance for the Private and Public Sectors: calculated using the LM Methodology.

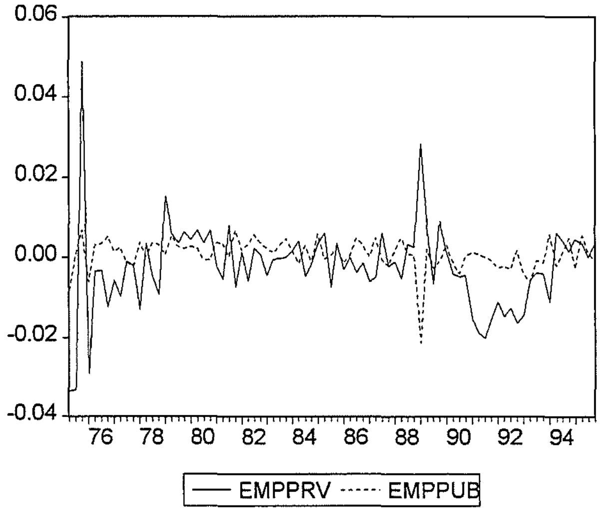


5.5.1.4 Labour Market Based Measure of Income Uncertainty

Our final approximation of income uncertainty is a labour market based measure. As outlined in section 5.4.2.4, we calculate the change in each sector's employment as a proportion of the total labour force. Figure 5.8 presents the resultant figures for both sectors. It is evident from the plot that both sectors exhibit cyclical behaviour, and that the private sector appears to be more cyclically sensitive as one would expect. The sharp decline in sectoral employment in the beginning of the 1990s, particularly with respect to the private sector, coincides with the deep recession of that time, the origins of which can be traced back to the financial liberalisation process and the collapse of Soviet export markets in the 1980s[53]. We interpret a decline in sectoral employment (represented as the decreasing values in Figure 5.8) as a rise in uncertainty; that is, as unemployment rises, we would expect consumers to perceive greater uncertainty about their future income.

[53] The total unemployment rate rose from 3.5% in 1990 to 18% in 1994.

Figure 5.8 Labour Market Based Measure of Uncertainty



Summary

In this section we calculated various measures to reflect income uncertainty. We now use these measures to conduct a comparative analysis to assess the evidence for varying degrees of uncertainty between different sectors.

5.5.1.5 Comparative Analysis

To obtain an understanding of the different measures of uncertainty calculated, some summary statistics, including the mean, standard deviation, minimum, maximum, skewness and kurtosis, are reported for each of the estimated measures in Table 5.12. The coefficient of variation is also reported so that we can compare across the measures (it is a scale-less measure).

Even though we found no evidence of significant ARCH or GARCH effects, we still include summary measures for the resultant conditional variances, purely to serve as a comparative aid. These are reported in the first four columns (in the first row) of Table

5.12. The coefficient of variation (hereafter CV) for ARCH effects indicate that there is greater variability in the private sector (0.286) relative to the public sector (0.148). The GARCH results suggest the opposite (CVs = 0.437 and 00.479 for the private and public sectors respectively). However, we merely note these results here, given our earlier findings of no significant ARCH or GARCH effects.

Turning to the descriptive statistics for the measures calculated using the Price methodology (columns titled Pricepr1, Pricepu1, Pricepr2 and Pricepu2), we find that public sector experiences greater volatility as indicated by the coefficient of variations for both sectors; the CVs for the private sector are 0.354 and 0.207, whilst for the public sector, the corresponding CVs equal 0.633 and 0.324. The estimates of the variance of income given by the LM methodology confirms these findings, where the CVs for the private and public sectors are 0.013 and 0.0147 respectively.

A different conclusion is found when we analyse the descriptive statistics for the labour market based measure of uncertainty. As noted earlier, this measure differs from the others as it is not based on income (wages and salaries). The CVs of 5.138 and 4.868 for the private and public sectors respectively, clearly indicate greater volatility within the private sector. This evidence is consistent with our argument that the private sector would experience greater volatility due to cyclical and other variations.

