Scotland's Baby Box Scheme: a mixed-methods public health evaluation

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Abstract

Scotland's Baby Box Scheme (SBBS) was introduced by the Scottish Government on the 15th of August 2017 and made available to all parents in Scotland. The scheme is universal, unconditional, and non-commercial, and is modelled on the Finnish Baby Box. SBBS can be understood as a non-monetary transfer. Despite potential implications for infant and maternal health, the scheme's public health impact has not been evaluated. This thesis aimed to provide a mixed-methods public health evaluation of SBBS using three distinct approaches. In the first approach I used a theoretically derived framework to analyse the political discourse surrounding SBBS introduction. This discourse featured the claim that the Finnish Baby Box (a component of the wider Finnish Maternity Grant) reduced infant mortality. For the second approach I addressed this claim using natural experimental methods. Applying interrupted time series and synthetic control analyses to international life-table data, I found no clear indication that the Finnish Maternity Grant had any effect on infant mortality rates; estimates were challenged by outcome variability and potential history bias. In the third approach I evaluated the introduction of SBBS as a natural experiment, applying interrupted time series analysis to linked administrative health data. I estimated the impact of SBBS on a range of infant and maternal health outcomes. SBBS had potential beneficial effects on infant and maternal tobacco smoke exposure, with a possible narrowing of inequalities by area deprivation in the former. A beneficial association with exclusive breastfeeding was also observed in younger mothers. SBBS had no observed effect on infant and maternal hospital admissions or infant sleeping position. Strengths of this thesis include the use of robust causal methods and linked administrative data with near complete population coverage. Limitations include a lack of long-term outcome measures. While non-monetary transfers such as baby boxes may have other benefits, policy makers and healthcare bodies should not assume that they reduce infant mortality. Policy makers should also plan for quantitative outcome evaluation when feasible. Further research is needed to confirm the health impact of SBBS, understand whether this impact persists over time, and understand the causal mechanisms involved.

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Author's declaration

I declare that, except where explicit reference is made to the contribution of others, this dissertation is the result of my own work and has not been submitted for any other degree at the University of Glasgow or any other Institution.

Signature:

Printed Name: Ronan McCabe

I have no competing interests to declare

Abbreviations

BSG-PBP: Best Start Grant Pregnancy and Baby Payment

CCT: Conditional Cash Transfer

CDA: Critical Discourse Analysis

CI: Confidence Interval

EA: Evaluability Assessment

eDRIS: electronic Data Research & Innovation Service

ITS: Interrupted Time-Series

MSPE: Mean Squared Prediction Error

NHS: National Health Service

OLS: Ordinary Least Squares

RCT: Randomised Controlled Trial

RR: Rate Ratio or Relative Risk

SBBS: Scotland's Baby Box Scheme

SC: Synthetic Control

SIDS: Sudden Infant Death Syndrome

SIMD: Scottish Index of Multiple Deprivation

SNP: Scottish National Party

UCT: Unconditional Cash Transfer

UK: United Kingdom

1 Introduction

1.1 Chapter overview

This chapter introduces the thesis. It first gives a background to and briefly describes Scotland's Baby Box Scheme, the research focus of this thesis (Section 1.2). It then situates Scotland's Baby Box Scheme within the wider policy context (Section 1.3) and discusses the scheme as a candidate for public health evaluation (Section 1.4). This section finishes with an overview of the thesis structure in which the contents of each chapter are outlined (Section 1.5). It also gives the aim and research questions addressed in the analysis chapters (Chapters 3-10). As will be the case throughout this thesis, sections headed by whole numbers are referred to as Chapters while sections headed with decimal numbers are referred to as Sections.

1.2 Scotland's Baby Box scheme

On April 20th 2016, in preparation for the upcoming Scottish Parliamentary Elections, the Scottish National Party (SNP) introduced their manifesto titled 'RE-ELECT'. Included was a pledge to introduce a baby box, modelled on a scheme said to improve the lives of infants in Finland:

> "Every new-born in Scotland will be entitled to a 'baby box', offering essential items for a child's first weeks – adapting the successful Finnish model which has helped to improve lives for babies and toddlers." - Scottish National Party (2016)

While the concept of baby boxes received media attention in the United Kingdom (UK) as early as 2013 (Lee, 2013), the concept did not feature in any Scottish Government policy documents or transcripts until 2015. The first documented mention comes from the Official Report (or transcript) of a Scottish Parliament Welfare Reform Committee meeting on June 2nd 2015 (The Scottish Parliament, 2015a). This document records an exchange between Belinda Phipps of the Fawcett Society and Ann Henderson of the Scottish Trades Union Congress. Here, Phipps posits that the Sure Start Maternity Grant – the UK Government administered predecessor to the Scottish Government administered Best Start Grant Pregnancy and Baby Payment (BSG-PBP) – is received later on in pregnancy and thus leaves a gap in financial support. They state that there "is an argument that a weekly benefit of a small amount, starting in early pregnancy, is needed [to address this gap]." It is in response to this that Henderson suggests the Finnish 'maternity box' as an option, on the grounds that there were no similar small-scale interventions in Scotland at that time.

Baby boxes appear again in an agenda for a Welfare Reform Committee meeting on September 15th 2015 (The Scottish Parliament, 2015b). It states that there were suggestions that Scotland should look beyond its "own borders for ideas to better support young babies" such as the Finnish Baby Box "idea". However, it is not clear who made these suggestions and the issue does not appear in the minutes for meeting. It is worth noting that the published agenda provides a hyper-link to the 2013 news article cited above (Lee, 2013). It could thus be asked to what extent a baby box was initially considered on the back of its public profile.

Baby boxes are not documented further in the Scottish policy context prior to the SNP's April 2016 manifesto announcement. This, however, is not suggestive of any lack of policy activity behind the scenes. The 2016 Scottish Parliamentary Elections led to the formation of an SNP minority Scottish Government. In keeping with their manifesto pledge, on the 15th of August 2017 this government introduced Scotland's Baby Box Scheme (SBBS). Nationwide introduction of the scheme followed a small-scale pilot (Scottish Government, 2017e). This pilot involved the distribution of 160 boxes to parents in the local authority areas of Orkney (n=49) and Clackmannanshire (n=111) with a due date between January and March 2017.

Consisting of a cardboard box fitted with a foam mattress and containing various items for parents to use in the initial months of life (see *Image 1* below), SBBS is intended to provide a safe sleeping space for the infant. Additionally, the box supplies parents with information leaflets concerning breastfeeding, safe sleeping (e.g., infant sleeping position and exposure to tobacco smoke), and postnatal depression. SBBS is non-commercial, unconditional, and universally available to all parents in Scotland. Parents may register for the scheme during 20-24th week antenatal appointment and receive the box between the 32nd and 36th week of pregnancy. SBBS is also associated with the ParentClub website - https://www.parentclub.scot/ - which is funded by the Scottish Government and provides parents with a range of information tailored to different stages of child development (from zero to ten years of age). The information present on the website expands on that provided directly via SBBS (e.g., educational videos aimed at supporting breastfeeding). Parents are made aware of the ParentClub upon registration for SBBS and can opt to receive regular emails linked to the website, although the contents and frequency of these emails is not clear (Bardsley *et al.*, 2021). While this brief description serves to introduce SBBS, a more detailed and structured description is given in 5 for the purposes of evaluation.

Image 1 This image shows the material components of SBBS.

Image credit: Vittal Katikireddi.

There are a number of other initiatives involving baby boxes in different geographical and legislative contexts around the world. Ball & Taylor (2020) identify four variants. The first type involve government run schemes that do not have any commercial element. SBBS would be categorised as such alongside the Finnish Baby Box. Indeed, as indicated in the SNP manifesto pledge quoted above, SBBS is conceptually derived from the Finnish Baby Box which was first introduced in 1938. A detailed and structured description of the Finnish Baby Box (or Maternity Package), and the wider Finish Maternity Grant of which it is a component, is given in 3.

The other variants identified by Ball & Taylor (2020) involve commercial reward schemes, commercial-health provider partnership schemes, and retailer for profit schemes. It is important to distinguish these from SBBS and the Finnish Baby Box from the outset as these schemes are often not orientated towards public health and are made commercially viable either through the harvesting of individuals' data or through the requirement of purchase. The commercial-health provider partnership variant – made commercially viable through the harvesting of data – has been particularly common in England, with several National Health Service (NHS) bodies having operated such schemes (ibid.).

1.3 Policy context

The introduction of SBBS came at a time of notable change in Scotland's social security landscape. Following the 2014 Referendum on Scottish Independence, the Smith Commission was tasked by then Prime Minister of the UK David Cameron with examining the devolution of further powers to the Scottish Parliament. A report of the Commission's recommendations was published on November 27th 2014 and formed the basis of the Scotland Bill, which received Royal Assent on March 23rd 2016 to become the Scotland Act (2016). The roll out of Universal Credit, precipitated by the UK Welfare Reform Act 2012, was also ongoing at this time.

The Scotland Act (2016) devolved legislative competence over eleven benefits to the Scottish Parliament, as well as the power to determine the structure and value of these benefits. A notable example is the BSG-PBP, which was rolled out in Scotland in 2018 and replaced the Sure Start Maternity Grant previously administered by the UK Government (Scottish Government, 2020c). The BSG-PBP provides low-income families in receipt of qualifying benefits (e.g., Universal Credit) with £600 for a first child and £300 for any subsequent children. This is compared to the Sure Start Maternity Grant still operating in England, Wales and Northern Ireland which provides low-income families with £500 for their first child only. Additionally, the Scotland Act (2016) devolved the powers to top-up reserved benefits and to create novel social security benefits in areas unrelated to reserved matters (Wane *et al.*, 2016). A new executive agency, Social Security Scotland, was established in 2018 to administer the benefits transferred under the Scotland Act (2016) (Kidner, 2019).

While the Scotland Act (2016) did not form the legislative basis for SBBS, there is a shared policy ethos between these developments. This ethos mirrors the prominent argument voiced in favour of devolution that a Scottish legislative body would engender greater political accountability and autonomy, and so allow for Scotland to pursue more progressive social policies (Stephens and Fitzpatrick, 2018).

This ethos is present in the underpinning principles of the Social Security (Scotland) Act 2018, which legislated for the provision of the powers newly acquired through the Scotland Act (2016). These principles stipulate that social security is itself a human right essential to the realisation of other human rights and that the dignity of individuals will be at the heart of the Scottish social security system. This has been contrasted with the ethos towards social security adopted by the UK Government, which has gained notoriety for its use of sanctioning to punish benefit claimants (Adler, 2016; Baumberg-Geiger, 2017; Beatty and Fothergill, 2018; Wright, Fletcher and Stewart, 2020). The Scottish Government draw on this contrast for political gain. For example, the Scottish Government's Programme for Scotland 2017-18 (Scottish Government, 2017a) states:

> "We are committed to upholding the rights and values of an open, inclusive, diverse, and progressive democracy. We do this in the face of continuing austerity and an increasingly punitive approach to welfare from the UK Government"

This explicit commitment to the values of openness and inclusivity aligns with values expressed elsewhere, such as the Scottish Government's current National Performance Framework. This framework "[…] aims to reduce inequalities and gives equal importance to economic, environmental, and social progress", whilst embodying the values of "kindness, dignity, and compassion" (Scottish Government, 2018e). As will be seen in Chapter 3, the political discourse surrounding the introduction of SBBS embodied a similar ethos drawing on the values of fairness, inclusivity, and equality.

SBBS can also be situated within the broader context of early years policy in Scotland. The term early years is ambiguous, although in the policy context it typically refers to the initial five years of life. There has been a long-standing policy emphasis on this period in Scotland. For example, the Early Years Framework was published in 2008 almost a decade prior to the introduction of SBBS. This sought to 'maximise positive opportunities for children to get the start in life that will provide a strong platform for the future success of Scotland' (Scottish Government, 2008). This framework was itself preceded by the Getting it Right for Every Child approach, adopted by the Scottish Government while led by the Scottish Labour Party in 2006 (Kidner, 2013).

Two elements of the Early Years Framework are of particular relevance. One concerns breaking the "cycles of poverty, inequality and poor outcomes in and through the early years" and speaks of the "critical period", a concept we will return to in 2 (Scottish Government, 2008: p.16). The other element concerns using "universal services to deliver prevention and early intervention" (Scottish Government, 2008: p.17). Being universally available and targeted at the early years, SBBS exhibits a continuity with this framework.

The UK Government also place an emphasis on the importance of the early years in relation to health and development in, for example, the recent Early Years Healthy Development Review (UK Government, 2021). However, previous actions of the UK Government such as repealing legally binding income-based targets on child poverty through the UK Welfare Reform and Work Act 2016 could negatively affect child health. These targets were reinstated by the Scottish Parliament through the Child Poverty (Scotland) Act 2017. Policies aimed at meeting these targets in Scotland include the Scottish Child Payment, which was introduced in 2021 and provides low-income families in receipt of qualifying benefits with a weekly payment of £10 (increasing to £20 in April 2022) for every child under the age of six (Hudson, 2021).

Thus, while the specific form of SBBS (i.e., a physical box containing various items) is without precedent in the Scottish policy context, there is a continuity both with the current social policy ethos of the Scottish Government and their long-held emphasis on the early years of life.

1.4 Public health evaluation

The impetus for this thesis extends from an Evaluability Assessment (EA) for SBBS published by the Scottish Government in 2018 (Scottish Government, 2018c). This provided a logic model describing the short-, medium-, and long-term outcomes for the scheme; these are outlined in *Table 1* below. The medium- (M1-4) and long-term (L1-4) outcomes are most clearly linked to health. The former concern reduced inequalities in access to new-born essentials, improved health behaviours, and increased service engagement. The latter concern improving overall and reducing inequalities in infant and maternal health, improving overall and reducing inequalities in early years development, and reducing inequalities in infant mortality. A full description of this logic model and how it relates to an evaluation of SBBS is outlined in 5.

The EA explored three approaches to evaluation:

1. A ‘process’ evaluation involving qualitative interviews and focus groups with, and a quantitative survey of, parents and healthcare practitioners.

2. A natural experimental evaluation of outcomes using routinely collected (or administrative) health data.

3. A cohort survey of parents in Scotland and comparison areas such as England and Wales.

Short-term outcomes		Medium-term outcomes		Long-term outcomes	
S1	Shared understanding of a society that values and supports children and families.	M1	Shared understanding of a society that values and supports children and families.	L1	Improved infant/maternal health and wellbeing outcomes.
S2	Reduced parental expenditure on new-born essentials.	M2	Reduced inequalities in access to new-born essentials.	L2	Reduced inequalities in infant/maternal health and wellbeing outcomes.
S3	Parents understand and use the box and its contents.	M3	Increased positive behaviours and reduced risk behaviours.*	L3	Reduced inequalities, and improvement, in early years development outcomes.
S4	Increased parent and healthcare worker understanding of risk and positive behaviours.				
S5	Healthcare workers understand the contents and purpose of box.	M4	Sustained parental engagement with wider services.	L4	Reduced inequalities in infant mortality.
S6	Parents attempt to engage with wider services.				

Table 1 Short- (S1-6), medium- (M1-4), and long-term (L1-4) outcomes of Scotland's Baby Box scheme (SBBS).

Adapted from the logic model presented in the Scottish Government evaluability assessment (Scottish Government, 2018c: p.8, *Figure 1*). * Breastfeeding, sleeping practice (e.g. infant sleeping position and tobacco smoke exposure), health seeking behaviour, and play/attachment.

However, only the first approach has been adopted, with an evaluation of SBBS conducted by Ipsos MORI Scotland on behalf of the Scottish Government published in 2021 (discussed further in Section 2.3.1) (Bardsley *et al.*, 2021). This thesis adopts the second approach and provides the first outcome evaluation of SBBS' impact on infant and maternal health. This approach considered SBBS to be a candidate for outcome evaluation on the basis that it a) represents a substantial public health intervention and b) can be viewed as a natural experimental event.

SBBS is of interest to public health for a number of reasons. Namely, it constitutes a transfer of material (or non-monetary) resources. These resources could function to promote health (e.g., an underarm thermometer alerting a parent to fever). Alternatively, having an equivalent monetary cost, these resources may increase the financial freedom of parents to purchase other health promoting resources. In addition to this, the scheme can be viewed as an educational intervention through the provision of health information and through acting as an engagement tool to be used by healthcare practitioners (e.g., midwives, family nurses, or health visitors). The universality of the scheme across Scotland also suggests that any potential health benefits will occur on a population level.

The introduction of SBBS also represents a 'natural' source of variability in exposure to an intervention of interest, otherwise known as a natural experimental event. This is opposed to variability in exposure designed for the purposes of research. In the simplest sense, this variability can be conceptualised in a pre-post fashion: births occurring in Scotland prior to the introduction of SBBS can be said to form an unexposed group, while those occurring after introduction form an exposed group. As noted by the EA, this presents an opportunity for evaluation using natural experimental methods such as interrupted time series (ITS) analysis; ITS is discussed further in Chapters 4 and 5. SBBS is particularly well suited to natural experimental evaluation as it has a clear point of introduction, lack of antecedent policy, a population level exposure, and a 'dose' that would be expected to have observable impacts.

1.5 Thesis structure

Chapter 2 provides an overview of the relevant literature. It begins by describing the social determinants of health, health inequalities, and the life-course approach in relation to infant health. It also pays specific attention to infant mortality. Continuing from this, the published research surrounding baby boxes is discussed including the research on SBBS commissioned by the Scottish Government thus far. The chapter then reviews the evidence surrounding the different elements of SBBS in relation to infant health. It concludes with a summary of this literature and considers the implications it has for our understanding of SBBS as a public health intervention.

Chapter 3 aimed to critically examine the political discourse that has been publicly expressed by key political actors in relation to SBBS. Using a theoretically derived approach in which political discourse is understood to fundamentally involve practical argumentation, Chapter 3 answers the following research questions:

1. What practical argumentation was publicly expressed by key political actors in relation to SBBS?

2. How did this practical argumentation represent the policy issue?

3. What tensions are present between representations of the policy issue?

Chapter 4 aimed to investigate the impact of the Finnish Maternity Grant's introduction in 1938 and its subsequent universalisation in 1949 on Finnish infant mortality rates. The Finnish Maternity Grant is the broader policy to which the Finnish Baby Box belongs. Using natural experimental methods, this chapter addressed the following research questions:

4. Did the introduction of the Maternity Grant in 1938 reduce infant mortality rates in Finland?

5. Did the universalisation of the Maternity Grant in 1949 reduce infant mortality rates in Finland?

6. How robust are any indications of impact?

Chapters 5 to 10 aimed to investigate the impact of SBBS on infant and maternal health. Using natural experimental methods, these chapters addressed the following research questions:

7. What impact did the introduction of SBBS have on infant hospital admissions, exposure to tobacco smoke, feeding, sleeping, and immunisations?

8. What impact did the introduction of SBBS have on maternal hospital admissions?

9. Did the impact of SBBS' introduction on these outcomes differ by maternal age, number of previous pregnancies, and SIMD-2016 quintile?

Chapter 5 details the methodological approach taken, while Chapters 6 to 10 detail findings. Chapter 6 details the impact of SBBS on all-cause infant and maternal hospital admissions, Chapter 7 details the impact on infant and maternal tobacco smoke, Chapter 8 details the impact on exclusive breastfeeding, Chapter 9 details the impact on infant sleeping position, and Chapter 10 details the impact on infant immunisation uptake.

Chapter 11 discusses the research presented in the thesis as a whole. It begins with a summary of findings followed by a discussion of these findings in relation to the wider evidence and research on the subject. Following on from this it reflects on the different methodological approaches taken in this thesis, highlighting their strengths whilst outlining a number of limitations. Finally, it discusses the wider implications of these findings for both policy and research.

2 Literature review

2.1 Chapter overview

In this chapter I review the literature most relevant to an evaluation of SBBS. Section 2.2 reviews the literature relating to infant health. I introduce the theoretical basis of the social determinants of health (Section 2.2.1), health inequalities (Section 2.2.2), and the life-course approach (Section 2.2.3). I also focus on infant mortality and its risk factors (Section 2.2.4). Section 2.3 reviews the research literature surrounding baby boxes. Here I focus on the research into SBBS that has been commissioned by the Scottish Government thus far (Section 2.3.1), qualitative (Section 2.3.2) and quantitative (Section 2.3.3) research on baby boxes more generally, and finally academic commentary on the subject of baby boxes (Section 2.3.4). Section 2.4 intends to deepen our understanding of SBBS as a public health intervention through considering its various components. I focus on non-monetary (in-kind) transfers more broadly (Section 2.4.1), monetary transfers (Section 2.4.2), and educational interventions (Section 2.4.3). Educational interventions are considered in relation to outcomes selected on the basis of the health information contained within SBBS. This chapter concludes with a summary of this literature and the implications it has for our understanding of SBBS as a public health intervention.

2.2 Infant health

The section provides a traditional review of the literature concerning infant health most relevant to SBBS. This review format was chosen as, rather than summarising the evidence on a single topic, as this section seeks to introduce relevant concepts that help frame an understanding of the potential health impacts extending from SBBS.

2.2.1 Social determinants of health

The social determinants of health encompass the conditions in which people live their lives and the social phenomena determining such conditions (Pearce *et al.*, 2019). It is now widely understood that the health of populations and individuals are affected by social phenomena beyond that of medical care (Stuckler, Basu and McKee, 2010; Braveman and Gottlieb, 2014). Indeed, the impact of medical care on health may be more limited than previously thought. This understanding signals a departure from the strictly biomedical model of health and illness that dominated the health sciences for much of the 20th century (Krieger, 2011; Valles, 2018: p.32).

Pearce et al. (2019) represent the social determinants of infant health with an adapted version of Dahlgren & Whitehead's (1991) famous Social Model of Health (see

Figure 1 below). This adapted model consists of concentric layers extending from the individual infant and their largely fixed characteristics (e.g., age, ethnicity, and sex), each representing a different sphere of influence on infant health. These spheres are conceived of as being both intra- and inter-related.

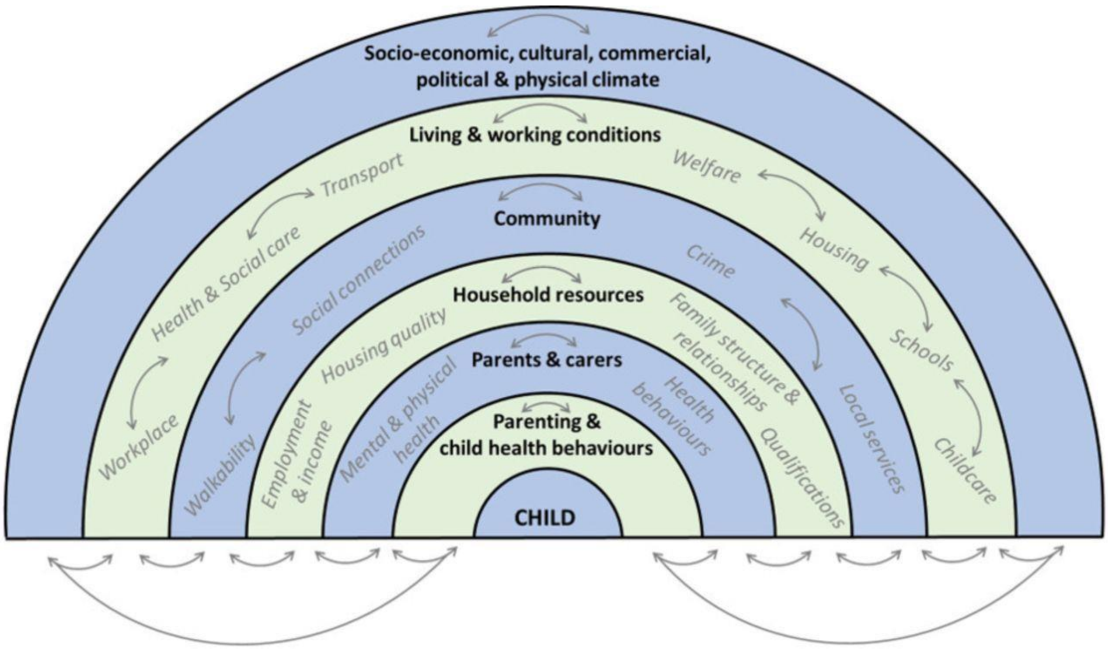

Figure 1 Pearce et al.'s (2019) framework for the social determinants of infant health.

A more proximal sphere of influence (or micro-level influence) in Pearce et al.'s (2019) framework concerns parents and carers. Parental behaviour, knowledge and education have important implications for infant health (Moore *et al.*, 2015; Balaj *et al.*, 2021). Breastfeeding and infant exposure to second-hand tobacco smoke, for example, are mediated by these factors. SBBS may function on this level through the provision of health information to and the promotion of positive health behaviours among parents.

Another sphere of influence concerns the household resources available to parents and carers. This would include parental employment and income, qualifications, support, family structure, and housing quality. For example, the recent slowing of improvements in infant mortality in the UK has been linked to worsening socio-economic conditions (Taylor-Robinson *et al.*, 2019; Harpur *et al.*, 2021). Relatedly, lone parents can experience high rates of material disadvantage with wide ranging implications for infant and child health (Spencer, 2005; Campbell *et al.*, 2016). With respect to housing quality, for example, damp and mouldy housing has been associated with poor respiratory outcomes among infants and children (Tischer, Chen and Heinrich, 2011; Ingham *et al.*, 2019). SBBS could also hypothetically function on this level in providing material resources to parents that could benefit infant health and also through increasing the financial freedom of parents to purchase other resources that could benefit infant health.

The outermost (macro-level or structural) spheres of influence include the wider living and working conditions surrounding the infant, and the socio-economic and political environment in which they are embedded. For example, there are likely consequences for infant health extending from what the sociologist Bob Jessop terms the 'austerity polity' (i.e., the institutionalisation of austerity politics) that emerged in the UK following the 2008 financial crash (Jessop, 2016). This has been linked to the aforementioned changes to UK infant mortality trends in recent years (Stuckler *et al.*, 2017; Taylor-Robinson *et al.*, 2019; Harpur *et al.*, 2021). Indeed, more severe austerity measures are associated with more adverse child health outcomes (Rajmil *et al.*, 2020). Relatedly, natural experimental evidence suggests that restrictions to income support for lone mothers in the UK negatively affected their mental health, with potential though unexplored consequences for infant health (Katikireddi *et al.*, 2018).

2.2.2 Health inequalities

McCartney, Popham, et al. (2019) define health inequalities as follows:

> 'Health inequalities are the systematic, avoidable and unfair differences in health outcomes that can be observed between populations, between social groups within the same population or as a gradient across a population ranked by social position.'

This definition is offered as an amalgam of the various definitions currently available. Common to the majority of definitions explored by the authors, there is an emphasis on notions of justice, fairness, and remedial action to avoid or reduce health inequalities. As will be explored in Chapter 3, the introduction of SBBS was closely tied to such notions. In certain contexts, the alternative term 'health inequities' is used to highlight the notion of injustice (Arcaya, Arcaya and Subramanian, 2015).

The research in this thesis focuses on socio-economic health inequalities specifically. Such inequalities are said to be related to socio-economic status or position as opposed to, for example, ethnicity or gender. The concept of socio-economic position is closely tied to the sociological concept of class (Scambler, 2019). Measures of socio-economic position used in public health research include occupation, income, education, and area (Galobardes *et al.*, 2006). Health inequalities are present in any given infant population, as they are in adult populations. However, for infants, these measures concern the socio-economic position of the parent(s) or primary carer. The Scottish Index of Multiple Deprivation (SIMD) is an area-based measure of socio-economic position and is the measure of socio-economic position used in this thesis; a full description of SIMD is provided in Chapter 5.

Various explanatory models of health inequalities have been proposed and have been covered extensively in the literature (Mackenbach, 2012; Bartley, 2016). Broadly, these models are differentiated by their emphasis on cultural-behavioural, psychosocial, material, and structural phenomena. As Pearce et al. (2019) discusses, these explanatory models are also of relevance to understanding infant health inequalities.

The cultural-behavioural model emphasises the link between health inequalities and inequalities in health-related behaviours (e.g., smoking, alcohol consumption, and diet). While such explanations are not thought to be as important as others, the degree to which health-related behaviours function as a symptom or a cause of health inequalities is a persistent topic of debate (Smith, Bambra and Hill, 2015). Infants have little if any control over their own health-related behaviours and thus, in relation to infant health inequalities, this model would concern the behaviour of parents and other caregivers.

The psychosocial model concerns psychosocial states (e.g., feelings of subordination, inferiority, and lack of control) and their subsequent implications for physiology (e.g., alteration of neuroendocrine or stress systems) and health. However, such processes are unlikely to affect infants directly as they have not yet formed a perception of the social hierarchies in which they are embedded. Rather, consequences of the psychosocial model for infant health inequalities would likely extend from the effects of such processes on parents or other caregivers. Related to the life-course approach and the concept of the developmental origins of health and disease (discussed further in Section 2.2.3), there is a growing body of evidence suggesting that psychosocial stress during pregnancy has long-term implications for infant health and development (Beijers, Buitelaar and de Weerth, 2014; Van den Bergh *et al.*, 2020).

The materialist model considers the consequences of wealth and income for health. Health inequalities here are seen to arise from differential access to health-promoting resources (e.g., nutritious food and housing quality) and differential exposure to risk factors of morbidity or mortality (e.g., environmental pollution and hazardous employment). There is a significant consensus supporting the relationship between material factors and health (Smith, Bambra and Hill, 2015). With respect to infant health inequalities, this would concern the wealth and income of parents or other caregivers.

The structuralist model understands the other models as being determined by broader macro-level or structural determinants. These include the labour market, politics, and the economy and how these systems function to unequally distribute and make accessible wealth, power and other resources in society (Phelan, Link and Tehranifar, 2010; Smith, Bambra and Hill, 2015). As an explanation for social inequality more broadly, and how social inequality may precipitate health inequalities, this model addresses somewhat the criticism that other models often take the presence of social inequality as a given rather than something also to be explained (Mackenbach, 2012, 2017; Scambler, 2012;

McCartney, Bartley, *et al.*, 2019). For example, it integrates the sociological concepts of power and dominance and considers their role in the reproduction of health inequalities (McCartney, Bartley, *et al.*, 2019).