Overall the calculated measures of income uncertainty do indicate that differences exist between our two groups of consumers (the public and private sectors), but they do not provide us with clear cut evidence to suggest that either sector is more volatile than the other. The income based measures clearly indicate that the public sector is the more volatile sector, whilst the measure based on employment suggests the private sector.

Table 5.12. Summary Statistics of the Income Uncertainty Estimates: Common Sample (1977Q3-1995Q4) (refer to notes at end of Table 5.12)

	ARCHPRV	**ARCHPUB**	**GARCHPRV**	**GARCHPUB**	**PRICEPR1**	**PRICEPU1**
Mean	0.000325	0.000947	0.000355	0.001329	0.000257	0.000248
Median	0.000295	0.000916	0.000304	0.001127	0.000250	0.000241
Maximum	0.000837	0.002071	0.001001	0.004132	0.000504	0.000696
Minimum	0.000253	0.000902	0.000204	0.000908	6.65E-05	-6.53E-05
Std. Dev.	9.28E-05	0.000140	0.000155	0.000636	9.11E-05	0.000157
Skewness	2.908036	7.167183	1.647540	3.076660	0.547754	0.479870
Kurtosis	14.28077	56.92779	6.062264	12.40499	2.881786	3.109272
Coef. of Var.	**0.285538**	**0.147835**	**0.436620**	**0.478555**	**0.354475**	**0.633065**
Observations	74	74	74	74	74	74
	PRICEPR2	**PRICEPU2**	**LMPRV**	**LMPUB**	**EMPPRV**	**EMPPUB**
Mean	0.012179	0.011794	0.000622	0.001404	-0.001562	0.000782
Median	0.012090	0.011735	0.000622	0.001396	-0.001027	0.000977
Maximum	0.019051	0.021531	0.000634	0.001443	0.028438	0.006875
Minimum	0.006702	0.003818	0.000606	0.001378	-0.020296	-0.021379
Std. Dev.	0.002521	0.003823	8.29E-06	2.06E-05	0.008025	0.003807
Skewness	0.229259	0.226544	-0.101467	0.585116	0.231740	-2.620101
Kurtosis	2.828628	2.821619	1.686349	1.805196	4.654692	16.44596
Coef. of Var.	**0.206996**	**0.324148**	**0.013328**	**0.014672**	**5.13764**	**4.868286**
Observations	74	74	74	74	74	74

Notes to Table 5.12

(1)
The table reports the summary statistics of the estimated measures of income uncertainty. The statistic Std. Dev. is the standard deviation, Skew. is the coefficient of skewness, the statistic 'Kurto' is the coefficient of kurtosis and Coef. of Var. is the coefficient of variation. For a normally distributed random variable, the value of the coefficient of skewness is 0 and the value of the coefficient of kurtosis is 3.

(2)

ARCHPRV:	ARCH(4) measure for the private sector
ARCHPUB:	ARCH(4) measure for the public sector
GARCHPRV:	GARCH(4,4) measure for the private sector
GARCHPUB:	GARCH(4,4) measure for the public sector
PRICEPR1:	Conditional variance measure obtained using Price(1993) methodology (using squared residuals as the dependent variable) for the private sector
PRICEPU1:	Conditional variance measure obtained using Price(1993) methodology (using squared residuals as the dependent variable) for the public sector
PRICEPR2:	Conditional variance measure obtained using Price(1993) methodology (using the absolute values of residuals as the dependent variable) for the private sector
PRICEPU2:	Conditional variance measure obtained using Price(1993) methodology (using the absolute values of residuals as the dependent variable) for the public sector
LMPRV:	Conditional variance measure obtained using Antle's (1983) linear moments methodology for the private sector
LMPUB:	Conditional variance measure obtained using Antle's (1983) linear moments methodology for the public sector
EMPPRV:	Measure of the change in private sector employment as a proportion of the total labour force
EMPPUB:	Measure of the change in public sector employment as a proportion of the total labour force

These are somewhat disappointing results, and ones which are not consistent with a priori expectations. In an attempt to explain why such inconsistent evidence may arise, we look towards the Finnish labour market and some of its main features which may partly explain the above findings[54]. We briefly noted some of the features of this market earlier in the literature review (Section 5.3.4.3). Here, we focus on the following points.

[54] For further information on the Finnish labour market, refer to the OECD country studies (various).

Firstly, similar to other Nordic countries, Finland has a strong tradition of labour legislation concerned with wage determination, the distribution of social benefits etc. With respect to the former, the Finnish wage system is one of the most centralised within the OECD, and there is a high degree of organisation of both workers and employers. In general, on either an annual or biannual basis, the Finnish government in consultation with trade unions and employers' unions decide on the general level of wage increases, which serves as a benchmark for the minimum level of wage increase and benefits over the forthcoming year. These negotiations cover approximately 80% of the workforce; those individuals not covered include the self-employed and higher levels of management. The existence of the long-standing centralised wage bargaining system, could lend a degree of assurance and also rigidity to the level of earnings in Finland, which may lead to a lower level of uncertainty perceived by consumers.

Furthermore, over the past years, the Finnish welfare system has provided a comprehensive safety network against unemployment. For example, the unemployment benefits are high, and of practically unlimited duration by international standards. While in more recent times, such features are seen as generating severe work disincentives, from our perspective they provide a certain level of income security for those who may become unemployed, and consequently may reduce the perceived level of uncertainty.

Secondly, as mentioned previously in 5.3.4.3, the number of people with fixed term contracts is one of the highest of OECD countries. Also, out of all the OECD countries, Finland has the smallest number of people in part time employment[55]. This is largely because most parents are in full-time employment, motivated by the fact that the

[55] For example, in 1993 only 11% of women had part-time jobs, while 6% of men were in part-time jobs (Statistics Finland, 1994).

State has facilitated the labour market by providing generous child day-care services etc. There is also a high degree of employment protection (by international standards), concerning for example the hiring and firing rules for employees; this partly explains the extensive use of fixed term contracts by employers. If all of the above mentioned mechanisms were not in place, its plausible to suggest that the perceived level of income uncertainty may be higher.

Thirdly, with respect to the higher volatility of public sector earnings (as suggested in table 5.12), may be partly explained by the recent increase in the share of public employment over recent years[56]. For example in 1980, the number of people employed in the public and private sectors were 562 and 1756 (thousands) respectively (23% and 73% of the total labour force), while the corresponding figures for 1995 were 650 and 1412, (26% and 57% of the total labour force).

Finally, we must also recognise that all of the income based methods treat workers as constantly employed; this may lead to an understatement of true uncertainty. Furthermore, as noted in Section 5.4.1.1, due to data constraints, our measures of uncertainty relate to earnings uncertainty and not to income uncertainty; once again this may lead to an understatement of the true degree of income uncertainty.

5.5.2 INCOME UNCERTAINTY MODEL RESULTS

The IVMA results of the estimation of equation 5.14 are presented in Table 5.13. We report the estimation results when the following uncertainty measures are included as

[56] Similar to the other sectors, there was a decrease in employment in this sector during the recession of the early 1990s,

regressors: the labour market based measure, the LM measures and Price's measures. The ARCH and GARCH estimates of the conditional variance are excluded given our earlier findings of no significant ARCH or GARCH effects. We estimate equation 5.14 using the IVMA procedure to detect if the error term has a first order moving average structure. Using the IVMA procedure also means that potentially valid instruments are those lagged twice or earlier. Our instrument set consists of a constant, the relevant uncertainty measures for each sector, and following the suggestion of Campbell and Mankiw (1989, 1990) the second, third and fourth lags of each of the sectoral income and wealth measures.

Each column in Table 5.13 corresponds to the IVMA estimation results for the alternative uncertainty measures. For all regressions, there is strong evidence of a significant MA(1) term, suggesting that potential valid instruments must be lagged more than one period. With respect to the IVMA results, when the labour market based measure of uncertainty is included as a regressor, we find the following. Firstly, for the private and public sector, the standard t-ratios indicate that the uncertainty terms are statistically insignificant (t-ratios = -0.612 and 0.477 respectively). This finding suggests that the log of consumption is not significantly responsive to changes in uncertainty as measured by changes in sectoral employment (as a proportion of the labour force). Turning to the other regressors in the regression, not surprisingly we find that both private sector income and wealth, have a positive and statistically significant on consumption (t-ratios = 25.70 and 2.54) respectively. Public sector income is also found to be statistically significant (t-ratio = -0.410), but surprisingly, it has a significant negative effect on consumption.