2.2.3 The Life-course approach

The life-course approach is principally concerned with the implications of exposures occurring during gestation, childhood, and adolescence for health and the development of illness in later life (Kuh *et al.*, 2003). That is, rather than simply considering the sum or totality of exposures over a given lifetime (or life-course), life-course theory explicitly considers the 'temporal ordering of exposures and their inter-relationships' (ibid.). Exposures may accumulate over time or form sequential chains, whereby one exposure leads to another. As a specific and well known example, allostatic load refers to the dysregulation of physiological systems as a result of accumulated or persisting exposures over time and the effect this has on health (McEwen, 1998; Robertson, Popham and Benzeval, 2014).

Early childhood is thought to constitute a 'critical period', laying the foundations for physiological, emotional, and intellectual development over the life-course (Sengpiel, 2007; Marmot, 2010). For example, early life stress – in this case emotional trauma, physical trauma, and low socio-economic position – has been associated with later life development of anxiety symptoms (Lähdepuro *et al.*, 2019). Elsewhere early life stress has been associated with a wide range of poor outcomes in later life such as heart disease, respiratory disease, alcohol and substance misuse, self-rated health, and inter-personal and self-directed violence (Hughes *et al.*, 2017). In turn, these outcomes may form possible sources of early life stress for the following generation. That is, health inequalities involve intergenerational processes (Cheng, Johnson and Goodman, 2016; McCartney, Bartley, *et al.*, 2019).

The implication of the life-course approach and the critical period would suggest that interventions targeted at early life, such as SBBS, can have life-long benefits for health and health inequalities that are greater than those precipitated by interventions targeted at later life.

2.2.4 Infant mortality

Infant mortality refers to death within the first year of life. This is typically presented as the infant mortality rate (IMR), which is defined as the number of deaths in the first year of life per 1000 live births per year. The logic model presented in the EA for SBBS emphasises reducing inequalities in infant mortality as a long-term outcome of the scheme ('L4'; see *Table 1*).

Infant mortality rates fell in Scotland between 2000 and 2018, from approximately 5.7 to 3.2 deaths in the first year of life per 1000 live births (Harpur *et al.*, 2021). However, stratifying this trend by socio-economic position indicates persistent inequalities across this period with IMRs rising among the most deprived groups in Scotland between 2016 and 2018. This may suggest that Scotland's socio-economic environment is 'beginning to disproportionately impact the most vulnerable' (ibid.). However, a longer follow-up period is necessary to establish whether this increase is simply due to normal annual fluctuations. IMRs also rose among the most socio-economically deprived groups in England between 2014 and 2017, with this explained by an increase in the number of early neonatal deaths among infants born at <24 weeks gestation (Taylor-Robinson *et al.*, 2019; Nath, Hardelid and Zylbersztejn, 2021). However, as Harpur et al. (2021) note, this is unlikely to be a sufficient explanation for Scottish trends as post-neonatal mortality (deaths aged 28 days to <1 year) also rose among the most deprived groups and infants born at <24 weeks gestation are unlikely to survive into this period.

The relationship between SBBS and infant mortality can be viewed more specifically in terms of sudden infant death syndrome (SIDS – otherwise known as 'cot death' or 'crib death'). SIDS can be defined as 'the sudden unexplained death of an infant <1 year of age, with onset of the fatal episode apparently occurring during sleep, that remains unexplained after a thorough investigation, including performance of a complete autopsy and review of the circumstances of death and the clinical history.' (Krous *et al.*, 2004) However, the broader term Sudden Unexplained Death in Infancy (or SUDI) has been favoured by some more recently to include deaths that are unascertained or explained as a result of an unsafe sleeping environment (e.g., accidental asphyxia) (Mitchell and Krous, 2015). The Office for National Statistics estimates that, for England and Wales in

2019, the annual rate was 0.16 deaths per 1000 live births for SIDS and 0.11 unascertained infant deaths (Office for National Statistics, 2021). There does not appear to be any publicly available up to date data for Scotland, however rates are likely comparable.

The connection between SBBS and SIDS is evident from the risk and protective factors listed under the third medium-term outcome in the logic model ('M3'; see *Table 1*) and those addressed by the health information leaflets provided to parents by SBBS. These include infant sleeping practices, infant exposure to tobacco smoke, and breastfeeding.

Sleeping practices such as the sleeping position of the infant (i.e., prone and side sleeping), co-sleeping in certain circumstances and aspects of the sleeping environment (e.g., soft bedding such as pillows, quilts, and comforters) are known risk factors of SIDS (Moon, Horne and Hauck, 2007; Bartick and Smith, 2014; Jullien, 2021).

A. M. Wood et al. (2012) investigated the relationship between socio-economic deprivation and the risk of SIDS in Scotland between 1985 and 2008. The rate of SIDS began to fall in the 1990s, although the onset of decline was earlier and the rate of decline was quicker in the least socio-economically deprived areas. The authors attribute this decline to the dissemination of information on infant sleeping position initially through reports of research findings in the print media in 1990 and subsequently through the 1991 Back to Sleep campaign, with parents in less deprived areas more likely to be exposed to the former. Rates of SIDS also began to fall in England and Wales prior to the onset of the Back to Sleep campaign, however others have questioned the extent to which limited coverage in the print media could precipitate such a change (Hilliard *et al.*, 2007). Back to Sleep campaigns have been linked to falling rates of SIDS elsewhere in Europe and in the USA (Wennergren *et al.*, 1997; Kiechl-Kohlendorfer, 2003; de Luca and Hinde, 2016).

Both antenatal and postpartum infant exposure to tobacco smoke is a significant risk factor for SIDS (Mitchell *et al.*, 1993; Zhang and Wang, 2013; Bednarczuk, Milner and Greenough, 2020). Antenatal exposure is possible as the placenta does not offer protection (Pugmire, Sweeting and Moore, 2017). The negative health consequences of infant tobacco smoke exposure are wide ranging and extend beyond SIDS. For example, antenatal exposure is associated with multiple obstetric complications and impaired pulmonary function following birth (Hoo *et al.*, 1999; Gray *et al.*, 2009; McEvoy and Spindel, 2017; Pereira *et al.*, 2017; De Queiroz Andrade *et al.*, 2020; Gould *et al.*, 2020). Postpartum exposure is associated with the development of asthma, respiratory infection, and the persistence of respiratory symptoms into young adult life (Stocks and Dezateux, 2003; Mitchell *et al.*, 2012; Pugmire, Sweeting and Moore, 2017; Vanker, Gie and Zar, 2017). Infant exposure to tobacco smoke exhibits clear socio-economic inequalities in the UK (Gray et al., 2009; Moore et al., 2012).

Breastfeeding is protective against SIDS, with exclusive breastfeeding conferring more protection than non-exclusive breastfeeding (Hauck *et al.*, 2011). Beyond SIDS, breastfeeding has been associated with a reduced risk of necrotising enterocolitis which has a high case-fatality rate (Victora *et al.*, 2016). Breastfeeding may also have long-term beneficial effects on blood cholesterol levels and obesity (Horta *et al.*, 2007). In mothers it has been associated with a reduced risk of breast and ovarian carcinoma, and may also play a role in mother-infant attachment (Chowdhury *et al.*, 2015; Linde *et al.*, 2020). However, while the World Health Organisation recommends exclusive breastfeeding for the first six months of life, the Infant Feeding Survey found that <1% of Scottish infants born in 2010 met this criterion (McAndrew *et al.*, 2012). Additionally, marked socio-economic inequalities in measures of breastfeeding have been observed across the UK and have persisted over time (Pearce *et al.*, 2012; Simpson *et al.*, 2019). Although recent data in Scotland suggests that such inequalities may be narrowing with proportional increases in breastfeeding highest among young and disadvantaged mothers (Fenton, Brunton and Clarke, 2021).

Rates of SIDS also differ by ethnicity, being lower among South Asian parents than White parents in the UK (Ball *et al.*, 2012). This is associated with differential exposure to risk and protective factors such as maternal smoking, breastfeeding, alcohol consumption, sofa-sharing, and solitary sleep (ibid.).

2.3 Baby boxes

This section provides a traditional review of the published literature relating to the concept of baby boxes. This literature covers the research conducted on SBBS so far by the Scottish Government (Section 2.3.1), as well as qualitative and quantitative research on relevant interventions (Section 2.3.3). While there are a range of interventions related to the concept of baby boxes that are either currently or have previously been in operation, few of these have undergone formal evaluation (either quantitative or qualitative). This was initially established through informal literature searches and subsequently it was decided that alternative review formats (e.g., scoping or systematic review) would not yield any additional insight. This narrative review was guided using key search terms (e.g., 'baby box', 'baby kit', and 'baby package') on Scopus and Google Scholar, as well as backward searching publications for relevant citations.

2.3.1 Qualitative research conducted by the Scottish Government

The Scottish Government has commissioned four pieces of research on SBBS thus far, in addition to the EA described in Section 1.4 (Scottish Government, 2017e, 2017d, 2017b; Bardsley *et al.*, 2021).

The first piece of research was conducted by Kantar TNS prior to the SBBS pilot mentioned in Section 1.2 (Scottish Government, 2017b). This research involved qualitative interviews with parents (n=23) of children less than one year old and an online survey of parents (n=226) who were either expecting a child or had a child under two years old. The majority (63%) of survey respondents held a positive view of SBBS as a concept, with some parents interviewed viewing the concept of SBBS as a symbolic commitment to 'egalitarianism' on behalf of the Scottish Government. Interviewed parents, who were shown a sample baby box, generally viewed the contents favourably. However, with respect to infant feeding, parents felt that the items and information leaflet were not inclusive of those who could not breastfeed. The latter was viewed as a duplication of information already received from healthcare practitioners (e.g., midwives). Only a small minority (14%) of survey respondents stated they would use the box as a sleeping device at night. The extent to which this research influenced the development of the pilot and full rollout of SBBS is not stated.

The second piece of research was conducted by Ipsos MORI Scotland and provides a qualitative evaluation of the SBBS pilot (Scottish Government, 2017e). Interviews were conducted with a sample of parents who received the pilot (n=34), healthcare practitioners involved in the pilot (n=11), and members of staff at the Scottish Government contractor providing the boxes (n=2). Interviewees held differing views on the proposed universality of SBBS, with some supporting it and others believing that a targeted scheme would be a better use of resources. Parents had a positive view of the SBBS pilot contents. Some health professionals raised concerns around 'overloading' parents with information and that information on breastfeeding specifically may add to the 'pressure' experienced by parents. Parents generally thought that baby boxes would only be used as a sleeping device when an alternative could not be afforded. Parents were also aware of the claim that the Finnish Baby Box had reduced SIDS. Some parents, particularly those from deprived areas, felt that financial saving associated with the box would make a big difference. It is stated that the Scottish Government made changes to SBBS informed in-part by this research, although does not give details on these changes (ibid.).

The third piece of research was conducted between the 6th and 18th of October 2017, less than a month after the introduction of SBBS (Scottish Government, 2017d). A 'Computer Aided Telephone Interview' survey was conducted with 204 participants who had received SBBS. It is stated that the sample was skewed towards more advantaged socio-economic groups. Satisfaction among parents was generally high, although only a minority had used (35%) or planned to use (27%) the box as a sleeping space for their infant. A majority of parents said the safe sleeping (83%) and breastfeeding (76%) information was useful. When information was not seen as useful, this was often because parents had received similar information already. This research was intended to inform re-procurement but did not recommend any changes to the contents of SBBS with the exception of some additional breastfeeding equipment.

The final piece of research was conducted by Ipsos MORI Scotland between the summer of 2019 and autumn of 2020, approximately two to three years after

SBBS introduction (Bardsley *et al.*, 2021). As stated in Section 1.4, this research corresponds with the first approach to evaluating SBBS suggested by the EA. This research involved a survey of 2,236 parents, a survey of 870 healthcare practitioners (i.e., health visitors, midwives, and family nurses), and in-depth interviews with 36 parents and 44 healthcare practitioners. A majority (81%) of parents surveyed reported that SBBS had resulted in financial savings on things they needed for their child. Only 26% reported that the scheme supported breastfeeding and only 21% reported that they had learned about breastfeeding as a result of the scheme (these figures were highest among parents aged 16-24 years at 45% and 38%, respectively). While the majority (84%) of surveyed parents indicated that the information of safe sleeping was useful, only 39% reported using SBBS as a sleeping space for their infant. 35% of parents surveyed reported that SBBS had encouraged them to talk more with healthcare practitioners and 45% of healthcare practitioners thought that SBBS was a useful tool in supporting conversations with parents.

2.3.2 Other qualitative research

Koivu et al. (2020) provide an analysis of different baby box programmes in operation around the world. The authors mapped 91 different baby box programmes in total and surveyed and interviewed representatives of 29 (described by the authors as 'interviewed programmes'); while SBBS was mapped, it is not clear if it was included as an interviewed programme as a list is not provided. The majority of interviewed programmes used a cardboard box and were intended for infant sleep. These programmes also aimed to promote safe sleep and minimise the risk of SIDS. Local circumstances played a role in determining the contents of programmes (e.g., programmes operating in Ghana, Haiti, and Mexico included mosquito nets). Other factors determining contents included programme aims, academic or governmental recommendations, and scientific evidence. Fifteen of the interviewed programmes included items related to breastfeeding (e.g., nursing cape, breast pump, and cushion). Some of the programmes included baby bottles, however the authors note that others purposively excluded baby bottles on the basis of evidence that suggests they may discourage breastfeeding; for example, neither the Finnish Baby Box nor SBBS include baby bottles. Programmes covered educational topics such as childcare, hygiene, breastfeeding, safe sleeping, pregnancy and delivery, HIV and malaria prevention and care, and available health services. Delivery of educational components included face-to-face interactions (e.g., talks, workshops, and mother-to-mother discussion groups). The majority of interviewed programmes included educational materials (e.g., leaflets, booklets, and videos). Some programmes integrated training, home visits, and personal counselling. Breastfeeding was a common educational topic among programmes operating in all income settings. Some programmes provided events, guidance, and mentoring to promote breastfeeding.

Other qualitative research on baby boxes has focussed on the perceptions and experiences of practitioners and parents (Ahlers-Schmidt *et al.*, 2017; Ball and Taylor, 2020). Ball & Taylor (2020) undertook a qualitative evaluation of baby boxes operating in England, involving interviews with practitioners and a survey of both practitioners and parents. They focused on commercial - health provider partnership schemes, with the health provider typically concerning an NHS body. While these share with SBBS a public health component in seeking to improve healthcare engagement, they differ in their intention to return profits for a commercial partner (e.g., through harvesting patient data). Practitioners involved in the implementation of these schemes often understood boxes as a means to addressing SIDS. Practitioners also had concerns over the safety of the boxes and the encouragement of parents to provide personal data for commercial use. Surveyed parents accepted boxes for use as a sleeping space, for their contents (with which the majority were satisfied), and for storage. However, there was a poor understanding among parents of the box providers with most assuming it was the NHS body rather than a commercial partner.

Ahlers-Schmidt et al. (2017) interviewed a small sample (n=28) of pregnant women in the USA to understand their perceptions of baby boxes as a concept. These women self-identified principally as White (43%), Black (36%), and Hispanic (18%), and were mostly publicly insured. The majority of interviewees had no prior knowledge of baby boxes. Of those who had heard of the boxes, the purported connection between boxes and SIDS or SUID was mentioned. Concerns around safety (e.g., low to the ground, ventilation, structural integrity) were common. Half of the interviewees stated they would not use the box as a sleeping space, although only one expressed an intention to co-sleep.

2.3.3 Quantitative research

There has been no quantitative research on the health impact of either SBBS or the Finnish Baby Box. Quantitative analysis of other baby boxes has focused on a range of outcomes (Van den Akker *et al.*, 2011; Wang *et al.*, 2016; Baddock *et al.*, 2017; Rossouw, Burger and Burger, 2017; Shapira *et al.*, 2017; Tipene-Leach *et al.*, 2018; Makins *et al.*, 2019; Benzies *et al.*, 2021).

Baby boxes formed part of an intervention aimed at improving perinatal mental health among first-time mothers in Alberta, Canada (Benzies *et al.*, 2021). This intervention provided a box as an engagement tool, alongside a mentoring and education programme. Similar to SBBS, the box included various 'essential' items and was intended for infant sleeping. Self-reported data from participating mothers showed a decrease in perinatal depression scores across the period of intervention (from 3rd trimester of pregnancy until 6 months postpartum). This decrease was seen to be sharper when compared to a sample of non-participating mothers from the same province over the same stages of birth. However, for an unknown reason, scores were noticeably higher at the start of the observation period (3rd trimester) among participating mothers. While SBBS shares a similar baby box, it does not share the broader mentoring component of this intervention. If the observed decrease in perinatal depression scores indicates an effect of the intervention, the causal role of each component in this effect is not clear.

An intervention trialled in Cape Town, South Africa, targeted at pregnant women who had not yet visited antenatal care, used a baby box (the 'Thula Baba Box') alongside monthly visits from community health workers (Rossouw, Burger and Burger, 2017). Receipt of the box was conditional on attending antenatal care at least four times, with the first attendance occurring four weeks after first interacting with the community health worker. Like SBBS, the box was explicitly modelled on the Finnish Baby Box and included various items for the child and mother (e.g., clothing, wash products, and information leaflets); unlike SBBS, however, it was not intended as an infant sleeping device. In comparison to an unexposed control group, antenatal care attendance was higher amongst those exposed to the intervention. Further, the exposed group were seen to attend antenatal care 1.35 months earlier than the unexposed group. There was no effect on the probability of delivering at a health facility.

In New Zealand, where the prevalence of neonatal mortality is three times higher among Māori than non-Māori, devices have been trialled as safe alternatives to bedsharing (Baddock *et al.*, 2017; Tipene-Leach *et al.*, 2018). One study conducted a randomised controlled trial (RCT) comparing a sleeping device developed in the Māori community (termed a Wahakura) that is intended to be used in the parental bed with a standard floor-standing bassinet (Baddock *et al.*, 2017). Study participants were mostly Māori women from deprived areas and were recruited during pregnancy. There were no meaningful differences in the internded outcomes (e.g., infant sleeping position) between Wahakura and bassinet groups. Exclusive breastfeeding was notably higher in the Wahakura group at six months after birth. The Wahakura is not strictly comparable with SBBS, however, as it is intended to be used in the parental bed (Blair *et al.*, 2018).

One observational study evaluated the impact of a 'baby package' on institutional deliveries in Northern Mozambique (Makins *et al.*, 2019). This package included cloth (*capulana*), soap, a plastic basin, and cloth nappies, and was given to mothers upon discharge following delivery. Despite a lack of promotional campaign, the number of institutional deliveries per total expected deliveries showed a marked increase following the intervention in the participating district. This increase was not observed in other non-participating districts. An earlier study of a similar post-delivery incentive that was implemented in Malawi found an increase in the number of institutional deliveries (Van den Akker *et al.*, 2011). However, as the analysis did not account for prior trends or utilise a control population, it is unclear whether this increase was related at all to the incentive. In another study, a cluster RCT was used to estimate the effect of a similar 'mama kit' on the proportion of pregnant women delivering at a health institution in rural Zambia (Wang *et al.*, 2016). These kits were given to mothers following delivery. Mothers in the treatment group had 1.63 (95% CI: 1.29 to 2.06) higher odds of delivering at a health institution than the control group, suggesting that the in-kind transfer was beneficial. While these baby packages are similar to the box and items provided by SBBS, institutional delivery is not explicitly given in the EA as an intended outcome of SBBS and home births in Scotland are rare.

2.3.4 Academic criticism

Academic criticimsm has focussed on baby boxes as an alternative to co-sleeping (including bedsharing). It has been suggested that framing bedsharing specifically as a risk factor of SIDS is inaccurate (Bartick and Smith, 2014). Observational evidence suggests that it poses no major risk when other known risk factors (e.g., sleeping on a sofa or parental alcohol use) are accounted for (Blair *et al.*, 2014). Bartick et al. (2018) raise the criticism that baby boxes extend from relatively recent western 'cultural innovations' of solitary infant sleep and bottle feeding with formula derived from cow's milk. They contrast this with 'breast-sleeping', which they describe as the evolutionary and cross-cultural norm for human beings. They argue that, through the promotion or further normalisation of these recent cultural innovations, baby boxes may actually undermine breastfeeding initiatives and exacerbate maternal-infant separation. Others have voiced similar concerns (Blair, Heron and Fleming, 2010). Elsewhere, concerns have been raised regarding the lack of data on baby boxes in comparison with other infant beds (e.g., traditional cots, Moses baskets, or bassinets) and possible safety issues (Blair *et al.*, 2018; Middlemiss *et al.*, 2019).

2.4 Interventions similar to Scotland's Baby Box Scheme

The previous section (Section 2.3) highlighted the limited evidence on interventions explictly related to the concept of baby boxes. Another way of understanding the possible health impact of SBBS is to review the evidence relating to each component of SBBS in isolation. As noted in Section 1.4, SBBS can be viewed as both a non-monetary transfer of resources as wells as an educational intervention. This section reviews the evidence relating to both non-monetary transfers (Section 2.4.1) and educational interventions (Section 2.4.3) in the early years. In addition to this, it focuses on monetary transfers (Section 2.4.2) as a form of intervention related to non-monetary transfers. In order to refine the sub-section relating to educational interventions (Section 2.4.3), emphasis is placed on interventions aimed at improving breastfeeding, infant sleeping position, and infant exposure to tobacco smoke. The rationale for this is that the health information associated with and provided by SBBS relates specifically to these outcomes and that these outcomes are most amenable to a public health evaluation. The approach taken in this section can be described as a traditional review. Evidence was acquired using a structured search on Scopus, an informal search using key terms on Google Scholar, and through backward searching articles for relevant citations. The search terms used for each section are presented in Appendix 1. This section would be amenable to more systematic approaches to reviewing the evidence (e.g., systematic reviews). However, as it contends with different forms of intervention (i.e., exposures) and their effects on different outcomes, this was beyond the scope of this thesis.

2.4.1 Non-monetary (in-kind) transfers

SBBS can be thought of as a non-monetary (or in-kind) transfer more broadly. However, with the exception of the other baby boxes or the interventions closely resembling baby boxes discussed in Section 2.3.3 above, examples of non-monetary transfers aimed at improving infant health are very limited (Kirby *et al.*, 2015; Shapira *et al.*, 2017). One experimental study found that a conditional transfer of gifts in Rwanda had a positive effect on both antenatal and postnatal service engagement (Shapira *et al.*, 2017). Gifts were valued up to 5 USD, however it is not stated what these gifts entailed. Measures of service engagement were also self-reported and so potentially unreliable. Another study from Papua New Guinea found that offering women gifts at the time of delivery was associated with an increase in supervised deliveries (Kirby *et al.*, 2015). This study does not establish whether this was an effect of the gifts transferred. As before, it is not clear what has been transferred. Despite being non-monetary transfers, neither of these examples benefit our understanding of how SBBS may impact infant health.

2.4.2 Monetary transfers

SBBS can also be viewed as a transfer of resources that has an equivalent and substantial monetary cost, potentially increasing the financial resources of parents. There are thus parallels with monetary transfers that seek to increase income. Although, in contrast with in-kind transfers, some have argued that monetary transfers provide more flexible benefits and do not carry the same logistical costs (Lagarde, Haines and Palmer, 2009). Monetary transfers can be either unconditional (unconditional cash transfers – or UCTs) like SBBS, or conditional (conditional cash transfers – or CCTs) through requiring some action on behalf of the recipient. In low- and middle-income settings, monetary transfers are often described explicitly in these terms. In high-income settings they are usually categorised in terms of 'social assistance', 'social security', or 'welfare' (Siddiqi, Rajaram and Miller, 2018). For example, the BSG-PBP and Sure Start Maternity Grant can be viewed as CCTs conditional on receipt of qualifying benefits. However, neither have been evaluated in relation to infant or maternal health.

Evaluations of UCTs impact on infant health have often concerned effects on birthweight (Currie and Cole, 1993; Forget, 2011; Brownell *et al.*, 2016; Chung, Ha and Kim, 2016; Leyland *et al.*, 2017). In a particularly relevant example, Leyland et al. (2017) used ITS analysis to evaluate the Health in Pregnancy Grant. Between 2009 and 2011, this Grant provided women in the UK reaching 25 weeks of pregnancy with £190 if they had sought health advice from a doctor or midwife; while this Grant was delivered in the prenatal period unlike SBBS, it is of a similar value to the equivalent monetary cost of SBBS (~£160). Neither the Grant's introduction nor its withdrawal were associated with any change in birthweight among the study population as a whole or among subgroups defined by socio-economic position. The authors also evaluated the impact of the Grant on secondary outcomes such as maternal smoking during pregnancy and booking before the 25th week of pregnancy. There were no associated changes for the former, while the odds of the latter increased following introduction and subsequently decreased following withdrawal. This may suggest that the Grant functioned to incentivise health-seeking behaviour, a finding of relevance to our understanding of SBBS.

In a further example, Brownell et al. (2016) evaluated the impact of the Healthy Baby Prenatal Benefit on outcomes such as low birthweight, Apgar score, breastfeeding initiation, and new-born hospital length of stay. This UCT was introduced in the Canadian province of Manitoba in 2001. It provides low-income mothers with a monthly income supplement (up to 81.41 Canadian dollars) as well as information pamphlets on prenatal nutrition and breastfeeding during the second and third trimesters (i.e., from the 13th week of pregnancy until birth). The authors used linked administrative data to compare recipients and non-recipients, who were matched on observed characteristics using propensity scores, between 2003 and 2010. This UCT was associated with a 6% (RR = 1.06, 95% CI: 1.03 to 1.09) increase in breastfeeding initiation, a 29% (RR = 0.71, 95% CI: 0.63 to 0.81) reduction in low birthweight, and a 24% (RR = 0.76, 95% CI: 0.69 to 0.84) reduction preterm birth.

CCTs are less similar to SBBS than UCTs as it is an unconditional scheme. While less common in high-income settings, there is evidence that CCTs can have beneficial effects on infant health (Siddiqi, Rajaram and Miller, 2018). One study evaluated the impact of changes in Earned Income Tax Credits on birthweight and maternal tobacco smoking in the USA (Strully, Rehkopf and Xuan, 2010). This CCT involved a tax refund given to low-income families conditional on employment, with a lager refund given to families with children. The authors performed an intention-to-treat analysis, restricting the study population to unmarried mothers with a high school qualification or less, on the assumption that this population would most likely be eligible for the tax credit. Using difference-in-difference methods, mothers in states where tax credits were enacted were compared with those where such credits were not. An associated increase in birth weight of 15.7g (SE: 1.21, 95% CI not given) was observed alongside a reduction in maternal smoking during pregnancy (OR = 0.949, SE: 0.006, 95% CI not given).

In another recent example of a CCT, Berlin et al. (2021) used an RCT to examine the effect of financial incentives on maternal smoking during pregnancy in France. Mothers in both arms of the trial received monthly face-to-face visits up until the expected delivery date (2-6 visits in total). Those in the intervention arm received vouchers conditional on abstinence on the day of visit and continuous abstinence between visits. That is, the potential value of vouchers received increased with the length of continuous abstinence (valued up to €520). The control arm received vouchers for participation only (valued up to €120). All participants received a ten-minute session on smoking cessation upon each visit which included motivational counselling, support, and relapse prevention. The authors observed a noticeably higher rate of continuous abstinence across visits (OR = 2.45, 95% CI: 1.34 to 4.49) and abstinence within the past seven days on day of visit (OR = 4.61, 95% CI: 1.41 to 15.01), although the confidence interval for the latter estimate was particularly wide. This suggests that maternal smoking is modifiable by conditional financial incentives. However, as SBBS is not a CCT, the extent to which the scheme may incentivise behaviour change around infant and maternal tobacco smoke exposure is unclear.

2.4.3 Education

2.4.3.1 Breastfeeding

Lumbiganon et al. (2016) conducted a systematic review and meta-analysis to examine the effectiveness of breastfeeding education delivered in the antenatal period on breastfeeding initiation and duration. The authors defined breastfeeding education simply as ‘information being imparted during pregnancy’. This information could be delivered to groups or individuals and through home visits, peer education programmes, clinical appointments, brochures and booklets, and electronic (including internet-based) education programmes. The majority of included studies (22 out of 24) were conducted in high-income settings. Primary outcome measures included duration of any breastfeeding, proportion of women any breastfeeding at three and six months, proportion of women exclusively breastfeeding at three and six months, and initiation of breastfeeding. The authors found no evidence that breastfeeding education improved any of these outcome measures when compared with standard care.

However, another meta-analysis of eleven trials published shortly after Lumbiganon et al. (2016) found that educational interventions were beneficial in promoting exclusive breastfeeding at six months postpartum (Oliveira *et al.*, 2017). A possible reason for divergent findings is that a majority of trials included by Oliveira et al. (2017) were from low- and middle-income settings (7 out of 11) and only two of these were also included by Lumbiganon et al. (2016). Comparing the inclusion criteria and outcome measures of interest, it is not immediately apparent why this would be the case.

A more recent systematic review of RCTs and quasi-experimental study designs examined the effect of educational interventions targeted at fathers and partners on perinatal breastfeeding (Abbass-Dick *et al.*, 2019). Findings of this review suggested that inclusion of fathers and partners can have a beneficial effect on breastfeeding. However, the included interventions were often dissimilar to SBBS involving what the authors describe as a psychological element (e.g., peer support and counselling). In addition to this, control arms of the included studies often received standard care which included breastfeeding education. Thus it is not clear what the role of education specifically is.

These findings, as they relate to high-income settings like Scotland, reinforce the argument that action to support and increase breastfeeding should focus on broader societal factors, rather than considering it as an issue to be addressed solely at the individual level (Brown, 2017). From this perspective, it would seem unlikely that the information relating to breastfeeding associated with SBBS alone would have any measurable public health benefit.

2.4.3.2 Infant sleeping practices

The apparent success of the Back to Sleep campaigns of the 1990s suggest that infant sleeping practices were responsive to educational efforts in the past (Wood *et al.*, 2012; Jullien, 2021). However, there are few examples of recent relevant interventions (Moon, Oden and Grady, 2004; Issler, Marostica and Giugliani, 2009; Moon *et al.*, 2017).

Issler et al. (2009) used an RCT to evaluate an educational intervention delivered to postpartum mothers in a region of Brazil on their day of discharge. The intervention arm received a one-to-one education session and were given educational materials on infant sleeping position, while both the intervention arm and the control arm received ‘routine orientation’ form healthcare practitioners throughout their hospital stay. The intervention was associated with an increase in the odds of parents placing their infant in the recommended (supine) sleeping position (OR = 2.22, 95% CI: 1.17 to 4.19).