These latter findings for private sector income and wealth, and public sector income are also found in the other regressions, where other uncertainty measures are used as regressors (refer to the third, fourth and fifth columns of Table 5.13). It is only for the case of the LM measures, that we find public sector wealth to be statistically significant, but with a negative effect on consumption (t-ratio = -2.992).

Of the uncertainty measures, only the LM measure for the public sector is statistically significant, suggesting that the uncertainty in income has a significant impact on consumption. This suggests that income uncertainty as calculated is not an important factor for Finnish consumers. On examination of the LM measure for the public sector, there is evidence of a significant but positive relationship between this measure of income uncertainty and consumption, which is inconsistent with the theoretical predications. This result suggests that income uncertainty has a positive effect on consumption, which is inconsistent with the predictions of precautionary savings theory that an increase in the amount of uncertainty will decrease the level of consumption, and thus result in an increase the in level of precautionary savings.

To summarise the empirical evidence: firstly, as expected private sector income and wealth are positively related to consumption; secondly, given our calculated measures (approximations) of income uncertainty, there is little evidence to suggest that income uncertainty is important for Finnish consumers. However we do find a positive and statistically significant effect of uncertainty on consumption for one of our measures (the LM measure for the public sector).

Table 5.13. IVMA Estimation of the Uncertainty Augmented Consumption Model (Equation 5.14); Dependent Variable = Consumption of nondurables and services (exclusive of transfers); (refer to notes at end of Table 5.13)

Regressor	**Labour Market Based Measure**	**LM Measure**	**Price Measure (Squared Residuals)**	**Price Measure (Absolute Residuals)**
constant	1.887(6.86)*	-0.221(-0.306)	1.921(6.044)*	1.902(6.141)*
private sector income	0.773(25.7)*	0.922(17.061)*	0.784(20.943)*	0.787(23.119)*
private sector wealth	0.182(2.540)*	0.487(4.266)*	0.132(1.748)**	0.137(1.909)**
private sector measure of uncertainty	-0.257(-0.612)	-137.845(-0.827)	-14.185(-0.343)	-0.129(-0.111)
public sector income	-0.196(-3.147)*	-0.349(-4.966)*	-0.215(-3.133)*	-0.218(-3.219)*
public sector wealth	-0.031(-0.410)	-0.412(-2.992)*	0.021(0.264)	0.017(0.222)
public sector measure of uncertainty	0.349(0.477)	2031.100(3.353)*	7.118(0.406)	0.289(0.437)
MA(1) term coef.	0.396(3.516)*	0.369(3.303)*	0.452(3.949)*	0.449(3.943)*

Notes to Table 5.13:

1. t-ratios in parentheses;
2. * = statistically significant at the 5 percent level; ** = statistically significant at the 10 percent level.

5.6 CONCLUSION

In this chapter we have dealt with the issue of the effects of income uncertainty on consumption. Specifically, we looked at the differing degrees of income uncertainty facing private and public sector consumers, and the potential impact on consumption. Firstly, we outlined our two group consumption model, which allowed for the effects of income uncertainty on consumption. Secondly, a number of time series measures of income uncertainty were calculated for each sector, and a comparative analysis between sectors was conducted. Some evidence was provided to show that the sectors did differ in terms of the degree of income uncertainty they faced. Thirdly, the estimated measures of uncertainty were then employed as regressors in our two group consumption model. However, for only one of our estimated uncertainty measures, did we find evidence that income uncertainty had a significant effect on Finnish consumption. In this latter case, the results were strongly consistent with the prediction that income uncertainty is important for consumers, and that consumers adjust their consumption plans in response to changing uncertainty. However the result shows that consumption is positively related to income uncertainty, which is not in accordance with the theoretically expected result of a negative relationship.

Possible explanations for our findings, specifically the lack of evidence concerning the impact of income uncertainty on consumption, include the following. Firstly, precautionary saving may be a response to specific individual risks rather than to aggregate risk. Uninsurable risk tends to wash out in aggregation. Hence the use of aggregate time series data may not be sufficient to empirically test the role of income uncertainty on consumption. Secondly, a further concern relates to the income process.