In another example, Moon et al. (2004) used a controlled trial to evaluate an educational intervention targeting Black mothers in the USA on the basis that, at the time of the study, they were more likely to place their infant in the prone sleeping position. The intervention arm consisted of a group session led by a healthcare practitioner which focussed on sleeping position, bedsharing and co-sleeping, and tobacco smoke avoidance. The control arm received only standard care. At 6 months follow-up, the intervention was associated with increased supine sleeping (75% versus 45.1%) and reduced bedsharing (22.4% versus 33.6%). Outcomes relating to tobacco smoke exposure were not included. In a more recent RCT from Moon et al. (2017), an educational intervention involving repeated messaging and videos was observed to improve supine sleeping (risk difference = 8.9, 95% CI: 5.3 to 11.7).

Given that information relating to infant sleeping practices is communicated to parents under standard care in Scotland, it seems unlikely that SBBS would have an effect on the population level as a whole. However, Moon et al. (2004)'s findings would suggest that it may benefit groups for whom advice and information around infant sleeping practices are not always received (e.g., disadvantaged ethnic and socio-economic groups).

2.4.3.3 Infant and maternal tobacco smoke exposure

Naughton et al. (2008) provide a relevant systematic review and meta-analysis of RCTs and quasi-randomised controlled trials evaluating self-help smoking cessation interventions delivered during pregnancy. Self-help was defined as structured materials that assist individuals without the support of a healthcare practitioner or group (i.e., smoking cessation counselling was not included as self-help). Twelve of the fifteen included trials compared self-help interventions to standard care. The remaining three trials compared what the authors describe as differing intensities of self-help (e.g., a self-help booklet versus the booklet plus an interactive telephone service). Standard care often involved routine cessation advice and brief written materials on cessation with only one included trial reporting that the control arm received nothing. Self-help interventions were categorised as involving booklets, videos, and booklets in addition to other components (e.g., written letters of encouragement from healthcare practitioners). All included trials were conducted in high-income settings. The pooled estimate (OR = 1.83, 95% CI: 1.23 to 2.73) for a random effects meta-analysis indicated that self-help increased cessation among pregnant mothers when compared with standard care.

A more recent RCT examined the effect of self-help booklets on postpartum smoking relapse in the USA (Brandon *et al.*, 2012). Women were recruited to the trial during pregnancy. The control arm of the intervention received two booklets. One provided general advice on cessation, while the other described the health benefits of cessation during pregnancy. It is not explicitly stated, but it appears these were delivered to mothers upon enrolment to the control arm of the trial. The intervention arm received a total of nine booklets on smoking cessation and relapse prevention. The first four were delivered at intervals between enrolment and the mother's expected due date, and the remaining five were delivered at intervals up until eight months postpartum. A beneficial effect on the proportion of mothers abstinent at eight months follow-up was observed (OR = 1.27, 95% CI: 1.04 to 1.56), however this effect was not observed at twelve months follow up. A beneficial effect was also observed among low-income and young mothers at both eight and twelve months follow up.

One recent systematic review and meta-analysis examined the effect of eHealth interventions on substance use during pregnancy and found a beneficial effect (random-effects pooled OR = 1.33, 95% CI: 1.06 to 1.65) (Silang *et al.*, 2021). However, the relevance of included trials to SBBS is questionable. For example, one compared an interactive internet-based smoking cessation intervention with a website offering information on cessation alone (Herbec *et al.*, 2014). Thus the control arm of the trial was more similar to the information associated with SBBS than the intervention itself. Elsewhere, others have found that repeated self-help messaging via text message does not increase maternal smoking cessation during pregnancy (Coleman *et al.*, 2021).

Other studies have focussed on what are described as educational interventions aimed at reducing maternal smoking and infant exposure to tobacco smoke (Lumley *et al.*, 2009; Behbod *et al.*, 2018; Scheffers-Van Schayck *et al.*, 2021). In the case of Lumley et al. (2009), included trials are of little relevance to SBBS involving components such as counselling, cognitive behavioural therapy, and motivational interviewing. In a systematic review and meta-analysis of family and carer programmes aimed at reducing child exposure to tobacco smoke, Behbod et al. (2018) found that only a minority of included trials registered a beneficial effect. However, the quality of evidence was judged to be poor and it wasn't clear what demarcated successful interventions from unsuccessful ones.

2.5 Chapter summary

This chapter explored the literature around infant health, baby boxes, and other interventions similar to baby boxes. Considering the social determinants of infant health (Section 2.2.1), we saw how SBBS can be conceptualised as operating at different spheres of influence. From this we covered a recent definition of health inequalities and reviewed the main theoretical pathways mediating infant health inequalities (Section 2.2.2). SBBS may function through cultural-behavioural (e.g., education/health promotion), psychosocial (e.g., relieving financial stress of parents), and material pathways (e.g., through providing material resources with an equivalent monetary value). However, it is unlikely that SBBS would operate on a structural level, as it does not immediately concern more macro-level phenomena such as the labour market or the economy.

The life-course approach was then described, including the implications that early events and exposures have for health in later life (Section 2.2.3). From this perspective, public health interventions such as SBBS that are targeted at early life can have lifelong benefits for health and health inequalities that are greater than those targeted at later life. Section 2.2 finished with a discussion of infant mortality (Section 2.2.4) in relation to SBBS and other baby boxes internationally, with a particular emphasis on SIDS.

Reviewing the research literature commissioned by the Scottish Government on SBBS so far, we saw that the scheme and its contents were generally well received by both parents and healthcare practitioners (Section 2.3.1). However, parents highlighted that, while useful, the information provided often duplicated that provided elsewhere. Only a minority of parents used the box as a sleeping space, reported that it supported breastfeeding, and reported that it supported conversations with healthcare practitioners. This research suggests that SBBS' impact as an educational intervention or a tool for health promotion may be limited. Both qualitative (Section 2.3.2) and quantitative (Section 2.3.3) research on baby boxes more generally was found to be limited. While the former generally focussed on the perceptions of parents, the latter indicated possible benefits on maternal mental health and healthcare utilisation in low-income settings. This research does not offer much insight into the potential health impact of SBBS.

Following from this, evidence on the effectiveness of interventions similar to SBBS was reviewed (Section 2.4). Evidence relating to non-monetary transfers, other than those closely resembling baby boxes, was very limited and of little relevance to our understanding of SBBS (Section 2.4.1). Evidence on monetary transfers was more abundant, and suggested that such transfers can benefit infant health, health seeking behaviour, breastfeeding, and maternal tobacco smoke exposure (Section 2.4.2). That being said, the monetary transfer that is arguably most relevant to SBBS, Leyland *et al.*'s (2017) evaluation of the Health in Pregnancy Grant, showed a potential effect on booking before the 25th week of pregnancy but had no effect on any of the other health outcomes measured. Conditionality is also an important difference between SBBS and CCTs, thus comparisons may be of limited value.

Evidence surrounding educational interventions similar to SBBS was then reviewed (Section 2.4.3). This indicated that, in high-income settings at least, such interventions are unlikely to influence breastfeeding outcomes (Section 2.4.3.1) but may have the potential to improve infant sleeping practices in disadvantaged groups (Section 2.4.3.2). Further, educational interventions involving information booklets and face-to-face contact between parents and healthcare practitioners may increase maternal smoking cessation with implications for infant tobacco smoke exposure (Section 2.4.3.3). It is possible that SBBS could be beneficial in this regard, however the scheme does not alter the duration of face-to-face contact between parents and healthcare practitioners. It is also the case that, as highlighted by the Scottish Government research discussed in Section 2.3.1 above, parents may already be in possession of the health information provided by SBBS prior to receiving it.

In summary, while SBBS may theoretically benefit infant health and infant health inequalities, there is limited and inconclusive evidence on the health impact of similar interventions.

3 Political discourse analysis of Scotland’s Baby Box scheme

3.1 Chapter overview

In this chapter I provide an analysis of the political discourse surrounding the introduction of SBBS. This analysis is first motivated (Section 3.2), drawing from an approach to policy analysis that considers the possible negative implications extending from seemingly uncontentious policy developments. After outlining the aims and research questions of this analysis (Section 3.3), I outline the methodological approach taken (Section 3.4). The findings of this chapter are then presented (Section 3.5) and subsequently discussed (Section 3.7).

3.2 Background

As Bacchi & Goodwin (2016, p.74) highlight, one function of policy analysis is to allow for reflection on the “potentially deleterious implications of proposals that appear to be clearly beneficial and uncontentious”. For example, with respect to public health, Alexander & Coveney (2013) undertook a critical discourse analysis of both Canadian and Australian public health recommendations in relation to the childhood obesity ‘epidemic’. Among these recommendations they identified problematic representations of childhood obesity and the framing of children in a way that may engender stigmatisation. In another article, drawing on the example of HIV/AIDS among injecting drug users, Roe (2005) questions the extent to which harm reduction initiatives in public health can mediate a more humane society in the absence of an opposition to the social and economic determinants of harm.

As a universal and unconditional transfer of material resources, SBBS may similarly appear to be beneficial and uncontentious. Indeed, the research commissioned by the Scottish Government on SBBS thus far appears to suggest that neither parents who participated in the pilot nor those who received the scheme following its introduction viewed SBBS as being particularly contentious (Section 2.3.1). With the intention to dig a little deeper, the approach to policy analysis I use in this chapter rests on the ontological assumption that social phenomena are socially constructed and that they are socially constructed in discourse (Fairclough, 2005). Thus, through living and acting within their concepts of social reality, people contribute to its reproduction and transformation. However, as Fairclough (2005) notes, this is not to yield to the more extreme leanings of constructivism (e.g., solipsism).

Hastings (1998), with respect to policy analysis, identifies two implications extending from this ontological assumption. The first implication is that a process of construction and selection, contingent on societal processes (e.g., culture and history), defines policy issues. That is, policy issues are not happened upon or discovered by policy makers as pre-existing givens. As Bacchi & Goodwin (2016) phrase it, a policy issue is 'problematised' by policy makers whereby it is constructed and represented as a "problem". This notion, in questioning the nature of the policy "problem" itself, challenges the view that policy making is simply a task of problem-solving.

The second implication highlighted by Hastings (1998) is that the policy process can be viewed more generally as discursive and characterised by argumentation. This invites an exploration of how language is used to both advance and legitimise selective representations of social reality. N. Fairclough & I. Fairclough (2012) contend that political discourse is fundamentally characterised by practical reasoning, which is embodied in the linguistic structure of practical argumentation. Practical reasoning concerns questions of what should be done as opposed to, say, epistemic reasoning which concerns questions of what can be known. Further, arguments, and not only isolated representations, should be considered if we are to "understand how our beliefs feed into what we do" (N. Fairclough & I. Fairclough, 2012: 87). Thus, representations or problematisations of policy issues can be viewed within the broader discursive category of practical argumentation.

Before proceeding, it is worth situating this approach within the broader discipline of critical discourse analysis (or CDA) from which it emerged. Discourse can be defined simply as language-in-use (Gee, 2014). However, different approaches to the analysis of discourse often offer more nuanced interpretations (Hewitt, 2009). For example, linguistic approaches typically focus on the content of discourse in terms of units of written and spoken communication. Conversely, other approaches view discourse in relation to broader social or cultural processes (ibid.). The approach taken in this chapter draws upon both of these interpretations (N. Fairclough & I. Fairclough, 2012).

The concept of social power is central to CDA with one definition of this concept being 'privileged [group] access to socially valued resources' (van Dijk, 1993). These resources could include income, wealth, education, and status. The concept of social power also implies the control of both action and cognition, most obviously by one social group over others. CDA is principally concerned with the latter. That is, how power is enacted through persuasion and manipulation to alter the beliefs and perceptions of others in line with one's own interests. However, as van Dijk (1993) notes, the enaction and reproduction of social power through discourse is not always overt or direct. Rather, it can take the form of everyday speech or text which can appear on the surface to be normal and acceptable. Relatedly, CDA is also concerned with how discourse is used to legitimise or naturalise both social power and illegitimate relations of social power (e.g., socio-economic inequality). The term dominance is used to demarcate illegitimate from legitimate uses of power. Both power and dominance are often institutionalised and, through hierarchies of power, certain members of dominant groups can have disproportionate influence over decision-making, planning, and the maintenance of social relations. Thus CDA, and political discourse analysis by extension, can be understood as ultimately concerning the role of language in the reproduction of social power and dominance (ibid.).

3.3 Aim and research questions

In this chapter I aim to critically examine the political discourse that has been publicly expressed by key political actors in relation to SBBS.

Three research questions follow:

1. What practical argumentation was publicly expressed by key political actors in relation to SBBS?

2. How did this practical argumentation represent the policy issue?

3. What tensions are present between representations of the policy issue?

3.4 Methods

3.4.1 Texts

Key political actors are defined here as those affiliated to the Scottish National Party (SNP), who introduced SBBS as a minority Scottish Government in 2017, and the four opposition parties who had representatives elected in the 2016 quinquennial Scottish Parliamentary Election. These parties were: the Scottish Conservative & Unionist Party, the Scottish Green Party, the Scottish Labour Party, and the Scottish Liberal Democrats.

Texts were retrieved from the official websites of the Scottish Government and the Scottish Parliament Official Report, as well as the official websites of the SNP and the four opposition parties. Internal search engines were searched simply using the term *"baby box"*. If internal search engines were not present, Google was searched using the term *("[website address]" AND "baby box")*. Alternative terms to baby box were not used on the basis that it seemed very unlikely that SBBS would be referred to in any other way by political actors in Scotland.

All texts retrieved with search terms, and published before July 2020, were considered for analysis with the exception of those retrieved from the Scottish Parliament Official Report. The search engine for this particular source did not give an indication of the number of texts retrieved and was not precise (e.g., texts were retrieved from as early as 1999). For this reason, a start date of January 1st 2015 was applied. This date was seen as suitable as it precedes the first known public mention of baby boxes in the Scottish political context, during a Scottish Parliament Welfare Reform Committee meeting in June 2015 (The Scottish Parliament, 2015a).

Texts were excluded if SBBS was not mentioned or was mentioned only in passing, if the contents were administrative in nature (e.g., budgets and committee reports), or if the contents were a reproduction of an already included text. A total of 71 texts were included in the final analysis (these are listed in Appendix The publication dates of these texts ranged from the May 25th 2016, before the introduction of SBBS, to May 15th 2020. A summary of the number of texts retrieved, excluded, and analysed from each source is presented in *Table 2* below. While the lack of texts from opposition parties is noticeable, opposition voices were also present in texts retrieved from the Scottish Parliament Official Report (e.g., during parliamentary exchanges).

Source searched	Texts retrieved (n)	Texts excluded (n)	Texts used in analysis (n)
Scottish Government	63	39	24
Scottish Parliament Official Report	~2600*	~2587	13
Scottish National Party	87	56	31
Scottish Conservative & Unionist Party	4	3	1
Scottish Labour Party	0	0	0
Scottish Liberal Democrats	1	1	0
Scottish Green Party	4	2	2
Total	2759	2688	71

Table 2 Number of texts retrieved and analysed from each source for political discourse analysis of Scotland's Baby Box scheme.

* = approximate number determined using documents per page parameter in search engine (100 documents per page x 26 pages).

3.4.2 Analysis

Identification, coding, and reconstruction of the practical argumentation

All texts were coded using a theoretical framework derived from the premise-conclusion structure of practical argumentation proposed by N. Fairclough & Fairclough (2012) (see *Figure 2* below). Discourse of interest that could not be categorised within this framework was coded as nondescript.

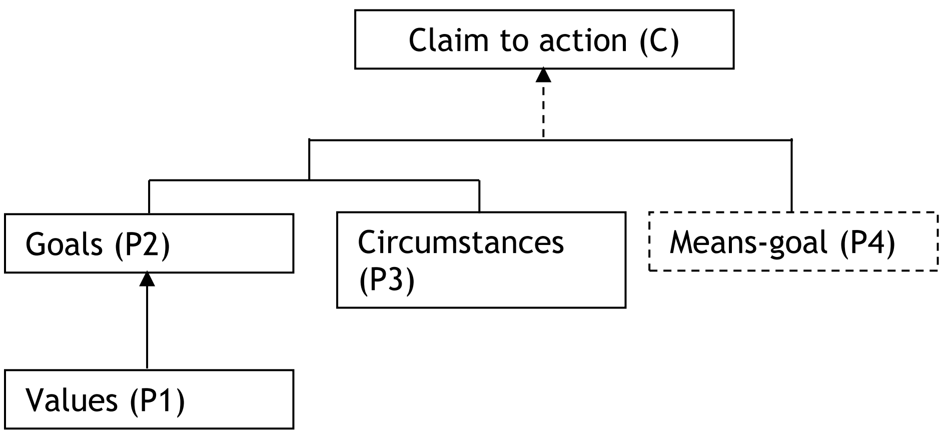

Figure 2 The basic structure of practical argumentation, showing a conclusion (C) with four supporting premises (P1-4).

Adaption of figure presented by N. Fairclough & I. Fairclough (2012, p. 45).

This coding framework had five elements which are now described in turn:

- The *claim to action* concerns the action that should be, or that already has been, undertaken. The action in the analysis presented here is the introduction of SBBS. This forms the conclusion that is supported by the following four premises.

- *Values* involve the actual concerns of a particular actor (i.e. the arguer), or the concerns the actor believes they should or ought to hold. For example, this may include actual wants, desires, and values in the former sense. Or, in the latter sense, may include a concern to act in accordance with obligations, duties, norms, and laws.
- *Goals* indicate a future possible state of affairs that often extends from, and is thus compatible with, an actor's values. It is a possible state of affairs where values, whether explicitly given or not, are realised or fulfilled, either partly or wholly. The values assumed by the actor will thus restrict and shape both goals and the claim to action. It is worth mentioning here that, as political discourse is used to both advance and legitimise selective representations of reality (see Section 3.2), there are likely to be discrepancies between the values and goals privately held by political actors and those they express publicly.
- *Circumstances* comprise social, institutional, and natural facts. The circumstances (or context) of action, as they are understood by the actor, limit the range of actions that are considered or undertaken. Further, the claim to action seeks to transform the context in which it is situated, in line with the actor's goals. It is conceivable that the values assumed by an actor will also determine, in part, the circumstances of action that are drawn upon in support of the argument.
- *Means-goal* is a 'conditional proposition' that functions as a minor premise in relation to the major goals premise (Fairclough and Fairclough, 2011).

It concludes that the action should be undertaken, or has been undertaken, as the action is the means to achieving the goals. The action may be framed as either necessary or sufficient in light of the goals. The action may also be framed as a beneficial or helpful contribution in light of the goals, but neither sufficient nor necessary.

- There is one further premise that Fairclough & Fairclough (2012) introduce that is worth mentioning here. The *negative consequences* premise may be the purported negative consequences of *not* undertaking the action. Alternatively, this premise may take the form of a counterargument, in highlighting purported negative consequences of undertaking the action. In this latter case, the counterargument would be highlighted by the actor only to be rejected or negated in order to bolster the argument supporting the action.

The practical arguments identified in the texts were entered into a matrix to facilitate further analysis. This matrix displayed text in cells corresponding to the codes (as columns) for each individual argument (as rows), where an individual argument corresponded to a particular actor on a particular occasion. Text in each cell was then inductively sub-coded to bring out more general themes. *Table 3* below provides an illustrative quote and subcode for each code in the matrix.

The matrix also allowed for visual re-analysis of initial coding on the basis of accuracy (i.e., if text was appropriately coded), consistency across cases (i.e., were codes similarly applied across texts), and consistency within cases (i.e., was there an internal logic between coded text within a single argument). With regards to the latter, it may be a sign of erroneous coding if for example the text coded under one code seems unrelated to text coded under another despite falling within the same argument. When prompted by re-analysis, texts were revisited, and coded text was revised. Following the coding phase of analysis, the overarching argumentation surrounding SBBS was reconstructed across texts to facilitate critical examination.

Error! Not a valid link. ***Table 3*** Coding framework and illustrative example of the practical argumentation relating to Scotland's Baby Box Scheme.

The illustrative example is from Aileen Campbell of the Scottish National Party, then Minister for Public Health and Sport, during a Meeting of the Scottish Parliament on June 16th 2016. Coded text is shown in quotation marks, with the sub-codes displayed in italics beneath.

Critical examination of the practical argumentation

Critical examination of the practical argumentation focused on how the policy issue was represented by political actors and, drawing from N. Fairclough & I. Fairclough (2012, p.64-65), was guided by the following questions:

a) Are representations of the policy issue (or premises) acceptable (or 'true')?

b) Does the action necessarily follow from these representations of the policy issue (or premises)?

c) What tensions are present between representations of the policy issue (or between premises)?

3.4.3 Reflexivity

Reflexivity can be described as a process of self-reflection and introspection, whereby the researcher is aware of their existence and subjectivity, and their relationship to and influence over the object of research (Popoveniuc, 2014). Unlike qualitative interviews or focus groups, where I might participate in the co-construction of data, I have no direct influence over the content of the data (texts) included in this analysis. Included texts were produced prior to any public awareness of the research presented in this thesis and, for the most part, prior to its commencement. However, I did have direct influence over the research approach in this chapter, into which my views and assumptions concerning being, knowledge, and value inevitably feed. Thus I would like to reflect here on my reasons for undertaking this research and my choice of methods.

My background is in the natural sciences (BSc Neurosciences). During this time I became interested in the social determinants of health and began to question the apparent primacy given to the natural sciences in explanations of human health. For example, the research I conducted during my BSc concerned mapping a neurological pathway that was hypothesised to play a role in opioid addiction and relapse. Long-term this research sought to understand whether this pathway was a possible target for pharmacological intervention. However, I felt a tension between this biomedical framing of the problem and my growing understanding of the social determinants of human health. That is, I came to see this research in part as 'silver bullet' thinking that ignored the wider causal mechanisms operating in the domain of the social. The continuation of this thought process was central to my choice of PhD. It has also led to an interest in social theory. Thus when a focus on the discourse surrounding SBBS was suggested by a supervisor as a possible avenue of enquiry, it was something I was immediately drawn to and viewed it as an opportunity to explore this interest.

The earlier work of the philosopher Ram Roy Bhaskar, in particular *A realist Theory of Science*, has had a notable influence on my worldview (Bhaskar, 2003). Bhaskar's elucidation of the 'epistemic fallacy' – the false equivalence of epistemology and ontology – was a useful tool of reconciliation between my biomedical training and my interests in social theory. That is, reality exists independently of our knowing (i.e., ontological realism) and, while we can develop an understanding of this reality, such knowledge is inevitably imperfect and contextually situated (i.e., epistemic relativism). However, the social world can be demarcated from the natural world in that the former is socially constructed. Additionally, while knowledge is imperfect and contextually situated, this does not imply that all representations of the world are equally valid (there is scope here for what Bhaskar termed a 'judgmental rationality'). This worldview aligns with the form of political discourse analysis espoused by N. Fairclough & I. Fairclough (2012) and CDA more broadly. That being said, the choice of methods was in part simply due to the prominence and accessibility of N. Fairclough & I. Fairclough's (2012) contribution to the field of political discourse analysis.

Finally, given that this chapter concerns political discourse, it is worth reflecting on my own political views and how they may influence the research presented in this chapter. Generally speaking, my political interests do not lie in the realm of parliamentary politics. That being said, I would most readily align myself with the Scottish Green Party and oppose myself to the Scottish Conservative & Unionist Party during an election. It is also the case that, on principle, I support the idea of Scottish independence. I have tried to be conscious of any biases that may arise from these views, especially as the analysis presented in this chapter includes texts emanating from individuals belonging to these political parties and that have differing views on the idea of Scottish independence.

3.5 Findings

3.5.1 Summary of argumentation

3.5.1.1 Values

The most frequently expressed values were those of fairness and equality. For example, an anonymous publication on the SNP website from May 25th 2016 (Scottish National Party, 2016a) states:

> **"This simple but powerful idea [SBBS] symbolises the fair and equal start that we want for all children."**

Indeed, during a Meeting of the Scottish Parliament on June 16th 2016, the values of fairness and equality were expressed by Aileen Campbell[1] as being the "hallmark" of the SNP Government's approach to social and economic policy more broadly (The Scottish Parliament, 2016b).

It is interesting to note that the symbolic dimension of SBBS is explicitly remarked upon, with the scheme represented as symbolising the values of fairness and equality. The representation of SBBS as a symbolic gesture – as symbolising values – was common across texts. This is again demonstrated by the following quotation from Nicola Sturgeon[2], spoken during the 2017 SNP party conference on October 8th (Scottish National Party, 2017d):

> **"The baby box really is a beautiful thing. Not just for all the practical help it provides or even the contact it promotes between pregnant mothers and midwives. It is beautiful because of what it says. All children are born equal. All children are valued. All children deserve the same start in life."**

[1] Then Minister for Public Health and Sport (SNP)

[2] Then First Minister (SNP)

On another occasion, in a speech made to the Chinese People's Association for Friendship with Foreign Countries on April 10th 2018, Sturgeon highlights that "these boxes [SBBS] also have a symbolic value" (Scottish Government, 2018d).

The above quotes also contextualise these values in relation to the start of life. As SBBS is targeted at mothers and new-borns, this positioning of course makes sense. However, it may also point to a more nuanced interpretation of the value expressed as being that of equality of opportunity. Equality of opportunity may be characterised as a value that is "opposed to caste hierarchy but not hierarchy per se", where competition on equal terms assigns individuals to their place within the social hierarchy (Stanford Encyclopedia of Philosophy, 2015). A further example, from a 2017 publication on the SNP website, expresses that children "regardless of their circumstances, should have the best start in life" (Scottish National Party, 2017e). Or, as put by Mhairi Black[3] in an article originally published in Daily Record and reproduced on the SNP website on August 21st 2017, "the SNP are taking a wide range of actions [including SBBS] […] so that everyone has an equal chance" (Scottish National Party, 2017a).

The value of equality of opportunity is explicitly given in relation to SBBS by John Swinney[4] in a publication on the SNP website from February 1st 2018 (Scottish National Party, 2018b):

> **"We will not tolerate a situation where the life chances of our young people are determined by where they're born, or what their background is. […] The Baby Box [SBBS] is perhaps the best physical demonstration of the equality of opportunity that we are determined to afford to every child."**

This nicely demonstrates the confluence between having the best start in life "regardless of circumstances" and the value of equality of opportunity. Again the symbolic side of the scheme is alluded to, being described as a "physical demonstration" of the value of equality of opportunity.

Related values given in relation to SBBS, though not so often expressed, included an opposition to child poverty, universalism, and inclusivity. Some texts

[3] Mhairi Black, then MP for Paisley and Renfrewshire South (SNP)

[4] Then Deputy First Minister (SNP)

emphasised the value of parenting, with Nicola Sturgeon stating that being a parent "is the most important but also the most difficult job" in a publication on the Scottish Government website from New Year's Day 2017 (Scottish Government, 2017c). Finally, it could be said that the discourse references the value of *internationalism*. For example, during a Meeting of the Scottish Parliament on September 14th 2016, Ivan McKee[5] praised the Scottish Government for "looking beyond our borders for ideas that can work in Scotland" highlighting that the Finnish Maternity package was the inspiration behind SBBS (The Scottish Parliament, 2016a).

3.5.1.2 Goals

As defined prior in *Table 3*, the goal premise is a future state of affairs in which values are realised or fulfilled, either partly or wholly. Goals can thus implicitly hold values that are not otherwise expressed, or indeed may be an explicit extension of stated values.

A clear example of this explicit extension of values is the aforementioned quote from John Swinney on February 1st 2018 (Scottish National Party, 2018b). Here, the goal of affording every child equality of opportunity extends from the value of equality of opportunity. Equality of opportunity as a goal was also connoted by Nicola Sturgeon during a speech made to the Scottish Parliament on May 25th 2016, where SBBS was described as an attempt to "level the playing field" in the first days of life (Scottish Government, 2016). Further, in an already quoted anonymous publication on the SNP website from May 25th 2016, SBBS was given as an example of an action made by the Scottish Government towards the goal of "delivering opportunity for all" (Scottish National Party, 2016a).

Other more explicit extensions of values include the goal of universal benefit (related to the value of universalism) or the goal of closing the poverty gap/eradicating child poverty (related to values of an opposition to child poverty and of equality).

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[5] Then MSP for Glasgow Provan (SNP)

The goals of tackling deprivation, improving health, and supporting parents were often expressed as a triad. Related to the goal of improving health, the further goal of reducing health inequalities was expressed by Nicola Sturgeon during a Meeting of the Scottish Parliament on June 22nd 2017 (The Scottish Parliament, 2017c). During this meeting, Sturgeon also suggested that one mechanism by which this goal will be achieved is through SBBS "encouraging women who do not register for antenatal services to do so". This is interesting to note as promoting engagement with antenatal services has been one of the suggested mechanisms by which the Finnish Baby Box could have hypothetically improved infant and maternal health, if at all (Koskenvuo, 2017).

3.5.1.3 Circumstances

A frequent circumstantial claim was that the Finnish Baby Box contributed to a fall in the Finnish infant mortality rate (this claim will be empirically tested in the next chapter). This was plainly stated by Ivan McKee[6] during a Meeting of the Scottish Parliament on September 14th 2016 (The Scottish Parliament, 2016a):

> **"The scheme [Finnish Baby Box] in Finland has contributed to a fall in infant mortality from 10 per cent to 0.2 per cent, which is one of the lowest rates in the world."**

Indeed, in an article originally published in the Sunday Post on September 24th 2017, and subsequently republished on the SNP website, Nicola Sturgeon[7] claimed that the Finnish Baby Box had a "proven record" of decreasing infant mortality (Scottish National Party, 2017f).

While there is no immediate connection between this circumstantial premise and any of the stated goals – decreasing Scottish infant mortality was not offered as a goal in relation to SBBS – it does offer implicit support to the goals of reducing inequality and tackling deprivation, as infant mortality rates are an indicator of both child poverty and (health) inequality in high-income settings (Arntzen and Andersen, 2004; Taylor-Robinson *et al.*, 2019).