While the idea of estimating the income process is a viable approach to access income uncertainty, particularly in the absence of other information relating to future income developments, we have to deal with the issue where consumers in general have more information than the econometrican, who tends to rely on historical data. Idiosyncratic risk, which is the relevant risk measure for this study, requires detailed information on individuals expectations. It is also that part of individual risk that washes out in the aggregate[57]. Hence relying on aggregate data could lead to an understatement of the effects of uncertainty on consumption. Thirdly, we used the IVMA technique for estimation. Given that co-integration exists among the variables, an alternative technique would be to model the consumption function in an error correction form, which would allow for the explicit separation of the long-run relationship between the modelled variables, and the short-run dynamic responses, which could be important.

In conclusion, our work can be seen as (a) contributing to the recent developments in this area, and (b) contributing to the Finnish consumption literature. With respect to the former, this is particular important, given the impact of income uncertainty and the consequent importance of precautionary savings, which bears on a number of economic issues, for example it will have an impact on government Programs such as unemployment insurance and welfare etc.

[57] The remaining risk is termed systematic risk.

5.7 APPENDICES

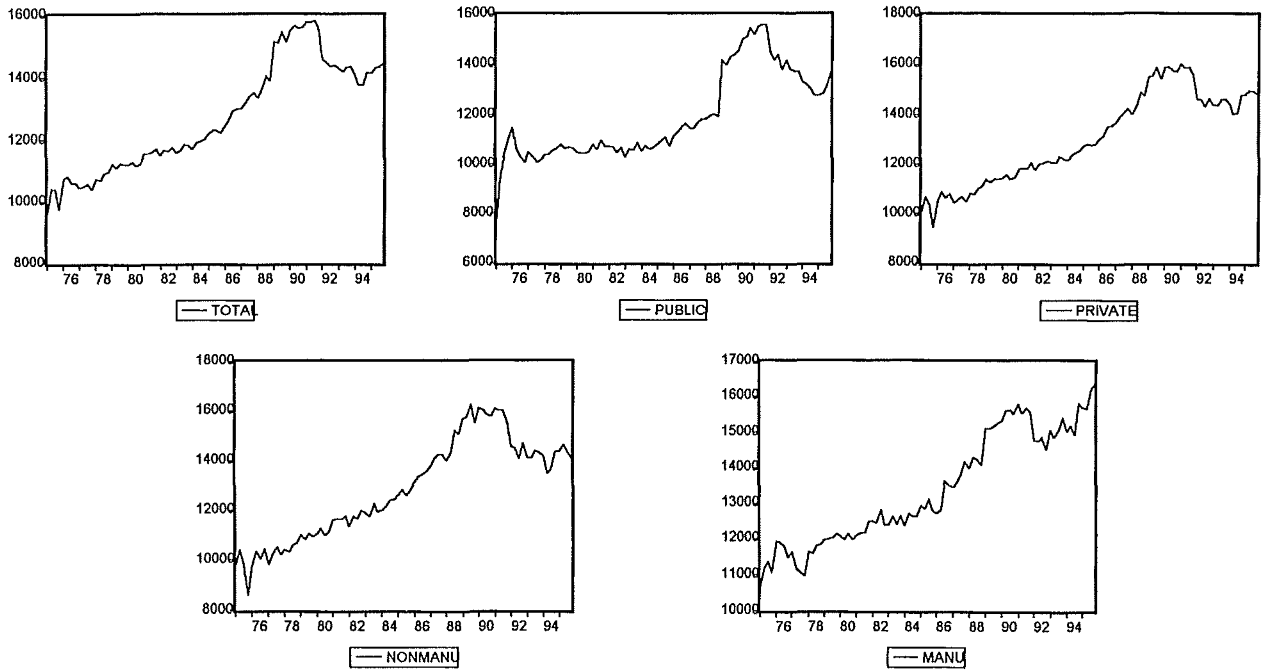
A5.1 TIME SERIES-PLOTS OF WAGES AND SALARIES DATA

This set of figures correspond to the Finnish data for wages and salaries. All data are expressed in logarithms and in real per worker terms.