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[6] Then MSP for Glasgow Provan (SNP)

[7] Then First Minister (SNP)

In an already cited speech made to the Scottish Parliament on May 25th 2016, Nicola Sturgeon[8] added the claim that the Finnish Baby Box also improved child health "partly because it encourages early contact between new mothers and health visitors." (Scottish National Party, 2016a). This lends further support to the goal of reducing health inequality. On another occasion, Liam Furby[9] claimed that the Finnish Baby Box has "a proven record in tackling deprivation, improving health and supporting parents" directly mirroring the triad of goals expressed in relation to SBBS elsewhere (Scottish National Party, 2018a).

The importance of the early years – what we may understand as a life-course perspective – was a prominent circumstantial premise. For example, in an already cited publication on the SNP website from August 21st 2017 (Scottish National Party, 2017a), Mhairi Black[10] stated that:

> **"All the evidence shows that the first few years of a child's life are crucial for their development and life chances."** – Mhairi Black

Subsequently, it is implied, intervening at this stage in life is thus crucial. In an article originally published in the Evening Times, and republished on the SNP website on January 10th 2017, Nicola Sturgeon points out that it is known "that inequality has its roots early in life and we must do more - much more - to tackle it at source." (Scottish National Party, 2017c) Elsewhere, during a meeting of the Scottish Parliament on June 16th 2016, Aileen Campbell[11] described the early years as providing a chance to "mould and shape a landscape of opportunity" for children where the "benefits can last a lifetime" (The Scottish Parliament, 2016b). Again, this phrasing pointing to the value of equality of opportunity.

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[8] Then First Minister (SNP)

[9] Then party spokesperson (SNP)

[10] Then MP for Paisley and Renfrewshire South (SNP)

[11] Then Minister for Public Health and Sport (SNP)

A final circumstantial premise concerns the presence of child poverty in Scotland. Liam Furby[12], in a publication on the SNP website from March 30th 2018 (Scottish National Party, 2018a), provides the following quote:

> **"It is projected that by 2030, 1 in 3 children in Scotland will be living in poverty as a result of Tory welfare cuts. That is not acceptable in 21st century Scotland."**

This circumstantial premise lends its support to values such as an opposition to child poverty and to goals such as tackling deprivation. This quote also externally situates responsibility for this situation, pointing a finger at the austerity measures ('cuts') undertaken by the Conservative & Unionist Party who at the time formed the Government of the United Kingdom.

In another example, during a meeting of the Scottish Parliament on the 2nd of June 2016 (The Scottish Parliament, 2016c), Christina McKelvie[13] states:

> **"Most heartbreaking of all, it [the food bank in question] has now started a baby bank - can members imagine not being able to supply even the basic essentials for everyday life to provide for a newborn baby with dignity? The baby box [SBBS], which I have spoken about before in the chamber, is a very welcome measure indeed."**

Again, responsibility in this circumstantial premise is similarly attributed to the "[…] benefit delays, mix-ups with lost files and sanctions – but mainly vicious Tory cuts to in-work benefits." (ibid.).

3.5.1.4 Negative consequences

The use of the negative consequence premise was essentially absent from the practical argumentation surrounding SBBS. Given the use of this premise to fortify arguments by addressing hypothetical or real counterarguments, the absence may be indicative of a perception amongst advocates of SBBS that the scheme is fairly innocuous and thus counterarguments were not anticipated.

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[12] Party spokesperson (SNP), SNP website, 30th March 2018.

[13] Then MSP for Hamilton, Larkhall, and Stenhouse (SNP), Meeting of the Scottish Parliament, 2nd June 2016.

Indeed, opposition voices were often tentatively supportive. For example, during a Meeting of the Scottish Parliament on January 18th 2017, Jackson Carlaw[14] believed SBBS was a “commendable idea” but added that “there should be no nascent SNP propaganda by saying that it is ‘A Gift from the Scottish Government’” (The Scottish Parliament, 2017a). Elsewhere, Alison Johnstone[15], in a publication on the Scottish Green Party website from April 18th 2016, also gave support to the idea of SBBS but added caution against the role of commercial interests in its delivery (Scottish Green Party, 2016). This point was not addressed in the broader argumentation by actors in support of SBBS.

That being said, counterarguments were expressed by opposition actors. One example, which received media coverage at the time, related to the safety of the box itself. In an exchange, during a Meeting of the Scottish Parliament on May 3rd 2018, Miles Briggs[16] claimed authoritatively that (The Scottish Parliament, 2018a):

> **“One of the world’s leading experts on cot deaths […] had raised significant safety concerns about the Government’s baby box scheme [SBBS]. […] Will she [Nicola Sturgeon, then First Minister of Scotland] confirm whether they have been accredited in full by the British Standards Institution?”**

Nicola Sturgeon[17] responded in turn to this counterargument, stating that “[safety accreditation] was done months ago. I do not believe that Miles Briggs does not know that. Therefore, the question is: why is he trying to wilfully mislead people about that?”.

In another meeting of the Scottish Parliament, this time on January 18th 2017, Monica Lennon[18] expressed support for SBBS while raising a concern over the scheme in relation to low breastfeeding rates among deprived communities, asking whether the SBBS pilot would take this into account (The Scottish

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[14] Then MSP for Eastwood (Conservative), Meeting of the Scottish Parliament, 18th January 2017.

[15] Then MSP candidate for Lothian (Greens)

[16] Then MSP for Lothian (Conservative)

[17] Then First Minister (SNP)

[18] Then MSP for Central Scotland (Labour)

Parliament, 2017a). While receptive of this concern, Aileen Campbell[19] replied that, owing to time constraints, "perhaps the detail [of the response] would be best dealt with outside the chamber."

During a meeting of the Scottish Parliament on April 19th 2017, Liam Kerr[20] described the scheme as "overbudget" and claimed that research had shown that "people neither want, respect or even use" it (The Scottish Parliament, 2017b).

A publication on the SNP website from August 13th 2017 gives perhaps the only clear example where a negative consequence premise is drawn upon in support of SBBS in order to bolster the argument (Scottish National Party, 2017b):

> **"Providing a box only to those on lower incomes would brand our babies with the stigma of poverty from their earliest days. [...] So our Baby Box is universal."**

Here the counterargument that SBBS should be a targeted as opposed to a universal scheme is anticipated and subsequently negated through the claim that this would encourage the negative consequence of stigma.

3.5.1.5 Means-Goal

Most prominently, SBBS was represented as a constituent means – as part of a range of actions – towards realising certain goals. For example, a previously cited anonymous publication on the SNP website from August 13th 2017, presented SBBS as "one part of a number of actions […] to support new and expectant parents and their children." (Scottish National Party, 2017b).

In another example, from a Meeting of the Scottish Parliament on March 21st 2018, Angela Constance[21] gave SBBS as an example of one of a "wide range of actions" the Scottish Government is taking to support those on low incomes and to tackle inequality (The Scottish Parliament, 2018b).

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[19] Then Minister for Public Health & Sport (SNP)

[20] Then MSP for Northeast Scotland (Conservative), Meeting of the Scottish Parliament, 19th April 2017.

[21] Then Cabinet Secretary for Communities, Social Security and Equalities (SNP)

One thing to note with respect to the means-goal premise is the professed symbolic dimension of SBBS. That is, rather than being the means by which certain values and goals are realised, SBBS was expressed explicitly on occasions as being the means by which certain values and goals are symbolised.

Some opposition actors questioned whether SBBS was the means to addressing certain problems. During the Meeting of the Scottish Parliament on June 16th 2016, Alex-Cole Hamilton[22] stated that "[SBBS and] similar ideas are fantastic initiatives" while adding that they are a "window dressing against the deeper challenges that our society faces" (The Scottish Parliament, 2016b). Echoing this, in a publication on the Scottish Green Party website from March 31st 2017, Alison Johnstone[23] declares that "[SBBS] is welcome, but we need to keep in mind that many new families need much more than a baby box to give their new-born the best start in life." (Scottish Green Party, 2017).

3.5.2 Reconstruction of argumentation

Drawing from the argumentation summarised in Section 3.5.1, the overarching practical argumentation that has been expressed by key political actors in relation to SBBS can now be reconstructed. Doing so attempts to give a clear outline of the contents of, and relations between, the premises. This, in turn, invites the more in-depth examination and critical questioning of the argumentation that follows in Section 3.5.3. The reconstructed argumentation is presented in *Table 4* below.

Action & premises	Description
Action	Introduction of Scotland's Baby Box scheme (SBBS).
Values	A fair and equal start in life, regardless of circumstances; equality of opportunity. Universalism, inclusivity, internationalism, and an opposition to child poverty. A recognition that parenting is an important and difficult job.

[22] Then MSP for Edinburgh Western (Liberal Democrats)

[23] Then MSP for Lothian (SGP)

Goals	SBBS seeks to deliver the best start in life, with equality of opportunity for all and a levelling of the playing field in the early years. The scheme seeks to provide universal benefit and help close the poverty gap. It will directly aim to tackle deprivation, support parents, and improve health/reduce health inequalities; in relation to the latter, SBBS aims to improved registration for antenatal services.
Circumstances	The Finnish Baby Box has a proven record of improving infant health and reducing infant mortality rates. Evidence shows how crucial the early years are to an infant's development; it is a chance to mould the landscape of opportunity in a way that may benefit infants across the life-course. Thus action towards improving this stage of life is important (implied). Despite this, by 2030 1 in 3 children will be living in child poverty in Scotland. This is a result of the austerity measures taken by the Conservative led UK Government. *In opposition* SBBS is overbudget and research has shown it is neither wanted nor used.
Negative Consequences	SBBS is a universal policy as a targeted approach would engender stigma. *In opposition* Concerns over safety and the use of the scheme as 'propaganda' or self-promotion on the part of the Scottish Government. In response to the former, advocates of SBBS claim that safety accreditation of the scheme has been conducted.

Means-Goal	SBBS is a constituent means – forming part of a range of actions – towards achieving the goals tackling (health) inequality, supporting parents, and giving infants the best start in life. SBBS is the means by which goals and values such as equality of opportunity are symbolised; it is the means by which a commitment to these goals and values is demonstrated. *In opposition* SBBS is not sufficient to addressing the deeper challenges in society; some children will require a lot more than SBBS to have the best start in life.

Table 4 Reconstruction across cases of the practical argumentation surrounding the introduction of Scotland's Baby Box scheme.

3.5.3 Critical examination of argumentation

3.5.3.1 Symbolic versus instrumental policy

Symbolic policy making has been conceptualised in a number of ways (Slaven and Boswell, 2019). Generally, it rests on a distinction between political interventions which are instrumental and those which are expressive. While the former intends to bring about tangible change within a population, for example, the latter intends to signal to a population a commitment to certain values and goals. This is not to say, however, that symbolic political interventions do not have 'substantive effects' (ibid.). Indeed, it is assumed here that discourse – which is inherently symbolic – is causally implicated in social reality.

The political discourse surrounding SBBS is interesting in that the expressive or symbolic nature of the scheme is explicitly referred to. On different occasions the scheme was posited as symbolising the "fair and equal start" that the Scottish Government wished for all children, as being a "physical demonstration" of equality of opportunity, and as being "beautiful for what it says". SBBS may be noted for its potency in this regard. For example, there are powerful connotations extending from the universal nature of the scheme (e.g., equality and togetherness) and the fact it targets mothers and infants (e.g., care and nurture). Even the contents can be viewed in this light with some connoting nationalism and national identity (e.g., the inclusion of a poem in the Scots language) and others signalling a commitment to environmentalism (e.g., inclusion of a voucher for reusable nappies). That is, akin to its physical form, SBBS serves as a metaphysical 'box' in which various symbols and discourses are contained and thus delivered to the recipient population.

It can be questioned whether there is a tension present between the explicit symbolic representation of SBBS and its representation as an instrumental scheme aiming to reduced health inequalities and tackle deprivation. Following a more cynical line, it could be asked whether the symbolic representation of the scheme is intended to compensate for a lack of more tangible or direct action towards realising values and goals. As others have argued, there is a risk that baby boxes such as SBBS fetishize the original Finnish Baby Box, extracting it from its specific socio-historical origins, placing the symbolic (e.g., as a desirable commodity) over the instrumental (e.g., as a health intervention) (Watson and Reid, 2021).

3.5.3.2 Equality of opportunity as meritocracy

> **"My dream for Britain is that opportunity is not an accident of birth, but a birthright."** – Then Prime Minister David Cameron, Conservative Party Spring Forum, March 2013 (as quoted by Littler (2013))

In discussing the image of an 'Aspiration Nation', drawing upon a 2013 speech by the then UK Prime Minister David Cameron, Littler (2013) describes the "language of meritocracy" as the notion that "all people, no matter where they are from, have the opportunity to climb the ladder of social mobility". From the practical argumentation examined in this chapter, it can be seen that this notion closely resembles the representation of SBBS as embodying the value of equality of opportunity.

As Littler (2013) highlights, a meritocratic conception of social and economic life has become somewhat normalised today as "wholly beneficial". Indeed, belief in meritocracy – a term popularised by Michael Young's 1958 publication of *The Rise of Meritocracy* – has become increasingly common among working and lower-middle class adults in the UK over the last four decades (Mijs and Savage, 2020). There are, however, a number of problematic implications and assumptions underlying this. Namely social and economic life are conceived of as being both competitive and linear. This can be seen in the political discourse surrounding SBBS, where competitive sports are metaphorically alluded to with the stated goal to “level the playing field in the very first days of […] life”.

While the meritocratic conception holds that personal development arises through merit as opposed to wealth or birthright, it nonetheless maintains a commitment to socio-economic hierarchy. Meritocracy can thus function as a myth which both conceals and upholds social and economic inequalities. Indeed, drawing on both theoretical and empirical support, Mijs (2021) argues that meritocratic beliefs function to establish consent for inequality among citizens.

This is not unique to the Scottish Government, however. To draw a parallel, the UK Government’s recent Early Years Healthy Development Review Report, titled the ‘Best Start for Life’, states:

> **“Every baby should be given the opportunity to thrive and achieve their full potential, regardless of their background.”** – UK Government (2021)

In addition to this similar representation of equality of opportunity, this report also places an emphasis on ‘universal offers’ and discusses the narrowing of inequalities.

It can be argued that these problematic implications, imbued in representations of SBBS, are in tension with other representations of the scheme such as the goal to “close the poverty gap” or values such as equality and inclusivity. Indeed, given the relationship between socio-economic inequality and health inequalities, there is also a tension with the goal of reducing health inequalities.

3.5.3.3 Scotland’s Baby Box scheme as a public health intervention

One overarching representation of SBBS, which could be seen as the more ‘instrumental’ conception of the scheme, was that of a public health intervention. For example, expressed goals included reducing health inequalities and talking deprivation, the value of universalism and the embodiment of this value in the universal nature of the scheme, and the importance placed on the early years with a recognition of the implications of this period across the life-course (i.e., as a critical period). Interestingly, these representations align closely with recommendations voiced by public health advocates such as Michael Marmot in the 2010 Marmot Review (Marmot, 2010). Indeed, the first policy objective extended by this review concerns giving ‘every child the best start in life’ (ibid.).

Thus, on the surface, the fact that the political discourse surrounding the introduction of SBBS draws on such representations could be seen as an example of successful knowledge transfer and exchange in public health. However, a more critical stance might question the extent to which this is simply a form of discursive mimicry or the adoption of research ideas (as opposed to research evidence) (Smith, 2007).

For example, public health advocates have argued for a proportionate universalism, whereby the scale and intensity of an intervention or policy differs according to need (Marmot, 2010; Dodds, 2016). The intention behind such an approach would be to address inequality and to avoid stigma, the latter being alluded to in the political discourse examined above. However, it can be noted that, despite representations of SBBS as engendering universal benefit, the universalism of SBBS is not intended to be proportionate. Consequently, there is perhaps a minor tension here with the goal of reducing health inequalities in that this goal may have been better served through a proportionate rather than a blanket approach to universalism. That being said, it is plausible that SBBS could unintentionally operate in a proportionate way if uptake was greater among more socio-economically deprived groups. However, as is highlighted later in Section 5.3.1, this was not the case.

Another indication of the limited role of research evidence relates to the circumstantial claim that the Finnish Baby Box has a ‘proven record’ of reducing infant mortality. Despite the confidence behind this claim, representatives of Finnish authorities have stressed that the relationship between the Finnish Baby Box and infant mortality has not been, and may not be possible to be, established (Hakulinen and Gissler, 2017; Koskenvuo, 2017). Relatedly, it was claimed that the Finnish Baby Box reduced infant mortality and improved health, in part, because “it encourages early contact between new mothers and health visitors."[24] However, the direct role health visitors play in preventing infant mortality in contemporary Scotland has not been established.

3.6 Implications for thesis

Through critically examining the practical argumentation surrounding the introduction of SBBS, this chapter has provided a number of findings that are of relevance to the wider direction of this thesis.

First, SBBS was commonly represented in the practical argumentation as symbolising and connoting certain goals and values. Critical examination of this representation questioned the extent to which there was a tension between this symbolic representation and the more instrumental representations of the scheme. However, it is conceivable that the scheme's symbolic function could have a beneficial and measurable impact on public health. For example, it could function to influence the behaviour of parents or healthcare practitioners.

Second, I explored the relationship between the value of equality of opportunity and a meritocratic conception of social and economic life. I highlighted how such a conception can function to build consent for or 'naturalise' socio-economic inequality. From this I argued that the value of equality of opportunity may actually exhibit a tension with the goal of reducing health inequalities. However, recognising this tension does not imply that SBBS is directly in conflict with efforts to reduce health inequalities. For example, as a universal transfer of material resources, it is more plausible that the SBBS could have an immediate beneficial impact on health inequalities. That being said, given the blanket as opposed to proportionate universalism adopted by SBBS, it plausible that the scheme could have a horizontal impact on inequalities but it is unlikely that it would have any vertical function (i.e., it may reduce differences in the distribution of resources between groups but is unlikely to redistribute resources that have been accumulated by certain groups) (Shipton *et al.*, 2021).

Third, the claimed impact of the Finnish Baby Box on infant mortality was a prominent representation of the circumstances supporting the introduction of

[24] Then First Minister (SNP), speech made to the Scottish Parliament, 25th May 2016.

SBBS. Beyond the analysis presented in this chapter, we can see the importance of this representation in the EA logic-model discussed in 1.4. This logic model featured the long-term policy outcome of reducing inequalities in infant mortality. It also featured the medium-term policy outcome of increasing positive and reducing risk health behaviours, which included several factors implicated in infant mortality (e.g., sleeping position, breastfeeding, and tobacco smoke exposure). However, doubt over the truthfulness of this claim brings the plausibility of these policy outcomes into question.

3.7 Chapter summary

In this chapter I critically examined the political discourse that had been publicly expressed by key political actors in relation to SBBS. Focussing on the practical argumentation, I described the goals, values, and circumstances drawn upon both in support and in opposition to SBBS. I then considered and examined the tensions between different representations of the policy issue.

With respect to the direction of this thesis, this chapter highlighted that symbolic representations of SBBS may have beneficial implications for health (e.g., through prompting behaviour change). It also highlighted the claim that the Finnish Baby Box reduced infant mortality and pointed to the importance of this claim in relation to the policy outcomes given by the EA of SBBS discussed in Section 1.4.

The next chapters follows this claim and presents a natural experimental evaluation of the Finnish Maternity Grant's – the broader policy to which the Finnish Baby Box is a component – impact on infant mortality. Following from this, the thesis turns towards a natural experimental evaluation of the impact of SBBS on infant and maternal health (Chapters 5 to 10).

4 Natural experimental evaluation of the Finnish Maternity Grant

4.1 Chapter overview

In the previous chapter (Chapter 3) I provided an analysis of the political discourse surrounding the introduction of SBBS, where I focused on the practical argumentation given by key political actors in support and in opposition to the scheme. This chapter takes its lead from a circumstantial premise of this argumentation, used to support the introduction of SBBS, that claimed the Finnish Baby Box reduced infant mortality. I begin with a brief description of this causal debate (Section 4.2.1) and a structured overview of the wider Finnish Maternity Grant (Section 4.2.2), of which the Finnish Baby Box is a component. Viewing both the introduction of the Finnish Maternity Grant in 1938 and its subsequent universalisation in 1949 as two distinct natural experimental events (Section 4.4), I then use interrupted time series analysis and synthetic control analysis to evaluate the impact of these events on infant mortality rates (Section 4.5).

There is a clear relationship between SBBS and the Finnish Baby Box as it presently operates, being the only other nationally operated universal and non-commercial baby box. However, as early 20th century Finland is a drastically different context to that of present-day Scotland, this cannot be said for the Finnish Baby Box at the point introduction in 1938 and universalisation in 1949. As such, the intention of this chapter is not to yield insight into the possible impact of SBBS on infant mortality. Rather it introduces the use of natural experimental methods and empirically tests the circumstantial premise used in the practical argumentation to support the introduction of SBBS.

4.2 Background

As discussed in the previous chapter, the practical argumentation given in support of SBBS drew upon the Finnish baby box as a circumstantial premise. This premise claimed that the box had a ‘proven record’ in reducing Finnish infant mortality rates. Imperial College Healthcare NHS Trust, which began piloting a baby box in June 2016, similarly state that the Finnish baby box is "thought to have reduced the infant mortality rate [of Finland]" (Imperial College Healthcare, 2016). It is also the case that, in recent years, there has been increasing international uptake of interventions modelled on the Finnish baby box. Often aimed at preventing SIDS, these interventions assume a beneficial effect on infant mortality (Ahlers-Schmidt *et al.*, 2017; Bartick, Tomori and Ball, 2018; Middlemiss *et al.*, 2019).

Nevertheless, the causal nature of the relationship between the Finnish baby box and infant mortality has not been formally investigated. Representatives of the Finnish Institute for Health and Welfare (*Terveyden ja hyvinvoinnin laitos* – or THL) and the Finnish Social Insurance Institution (*Kansaneläkelaitos* – or KELA) have voiced their scepticism and, citing a lack of appropriate data, doubt whether this relationship is even amenable to scientific investigation (Hakulinen and Gissler, 2017; Koskenvuo, 2017).

Through the use of natural experimental methods, this chapter hopes to make a novel contribution. It is worth noting at this point that the Finnish baby box is known officially as the Finnish Maternity Package. Further, the Maternity Package is not a stand-alone policy but is rather one component of the broader Finnish Maternity Grant. Owing to a lack of individual-level data on recipients of either component, I evaluate the broader Maternity Grant at the point of introduction in 1938 and the point of universalisation in 1949. Before outlining the aim and research questions, I will first give a brief overview of infant mortality in early-20th century Finland and, subsequently, a structured overview of the Maternity Grant.

4.2.1 Infant mortality in 20th century Finland

In the late 19th and early 20th century, European countries experienced what has been termed the 'mortality transition' involving a secular decline in infant mortality (Klüsener *et al.*, 2016). Despite experiencing low levels of economic prosperity by European standards at the time, several of the Nordic countries led this transition (see *Figure 3*). In 1850, Sweden, Norway, and Denmark had the lowest recorded infant mortality rates (IMRs) in the world after New Zealand (Edvinsson et al., 2008); it should be considered, however, that mortality data are not available for many non-European countries during this time period.

Despite this, Finland's IMR remained somewhat of an outlier amongst the Nordics well into the 20th century (see *Figure 3*). In descending order, the average IMR between 1915 and 1920 was 114.2 deaths per 1000 live births in Finland, 91.9 in Denmark, 68 in Iceland, 67.9 in Sweden, and 57.7 in Norway[25]. Finland did eventually converge with the other Nordic countries around the end of the century and, at present, has one of the lowest IMRs globally (~2 deaths per 1000 live births).

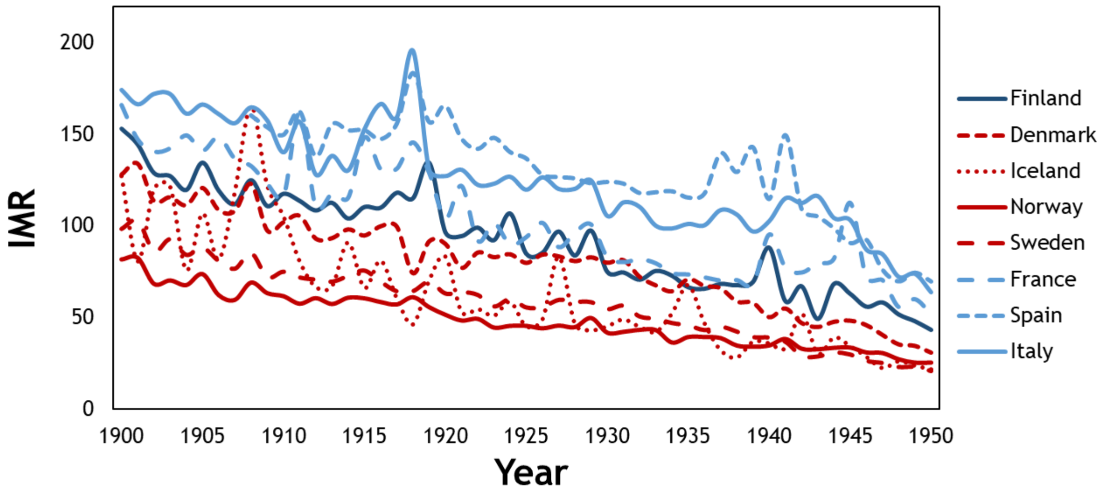

Figure 3 Infant Mortality Rate (IMR) trends in Europe between 1900 and 1950.

Nordic countries are in red with the exception of Finland, itself being in dark blue. France, Spain, and Italy are shown in light blue.

The comparatively high IMR in Finland over the 20th century aligns with the perception of the country as a latecomer to Nordic welfare state development (Niemelä and Salminen, 2006). Common explanations for this delay centre around the events of Finnish independence in 1917, the Finnish Civil War of 1918, and the postponed industrialisation of the Finnish economy which retained a comparatively significant agrarian sector. However, Kettunen (2001) has challenged this view of Finnish welfare state development. They suggest that linear or chronological descriptions of Finnish welfare state development focussing solely on social reforms often overlook the 'temporal incongruity' between discourses and institutions, and the role that this incongruity played.

[25] Calculated using data from the Human Mortality Database

Nonetheless, there were a number of social and medical reforms that may have played a role in reducing Finland's infant mortality rates (see *Figure 4*). These reforms included 1944 legislation that mandated the establishment of maternal and child health (antenatal) clinics in all Finnish municipalities (Siivola and Martikainen, 1990). These clinics largely came into force between 1945 and 1949 and were to function within a dense network of local provision that included a community physician, midwife, and public health nurse (ibid.). It was also the case that at this point in time, a majority of births in Finland still occurred at home (e.g., in 1944, 55.4% births occurred at home with 14.5% of these being unassisted[26]).

Prior to and influencing the 1944 legislation, a nurse by the name of Sophie Mannerheim established a women's shelter in Helsinki in 1918 for single mothers. Soon the shelter began providing child healthcare services for families in the local area, with Mannerheim inviting the noted paediatrician Arvo Ylppö to help. Local infant mortality was observed to fall from 15% to 3% in the three years following the provision of such services (Koivu *et al.*, 2020). Mannerheim was the founder of the Mannerheim League for Child Welfare. This non-profit organisation promoted more comprehensive child and maternity healthcare and introduced in 1922 what could be understood as the precursor to the concept of the Maternity Package (*kiertokorit* – or "circulating baskets"), which were given to mothers and included baby clothes and other necessities (ibid.).

Other medical developments included the introduction of anti-bacterial drugs to treat otherwise fatal infections (e.g. sulphonamides in 1935 and penicilin in 1945) and the expansion of vaccines available to newborns (e.g., BCG in 1941, pertussis in 1952, and poliomyelitis in 1957) (Koskenvuo, 2017). One social reform of note is the Child Allowance (or Benefit) System which was established in 1948, providing mothers with a monthly cash trasnfer for each child in the family (Finnish Ministry of Social Affairs and Health, 2006). Factors such as increasing breastfeeding rates and, in urban settings, improvements in sanitation infrastructure may have also contributed to falls in infant mortality (Edvinsson, Gardarsdóttir and Thorvaldsen, 2008; Peltola and Saaritsa, 2019). However, with the exception of the latter (Peltola & Saaritsa, 2019), there has been no

[26] Data acquired from Mika Gissler, Finnish Institute for Health and Welfare (THL).

empirical evaluation of the contributions of the above developments to declines in Finnish infant mortality rates.

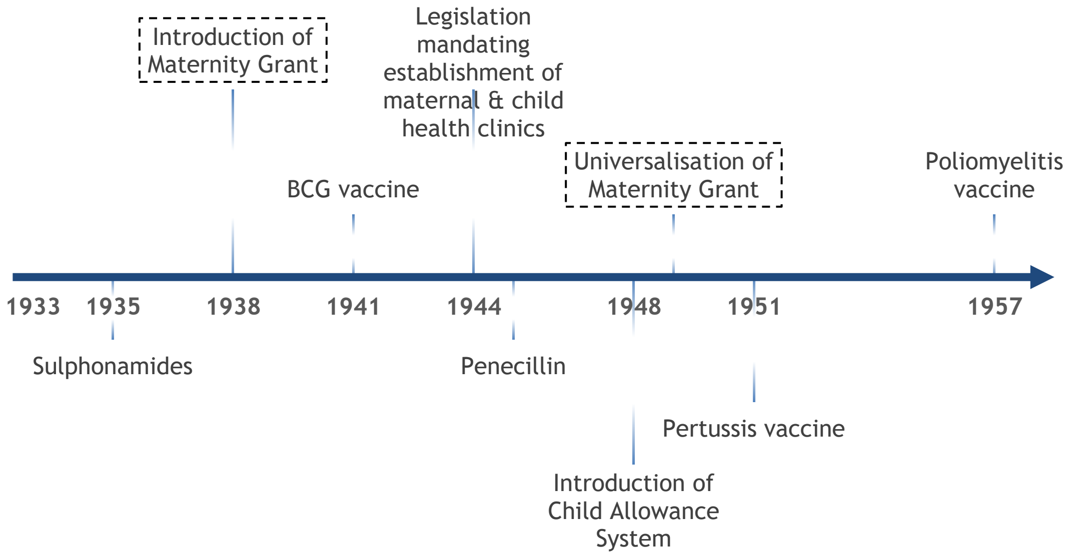

Figure 4 Timeline of interventions that may have influenced infant mortality rates (IMRs) in Finland between 1930 and 1960.

4.2.2 The Finnish Maternity Grant

This section will outline the Finnish Maternity Grant using the TIDieR-PHP template (Campbell *et al.*, 2018). This template is an extension of the Template for Intervention Description and Replication geared towards Population Health and Policy (PHP). It should be noted that, as a result of not speaking Finnish, there are limitations to my knowledge of the Maternity Grant's evolution over the 20th century. Thus, while discussion with Finnish colleagues has informed my understanding of the Finnish Maternity Grant, presented here is information that is readily available in English and thus does not represent an exhaustive overview. Nonetheless, it is hopefully sufficient for the analysis presented in this chapter.

Policy name

The Finnish Maternity Grant is the name of the policy under evaluation in this chapter. As previously stated, this includes the famous Maternity Package (i.e., Baby Box) component. The Finnish context of this is important to note, given that "maternity grant" is common to other policies (e.g., the Sure Start Maternity Grant, described in Section 1.3).

Policy context

The introduction of the Maternity Grant came at a time when concerns over low birth rates and infant mortality were prominent amongst the Nordic countries (Burström, 2003; Forssén et al., 2008). Notable in this regard was the 1934 publication *Kris i Befolkningsfrågan* ("Crises in the Population Issue") by Swedish social scientists Gunnar and Alva Myrdal (Myrdal and Myrdal, 1934), who proposed introducing family policies alongside the means-tested equalisation of family costs as possible solutions.

Materials

The Maternity Package component of the Maternity Grant includes care items, however it was not until 1942 that these care items were packaged in a cardboard box (Koivu *et al.*, 2020). Originally the box was not intended as a sleeping space, rather such usage extended from parents. The care items provided by the maternity package have varied historically. The value of the Maternity Grant in 1938 was ~450 Finnish Markka (equivalent to ~170 Euros in 2020[27]), approximately a third of an industrial worker's average monthly wage at the time (Kela, 2018). It is unclear, however, whether this value pertains to the cash benefit, maternity package, or both.

What & how

The Maternity Grant was, as it remains today, conditional on receiving a pregnancy certificate from a doctor or antenatal clinic which confirmed a pregnancy of more than 154 days and that a health examination had been undertaken before the fifth month of pregnancy (Hakulinen and Gissler, 2017). However, prior to the aforementioned legislation in 1944, such clinics were not ubiquitously available across Finland (Koivu *et al.*, 2020); only by the time of Maternity Grant universalisation in 1949 were these clinics widely established across the whole country (ibid.). The implications of this with respect to uptake of the Maternity Grant are not known. Relatedly, data on national uptake throughout the 20th century, as well as uptake by municipality, are not

[27] Equivalent value calculated using a cost-of-living index. Statistics Finland's 'value of money converter': https://www.stat.fi/tup/laskurit/rahanarvonmuunnin_en.html

available. Data concerning uptake by component of the grant (e.g., Maternity Package versus cash-transfer) are only available from 1974 onwards (see *Figure 5*). These show that the majority of mothers (ranging between 65-85%) favoured the Maternity Package over the cash-transfer between 1974 and 2019. Indeed, for first-time mothers specifically, around 95% opt for the Maternity Package at present (Kela, 2019b). While this may indicate that the Maternity Package was generally favoured over the cash-transfer option from the policy's inception, this cannot be said definitively without data.

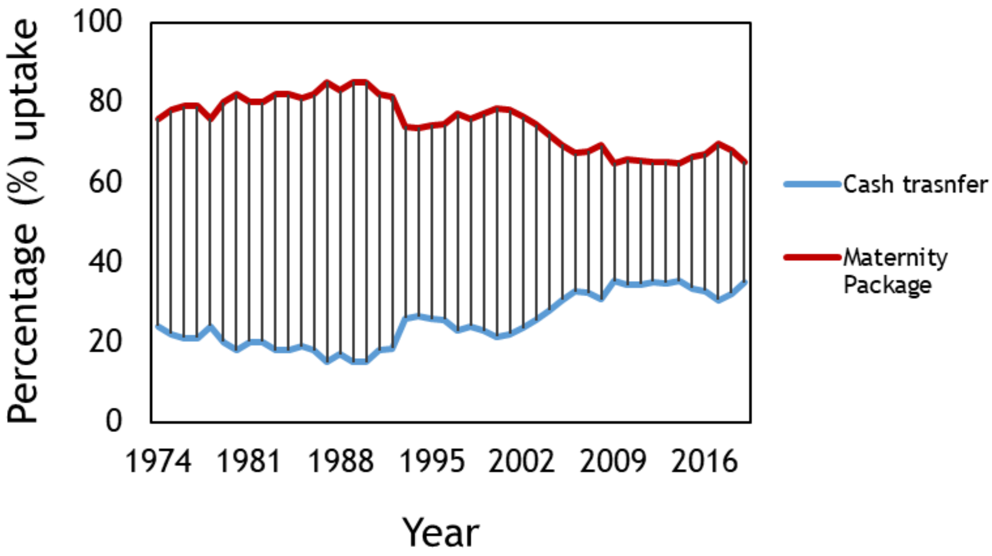

Figure 5 Percentage (%) uptake of in-kind vs. cash benefit components of the Finnish Maternity Grant, from 1974 to 2019.

In-kind trend includes those who received both in-kind and cash benefits in instances of multiple births. Data obtained on request from Kela (https://www.kela.fi/).

Administration of the Maternity Grant was undertaken by the National Board of Social Welfare and the Government Purchasing Centre until 1994, after which it was the responsibility of the Social Insurance Institution (Kela, 2018).

Time and duration of interventions

This chapter considers the introduction of the Maternity Grant in 1938 and its subsequent universalisation as two distinct points of intervention. Study timeframes for each intervention point are given in Section 4.4.5 below.

When the Maternity Grant was initially introduced in 1938, it was only made available to disadvantaged mothers (Koivu *et al.*, 2020). While it is not clear what identified mothers as disadvantaged, this is said to have comprised of around two-thirds of all new mothers at the time (Kela, 2018). Universalisation in 1949 made the grant available to all mothers.

4.3 Aim and research questions

In this chapter I aim to investigate the causal impact of Maternity Grant introduction in 1938 and Maternity Grant universalisation in 1949 on Finnish infant mortality rates. I address the following research questions:

1. Did the introduction of the Maternity Grant in 1938 reduce infant mortality rates in Finland?

2. Did the universalisation of the Maternity Grant in 1949 reduce infant mortality rates in Finland?

3. How robust are any indications of impact?

I hypothesised that, should the Maternity Grant have had an impact on infant mortality rates, this impact is likely larger for introduction in 1938 than for universalisation in 1949. This is premised on the fact introduction in 1938 made a majority of Finnish mothers eligible and that these mothers were of lower income, thus likely to derive more benefit from receiving financial and material support.

4.4 Methods

4.4.1 Study design

In this chapter I view the introduction of the Maternity Grant in 1938, and its subsequent universalisation in 1949, as distinct natural experimental events. There are various methods of analysis available in the study of such events (for an overview, see Craig et al., 2017). Two different natural experimental methods are used here: interrupted time series (ITS) analysis and synthetic control (SC) analysis. Both are used to evaluate each intervention point. These methods were selected on the basis of data availability, their ability to address the research questions, and also simply to highlight different approaches to natural experimental evaluation. It is also the case that the use of multiple methods, where the assumptions of such methods differ, can improve the case for causal inference where findings are consistent (Lawlor, Tilling and Smith, 2016; Craig *et al.*, 2017). As will be explained below, SC analysis draws on data from multiple geographic regions while ITS analysis only draws on data from the one exposed region. Thus the addition of SC analysis may prove beneficial in capturing certain types of history bias (e.g., events affecting the outcome measure across exposed and unexposed regions) that would not be captured by the use of ITS analysis alone.

4.4.1.1 What are natural experimental methods?

The potential-outcomes model of causality is useful in distinguishing between true experiments and natural experiments (Greenland and Brumback, 2002; Craig *et al.*, 2017). This refers to the outcomes that would be observed in an individual had they been simultaneously exposed to an event (Y_1) and its corresponding control or counterfactual scenario (Y_0). Y_0 is defined as the expected outcome *ceteris paribus* had the exposure of interest not occurred. Comparison between Y_0 and Y_1 would then give the effect of exposure. However, the 'fundamental problem of causal inference' is that in reality Y_0 and Y_1 cannot be simultaneously observed (Holland, 1986). As such we can only estimate the average effect of an exposure through a comparison of individuals assigned to an exposed scenario with individuals assigned to a corresponding control scenario (Craig *et al.*, 2017).

In an RCT, assignment to either the control scenario or exposed scenario occurs at random. Randomisation seeks to evenly distribute all unmeasured predictors of an outcome between groups such that the differences in average outcomes between the two groups would be the same, except by chance, had those assigned to the control scenario actually experienced the exposed scenario and vice versa (i.e., groups are 'exchangeable'). However, in the evaluation of large-scale policies such as SBBS, randomisation is typically not possible in light of ethical, practical, and political considerations.

In common with all observational studies, most natural experimental methods instead rely on an understanding of the assignment mechanism to achieve what can be called conditional exchangeability (Sekhon and Titiunik, 2012; Craig *et* *al.*, 2017). It is this assignment mechanism, when involving a variation in exposure within a population, that is described as a natural experimental event. Interventions that are introduced or withdrawn abruptly, affect a large population, and that limit the ability of individuals within the population to alter their exposure status are seen as most suitable to natural experimental evaluation (Craig *et al.*, 2017, 2018). However, it is important to consider whether the assignment mechanism in reality achieves conditional exchangeability (i.e., are groups exchangeable with respect to unmeasured predictors) (Sekhon and Titiunik, 2012).

4.4.1.2 Interrupted time series analysis

ITS analysis is widely used in the evaluation of healthcare and population-level health interventions (Wagner *et al.*, 2002; Penfold and Zhang, 2013; Taljaard *et al.*, 2014; Jandoc *et al.*, 2015; Craig *et al.*, 2017). It has been espoused as an alternative to traditional epidemiological designs (e.g., cohort and case-control designs), which are often vulnerable to selection bias (Bernal et al., 2017). ITS analysis is robust to selection bias as it does not rely on a control population to estimate the counterfactual. The counterfactual is instead estimated through an extrapolation of the pre-intervention outcome trend into the post-intervention period. Comparison between the post-intervention counterfactual trend and the actual post-intervention trend gives a measure of effect. ITS analysis is beneficial in this regard, as finding a control population that is suitably exchangeable with the exposed population (e.g., meeting the parallel trends assumption necessary for difference-in-difference analysis) is often difficult (Kreif *et al.*, 2016). Further, ITS analysis can control for short term fluctuations and secular trends in the outcome (Bernal et al., 2018).

The key assumption of ITS analysis is thus: in the absence of the intervention of interest, the pre-intervention outcome trend would continue its trajectory unperturbed into the post-intervention period (Kontopantelis et al., 2015). An obvious weakness of this assumption is the presence of time-varying confounding (Bernal et al., 2017). This may take the form of history bias whereby an event co-occurs with the intervention of interest and has an independent effect on the outcome. Another example of time-varying confounding is instrumentation bias, whereby the means of outcome measurement change over time (e.g., due to changes in data collection practices, outcome definitions, or population boundaries) (Bernal et al., 2018).

4.4.1.3 Synthetic control analysis

SC analysis is a relatively recent addition to the natural experimental methodological toolbox. The method was developed by Abadie et al. (2010) and Abadie & Gardeazabal (2007). It has subsequently seen widespread uptake in the areas of policy and econometric evaluation (Billmeier and Nannicini, 2013; Bilgel and Galle, 2015; Kreif *et al.*, 2016; O'Neill *et al.*, 2016). Indeed, it has been described by Athey & Imbens (2017) as 'the most important innovation in the policy evaluation literature in the last 15 years'. It has also been noted for its application in the evaluation of population-level health interventions (Craig *et al.*, 2017, 2018; Bouttell *et al.*, 2018).

Similar to ITS analysis, SC analysis avoids potential confounding from group differences and selection bias. Instead of relying on a single control population chosen to represent the counterfactual, the counterfactual is drawn from several donor populations (or 'units'). It uses a weighted combination of these populations (collectively termed the 'donor pool') to best emulate the pre-intervention outcome trend of the exposed population (Abadie, Diamond and Hainmueller, 2010; Kreif *et al.*, 2016). This 'synthetic' pre-intervention trend is then carried forward into the post-intervention period to reconstruct the counterfactual (i.e. a synthetic control). A key strength of the SC analysis is that, by incorporating the pre-intervention outcome trend into the construction of the control, it can accommodate time-varying unmeasured confounders (Abadie, Diamond and Hainmueller, 2010).

There are a number of assumptions underlying SC analysis. One such assumption is the stable unit treatment value assumption (often referred to as SUTVA), which holds that the intervention should not affect any of the donor populations (Abadie, Diamond and Hainmueller, 2010). A further assumption is that the outcome trend of the population exposed to the intervention should not be an outlier in relation to the outcome trends of the selected donor populations (Bouttell *et al.*, 2018). An implicit assumption here is that, if outcome trends are similar across the board, measured and unmeasured characteristics influencing trends are also likely to be similar (Abadie, Diamond and Hainmueller, 2015). Bouttell et al. (2018) further contend that any shocks or events affecting the outcome should not be differentially experienced between the exposed and donor populations; this is often referred to as the 'common shocks' assumption and is shared by other methods such as difference-in-difference analysis. A drawback of SC analysis is that traditional statistical inference may not be appropriate given the typically small number of exposed and comparator populations available (Bouttell *et al.*, 2018). This chapter uses SC analysis as a visual method of inference, as an alternative to the statistical methods offered by ITS analysis.

4.4.2 Study population

Interrupted time-series and synthetic control analyses

Finland is the aggregate population exposed to the Maternity Grant at both introduction in 1938 and universalisation in 1949.

Synthetic control analyses only

Eleven aggregate donor populations are utilised for SC: Denmark, Iceland, Norway, Sweden, Netherlands, France, Italy, Spain, Belgium, Switzerland, and the UK. These populations were selected on the basis that there exists, for each, data of a uniform quality over the time period of interest for the outcome variable. Further, all selected donor populations fall into the broadly similar geographic region of Europe and, similar to Finland, experienced secular declines in the outcome variable across the time-period of interest. It would have been beneficial to consider other populations (e.g., Estonia, Latvia, and Lithuania) that share a more specific geographical position with Finland; notably, these countries shared the geopolitical influence of the Russian state across 19^{th} and 20^{th} centuries. Sadly, however, time-series data for the outcome variable are not available (irrespective of data quality) for these populations until 1959.

4.4.3 Outcome variable

Infant mortality rate (IMR) formed the outcome variable for all analyses in this chapter. Outcome data were formatted as time series, segmented on an annual basis over the periods of interest. These data were derived from the Human Mortality Database (HMD) (Human Mortality Database, 2019), with annual IMRs per 1000 live births calculated as standard:

(Number of deaths in first year of life / number of live births) × 1000

The HMD provides high quality annual birth and mortality estimates. The input for these estimates consists of census and death registration data aggregated on a national basis. Only countries where these data are virtually complete (~99% completeness) were included (Barbieri *et al.*, 2015). Methods of adjustment for raw data (e.g., distribution of individuals with an unknown age) used by the HMD are standardised across populations, lending to comparison. The HMD is seen to be of higher quality than other established life-table data such as the Human Lifetable Database, which includes non-official sources and has high missingness. This database does not offer the birth rates necessary for calculating IMRs and is thus not considered as an alternative source of outcome data.

4.4.3.1 Threats of bias

Bernal et al. (2018) state that in defining the pre-intervention period, events and other interventions targeting the outcome (i.e., history bias) should be addressed through either omitting the period in which they occur from analysis or through appropriately modelling their effect on the outcome. The rationale is that such interventions could impact the underlying outcome trend, thus skewing a counterfactual drawn from this period. However, in the case of the study timeframes defined above, I assume that such interventions and events are, owing to their frequency and the sensitivity of IMR as a population health indicator, constitutive of, rather than anomalous to, the outcome trend trajectory. Indeed, it is under this assumption that the pre-universalisation period includes the introduction of the Maternity Grant. Following from this, other interventions and events are only considered when occurring close to the point of intervention under evaluation. These are noted *Table 5* below.

Year	Event
1935	Introduction of sulphonamides
1938	Introduction of Maternity Grant

1939-1940	Invasion of Finland by USSR and Winter War
1941-1944	Continuation War
1944-1945	Lapland War
1948	Child Allowance System
1949	Universalisation of Maternity Grant

Table 5 Potential sources of history bias with respect to Finnish Maternity Grant introduction in 1938 and universalisation in 1949

The introduction of the Child Allowance System is of particular concern here. This was a universal benefit involving a direct tax-free monthly cash transfer to mothers, similar in a number of ways to the Maternity Grant that was universalised a year later. The amount of cash received was proportional to the number of children in the family (payments would stop upon the child becoming 17 years old). However, the value of the transfer at the time is not clear. While this poses a significant threat of history bias, there is no noticeable wild point in this instance. Temporal falsification was used to examine the threat of history bias (described in Section 4.4.7).

4.4.4 Predictor variables (synthetic control analysis only)

SC analysis makes use of predictor variables that are independent of exposure status to improve 'fit' between the synthetic trend and the outcome trend in the pre-intervention period (Abadie, Diamond and Hainmueller, 2010).

It is common practice to include all pre-intervention outcome values as predictor variables (Billmeier and Nannicini, 2013; Bohn, Lofstrom and Raphael, 2014; Bilgel and Galle, 2015; Kreif *et al.*, 2016). In doing so however, as Kaul et al. (2018) demonstrate, all other predictors entered into the model are rendered obsolete in their contribution to forming the synthetic outcome trend. It is also argued by the authors, while the use of all pre-intervention outcomes as predictors optimises model fit, it can introduce bias if the excluded covariates were in reality influential for future outcomes. They show this to have implications for the level and trajectory of the post-intervention synthetic trend, possibly leading to false conclusions.

In the analysis presented here, there was an issue of high outcome variability in the pre-intervention period for both Finland and donor populations. This posed a challenge to achieving a suitable pre-intervention fit, particularly so as this variability was differentially experienced between all populations (in possible violation of the common shocks assumption). Predictors of the outcome for the study period in question were also sparse.

Two predictors other than the outcome variable were considered: annual GDP per capita data from the Maddison Project Database (Bolt and van Zanden, 2014), used as an indicator of economic development and predictor of secular mortality declines in line with Ranganathan et al. (2015); and female education enrolment ratio (at primary, secondary, and tertiary levels) data from Lee & Lee (2016), as a proxy for maternal education levels which exhibit an established association with infant and child mortality across different income settings (Fuchs, 2010; Gakidou et al., 2010). The latter data were similarly used by Ranganathan et al. (2015) in their modelling of demographic transition relative to economic growth.

Nonetheless, the SC analysis presented here prioritised the optimisation of fit and thus used all pre-intervention outcomes as the sole predictors. While this may have implications for the post-intervention trend, poor pre-intervention fit similarly does not bode well for model robustness in the post-intervention period.

4.4.5 Study timeframe

The study timeframes for the analyses used here comprised both pre- and post-intervention periods. Importance was placed on the former owing to its role in the formation of the counterfactual. Bernal et al.'s (2018) consideration of the pre-intervention period in ITS analysis likely also applies to SC analysis. That is, the choice of pre-intervention period lies between having (a) too few time points, thus failing to accurately model the trend, and (b) too many time points, thus risking the inclusion of historically different trends. With regards to SC analysis, there appears to be no consensus on the necessary number of pre-intervention time points (Bouttell *et al.*, 2018); Abadie et al. (2010) included 19 annual pre-intervention time-points and, in a later example, Abadie et al. (2015)

included 30. The timeframes for each intervention point are outlined below and held constant between methods for consistency. With respect to the different intervention points I will refer to intervention periods as pre- and post-introduction and pre- and post-universalisation, respectively.

4.4.5.1 Maternity Grant introduction in 1938

The pre-introduction period extended from 1922 to 1937 (16 years) and the post-introduction period from 1938, the year of introduction, until 1953 (16 years). The pre-introduction period was defined in recognition of the upheaval of Finnish independence 1917 and the Finnish Civil War of 1918. Beginning the timeframe in 1922 also allowed for the inclusion of the UK, whose outcome data were only available from this point, as a donor population in SC analysis.

4.4.5.2 Maternity Grant universalisation in 1949

The pre-universalisation period extended, as for Maternity Grant introduction, from 1922 until 1948 (27 years). The post-universalisation period extended from 1949, the point of universalisation, until 1975 (27 years) to give equal data points in each period. In defining the study timeframes, and in consideration of historically different trends, analyses sought to maximise the data used in the models. Thus the timeframe for Maternity Grant universalisation was greater than that for introduction.

4.4.6 Main analyses

4.4.6.1 Interrupted time-series analyses

It is important to *a priori* select an impact model that represents the hypothesised change in outcome following the intervention (Bernal et al., 2017). Impact models typically concern changes in the post-intervention trend in terms of a) a change in level, b) a change in slope or trend, and c) the expected timing of a) and b). The impact model selected for both the introduction and universalisation of the Maternity Grant anticipated a change in level and a change in trend. Further, there was no reason to believe that any impact would be delayed.

For the main analysis of Maternity Grant introduction in 1938, a segmented ordinary least squares (OLS) regression of the following form was used (Wagner *et al.*, 2002):

$$\boldsymbol{Y_t = \beta_0 + \beta_1 \cdot time_t + \beta_2 \cdot level_t + \beta_3 \cdot trend_t + e_t}$$

$\boldsymbol{Y}$ denotes the outcome variable (IMR), $\boldsymbol{time}$ ($\boldsymbol{t}$) is a continuous variable (1:32) that indicates time in years across the observation period (1922:1953), $\boldsymbol{level}$ is a binary variable (0 = pre-introduction period; 1 = post-introduction period), and $\boldsymbol{trend}$ is a continuous variable counting the number of years in the post-introduction period (0 = pre-introduction period; 1:16 = post-introduction period). *Table 6* provides an example of how these data are presented.

Country	Year	IMR (Y)	$time$	$level$	$trend$
Finland	1922	99.2388	1	0	0
Finland	1923	92.4098	2	0	0
Finland	1924	106.9475	3	0	0
Finland	1925	84.9859	4	0	0
Finland	1926	85.6195	5	0	0
Finland	1927	97.0891	6	0	0
Finland	1928	84.0396	7	0	0
Finland	1929	97.6306	8	0	0
Finland	1930	75.1369	9	0	0
Finland	1931	74.8337	10	0	0
Finland	1932	70.9136	11	0	0
Finland	1933	75.6684	12	0	0
Finland	1934	73.0140	13	0	0
Finland	1935	66.7553	14	0	0
Finland	1936	65.9409	15	0	0
Finland	1937	68.5850	16	0	0
Finland	1938	67.8271	17	1	1
Finland	1939	69.6793	18	1	2
Finland	1940	88.3385	19	1	3
Finland	1941	59.1861	20	1	4
Finland	1942	67.2915	21	1	5
Finland	⋮	⋮	⋮	⋮	⋮
Finland	1953	34.1822	32	1	16

Table 6 Example of dataset used in the evaluation of the Finnish Maternity Grant introduction in 1938

From this, $\boldsymbol{\beta_0}$ gives $\boldsymbol{Y}$ at $\boldsymbol{t = 0}$ (i.e. the intercept), $\boldsymbol{\beta_1}$ estimates the change in Y for each year of the pre-introduction period (baseline trend), $\boldsymbol{\beta_2}$ estimates the immediate change in $\boldsymbol{Y}$ between pre-introduction and post-introduction periods (i.e., level change), $\boldsymbol{\beta_3}$ estimates the change in Y over the post-introduction period compared to the pre-introduction period (i.e., trend change).

For the main analysis of Maternity Grant universalisation in 1949, a segmented OLS regression of same form was used. However, in this instance, $\boldsymbol{time}$ (1:56) indicated the enlarged observation period (1922:1975) and $\boldsymbol{trend}$ indicated the enlarged post-universalisation trend extending from the intervention point in 1949 (0 = pre-universalisation period; 1:27 = post-universalisation period).

Autocorrelation and normality

OLS regression assumes that the error terms (or residuals) of each observation are not correlated. However, in the case of segmented regression analysis, where $time$ is a predictor, error terms often display consecutive correlation (Wagner *et al.*, 2002). This is referred to as autocorrelation, or serial correlation, and should be adjusted for where present. Each model was assessed for autocorrelation through the use of autocorrelation function (ACF) and partial-autocorrelation function (P-ACF) plots. These were preferred to other methods of checking for autocorrelation, such as plotting model residuals and the Durbin-Watson test, owing to their ease of interpretation.

For the ITS models used in this evaluation, partial autocorrelation concerns the correlation between Y and its own lagged values that is not explained by correlations at all lower-order lags. That is, partial autocorrelation is the difference at lag 2, for example, between the actual correlation and that expected as a result of the propagation of correlation a lag 1. ACF and P-ACF indicate whether auto-regressive (AR) or moving average (MA) terms should be added to the model to account for autocorrelation. An AR signature is indicated by a slow decay in significant lags in the ACF accompanied by a sharp drop off from lag p in the P-ACF. Conversely, an MA signature is indicated by slow decay in the P-ACF and a sharp drop off from lag q in the ACF. However, there was no indication of autocorrelation in any of the ITS models used in this analysis.

Models were checked for normality through a Q-Q plot of residuals, with the predicted trends of models plotted to highlight any changes between pre- and post-intervention periods.

4.4.6.2 Synthetic control analyses

Models used for the main SC analysis of both Maternity Grant introduction and universalisation were developed using the Synth package for R-studio, developed by Abadie et al. (2011). Following the notation used by Abadie et al. (2011) I will give a brief overview of a SC model as it applies here.

All populations ($\boldsymbol{j = 1{:}12}$) are observed over the time period $\boldsymbol{t = 1, \ldots, T}$. The first population is Finland ($\boldsymbol{j = 1}$), the exposed group, and the remaining populations are the unexposed donor populations ($\boldsymbol{j = 2{:}12}$). There is a defined intervention point ($\boldsymbol{T_0 + 1}$), and thus defined pre-intervention ($\boldsymbol{1, 2, \ldots, T_0}$) and post-intervention periods ($\boldsymbol{T_0 + 1, +2, \ldots T}$). For Maternity Grant introduction and universalisation, pre- and post-intervention periods were described previosuly in Sections 4.4.5.1 and 4.4.5.2, respectively. From here, $\boldsymbol{Y_{jt}^N}$ is the potential outcome observed for population $\boldsymbol{j}$ at time $\boldsymbol{t}$ in the absence of the intervention and $\boldsymbol{Y_{jt}^I}$ is the potential outcome observed for population $\boldsymbol{j}$ at time $\boldsymbol{t}$ if exposed to the intervention. However, for $\boldsymbol{j = 1}$ (i.e. Finland), $\boldsymbol{Y_{jt}^N}$ is only observed across the time period $\boldsymbol{1, 2, \ldots, T_0}$. For $\boldsymbol{j = 2{:}12}$, who are not exposed to the intervention, $\boldsymbol{Y_{jt}^I}$ is not observed in either time periods. SC analysis thus seeks to construct a control population that gives an estimate of $\boldsymbol{Y_{jt}^N}$ when $\boldsymbol{j = 1}$ in the post-intervention time period ($\boldsymbol{T_0 + 1, +2, \ldots T}$). To do this, a synthetic population is constructed on the basis that it best resembles the characteristics of Finland ($\boldsymbol{j = 1}$) in the pre-intervention period. As stated in Section 4.4.4, all pre-intervention outcomes were used as the sole predictors. The Synth function in R-studio selects a vector of weights $\boldsymbol{W^*}$, conditional on $\boldsymbol{V}$, such that the difference between the values of the characteristics of exposed and synthetic populations are minimised. $\boldsymbol{V}$ is a matrix that assigns weights based on their predictive power on the outcome and is optimally chosen by Synth such that the mean squared prediction error ($\boldsymbol{MSPE}$) for the synthetic model is minimised. Thus, the $\boldsymbol{MSPE}$ of the synthetic population can be taken as an indicator of the synthetic model fit whereby the lower the $\boldsymbol{MSPE}$ the better the pre-intervention fit.

Results are reported as the $\boldsymbol{MSPE}$ of the synthetic Finland and $\boldsymbol{W}^*$ (that is, the percentage contributions of each donor population to the synthetic Finland). The IMR trends of Finland and synthetic Finland are compared side-by-side graphically. A causal effect would be indicated by a close fit between Finland and synthetic Finland in the pre-intervention period, followed by a divergence in trends in the post-intervention period. Differences between the two trends can be further inspected using a 'gaps plot', as used by Abadie & Gardeazabal (2007).

4.4.7 Sensitivity analyses

4.4.7.1 Interrupted time-series analyses

Extending from the main ITS analyses for Maternity Grant introduction and universalisation, several sensitivity analyses were performed.

Wild point

Extreme values or outliers in a time series are often referred to as 'wild points' and can be adjusted for when of a known or suspected cause (Wagner *et al.*, 2002). There was a noticeable spike in Finnish IMRs in 1940 following the introduction of the Maternity Grant in 1938, with the IMR jumping from 69.7 in 1939 to 88.3 in 1940, before returning to 67.3 in 1941. This coincides with invasion of Finland by the USSR in 1939 and the Winter War that ensued between 1939-40. As this wild point is close to the points of intervention in 1938 and 1949, it is a potential source of history bias. To understand the impact of this wild point on model estimates, a sensitivity model using a binary variable (1 = wild point; 0 = no wild point) to adjust for the 1940 wild point was used for both Maternity Grant introduction and Maternity Grant universalisation. If model estimates differ markedly from the main ITS analyses, it would suggest that the main analyses are biased.

Truncated timeframe

Sensitivity models truncating the pre-intervention and post-intervention periods to 10 years (1928-1937 and 1938-1947, respectively, for Maternity Grant introduction; 1939-1947 and 1949-1958, respectively, for Maternity Grant universalisation) were used to check whether past trends were indicative of trends immediately preceding the point of intervention. The inclusion of non-indicative past trends could introduce bias to the model. Again, should model estimates differ markedly from the main ITS analyses, it would suggest that the main analyses are biased.

Temporal falsification

Temporal falsification involves reassigning the point of intervention in the model to understand whether associations are temporally specific to the true point of intervention. Associations that are not temporally specific may indicate the presence of history bias. For both Maternity Grant introduction and universalisation, the intervention point was re-assigned two years prior (1936 and 1947, respectively) in one sensitivity model and two years following (1940 and 1951, respectively) in another. Should we observe similar estimates in these models compared to the main ITS analysis, it would suggest the potential presence of history bias.