Notes to Figure A5.1

Total = Total wages and salaries;
Public = Wages and salaries for the Public Sector ;
Private = Wages and salaries for the Private Sector ;
Manu = Wages and salaries for the Manufacturing Sector ;
Non-manu = Wages and salaries for the Non-manufacturing Sector.

Figure A5.1: Finland - Wage and Salary Data; Time Period: 1975Q1-1995Q4



CHAPTER SIX

CONCLUSION

Since the seminal work of Hall (1978), a number of papers have examined and tested the implications of the pure RE-LCPI hypothesis. One of the prominent findings is that actual consumption is excessively sensitive to anticipated income innovations, a phenomenon referred to as simply "excess sensitivity" (Flavin (1981)). A large literature has investigated the causes and extent of excess sensitivity. A number of competing explanations have been suggested; these include myopia (Flavin (1985, 1991)), the existence of liquidity constraints (Flavin (1985), Hayashi (1987), and Zeldes (1989a)), and precautionary savings motives (Skinner (1988), Blanchard and Fisher (1989), Cabellero (1990), Normandin (1994)). A particular feature of the literature is that most studies have focused on one particular explanation but few attempted to discriminate between the alternative explanations. Notable exceptions included Flavin (1985), Shea (1995b), and Chah et al (1995) who considered myopia versus liquidity constraints.

The primary objective of this dissertation was to investigate the observation of excess sensitivity for the Nordic countries (Finland, Norway and Sweden), and to identify and discriminate between the three main competing explanations of excess sensitivity. The thesis consisted of four main chapters (exclusive of introduction and conclusion), and was structured as follows.

Chapter two investigated whether consumption responded to predictable income movements, that is, attempted to identify "excess sensitivity" for Finland, Norway and Sweden. It then proceeded to assess whether financial deregulation had a statistically significant effect on Nordic consumer behaviour. The chapter made two key contributions (i) the income process was modelled for each country; and (ii) the time varying properties of the excess sensitivity parameter were investigated for each country. Employing the modified Euler equation specification popularised by Campbell and Mankiw (1989, 1990, 1991), we found that prior to the financial deregulation period of the 1980s, excess sensitivity was evident for all countries. The full sample estimates revealed that excess sensitivity was only statistically significant in the case of Finland. Some evidence was found for a decline in the sensitivity of consumption to current changes in income, and the decline was found to be statistically significant for Finland and Norway. This was itself consistent with diminished liquidity constraints, and could be attributed to the regulatory reform of the Nordic financial markets during the 1980s, and the associated decline in the prevalence of binding credit constraints.

In chapter three, we tested for asymmetric behaviour in consumption data with a view to distinguishing between myopia and liquidity constraints as potential explanations for excess sensitivity. Specifically we employed Sichel's (1993) tests of deepness and steepness, and Shea's (1995) asymmetry test. We found no evidence to reflect the importance of liquidity constraints over myopic behaviour as potential explanations for excess sensitivity. The key contributions of this chapter included the extensions made to Shea's work, and the application of Sichel's and Shea's methodologies to the Nordic countries. With respect to the former, we built upon the work of Shea in a number of ways, including the use of a more appropriate estimator, and the use of alternative and more powerful methods of identifying positive and negative changes in income growth.

Chapter four extended the work on asymmetries in a new direction. Specifically we tested for asymmetries in the growth of total consumption, income, and expenditure on durables, and expenditure on non-durables and services. Employing Sichel's asymmetry tests, we tested to see if there was evidence of deepness and/or steepness in income growth, and whether such evidence was reflected to the same extent in consumption growth. We found that there was evidence of asymmetries present in some categories of consumption data, but no such asymmetries were apparent in the disposable income measure for any of the countries. This would suggest that the observed asymmetries in the consumption categories were not driven by fluctuations in income.

Based on the observation of excess sensitivity estimated using Finnish data (chapter 2), and the inconclusive results found in chapters 3 and 4 as to whether liquidity constraints or myopia were the potential explanations of the observed excess sensitivity, a third explanation for the rejection of the pure RE-LCPI Hypothesis was examined in chapter five, that of the precautionary savings motive. The empirical models studied in chapters two and three effectively assumed certainty equivalence. One of the key disadvantages of the RE-LCPI hypothesis with certainty equivalence is that it rules out the precautionary savings motive. In chapter five the assumption of certainty equivalence was relaxed allowing the effect and the extent of precautionary savings arising as a result of risk aversion and labour income uncertainty to be examined. Specifically we aimed to discover whether these factors could account for the observed excess sensitivity, whereby their inclusion in an aggregate consumption function would provide a better approximation of the data.

The key contributions of chapter five included the following. Firstly, we derived a two-group consumption model, which allowed us to investigate the effects of income uncertainty on Finnish consumption. Specifically, we looked at the differing degrees of income uncertainty facing private and public sector consumers, and the potential impact on consumption. Secondly, a number of time series measures of income uncertainty were calculated for each sector, and a comparative analysis between sectors was conducted.

Some evidence was provided to show that the sectors did differ in terms of the degree of income uncertainty they faced. Thirdly, the estimated measures of uncertainty were then employed as regressors in our two-group consumption model. However, for only one of our estimated uncertainty measures, did we find evidence that income uncertainty had a significant effect on Finnish consumption. The direction of the effect however, was positive which was not evidence for the theoretically expected result (that is that consumption is negatively related to income uncertainty).

In summary, the significant contributions of this thesis included the following: (i) it contributed to the study of Nordic consumption, particularly in the areas of identifying and explaining excess sensitivity, and identifying a role for income uncertainty in influencing Nordic consumers; (ii) it contributed to the recent resurgence of interest in asymmetric consumer behaviour, and in particular the role of asymmetries in discriminating between competing hypotheses of consumer behaviour; and (iii) it contributed to the research on income uncertainty and its effect on consumption through the development of a two-group uncertainty consumption model, and the estimation of different measures of uncertainty.

With respect to future research, the thesis has identified a number of potentially fruitful avenues. Firstly, the methodologies of identifying asymmetric responses in disposable income and categories of consumption (Sichel's (1993) deepness and steepness tests, and our modified version of Shea's (1995) model) could be applied to other countries. Secondly, the role of asymmetries in distinguishing between competing hypotheses other than for consumption could be explored. Thirdly, the effects of income uncertainty and risk aversion on consumer behaviour as embodied in our two-group model could be used to examine the role of precautionary savings and income uncertainty in other countries. Finally, additional work on the measurement of income uncertainty could be further explored, particularly for those countries where richer data sets such as panel data sets are available; for example the Panel Study of Income and Dynamics in the US.

DATA APPENDICES

APPENDIX 1: DATA FOR CHAPTERS TWO, THREE AND FOUR

The work conducted in Chapters Two-Four uses data from several sources; where possible all data was cross checked with either OECD or IMF data banks. Table A.1 provides data definitions.

(1) For Finland, the bulk of the data was kindly provided by Kari Takala of the Bank of Finland. Additional data was received from Kaija-Leena Rikkonen, Economics Department, Bank of Finland, and Mia Suokko, Statistics Finland. The data are obtained from the Bank of Finland's BOF5 data bank, the primary source of which are the Finnish National Income and Expenditure Accounts. The data are quarterly and cover the period 1970:1-1995:4.

(2) For Norway the data was kindly provided by Ragnar Nymoen of the National Bank of Norway and the University of Oslo, and by Eika, Torbjørn, Statistics Norway. The data are quarterly and cover the period 1967:4-1994:4. The Norwegian National Accounts are at present being converted to the OECD standard, and as a result a more up to date data bank was not available.

(3) The Swedish data set was kindly provided by Lennart Berg, Department of Economics, University of Uppsala, by Bharat Barot, National Institute of Economic Research, and by Peter Degerstedt, National Accounts Division Sweden. The data are quarterly and cover the period 1970:1-1995:4.

In each case, consumption and income are only available in seasonally unadjusted form. To seasonally adjust the data, the X11 Census of Bureau method (multiplicative) was employed. To convert the data to per capita form, the IMF annual population data was used. These population numbers are mid year estimates. A quarterly population series was created by log linear interpolation. The Finnish data are expressed in 1990 prices; the Norwegian data are expressed in 1991 prices; and the Swedish data are expressed in 1991 prices. In each case the data is deflated where appropriate by the implicit price deflator for the consumption of nondurables and services, which is calculated from the seasonally adjusted version of the data.