Quadratic term

For the analysis of Maternity Grant universalisation only a quadratic term ($\beta_5 \cdot trend_t^2$) was retrospectively applied to the ITS model. This sought to more accurately model the post-universalisation period which upon visualisation was seen to take on a curvilinear form.

4.4.7.2 Synthetic control analyses

Extending from the main SC analyses for Maternity Grant introduction and Maternity Grant universalisation, two sensitivity anlyses were performed.

Truncated timeframe

A sensitivity model truncating the pre-intervention and post-intervention periods to 10 years each was used for the analysis of both Maternity Grant introduction and Maternity Grant universalisation. Unlike the use of truncation in the ITS models, which sought to understand whether past trends were indicative of those immediately preceding the point of intervention, truncation for SC models sought to improve pre-intervention fit.

Exposure falsification

The second involved reassigning exposure status to the top weighted donor population (Abadie and Gardeazabal, 2007). This sought to understand whether any effect observed was specific to Finland. If effects are observed to be non-specific to Finland, it would suggest that they are not attributable to the Maternity Grant.

4.5 Findings

This section details the results of the ITS and SC analyses evaluating the introduction of the Maternity Grant in 1938 and its subsequent universalisation in 1949 as two distinct intervention points. Finnish IMRs from 1922-1975 are plotted in *Figure 6* below, where dashed lines indicate the two intervention points, respectively. It is immediately obvious that variability in the outcome trend diminishes over time.

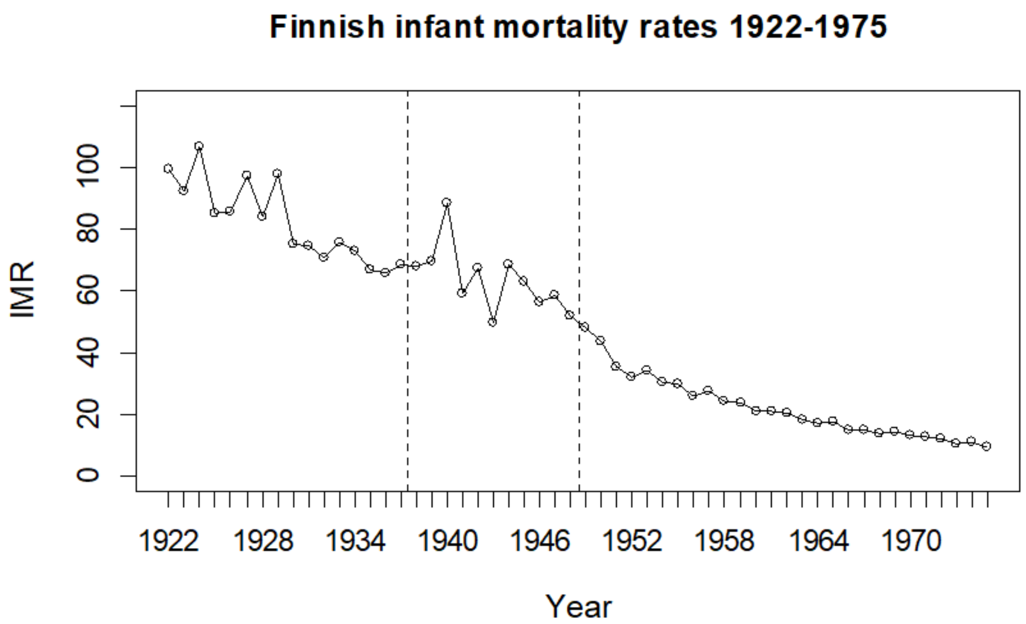

Figure 6 Finnish infant mortality rate (IMR) between 1922 to 1975.

First dashed line indicates point of Finnish Maternity Grant introduction in 1938, second dashed line indicates point of Finnish Maternity Grant universalisation in 1949.

4.5.1 Maternity Grant introduction in 1938

4.5.1.1 Interrupted time series analysis

Main analysis

Descriptive statistics for the outcome measure, IMRs, across the pre- and post-intervention periods are presented in *Table 7* below. The wide range of the outcome measure can be observed in both periods, indicating the steep decline in IMRs across the study period (see *Figure 6* above). The mean IMR is noticeably lower in the post-intervention period, however, given the slope of the outcome across the whole timeframe, this would be expected.

Study period	Min.	1st Quartile	Median	Mean	3rd Quartile	Max.
Pre-intervention	65.94	72.49	79.85	82.43	93.58	106.95
Post-intervention	31.78	47.09	57.34	55.83	67.43	88.34

Table 7 Descriptive statistics for infant mortality rates (IMRs) across the pre- and post-intervention periods for the analysis of Maternity Grant introduction in 1938.

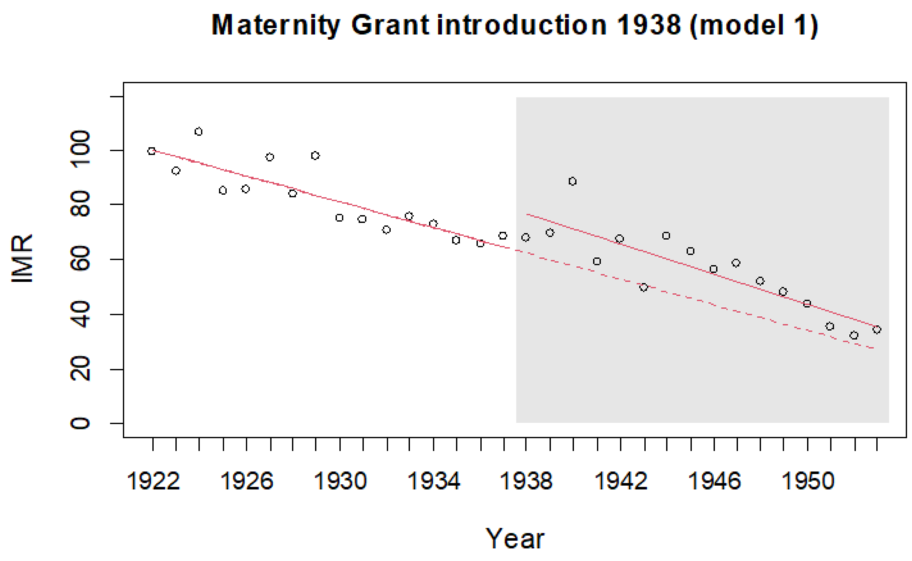

Figure 7 Finnish infant mortality rate (IMR) between 1922 and 1953.

Solid line: predicted trend of model 1 evaluating Finnish Maternity Grant introduction. Dashed line: counterfactual trend of model 1. Shaded area: post-introduction period.

Estimates for all models relating to the ITS analysis of the Maternity Grant's introduction are presented in *Table 8* below. The main analysis (*Table 8*; model 1*)* estimated a sizeable level increase (*β* = 14.59, 95% CI: 4.30 to 24.89) alongside a minor trend decrease (*β* = -0.40, 95% CI: -1.52 to 0.71) in IMRs following the introduction of the Maternity Grant in 1938. In absolute terms, there were 13.79 more deaths per 1000 live births in 1939 than what would have been expected based on previous trends (representing a 23% increase). The predicted trend of model 1 is represented above in a plot of the outcome trend over time (*Figure 7*).

	Estimate (95% CI)	
	Level	**Trend**
Main analysis		
Main (model 1)	14.59 (4.30 to 24.89)	-0.40 (-1.52 to 0.71)
Sensitivity analyses		
Wild point (model 2)	10.51 (0.89 to 20.13)	-0.07 (-1.09 to 0.95)
Truncated (model 3)	10.37 (-3.87 to 24.62)	0.67 (-1.80 to 3.13)
Falsification 1936 (model 4)	10.52 (-0.44 to 21.48)	0.15 (-1.09 to 1.40)
Falsification 1940 Model 5	15.17 (4.92 to 25.41)	-1.12 (-2.26 to 0.02)

Table 8 Estimates (95% confidence interval) for interrupted time-series models analysing of Maternity Grant introduction in 1938.

Main analysis (model 1); wild point analysis (model 2); truncated analysis (model 3); temporal falsification analysis 1936 (model 4); temporal falsification analysis 1940 (model 5). Q-Q, ACF, and P-ACF plots for all models are provided in Appendix 3.

<u>Sensitivity analyses</u>

Adjusting for the wild point in 1940 (*Table 8;* model 2) did not affect the direction of model estimates. While truncation (*Table 8;* model 3) and temporal falsification in 1936 (*Table 8*; model 4) indicated a similar level association to the main analysis, the trend associations were reversed (however estimates were small and imprecise). Temporal falsification in 1940 was associated with a marginally larger level increase (*β* = 15.17, 95% CI: 4.92 to 25.41) and a larger trend decrease (*β* = -1.12, 95% CI: -2.26 to 0.02) than the main analysis.

4.5.1.2 Synthetic control analysis

Main analysis

The synthetic control for the main analysis is comprised of 44.5% Netherlands, 48.4% Italy, and 7.1% Iceland (*Table 9* below). Pre-intervention fit was poor ($\boldsymbol{MSPE = 30.187}$), likely as a result of variability in the outcome trend prior to 1930 (*Figure 8* below).

W*	Donor country
0.000	Denmark
0.000	Norway
0.000	Sweden
0.445	Netherlands
0.000	France
0.484	Italy
0.000	Spain
0.000	Belgium
0.071	Iceland
0.000	Switzerland
0.000	United Kingdom

Table 9 Weights (*W**) for main synthetic control analysis of Maternity Grant introduction in 1938

This model suggested that IMRs were higher than expected following the introduction of the Maternity Grant in 1938. It can be noted, however, that the wild point adjusted for in the ITS analysis is not adjusted for here.

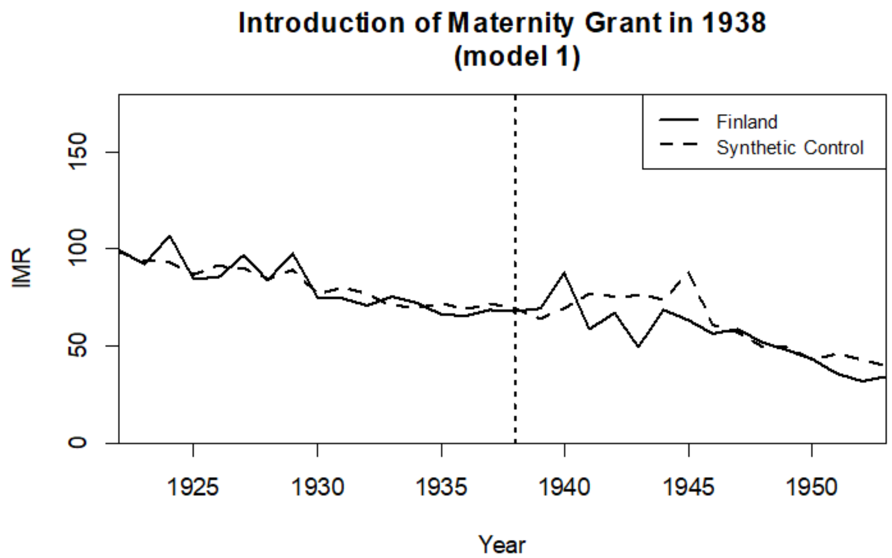

Figure 8 Main synthetic control analysis of Maternity Grant introduction in 1938.

Solid line: Finnish infant mortality rate (IMR) between 1922 and 1953. Dashed horizontal line: synthetic Finland. Dashed vertical line: point of introduction in 1938

Sensitivity analyses

Model fit improved upon truncating the pre-introduction trend to 10 years ($\boldsymbol{MSPE = 14.42}$). This suggests that in the main analysis synthetic Finland struggled to model the variability in the outcome trend prior to 1930. The truncated model was composed of the Netherlands (*W** = 45.0%), Italy (*W** = 24.7%), and Belgium (*W** = 30.3%). A similar result was observed, with IMRs higher following Maternity Grant introduction than that predicted by synthetic Finland. Given the unlikelihood that introduction of the Maternity Grant caused a rise in IMRs, further robustness checks (e.g., reassigning exposure status) were not seen as necessary.

4.5.2 Maternity Grant universalisation in 1949

4.5.2.1 Interrupted time series analysis

Main analysis

Descriptive statistics for the outcome measure, IMRs, across the pre- and post-intervention periods are presented in *Table 10* below. Again a wide range of the outcome measure can be observed in both periods, indicating the steep decline in IMRs across the study period (see *Figure 6* above). Compared to the analysis of Maternity Grant introduction (Section 4.5.1.1), the difference in mean IMR between pre- and post-intervention periods is smaller for Maternity Grant universalisation. Nevertheless, the direction of this difference is what would be expected with the decline in IMRs over the study timeframe.

Study period	Min.	1st Quartile	Median	Mean	3rd Quartile	Max.
Pre-universalisation	13.85	20.74	48.27	51.68	77.76	106.95
Post-universalisation	9.60	17.87	48.88	43.75	62.19	88.34

Table 10 Descriptive statistics for infant mortality rates (IMRs) across the pre- and post-intervention periods for the analysis of Maternity Grant universalisation in 1949.

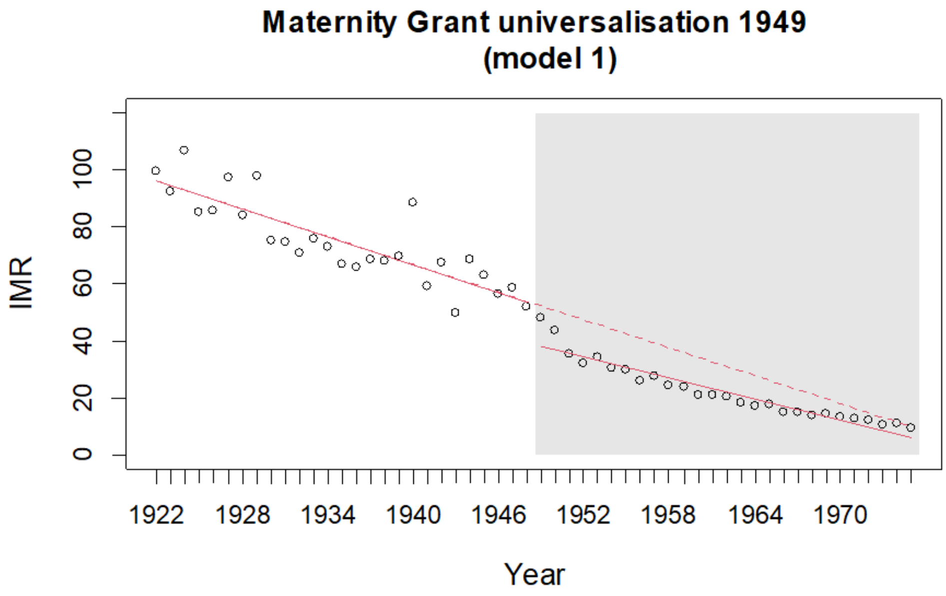

Figure 9 Plot of annual Finnish infant mortality rate (IMR) between 1922 and 1975.

Solid line: predicted trend of model 1 evaluating Finnish Maternity Grant universalisation. Dashed line: counterfactual trend of model 1. Shaded area: post-universalisation period.

Estimates for all models relating to the ITS analysis of Maternity Grant universalisation are presented in *Table 11* below. The main analysis (*Table 11*; model 1) estimated a notable level decrease (*β* = -14.35, 95% CI: -21.10 to -7.60) alongside a minor trend increase (*β* = 0.40, 95% CI: -0.03 to 0.84) in IMRs following Maternity Grant universalisation in 1949. The level estimate exhibited high precision. This suggests that there were 13.54 less deaths per 1000 live births in 1950, the year following universalisation, than would have been expected based on previous trends (representing a 27% reduction). However, a Q-Q plot of model residuals indicated that the assumption of normality was not met for model 1 (see Appendix 4). The predicted trend for model 1 is represented above in a plot of the outcome trend over time (*Figure 9*).

	Estimate (95% CI)	
	Level	**Trend**
Main analysis		
Main (model 1)	-14.35 (-20.94 to -7.76)	0.40 (-0.02 to 0.82)
Sensitivity analyses		
Wild point (model 2)	-12.59 (-18.37 to -6.81)	0.47 (0.10 to 0.84)
Truncated (model 3)	-7.09 (-19.35 to 5.18)	-0.03 (-2.15 to 2.09)
Falsification 1947	-10.79	0.21

(model 4)	(-17.96 to -3.63)	(-0.26 to 0.68)
Falsification 1951 (model 5)	-15.16 (-21.52 to -8.81)	0.65 (0.24 to 1.06)
Quadratic term (model 6)	-7.88 (-16.33 to 0.56)	-0.94 (-2.16 to 0.29)

Table 11 Estimates (95% confidence interval) for interrupted time-series analysis of Maternity Grant universalisation in 1949.

Main analysis (model 1); wild point analysis (model 2); truncated analysis (model 3); temporal falsification analysis 1947 (model 4); temporal falsification analysis 1951 (model 5); quadratic term (model 6). Q-Q, ACF, and P-ACF plots for all models are provided in Appendix 4.

Sensitivity analyses

All sensitivity analyses returned a level decrease in IMRs (see *Table 11*). Contrary to the main analysis, truncation (*Table 11*; model 3) and adding a quadratic term (*Table 11*; model 6) returned a trend decrease however these estimates were small and imprecise. To highlight how the quadratic term modelled the post-universalisation period, the predicted trend of model 6 is plotted in *Figure 10* below.

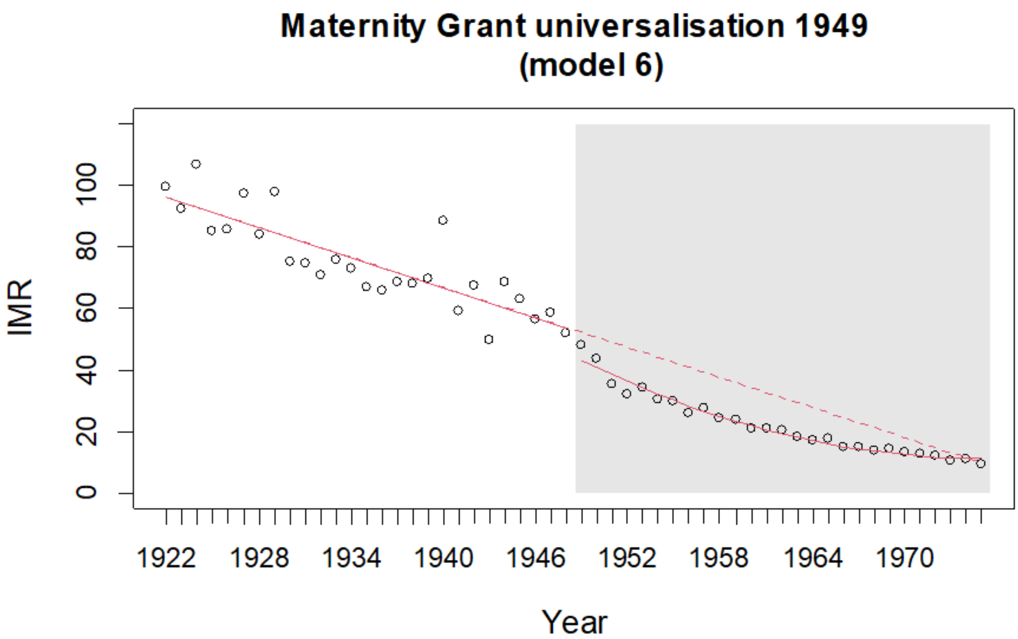

Figure 10 Plot of annual Finnish infant mortality rate (IMR) between 1922 and 1975.

Solid line: predicted trend of model 5 evaluating Finnish Maternity Grant universalisation. Dashed line: counterfactual trend of model 5. Shaded area: post-intervention period.

4.5.2.2 Synthetic control analysis

The synthetic control model for the main analysis of Maternity Grant universalisation in 1949 was mainly comprised of Belgium (*W** = 34.5%), Denmark (*W** = 23.6%), and Italy (*W** = 11.3%) (*Table 12* below). Pre-intervention fit was very poor ($\boldsymbol{MSPE = 59.07}$).

W*	Donor country
0.236	Denmark
0.000	Norway
0.022	Sweden
0.000	Netherlands
0.090	France
0.113	Italy
0.016	Spain
0.345	Belgium
0.056	Iceland
0.090	Switzerland
0.032	United Kingdom

Table 12 Weights (*W**) of synthetic control for main synthetic control analysis of Maternity Grant universalisation in 1949

Looking at *Figure 11* below, it is clear that synthetic Finland struggled to model the variability in the pre-intervention outcome trend. Nonetheless, there is a clear divergence where actual IMRs are consistently lower than what was predicted by the synthetic Finland from 1950 onwards.

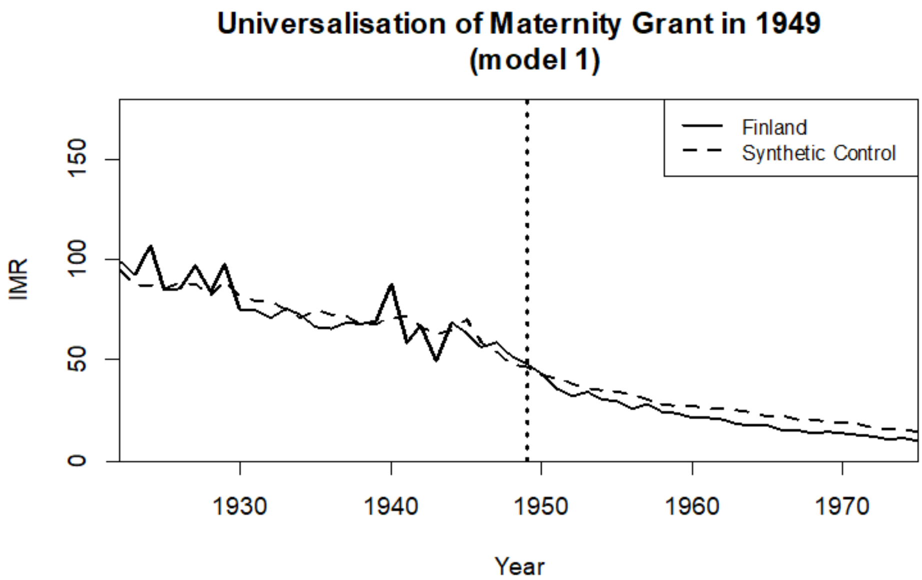

Figure 11 Main synthetic control analysis of Maternity Grant universalisation in 1949.

Solid line: Finnish infant mortality rate (IMR) between 1922 and 1975. Dashed horizontal line: synthetic Finland. Dashed vertical line: point of introduction in 1949

Both the poor intervention fit and the divergence between trends from 1950 onwards can be seen more clearly in a gap plot for the main analysis (*Figure 12* below).

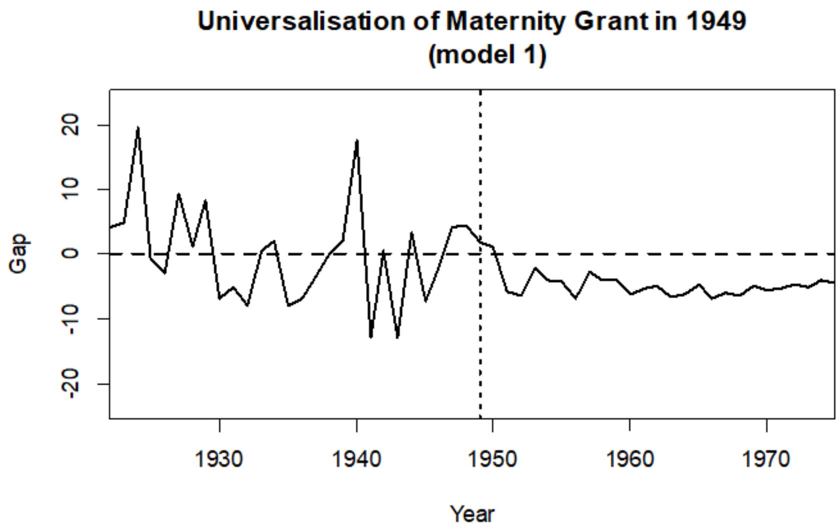

Figure 12 Gap plot for main synthetic control analysis of Maternity Grant universalisation in 1949.

Solid line: Finnish infant mortality rate (IMR) trend 1922-1975. Dashed horizontal line: Synthetic Finnish infant mortality rate (IMR) trend 1922-1975. Dashed vertical line: point of universalisation in 1949.

Sensitivity analyses

The robustness of this association was tested further through truncating the pre-intervention trend to 10 years and through reassigning exposure status to the top weighted country. Truncation did not improve model fit ($\boldsymbol{MSPE = 62.20}$), as might have been expected, and continued to show the divergence between synthetic and actual Finnish trends from 1950 onwards. Reassignment of exposure status to Belgium (top-weighted country) returned a better pre-intervention fit ($\boldsymbol{MSPE = 35.08}$), with contributions from Finland (16.7%), Netherlands (24.9%), Italy (47.8%), and Spain (10.6%). Looking at *Figure 13* below, it can be seen that there is a similar although less clear divergence between synthetic and actual IMR trends for Belgium. This suggests that the decrease in IMRs following Maternity Grant universalisation may not have been unique to Finland.

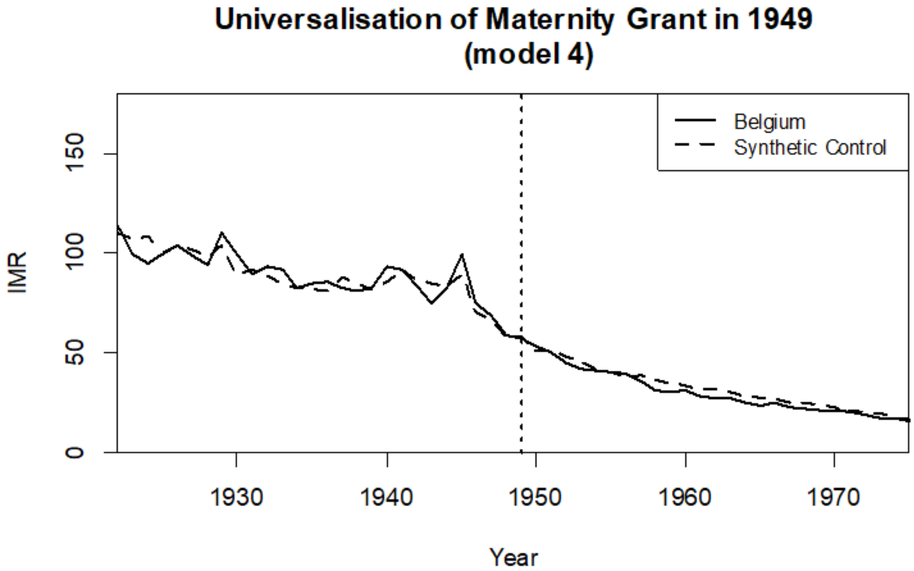

Figure 13 Synthetic control analysis of Maternity Grant universalisation in 1949 – reassignment of exposure status to Belgium (top-weighted country).

Solid line: Belgian infant mortality rate (IMR) between 1922 and 1975. Dashed horizontal line: synthetic Belgium. Dashed vertical line: point of introduction in 1949

4.6 Discussion of findings

4.6.1 Summary of findings

Maternity Grant introduction in 1938 was associated with a level increase in IMRs. This association was robust to truncation of the pre-introduction period. The SC model for Maternity Grant introduction exhibited poor pre-introduction fit as a result of outcome variability prior to 1930. IMRs were observed to be higher following introduction than predicted by the synthetic control. However, the relationship between outcome and synthetic trends at this point is not clear as SC models could not control for the 1940 wild point. Considering possible sources of history bias, the period following the introduction of the Maternity Grant was particularly tumultuous with events such as the Continuation War from 1941-1944 and the Lapland War from 1944-1945. It is conceivable that such events increased IMRs which is reflected in the estimates for Maternity Grant introduction in 1938, even after adjusting for a wild point in 1940. However, the extent to which this is the case cannot be known.

Maternity Grant universalisation in 1949 was associated with a notable level decrease in IMRs, indicating a beneficial effect. Although robust to truncation of the pre-universalisation period, the placebo intervention point of 1948 returned a similar association indicating bias. The use of a quadratic term to improve model fit in the post-universalisation period resulted in a diminished estimate, consistent with no effect (model 5). As with Maternity Grant introduction in 1938, SC models for universalisation in 1949 could not account for variability in the pre-universalisation trend and exhibited poor fit. While the SC model for universalisation did indicate a clear reduction in IMRs on what was predicted by the synthetic control, this divergence between the synthetic and actual IMR trends appeared to begin around 1950. This model was not robust to reassignment of exposure status to Belgium which suggested the divergence was not entirely unique to Finland and thus unlikely to be as a result of the Maternity Grant. Considering sources of history bias, the introduction of the Child Allowance System in 1948, the year before universalisation, likely had similar implications for infant health and is thus a notable source of possible bias. Similarly, the 1944 legislation for infant and maternal health clinics came into effect from 1945 onwards with likely implications for IMRs (e.g., 86.4% of mothers attended antenatal care in 1945 compared to just 31.3% in 1944). As a similar pattern of falling IMRs was observed in the synthetic control model of Belgium may indicate a more general pattern of falling IMRs across Europe due to the end of the upheaval and conflict of the Second World War.

There are a number of limitations to the evaluation presented in this chapter that are worth considering. It was not possible to separate the effect of the Finnish Baby Box from the broader Maternity Grant to which it belongs. A further limitation is the high variability in the outcome trend, particularly at the beginning of the study timeframes. For SC models specifically, this prevented good model fit which is necessary for assessing causal effects (Abadie and Gardeazabal, 2007). Similarly, were statistical methods considered for SC analyses, these would not have been possible due to poor model fit. Lastly, as discussed, history bias was a big obstacle in assessing the causal implications of Maternity Grant introduction and universalisation. It is conceivable that both did have a beneficial impact on IMRs, however it is likely not possible to detect this as a result of history bias. There was scope for the use of further placebo intervention points for both ITS and SC models, however this thought to be unnecessary as initial models and robustness checks did not indicate any clear effects.