Table A.1: Data definitions

Variable	Definition
CP	Total Private Consumption
CNDS	Consumption of Non-durables and Services
CD	Consumption of Durables
YD	Total Disposable Income
WEALTH	Net Wealth of Households
EXPT	Exports
GOVT	Government Expenditure
BUSINV	Business Investment
I	Nominal Interest Rate (Market Interest Rate (3 months))
R	Real Interest Rate
UR	Unemployment Rate
INF4	Inflation Rate
POP	Population

APPENDIX 2: DATA FOR CHAPTER FIVE

The work conducted in Chapter Five uses data from several sources. The main data set was kindly provided by Kari Takala of the Bank of Finland. The data are obtained from the Bank of Finland's BOF5 data bank. The data are quarterly and cover the period 1970:1-1995:4. Data for the number of employed persons by industry was kindly provided by Hannu Siitonen (Statistician, Labour Force Survey) and Jari Tarkoma (Statistician, Employment), both of Statistics Finland. Table A.2 provides data definitions. All variables are expressed in real (1990) prices and in per capita terms. The price deflator is the implicit price deflator for the consumption of nondurables and services (impccnds) and is used to deflate all variables including wealth and labour income. The consumption measure is consumption of nondurables and services, divided by total pop.

Wages and Salaries

Disposable wages and salaries is obtained by multiplying each sectoral wage and salaries by the average income tax rate of wages and salaries. Per capita measures are obtained by dividing by the number of workers in each sector.

Disposable Income

Disposable income (YD) is defined as household disposable income and is constructed in the BOF5 model as follows:

$$YD = YFIH + YINH + YTRH - TRHGTOT$$

where YFIH = factor income by households; YINH = Entrepreneurial and property income of the household sector; YTRH = transfer income of households received from other sectors; and TRHGTOT = transfers of households to other sectors.

Wealth

The wealth measure used is defined as net wealth of households (WEALTH) and is constructed in the BOF5 model as follows:

$$WEALTH = PHM*KH/100 + .83895*MON2 - LBH - LCGH$$

where PHM = House price index, for all dwellings in the entire country (1990=100); KH = Net stock of private residential capital (millions of 1990 FIM); MON2 = Monetary aggregate M2 (FIM million); LBH = Bank loans to the households (FIM million); and LCGH = Stock of central government housing loans (FIM million).

Industrial Classification Change in 1989

The classification of industries is the Standard Industrial Classification (hereafter SIC) 1979 upto 1988 and the SIC 1988 for 1989 onwards. The discontinuity of the time series concerns mainly the division between the trade, business services and public sectors. Table A3 reports the differences in the data for year 1989 classified according to the SIC 1979 and SIC 1988 classifications.

Table A.3: Sectoral Distribution of Employment (100 people), 1989

Main Groups	SIC 1979	SIC 1988	Difference
Total	24702	24702	
Agriculture, Hunting, Forestry, Fishing	2179	2178	-1
Manufacturing, Mining and Quarrying, Electricity, Gas and Water	5613	5622	+9
Construction	1990	2010	+20
Trade, Restaurants and Hotels	3678	3871	+193
Transport, Storage and Communication	1790	1783	-7
Financing, Insurance, Real Estate and Business Services	1940	2345	+405
Community, Social and Personal Services	7490	6869	-621

Table A.2: Data definitions

Variable	Definition
CNDS	consumption of non-durables and services
YD	total disposable income
YW	Wages and Salaries, Total
YWM	Wages and Salaries, Manufacturing
YWPR	Wages and Salaries, Services etc.
YWPU	Wages and Salaries, Public Sector
ATAX	Average income tax rate of wage and salary earners
WEALTH	Net Wealth of Households
YTRH	Unrequited current transfers to households and own profit institutions
EXPT	Exports
GOVT	Government Expenditure
BUSINV	Business Investment
I	Nominal Interest Rate
R	Real Interest Rate
UR	Unemployment Rate
INF4	Inflation Rate
POP	Population

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