4.7 Chapter summary

In this chapter I found no clear indication that either Finnish Maternity Grant introduction in 1938 or subsequent universalisation in 1949 had a causal impact on Finnish IMRs. This stands as the first use of natural experimental methods in this causal debate. Model estimates were challenged by high outcome variability in the pre-intervention periods and unaccounted for threats of history bias. That is, despite using robust causal methods and the best available data, the effect of the Maternity Grant introduction and universalisation on IMRs could not be discerned. The main implication of the research in this chapter for this thesis is to highlight that one of the main circumstantial claims of the practical argumentation surrounding the introduction of SBBS was not evidence-based. With respect to the evaluation of SBBS, the implications of the current chapter are limited owing to the particular geo-historical context of Finnish Maternity Grant introduction and universalisation. Finnish IMRs were considerably higher during this time than they are in present-day Scotland, and most low- and middle-income countries for that matter. Additionally, the causes and risk factors of infant mortality likely differ between this context and present-day Scotland. As such, if this chapter did indicate a clear effect of the Maternity Grant on infant mortality, this would be unlikely to translate to SBBS. The thesis now turns to a natural experimental evaluation of SBBS using linked-administrative health data (Chapters 5-10). Chapter 5 outlines the methodological approach taken, while Chapters 6-10 detail the findings of this evaluation.

5 Methodological approach for natural experimental evaluation of Scotland's Baby Box Scheme

5.1 Chapter overview

In Chapter 3 I provided an analysis of the political discourse surrounding the introduction of SBBS and in Chapter 4 examined the claim that the Finnish Baby Box had reduced infant mortality rates using natural experimental methods. In this chapter (Chapter 5) I outline the methodological approach taken to an evaluation of SBBS' introduction on August 15th 2017, which I view as a natural experimental event. This chapter first establishes the aim and research questions of this evaluation (Section 5.2). Following from this, I give a structured description of SBBS (Section 5.3.1) and detail the research design (Section 5.3.2), study population (Section 5.3.4), and data used in this evaluation (Section 5.3.5). Following this chapter, I present the findings of this evaluation (Chapters 6-10) before discussing the thesis as a whole (Chapter 11).

5.2 Aim and research questions

In this evaluation I aimed to investigate the causal impact of SBBS introduction of infant and maternal health. I addressed the following research questions:

1. What impact did the introduction of SBBS have on infant hospital admissions, tobacco smoke exposure, feeding, sleeping, and immunisations?

2. What impact did the introduction of SBBS have on maternal hospital admissions and tobacco smoke exposure?

3. Did the impact of SBBS' introduction on these outcomes differ by maternal age, number of previous pregnancies, and SIMD-2016 quintile?

5.3 Methods

5.3.1 The intervention

Similar to the evaluation of the Finnish Maternity Grant presented in the previous chapter (Chapter 4), the TIDieR-PHP reporting guideline from Campbell et al. (2018) was used here to give a structured description of SBBS. It is worth noting that the ordering of guideline items have been tailored and, in certain cases, combined to best facilitate a description of SBBS.

Name

The evaluation detailed in this chapter concerns the introduction of Scotland's Baby Box Scheme (or SBBS). It is often referred to as Scotland's Baby Box or, simply, in the context of Scotland, the Baby Box. Noting this context is important in distinguishing SBBS from the other policies and initiatives with similar names operating in other political and geographical contexts across the world.

Materials

SBBS materially consists of a cardboard box containing various items 'essential' to the initial months of life (Scottish Government, 2018c). These items include clothing for the new-born infant, a blanket, a bath towel, a baby wrap, toys, underarm and bath thermometers, and a voucher for reusable nappies; a full list of included items is provided in Appendix 5. The cardboard box itself is fitted with a foam mattress and is intended as a safe sleeping place for the new-born infant. Information leaflets concerning breastfeeding, safe sleeping (e.g., risk factors such as non-supine sleeping and exposure to second-hand tobacco smoke), and postnatal depression are also contained within the box. This information is also present on the Scottish Government's designated parental website – *www.parentclub.scot* – which parents are directed to upon registering for the scheme. Research conducted by the Scottish Government shortly after the introduction of SBBS suggested 54% of parents had used or were aware of the *www.parentclub.scot* website (Scottish Government, 2017d). Parents can also opt to receive regular emails from the ParentClub website upon registration

(Bardsley *et al.*, 2021). However, the exact frequency and content of these emails is not clear (although they do address topics such as breastfeeding and infant sleeping[28]).

What and how

SBBS is universally available to all mothers and new-born infants in Scotland. It was introduced nationally by the Scottish Government on August 15th 2017. A pilot scheme was conducted between January and March 2017 in the local authority areas of Clackmannanshire and Orkney. However, this was small, involving the distribution of only 160 boxes, and is thus not considered here.

Initial registration in preparation for introduction began on June 15th 2017. Mothers are assisted by midwives to register for SBBS by completing a registration card during their 20–24th week antenatal appointment. SBBS is delivered to parents between the 32nd and 36th week of pregnancy and can be cancelled at any point prior to receipt. The scheme is ongoing and, as of yet, there have been no unplanned variations and there are no planned variations to the scheme currently in the pipeline.

APS Group (Scotland) are commissioned by the Scottish Government to supply SBBS until July 2021 in a contract valued at £35.3 million. Each box, including contents and distribution, cost the Scottish Government approximately £160. The equivalent cost of the box (i.e., how much the materials would cost parents to buy independently) is of more relevance here, however, there does not appear to be any available information specifying this. Nonetheless, it is likely that the equivalent cost exceeds that of £160.

Delivery

Uptake of SBBS within the first year post-introduction was estimated by the Scottish Government to be at 85% of all new parents, rising to 96% in 2019 and 93% in 2020 (Scottish Government, 2018b, 2020b, 2020a). Registration data obtained by Bardsley et al. (2021) shows that uptake did not differ meaningfully

[28] Established through e-mail contact with Parent Club website staff.

by area level deprivation (see *Table 13*), an indication that socio-economic position does not clearly determine uptake of SBBS.

Year	Uptake (%) by SIMD quintile				
	1	2	3	4	5
2017 (15th August – 31st December)	88.1	89.6	88.0	87.1	91.1
2018	91.6	92.5	93.1	90.3	93.3
2019	91.7	92.0	91.3	88.8	91.0

Table 13 Percentage uptake of Scotland's Baby Box scheme (SBBS) by Scottish Index of Multiple Deprivation quintile.

1 indicates most deprived and 5 least deprived. Adapted from table presented in Bardsley et al. (2021: p.113, *Appendix E*).

Why

This item of the TIDieR-PHP guideline states that the logic, mechanisms, or rationale of the intervention should be described, with intervention elements clearly linked to the expected effects on immediate or longer term outcomes (Campbell *et al.*, 2018). For this I will take my lead from the Scottish Government EA logic model that was introduced prior in Section 1.4 (Scottish Government, 2018c).

This logic model specifies the hypothetical mechanisms mediating the intended short-, medium-, and long-term outcomes of SBBS, and the relationship between these outcomes. A representation of this model can be seen in *Table 14* below, describing the six short-term (S1-6), four medium-term (M1-4), and four long-term (L1-4) outcomes. This is an updated version from that presented in Section 1.4 and now highlights the outcomes which are evaluated presently and those which are not, as well as indicating which outcomes have already been evaluated elsewhere.

Looking at *Table 14*, the first short- and medium-term (S1 & M1) outcome of a "shared understanding of a society" links back to the symbolic element of SBBS discussed previously in this thesis. It is conceivable that the symbolism of SBBS could have causal implications for infant and maternal health, as noted in Section 3.6. However, I do not consider isolating such an effect here.

In the EA logic model, the medium-term outcome of “reduced inequalities in access to new-born essentials” (M2) flows from the short-term outcome of “reduced parental expenditure on new-born essentials” (S2). Both M2 and S2 conceive of SBBS functioning as a non-monetary transfer. A recent Ipsos MORI Scotland evaluation, conducted on behalf of the Scottish Government, suggested a positive impact of SBBS in relation to S2, with 91% of parents surveyed agreeing that receiving the box had saved them money on things they ‘would otherwise have had to buy’ (Bardsley *et al.*, 2021). Lending support to M2, of health professionals surveyed by Ipsos MORI Scotland, 76% agreed that SBBS is an effective means of ‘ensuring that every family has access to new-born essentials’ (ibid.). M2 is premised in the logic model on an expected high uptake of SBBS across all socio-economic groups. Indeed, the Ipsos MORI Scotland evaluation indicates this to be the case, as displayed in *Table 13* above.

Short-term outcomes		**Medium-term outcomes**		**Long-term outcomes**	
S1	Shared understanding of a society that values and supports children and families.	M1	Shared understanding of a society that values and supports children and families.	L1	Improved infant/maternal health and wellbeing outcomes.
S2	Reduced parental expenditure on new-born essentials.	M2	Reduced inequalities in access to new-born essentials.	L2	Reduced inequalities in infant/maternal health and wellbeing outcomes.
S3	Parents understand and use the box and its contents.	M3	Increased positive behaviours and reduced risk behaviours.	L3	Reduced inequalities, and improvement, in early years development outcomes.
S4	Increased parent and healthcare worker understanding of risk and positive behaviours.				

S5	Healthcare workers understand the contents and purpose of box.	M4	Sustained parental engagement with wider services.	L4	Reduced inequalities in infant mortality.
S6	Parents attempt to engage with wider services.				

Table 14 Short-, medium-, and long-term outcomes of Scotland's Baby Box scheme (SBBS). Reproduced from the logic model presented in the Scottish Government evaluability assessment (Scottish Government, 2018c: p.8, *Figure 1*). Outcomes shaded in blue denote those addressed by the evaluation presented in this thesis, while those shaded in green denote those addressed by research elsewhere.

M3 concerns "increased positive behaviours and decreased negative behaviours", referring to the following behaviours: a) safe sleeping, b) breastfeeding, c) health seeking, and d) play/attachment.

With respect to safe sleeping, this thesis empirically evaluates the impact of SBBS introduction on infant exposure to tobacco smoke (Chapter 7) and on infant sleeping position (Chapter 9). The scheme may function to influence such behaviour through the information leaflet provided within and the information available on the www.parentclub.scot website. This information specifies that the infant should only sleep in a supine position (i.e., on their back) and that the infant should not be exposed to tobacco smoke, behaviours that are known to mitigate the risk of sudden infant death syndrome (or SIDS) (Section 2.2.4). Health professionals interviewed by Ipsos MORI Scotland noted that SBBS, functioning as an educational tool, had been useful in facilitating conversations around safe sleeping and provided an opportunity to demonstrate safe sleeping practices (ibid.). If SBBS "increased positive behaviours and decreased negative behaviours" in relation to safe sleeping, we would expect to observe a decrease in tobacco smoke exposure and an increase in supine sleeping following introduction.

The box itself may also promote an alternative to co-sleeping between parent and infant, another known risk factor to safe sleeping in certain contexts (see

Section 2.2.4). The recent Ipsos MORI Scotland evaluation found that 39% of parents surveyed had used the box for infant sleeping, however it is not clear to what degree this was an alternative to co-sleeping (ibid.). Routine administrative data regarding co-sleeping, as well as other factors relating to safe sleeping (e.g., parental alcohol use), were not available and thus could not be included in this evaluation.

Linked to safe sleeping is the long-term outcome (L4) of “reducing inequalities in infant mortality”. The evaluation presented here does not evaluate the impact of SBBS on infant mortality as low IMRs in Scotland (currently 3.98 per 1000 live births) would make it difficult to detect any effect of SBBS introduction.

Another behaviour identified by outcome M3 in the EA was breastfeeding. This thesis evaluated the impact of SBBS on breastfeeding rates at different points following birth. As with safe sleeping, the scheme may function to promote breastfeeding by providing a source of information or through acting as an educational tool to aid health professionals in providing parents with support and advice. The recent Ipsos MORI Scotland evaluation found that 26% of parents surveyed felt that SBBS had helped with breastfeeding, with 66% stating that they found the inclusion of the information leaflet on breastfeeding to be very or fairly useful (ibid.). However, health professionals who were interviewed for the evaluation did not believe the scheme to have had any significant effect on breastfeeding rates; although, in some cases, it may have helped to facilitate conversations around this health behaviour. If SBBS “increased positive behaviours and decreased negative behaviours” relating to breastfeeding, we would expect to see an increase in breastfeeding rates following introduction. Routine administrative data for other possible breastfeeding outcomes (e.g., initiation) were not available.

Another medium-term outcome of SBBS identified by the EA was “sustained parental service engagement” (M4). For example, SBBS may function to promote other forms of service engagement through the provision of items such as the underarm thermometer (e.g., alerting the parent to a high temperature in the infant). The ambiguity of this outcome does not lend itself easily to evaluation. Nonetheless, the evaluation presented in this thesis used infant immunisation uptake as a proxy measure of service engagement. This outcome measure was selected on the basis that routine administrative data was relatively available and that it is intended for all infants in Scotland to engage with this service, thus lending itself to evaluation on the population level. If the introduction of SBBS increased "sustained parental [service] engagement", we would expect to see an increase in immunisation uptake that persists over time.

This thesis did not focus on play/attachment behaviours with respect to SBBS, however the Ipsos MORI Scotland evaluation found that 37% of parents surveyed 'felt they had learned about bonding with their baby through, playing, talking, and reading' as a result of the scheme (ibid.). This figure was higher among parents aged 16-24 (57%), first-time parents (46%), and parents on lower incomes (42%). Further, 52% of parents surveyed cited SBBS as encouraging play, talk, and reading with their baby at an earlier stage than otherwise would have been the case. However, findings from interviews with parents suggested that SBBS had not necessarily altered parental behaviours around play and interaction but was useful in providing additional 'tools' to help in this regard. Interviews with midwives and health visitors highlighted the perception that SBBS would help to support and reinforce the conversations with parents about play/attachment that they are already having. Items included in SBBS (e.g., playmat, baby wrap) were noted as particularly useful in this regard.

A number of short-term outcomes (S3-5) feed into M3. These outcomes are "increased parent and healthcare worker understanding of risk and positive behaviours", that "parents understand and use the box and its contents", and that "healthcare workers understand the contents and purpose of box". While the evaluation presented in this thesis did not cover these outcomes, the Ipsos MORI Scotland evaluation indicated that a majority of health professionals surveyed (e.g., health visitors, family nurses, and midwives) understood the purpose of SBBS (88%) and their role in relation to the scheme (61%) (ibid.). Only 24% of health professionals surveyed, however, believed that encouraging positive parenting behaviours was one of the main contributions of SBBS.

In the EA logic model, the medium-term outcomes collectively feed into the long-term outcomes (L1-4). While the evaluation presented in this thesis did not address the longer-term impact of SBBS (i.e., beyond two years follow-up), it nonetheless generated some insight into the long-term EA outcome of "improved infant/maternal health and wellbeing outcomes" (L1). All-cause infant and maternal hospital admissions were used as an indicator of general health outcomes. This was selected on the basis that routine administrative data was readily available and that it was broad enough to capture different forms of morbidity. If the introduction of SBBS "improved infant/maternal health and wellbeing outcomes", we might expect to see a decrease in all-cause hospital admissions among infants and mothers. That being said, it is the case that measures of all-cause hospital admissions do not exhaustively capture the broad category of "health and wellbeing outcomes". The research presented here also performed subgroup analyses between relevant socio-demographic characteristics, generating insight into possible implications for health inequalities (L2-3).

5.3.2 Research design

The introduction of SBBS was viewed as a natural experimental event and evaluated using ITS analysis. As SBBS is a universal scheme, research designs utilising a control population, whether randomly assigned or otherwise, were not an option. While regions outwith Scotland (e.g., England or Northern Ireland) could in theory provide a suitable control population, the difficulty and expense of acquiring comparable data meant this was not possible. Finding comparable data is further challenged by the fact that the data used in this evaluation are specific to Scotland and Scottish data collection systems.

ITS analysis was used in the previous chapter to evaluate the impact of the Finnish Maternity Grant on infant mortality rates (Chapter 4). As was discussed then, a comparator population is not needed to form the counterfactual. Instead, the counterfactual is formed through an extrapolation of the pre-intervention trend into the post-intervention period. The effect of the intervention is then estimated by comparison between the actual and counterfactual trend. As discussed in Chapter 4, ITS rests on the assumption that, in the absence of the intervention of interest, the pre-intervention outcome trend would continue its trajectory into the post-intervention period. Time-varying confounding is an obvious threat to this and can take the form of both instrumentation bias and history bias. Potential instrumentation bias is examined in relation to each data source used in this evaluation in Section 5.3.5.2 below, while possible sources of history bias are discussed with respect to each outcome measure in Section 5.3.5.3.

5.3.3 Public input

In the process of designing this evaluation I (Ronan McCabe) attended a postnatal group session at Drumchapel Community Centre in Glasgow on December 4th 2019, supported by a colleague (Dr Susan Patterson) from the MRC/CSO SPHSU.

This session was open to all parents, however only mothers attended on the day. Mothers were asked questions about whether they thought SBBS would have any health impact on either themselves or their child, whether they thought any impact would be felt immediately or at a later point (e.g., weeks/months after receiving SBBS), whether they thought there were any benefits as a result of SBBS not immediately linked to health (e.g., financial, service engagement), and whether they perceived SBBS as a worthwhile investment on the part of the Scottish Government.

Approximately ten mothers and their children attended the group session and were spoken to individually. Most did not think that there would be any connection between SBBS and either their own health or the health of their child; indeed, the idea that there would be seemed far-fetched to the mothers present. However, there seemed to be widespread use of SBBS' contents (e.g., the clothing, playmat, and thermometers) and it was unanimously seen as a worthwhile investment by the Scottish Government. It was not possible to ask mothers about specific outcomes, which could have been useful in informing this evaluation.

5.3.4 Study population

The study population was defined as all mother and infants of live singleton births in Scotland that occurred between August 17th 2015 and August 11th 2019. Births occurring during the week of SBBS introduction (14th to 20th August 2017) were excluded from the analysis (Section 5.3.5.6 below). Cases of multiple birth were excluded on the basis that such infants are not strictly independent observations.

5.3.5 Data

5.3.5.1 Ethics & information governance

The routine administrative data used in this study were provided by the electronic Data Research & Innovation Service (eDRIS) at Public Health Scotland. Access to these data was approved through the Public Benefit and Privacy Panel for Health and Social Care. The application to this panel entailed the completion of both a Data Protection Impact Assessment and a Data Management Plan; the former was reviewed by the University of Glasgow's Data Protection Office. Approval was conditional on the completion of valid and approved information governance (disclosure control) training. Access to and use of these data is strictly controlled by protocols governing confidentiality and disclosure. Data access was available to myself and my supervisors (PC, RD, and SVK) only. As a result public sharing of these data was not a possibility, however access may be obtained by independent researchers upon application to eDRIS. All output from these data presented in this thesis have undergone disclosure control and have been signed-off for publication by eDRIS.

5.3.5.2 Data sources

Four sources of data were used in this evaluation: Scottish Morbidity Record 01 (SMR-01), Scottish Morbidity Record 02 (SMR-02), Child Health Surveillance Programme – Pre-School (CHSP-PS), and Scottish Immunisation & Recall System (SIRS). Data from each source were requested for the full study population only.

All sources were seeded with the Community Health Index (CHI) number – a unique numeric identifier allocated to all patients in Scotland – allowing for the identification of individuals across sources. In the data extracts provided, individuals were given a unique ID derived from their CHI number to allow for deterministic linkage across extracts. Each data source will now be described in turn; further information for each source can be found on the National Data Catalogue webpage (please see: https://www.ndc.scot.nhs.uk/National-Datasets/index.asp).

With respect to instrumentation bias (e.g., changes in data collection or variable definitions between pre- and post-introduction periods or around the point of introduction), there was no indication of threat with any of the data sources used. CHSP-PS data forms did change in 2016, however this does not appear to have had any effect on data collection or variable definitions (Public Health Scotland, 2022b).

SMR-01

SMR-01 collects individual-level data on general and acute inpatient and day-case hospital activity in Scotland. SMR-01 data are regularly audited at source in Scottish hospitals to determine if recording is accurate. Two extracts were provided from SMR-01, one provided all-cause hospital admissions data for mothers (n of observations = 17, 871) and the other all-cause hospital admissions for infants (n of observations = 49, 430).

SMR-02

SMR-02 has collected individual-level data on obstetric activity (antenatal, delivery, or postnatal) in Scotland since 1975; home births, whether planned or unplanned, should also be present in these data. SMR-02 achieves a national coverage of 98% of all births and pregnancies in Scotland (The Scottish Public Health Observatory, 2020). As with SMR-01 data, SMR-02 data is regularly audited at source in Scottish hospitals to determine if recording is accurate. A single SMR-02 extract was used in this evaluation (n of observations = 207, 537) to identify the study population. The SMR-02 extract also provided covariate and negative control data (see Section 5.3.5.4).

CHSP-PS

CHSP-PS data are collected during scheduled health reviews universally provided under the Child Health Programme. CHSP-PS reviews are conducted by health visitors at ~10-days (initial), 6-8-weeks, 13-15-months, 27-30-months, and 4-5-years postpartum. These health reviews involve an assessment of infant health, development, and wider wellbeing alongside the delivery of health promotion and parenting support. Information collected differs by visit but includes whether English is first language spoke in home, ethnicity of carer present, whether the primary carer is a current smoker, whether the infant is exposed to second-hand smoke, concerns raised by carers (e.g., on feeding/diet, growth/weight, sleep, development, and physical health), infant feeding, sleeping position, hearing screening results, length and weight, development variables (e.g., gross motor, hearing, speech, and vision) and future actions; copies of the information collection forms are available at: https://www.isdscotland.org/Health-topics/Child-health/Child-Health-Programme/Child-Health-Systems-Programme-Pre-School.asp#HealthVisitor.

Three extracts were provided from the CHSP-PS data, relating to the initial review (n of observations = 203, 791), 6-8-week review (observations = 189, 959), and 13-15-month review (n of observations = 124, 748), respectively. These extracts provided valuable data on infant exposure to second-hand smoke, smoking status of the primary carer, infant feeding status, and infant sleeping position. Owing to high levels of missingness within the study population for most variables (~50%), the CHSP-PS 13–15-months extract was not utilised in this evaluation.

Percentage coverage of the CHSP-PS initial review increased very slightly by fiscal year from 97.0% to 97.2% between 2016/17 and 2017/18 (Public Health Scotland, 2022a). In the same period, percentage coverage increased in all SIMD quintiles with the exception of SIMD 4 where coverage decreased by 0.1%. Percentage coverage of the CHSP-PS 6-8-week review also increased between 2016/17 and 2017/18 from 90.5% to 91.7%, and increased in all SIMD quintiles over the same period.

SIRS

SIRS collects data on the immunisation status, in accordance with the UK childhood immunisation schedule, of children under the age of six in Scotland. Of most relevance to the evaluation of SBBS introduction, this schedule indicates that infants should receive immunisations at eight, twelve, and sixteen weeks after birth; the specific diseases immunised against at each schedule time point are displayed in *Table 15* below.

Uptake has remained high across Scotland, with completed primary courses by twelve months of age for the five-in-one vaccine (diphtheria, tetanus, pertussis, polio, and haemophilus), the pneumococcal conjugate vaccine (PCV), and the meningitis B vaccine remaining above 95% between 2017 and 2020 (Public Health Scotland, 2021). Completed courses for the rotavirus vaccine by twelve months of age were slightly lower over this time period at ~93%; a possible reason for this is the strict time window in which these vaccines should be received (Public Health Scotland, 2019).

SIRS provided a single extract giving the week of uptake post-birth for all schedule immunisations (n of observations = 207, 086). This evaluation focusses on the uptake of immunisations at the two scheduled time-points of 8- and 12-weeks post-birth. Data on scheduled immunisations at 16-weeks and beyond were also provided, however, owing to high missingness, these were not included in the evaluation.

Scheduled	**August 2017 to July 2020**
Eight Weeks	Diphtheria Tetanus Pertussis Polio Haemophilus influenzae type b Hepatitis B Pneumococcal Meningococcal group B Rotavirus gastroenteritis
Twelve weeks	Diphtheria Tetanus Pertussis Polio Haemophilus influenzae type b Hepatitis B Rotavirus gastroenteritis
Sixteen weeks	Diphtheria Tetanus Pertussis Polio Haemophilus influenzae type b Hepatitis B Pneumococcal Meningococcal group B

Table 15 United Kingdom child immunisation schedule from August 2017 to July 2020.

Information on immunisation schedules can be found at:

https://webarchive.nationalarchives.gov.uk/ukgwa/20220202010608/https://www.gov.uk/government/publications/the-complete-routine-immunisation-schedule

5.3.5.3 Outcome measures

Thirteen outcome measures were used in this evaluation. Broadly, these related to hospital admissions, tobacco smoke exposure, breastfeeding, infant sleeping position, and infant immunisation uptake. All outcome measures were aggregated by week.

Hospital admissions

Two outcome measures relating to infant hospital admissions, and two relating to maternal hospital admissions, were used. These were derived from the SMR-01 extract. These outcome measures were used as general indicators of infant and maternal health, recognising that the cause for admission is unknown. Admissions occurring within 26 weeks (6 months) and 52 weeks (1 year) were requested from eDRIS to form these outcome measures. The former was chosen on the basis that it would provide enough data for analysis (i.e., the shorter the follow-up period the less admissions) while allowing for the observation of any effects closely following receipt of SBBS. The latter was selected to capture longer term effects, although any effect of SBBS on hospital admissions was not anticipated to occur beyond a year.

1) Incidence rate of all-cause *infant* admissions (general/acute inpatient and day-case) within *26 weeks of birth*

2) Incidence rate of all-cause *infant* admissions (general/acute inpatient and day-case) within *52 weeks of birth*

3) Incidence rate of all-cause *maternal* admissions (general/acute inpatient and day-case) within *26 weeks of birth*

4) Incidence rate of all-cause *maternal* admissions (general/acute inpatient and day-case) within *52 weeks of birth*

Weekly incidence rates (i.e., the weekly number of admissions per person-week at risk) were calculated as follows:

$$\frac{N\ of\ admissions\ per\ week}{(N\ of\ persons\ observed\ per\ week\ \times \Sigma\ follow\ up\ (in\ weeks)\ per\ week)}$$

There were no immediate threats of history bias with respect to these outcome measures. However it is perhaps worth noting here the BSG-PBP (described in Section 1.3), which provides low-income families in Scotland (conditional on receipt of specific social security benefits at time of application) with a payment of £600 for a first child and £300 for any subsequent children (Scottish Government, 2020c). Applications have been taken since the December 10th 2018. It is possible that this may have had a positive general effect on infant and maternal health among the low-income families in receipt of the grant and that this effect may be evident in hospital admissions. However, as it was introduced over a year after SBBS it is not of particular concern.

Infant tobacco smoke exposure

Both outcome measures relating to tobacco smoke exposure were derived from the CHSP-PS initial visit extract and were thus recorded approximately ten days after birth. The same two variables behind these outcomes were also present in the CHSP-PS 6-8-weeks extract but were not used owing to high missingness. As discussed in Section 2.2.4, exposure to tobacco smoke is a known risk factor of SIDS, a fact that is mentioned in the supporting literature of SBBS in relation to safe sleeping practices. These outcome measures allow for the investigation of the scheme's impact on exposure to second-hand smoke and the smoking status of primary carers.

5) Prevalence of infants exposed to second-hand smoke

6) Prevalence of primary carers currently smoking

Weekly prevalence was calculated for all outcome measures as standard:

$$\frac{N\ of\ cases\ per\ week}{N\ of\ observations\ per\ week}$$

These outcome measures may be vulnerable to history bias from other interventions and phenomena affecting tobacco use. Fluctuations in the price of smoking tobacco are one possible source of bias. However, data from the Office for National Statistics does not indicate any dramatic change on previous trends in the average price of cigarettes in the UK around the point of SBBS introduction in August 2017 (Payne, 2021); perhaps most notable is an increase in the average price for 20 king size cigarettes from £9.64 in November 2017 to £9.90 in December 2017, as well as a small but noticeable decrease in the average cost by £0.28 in February 2017. Another possible source of bias is the Standardised Packaging of Tobacco Products Regulations that was phased in by the UK Government between May 20th 2016 and May 20th 2017 across the UK. This required the standardisation of tobacco packaging including colour, the removal of all branding, and the size, font, and place of brand information on the pack. However, as this was a phased policy we would be less likely to expect any impact on parental tobacco use to take the form of a step or level change. Further, the introduction period does not cross over with the introduction of SBBS although it does closely precede it. A final possible source of bias is the influence of e-cigarette use on smoking tobacco. Data from the Scottish Health Survey indicates that the prevalence of e-cigarette use among the adult Scottish population remained stable in recent years falling from 19% in 2016 and 2017 to 18% in 2018, before rising to 20% in 2019 (Scottish Government, 2020d). While this does not give any indication of tobacco use among primary carers or infant exposure to tobacco smoke, it does suggest that e-cigarettes are an unlikely source of bias.

<u>Breastfeeding</u>

Two infant feeding outcomes measures were used, one derived from the SMR-02 extract and the other from the 10-day CHSP-PS review. A breastfeeding variable was also present in the CHSP-PS 6-8-week extract, however it was excluded owing to high missingness. Breastfeeding was noted in the EA logic model as a positive behaviour that may be encouraged by SBBS (Section 5.3.1). These outcome measures allowed for the investigation into whether SBBS influenced the prevalence of breastfeeding at two different time points after birth.

7) Prevalence of exclusive breastfeeding <u>*on discharge*</u>

8) Prevalence of exclusive breastfeeding *at initial CHSP-PS review*

A possible source of history bias worthy of note here is the additional Scottish Government funding to support breastfeeding initiatives. In July 2018 £2 million was distributed to NHS boards and third sector organisations, adding to the £2.3 million the Scottish Government already provides annually to support breastfeeding (Scottish Government, 2018a). This is a sizeable increase in funding, although, as it does not lie directly after or before the introduction of SBBS, it is not of immediate concern.

Infant sleeping position

Infant sleeping outcome measures were derived from the 6-8-weeks CHSP-PS review. Supine is understood to be the safest infant sleeping position as noted and encouraged in the information provided with SBBS. These outcome measures allow for the investigation into whether SBBS had an impact on sleeping position. Three options for sleeping position (supine, prone, and side) are present on the forms used to collect data and only one is supposed to be checked by the health visitor. However, it was the case that a number of observations had multiple options checked and thus two outcome measures were derived to reflect this.

9) Prevalence of infants sleeping in supine position *only*

10) Prevalence of infants sleeping in supine position

There are no interventions or events I am aware of that would have an effect on infant sleeping position around the time of SBBS introduction.

Infant immunisation uptake

Two outcome measures were derived from the SIRS extract. These measures were intended to function as an indicator of health seeking behaviour and health-service engagement.

11) Prevalence of complete infant immunisation uptake by eight weeks

12) Prevalence of complete infant immunisation uptake by twelve weeks

These outcome measures were derived as a measure of complete uptake across vaccines scheduled at the respective timepoints of eight weeks and twelve weeks after birth.

Outcomes were derived as a combined measure of uptake across all scheduled vaccines with the exception of Hepatitis B at both scheduled time points and Rotavirus at twelve weeks. Data were not provided in the extract for the former, while the latter were excluded owing to high missingness around the point of intervention. Implausible observations were present in the data (e.g. vaccines received at week 0 after birth). A lower bound for identifying implausible observations was defined as those receiving vaccinations at less than 6 weeks after birth. This is the minimum recommended age, under exceptional circumstances, that scheduled vaccines should be administered at (UK Health Security Agency and Department of Health and Social Care, 2019). Similarly, observations indicating the infant had received their second dose less than four weeks after their first for the vaccinations included in the analysis were similarly treated as implausible observations (i.e., less than the scheduled spacing between first and second doses).

5.3.5.4 Negative controls

The purpose of negative controls is to improve confidence in findings. As Lipsitch et al. (2010) succinctly put it, negative controls aim “to reproduce a condition that cannot involve the hypothesized causal mechanism but is very likely to involve the same sources of bias that may have been present in the original association.” Two negative control outcome measures, derived from the SMR-02 extract, were used in this evaluation:

1) Weekly prevalence of mothers smoking during pregnancy

2) Weekly prevalence of mothers smoking at booking

These negative control outcome measures are used to interpret findings relating to the main outcome measures concerning exposure to tobacco smoke. The assumption made here is that the negative control outcome measures and main outcome measures are embedded within similar causal processes generally but differ specifically with respect to any causal mechanism precipitated by SBBS. Thus, hypothetically, if a decrease was observed in the outcomes concerning exposure to tobacco smoke following SBBS introduction, alongside a similar decrease in the negative controls, we may have reason to believe this effect is confounded.

5.3.5.5 Subgroups

Subgroups were defined by the variables age of mother, total previous pregnancies, and SIMD-2016 quintile, which were present in the SMR-02 extract. Ethnic group was also present in the SMR-02 extract but it was not used owing to high missingness. The following subgroups were defined as follows:

Age of mother

To minimise risk of disclosure, age of mother was provided as a categorical variable, with five bins representing ages between <18, 18-24, 25-31, 32-38, 39-44, 45-51, 52-58. This evaluation was primarily interested in the impacts on younger mothers. Three subgroups were defined by ages <25, 25-38, and >38.

Total previous pregnancies

This nominal variable gave the total number of previous pregnancies, including those where the outcome of pregnancy was abortion, therapeutic abortion, caesarean section, stillbirth, and neonatal death. A single subgroup was defined by observations with zero previous pregnancies. This was used as an indicator of first-time mothers, understanding that first-time mothers who had had previous pregnancies resulting in abortion or stillbirth would not be included in this subgroup (i.e., all members of the subgroup were first-time mothers, but not all first-time mothers were members of the subgroup).

SIMD-2016 quintiles

The Scottish Index of Multiple Deprivation (or SIMD) is an area-based measure of deprivation in Scotland. The measure demarcates ~7000 area-based ‘data zones’ that each contain approximately 700 to 800 individuals and combines a number of indicators of deprivation to rank each data zone by level of deprivation from most to least deprived. These data zones are often aggregated into quintiles where 1 indicates the 20% most deprived data zones and 5 indicates the 20% least deprived data zones. Using the 2016 version, this evaluation defined five subgroups (derived from these SIMD quintiles) to analyse the differential impact of SBBS by area deprivation.

5.3.5.6 Data processing

Step 1: defining study timeframe

The first step was to identify the study timeframe, using the SMR-02 data extract. A flow chart representing steps 1-3 is presented below in *Figure 14*.

The specific date of delivery was withheld to minimise the risk of disclosure. Instead, a *delivery* variable was given indicating the week of birth relative to the week of SBBS introduction. This was to be interpreted in conjunction with binary *cohort* variable indicating whether this week of birth occurred in the pre- or post-introduction period. A consecutive time variable in weeks was constructed using these two variables (see Section 5.3.5.7).

The SMR-02 extract provided 105 weeks of observations prior to introduction and 104 weeks following. The 105th week prior to the week of SBBS introduction (i.e., the earliest week of data provided) was excluded due to a low number of observations (n=684). Births occurring in the week of SBBS introduction were also dropped (n=1070). The rationale behind this was that it could not be certain which births occurred before or after introduction date and, further, that this would serve as a wash-in period to better delineate between those in receipt of SBBS and those not. This gave a consecutive timeframe of 208 weeks, with 104 prior to and 104 following the week of SBBS introduction. It is worth noting that these weeks are referred to in the evaluation as *weeks of birth* (or delivery) – this is not to be confused with week of pregnancy or gestation.

However, it should be noted that, for some observations around the date of introduction, exposure status as assigned here may not accurately represent treatment status. This evaluation can thus be described as an intention-to-treat analysis whereby the effect of exposure status, rather than the direct effect of SBBS, is estimated.

Step 2: defining the study population

As the study population of interest concerned only singleton live births, observations of multiple (n= 6021) or non-live (n= 39) were identified and dropped. Two instances of duplication were defined: a) where observations identical across all variables; and b) where observations were identical across *ID number* (derived from CHI number), *delivery*, and *cohort* variables but differed across other variables. For the former one observation was kept with the remaining duplicates dropped (n= 99) while, for the latter, all observations were removed as it could not be known which was authentic (n= 162).

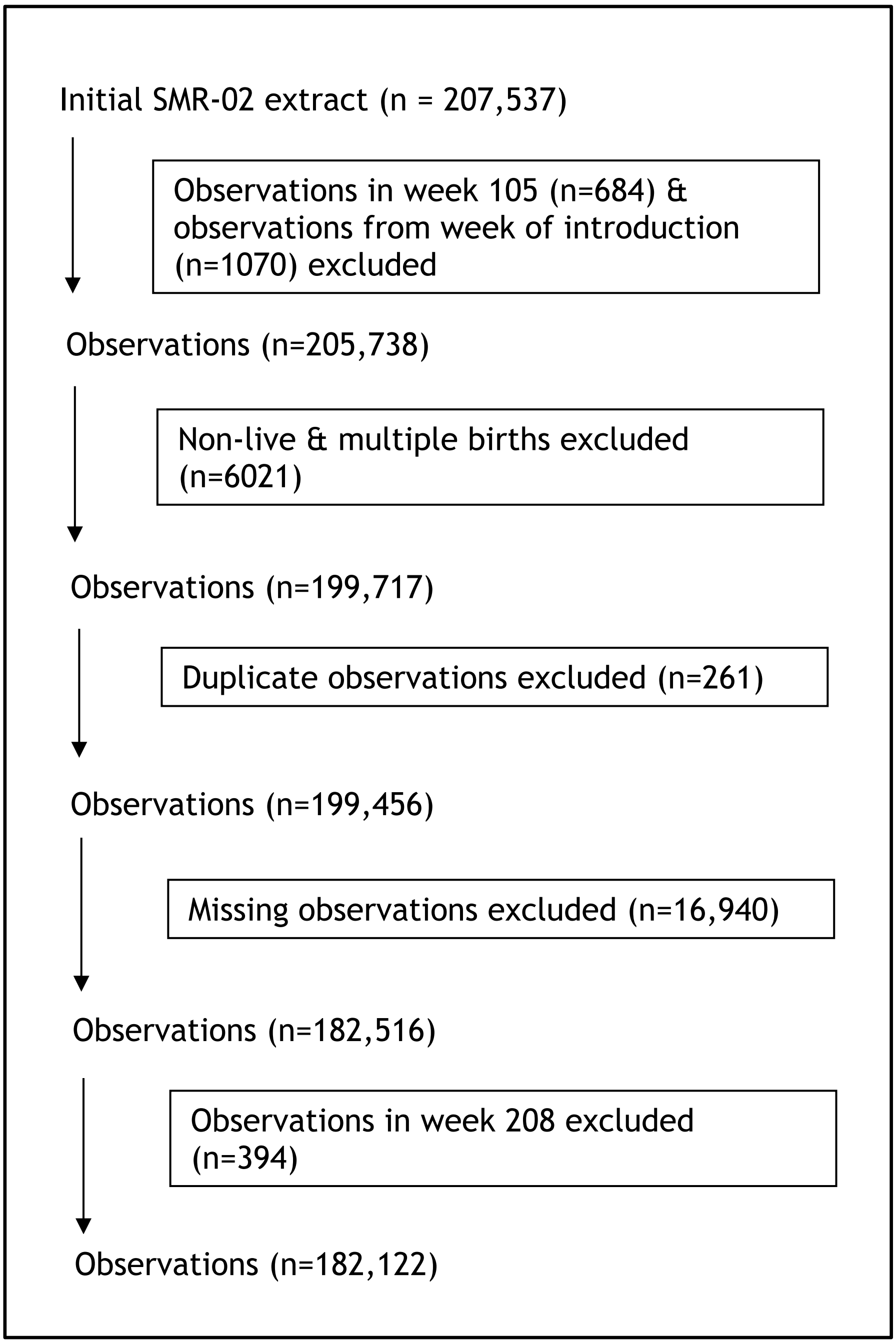

Figure 14 Initial stages (Steps 1-3) in processing of SMR-02 extract for the purposes of evaluating the introduction of Scotland's Baby Box Scheme.

Final number of observations defines the study population used in the evaluation of Scotland's Baby Box scheme.

Step 3: initial variable checking & transformations

All variables in the SMR-02 extract were checked for missingness and implausible values. Entries for each variable were checked against variable definitions, with values indicating missingness recoded as missing (see *Table 16*). Some variables were dropped from the analysis owing to high missingness (e.g. marital status). For total previous pregnancies, values greater than 15 were treated as having a higher risk of error and coded as missing (n=30). All observations with missing values were subsequently dropped (n= 16,940). However, similar to the 105th week in the initial extract, it was noticed before analysis that the number of observations in the final week of the study timeframe (week 208) were substantially lower than the number of observations at any other point (see *Figure 15*). Thus this week was dropped (n=394) to give a complete-case SMR-02 extract with 182,122 observations across a final study timeframe of 207 weeks (104 prior to week of SBBS introduction; 103 following SBBS introduction).

Variable	Transformations (n)	Number missing (%)
Sex	Values of 99 coded as missing (91)	91 (0.046)
Feed on discharge	Values of 9 (5971) & 3 (259) coded as missing	6230 (3.123)
Total previous pregnancies	Values of 99 coded as missing (1004) Values >15 treated as implausible and coded as missing (30)	1034 (0.518)
Smoking history at booking	Values of 9 coded as missing (6441)	6441 (3.229)
Smoking during pregnancy	Values of 9 coded as missing (8727)	8727 (4.375)
Ethnic group	Values of 99 & 98 coded as missing (25,225)	41360 (20.736)
Mothers age	None	0 (0)
SIMD-2016	None	346 (0.173)

Table 16 Missingness and transformations undertaken for all variables in the SMR-02 extract.

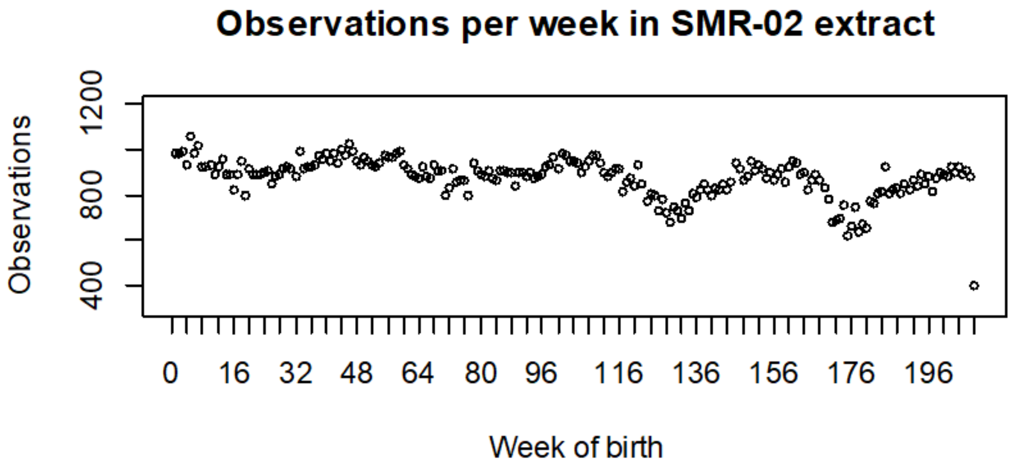

Figure 15 Observations per week of birth over the full study timeframe (week of birth 1:207) in the final SMR-02 extract (total number of observations = 182,122).

Step 4: linkage of data extracts

Prior to linkage, duplicates were identified and removed in the remaining extracts following the same two-step process as for the SMR-02 extract (*Table 17* below). The remaining extracts were then deterministically linked by *ID number* (derived from CHI number), *delivery*, and *cohort* variables to the SMR-02 extract using a left join (i.e., retaining all cases in the SMR-02 extract & dropping cases from other extracts that are not present in the SMR-02 extract).

Extract	Initial observations	Duplicates & ALL cases matching on ID variables removed	Remaining observations
SMR-01 (infant)	49,430	880	48,550
SMR-01 (maternal)	17,871	0	17,871
CHSP-PS first visit	203,791	3290	200, 501
CHSP-PS 6-8 weeks visit	189,959	5382	184,577
SIRS	207,086	6121	200,965

Table 17 Duplicates removed in each data extract prior to linkage.

Step 5: grouping & aggregation

The final step in processing data for analysis involved the aggregation of outcomes in the main and subgroup analyses. All outcomes were aggregated on a weekly basis. It is at this stage that missing and implausible observations were removed with respect to the particular outcome under evaluation (see Section 5.3.5.8).

5.3.5.7 Constructed variables

ITS variables

For the segmented regression analysis detailed in the section below, it was necessary to construct variables for time, trend, and level.

As date of birth was not provided a time variable could not be simply made through bracketing study weeks. Instead, a sequential *time* variable (in weeks) was created using the *delivery* and *cohort* variables provided in the extract (described in Section 5.3.5.6 above). The former was a nominal variable that provided a week number relative to the introduction week of SBBS (coded as 0), while the latter was a binary variable ("unexposed" or "exposed") indicating whether this week number preceded or followed the introduction week of SBBS. There were initially 105 weeks in the "unexposed" cohort, and 104 in the "exposed" cohort. Thus, when $cohort = "unexposed"$, *time* was calculated as $(delivery - 105) \times -1$ and when $cohort\ id = "exposed"$, *time* was calculated as $delivery + 104$. After week 105 of the "unexposed" cohort (now coded as *time* = 0) and the week of SBBS introduction (now coded as an additional *time* = *104*) were dropped, this provided a consecutive time series of 208 weeks (for pre-introduction period, *time* = 1 to 104; for post-introduction period, *time* = 105: to 208). Week 208 was dropped prior to analysis as indicated above. Using *time*, a *level* variable (0 for the pre-introduction period; 1 for the post-introduction period) and *trend* variable (0 for the pre-introduction period; 1 to 104 for the post-introduction period) were then created.

Infant sleeping position

Three binary sleep variables indicating infant sleeping position (supine, side, and prone) were provided in the CHSP-PS 6-8-weeks review extract. Two binary variables were created with one indicating whether supine alone was checked and the other indicating whether supine in addition to another variable was checked. Cases with missing values across all three sleep variables were coded as missing.

Infant immunisation uptake

Two binary variables were created for immunisations, one relating to immunisations scheduled at eight weeks (when all scheduled vaccines received eight weeks or before = 1, otherwise = 0) and the other relating to those scheduled at twelve weeks (when all scheduled vaccines received twelve weeks or before = 1, otherwise = 0).

5.3.5.8 Observations used in analyses

The number of observations used in each analysis is presented in *Table 18* below. For both outcome measures of primary carer current smoker and infant exposure to second-hand smoke, missingness was notably more pronounced at the beginning of the study timeframe (see Appendix 10 and Appendix 12, respectively). All analyses took a complete-case approach, whereby observations with missing values across any of the variables of interest were omitted from the study population. To minimise the loss of observations, variables with high missingness were omitted instead of the observations exhibiting missing values (see Section 5.3.5.6 above).

Outcome	Observations used (%)	Missing (%)	Excluded (%)
Infant & maternal hospital admissions	182,122 (100)	0 (0)	NA
Primary carer current smoker	177,363 (97.4)	4759 (2.6)	NA
Infant exposure to second-hand smoke	176,864 (97.1)	5258 (2.9)	NA
Current smoker at booking & smoking during pregnancy	182,122 (100)	0 (0)	NA
Exclusively breastfeeding at discharge	182,122 (100)	0 (0)	NA

Exclusively breastfeeding at ~10 days after birth	178,546 (98.0)	3576 (2.0)	NA
Infant sleeping position (supine only & supine plus)	161,108 (88.5)	21,014 (11.5)	NA
Infant immunisation uptake	176,473 (96.9)	3905 (2.1)	1st dose <6 weeks after birth: 436 (0.2) 2nd dose >4 weeks after 1st: 1308 (0.7)

Table 18 Number of observations used, missing, and excluded for each analysis.

Percentage (%) derived from the total of the study population identified in the SMR-02 extract (n=182,122).

5.3.5.9 Statistical modelling

<u>*Statistical model*</u>

All discrete and dichotomous outcomes were aggregated as a count per week of birth (B_t). A Poisson segmented regression model was fitted as follows:

$$\log(Y_t) = \beta_0 + \beta_1 \cdot time_t + \beta_2 \cdot level_t + \beta_3 \cdot trend_t + \log(B_t) + e_t$$

The offset term, $\log(B_t)$, allows the model to account for differences in the number of births between weeks of birth. As $\log(\text{rate}) = \log(Y_t/B_t) = \log(Y_t) - \log(B_t)$ (Kirkwood & Sterne, 2003: p.255-256), this model may be similarly expressed as:

$$\log(Y_t/B_t) = \beta_0 + \beta_1 \cdot time_t + \beta_2 \cdot level_t + \beta_3 \cdot trend_t + e_t$$

For the analyses presented here, Y_t denotes the mean number of events within a given week of observations. With the exception of outcomes relating to hospital admissions, the denominator (B_t) is simply the number of observations in each week of the study timeframe and thus Y_t/B_t represents prevalence (i.e., the mean number of events per observation). For hospital admissions, the denominator was instead person-weeks at risk and in such cases Y_t/B_t

represented the person-week incidence rate (i.e., the mean number of events per person per week at risk).

Following Wagner et al. (2002), $t$ime is a continuous variable indicating month of birth at time t from the start of the observation period, $\boldsymbol{level}$ is a binary variable indicating the pre- and post-introduction period (0 = pre-introduction period; 1 = post-introduction period), and $\boldsymbol{trend}$ is a continuous variable counting the week of birth from the point of SBBS introduction at time t (0 = pre-introduction period; 1, 2, 3,… *N* = post-introduction period). Thus, $\boldsymbol{\beta_0}$ gives the baseline level of the outcome at t=0 (*Y*-intercept), $\boldsymbol{\beta_1}$ estimates the change in the outcome for each week of birth (baseline trend), $\boldsymbol{\beta_2}$ estimates the immediate change in level between pre-introduction to post-introduction period, $\boldsymbol{\beta_3}$ estimates the change in trend in the post-introduction period compared to the pre-introduction period.

Relative risk, as opposed to odds ratios, is often the parameter of interest in epidemiological analysis (Zou, 2004). As such, for outcome measures that concerned prevalence, I used Poisson and quasi-Poisson models modified using sandwich estimation to compute robust standard errors (ibid.). For all models I extracted estimates of relative effect – Rate Ratios when the outcome measure was incidence rate, Relative Risk when the outcome measure was prevalence – and 95% confidence intervals. To give an indication of absolute effects, I contrasted the predicted values of models with those of their baseline trend (i.e., nullifying $\boldsymbol{\beta_2}$ and $\boldsymbol{\beta_3}$) at defined points in the post-intervention period; this was only possible for models unadjusted for seasonality. Given the common misinterpretation of *p*-values these have been avoided when presenting model outputs (Greenland *et al.*, 2016). Instead, the 95% CI is used for all model estimates to give an indication of precision alongside effect size (ibid.).

5.3.5.10 Model robustness

Over-dispersion

Models based on the Poisson distribution assume that the sample variance is equivalent to the sample mean. However, real world data are often over-dispersed with the variance exceeding the mean. This can result in an incorrect estimation of the standard errors. Quasi-Poisson models of the same form described in Section 5.3.5.9 above were used to adjust for over-dispersion.

Autocorrelation & seasonality

A further assumption of Poisson models is that observations are independent. Time series data often violates this assumption displaying autocorrelation, as consecutive observations display a higher degree of similarity than those further apart (Bernal, Cummins and Gasparrini, 2017). For administrative health data, seasonal variation in the outcome or seasonality often causes autocorrelation (this was not an issue in Chapter 4 as IMR is an annual measure). All models were checked for autocorrelation first by plotting model residuals and then through inspecting autocorrelation and partial-autocorrelation function plots. Seasonality was adjusted for through the inclusion of harmonic terms in the model; models were fitted with two sin and cosine pairs across a period of 52 weeks (approximately a year). After adjustment, models were assessed for residual autocorrelation. None of the models included in this evaluation required further adjustment for autocorrelation after adjusting for seasonality.

Truncation

Truncation of the pre-intervention trend was used in certain instances to account for missingness concentrated at the beginning of the study timeframe. This use of this robustness check is indicated where relevant in the results chapters to follow.

Placebo intervention points

Placebo intervention points were used to identify possible history bias occurring near the point of intervention where this was indicated. As before, the use of this robustness check is described where relevant in the results chapters that follow.

5.4 Chapter summary

This chapter (Chapter 5) provided a methodological overview for the natural experimental evaluation of SBBS introduction. I first gave the aim and research questions of this evaluation before providing a structured description of the scheme. This description used the logical model of the Scottish Government's EA (described previously in Section 1.4) to highlight the outcomes evaluated presently and those that have been previously evaluated elsewhere. Following this I described the study design – in which I viewed SBBS introduction as a natural experimental event to be analysed it using ITS analysis – and defined the study population. Lastly I described the data used in the evaluation including data sources, outcome measures, subgroups, data processing, and statistical modelling. I will now turn to the findings of this evaluation (Chapters 6-10). I first describe findings relating to infant and maternal hospital admissions (Chapter 6), followed by findings relating to tobacco smoke exposure (Chapter 7), breastfeeding (Chapter 8), sleeping position (Chapter 9), and infant immunisation uptake (Chapter 10).

6 Impact of Scotland's Baby Box Scheme on all-cause infant and maternal hospital admissions

6.1 Chapter overview

The previous chapter detailed the methodological approach underpinning this natural experimental evaluation of SBBS. This chapter details the findings of this evaluation as they relate to infant and maternal hospital admissions. Using ITS models, it focusses on four outcome measures (underscore and italics are used to highlight differences between measures):

1) Incidence rate of all-cause *infant* hospital admissions (general/acute inpatient and day-case) *within 26 weeks of birth*

2) Incidence rate of all-cause *infant* hospital admissions (general/acute inpatient and day-case) *within 52 weeks of birth*

3) Incidence rate of all-cause *maternal* hospital admissions (general/acute inpatient and day-case) *within 26 weeks of birth*

4) Incidence rate of all-cause *maternal* hospital admissions (general/acute inpatient and day-case) *within 52 weeks of birth*

Main and subgroup analyses are detailed in Sections 6.2, 6.3, 6.4 and 6.5 for each of the four outcome measures above. ITS models assessed both the impact of SBBS immediately following its introduction (level change) and across the study timeframe (trend change). This chapter will be followed by findings chapters as they relate to tobacco smoke exposure (Chapter 7), breastfeeding (Chapter 8), sleeping position (Chapter 9), and infant immunisation uptake (Chapter 10).

6.2 Infant admissions within 26 weeks

In this section I detail findings from the analysis of the incidence rate for all-cause *infant* hospital admissions (general/acute inpatient and day-case) occurring within *26 weeks of birth*. The full study population was used in this analysis (n of observations = 182,122).

6.2.1 Main analysis

Descriptive statistics for both number of admissions and incidence rates indicated no major divergence between pre- and post-introduction periods (*Table 19* below). The median rate was marginally higher in the post-introduction period. Additionally, there were no abnormally low or high values; note that for all counted values (e.g., number of admissions) in this evaluation, minimum and maximum are not displayed to minimise risk of disclosure. Looking at *Figure 16* above, it can be seen that the outcome trend exhibited seasonality.

Rate ratios (RR) and confidence intervals (CI) for all models in this analysis are presented in *Table 18* below. After adjusting for over-dispersion and seasonality, SBBS introduction was associated with a level decrease of 2.8% (RR = 0.9719, 95% CI: 0.9129 to 1.0346) and a minor trend increase of 0.07% (RR = 1.0007, 95% CI: 0.9998 to 1.0017) in all-cause infant hospital admissions occurring within 26 weeks of birth (model 3; *Table 20*). However, as these estimates were not significant, this is unlikely to be indicative of an effect.

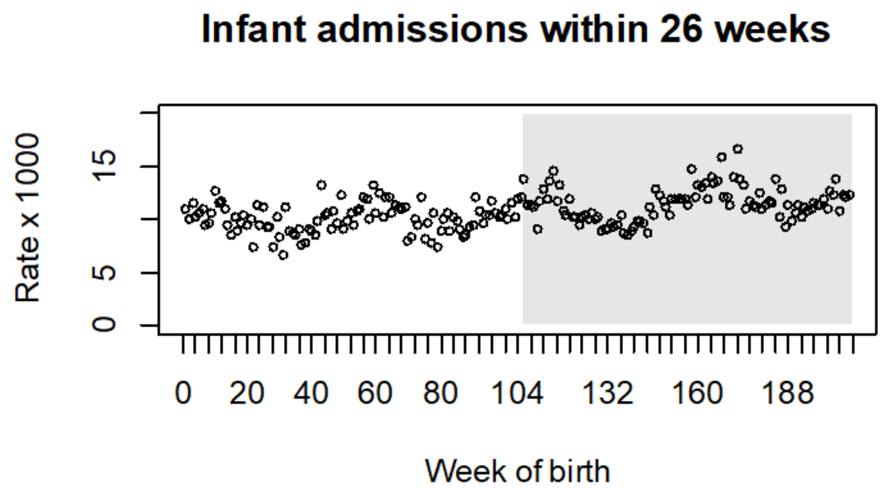

Figure 16 Incidence rate x 1000 of all-cause infant hospital admissions (general/acute inpatient and day-case) within 26 weeks of birth.

Aggregated by week of birth, over the study time period (week of birth 1 to 207). Pre- and post-introduction periods are indicated by the unshaded (week of birth 1 to 104) and shaded (week of birth 105 to 207) areas, respectively.

Measure	Study period	Min.	1st Quartile	Median	3rd Quartile	Max.
Number of admissions	Pre-introduction	-	217.0	245.0	267.5	-
	Post-introduction	-	215.5	253.0	281.0	-
Incidence rate x 1000	Pre-introduction	6.74	9.2	10.19	11.05	13.31
	Post-introduction	8.65	10.37	11.4	12.31	16.74

Table 19 Descriptive statistics relating to the outcome measure of all-cause infant hospital admissions (general/acute inpatient and day-case) within 26 weeks of birth.

Comparison of aggregated values between pre- and post-introduction periods for both number of admissions and incidence rates x 1000.

	RR (95% CI)		
	Model 1	Model 2	Model 3
level	1.0670 (1.0307 to 1.1046)	1.0670 (0.9915 to 1.1483)	0.9719 (0.9129 to 1.0346)
trend	1.0006 (1.0000 to 1.0012)	1.0006 (0.9994 to 1.0018)	1.0007 (0.9998 to 1.0017)
Dispersion	1	4.49	2.77

Table 20 Interrupted time series models for all-cause infant hospital admissions (general/acute inpatient and day-case) within 26 weeks of birth.

Rate ratios (RR) and confidence intervals (CI) for an unadjusted Poisson model (model 1), a quasi-Poisson model adjusting for over-dispersion (model 2), and a quasi-Poisson model adjusting for seasonality using harmonic terms (model 3). *Dispersion* refers to the dispersion parameter for each model, where a value >1 indicates the degree to which the model adjusts for over-dispersion in the outcome measure. Residual, ACF, and P-ACF plots for models 2 and 3 provided in Appendix 6.

6.2.2 Subgroup analyses

The introduction of SBBS was not associated with any clear differential effects on the outcome measure by maternal age, area deprivation, or number of previous pregnancies (*Table 21*). Generally, subgroup estimates lacked precision. While the mean incidence rate exhibited a clear gradient by area deprivation, there is no indication that SBBS introduction had an effect on these inequalities (*Table 22*). The mean incidence rate was observed to be higher in the post-intervention period across all SIMD-2016 quintiles (see *Table 20*).

Subgroup	Observations (%)	RR for level (95% CI)	RR for trend (95% CI)
Maternal age (years)			

<25s	33,122 (18.19)	0.9626 (0.8489 to 1.0916)	1.0011 (0.9991 to 1.0030)
25-38s	138,132 (75.85)	0.9715 (0.9026 to 1.0457)	1.0008 (0.9997 to 1.0019)
>38	10,868 (5.967)	1.0836 (0.8475 to 1.3854)	0.9985 (0.9944 to 1.0027)
Area deprivation (SIMD-2016 quintile)			
1s (most deprived)	44,818 (24.61)	0.9818 (0.8762 to 1.1001)	1.0008 (0.9991 to 1.0026)
2s	38,584 (21.19)	1.0085 (0.8874 to 1.1461)	1.0003 (0.9984 to 1.0023)
3	33,210 (18.24)	1.0000 (0.8749 to 1.1429)	0.9996 (0.9973 to 1.0018)
4	34,052 (18.7)	1.0832 (0.9417 to 1.2459)	1.0012 (0.9989 to 1.0036)
5 (least deprived)	31,458 (17.27)	1.0240 (0.8778 to 1.1946)	1.0017 (0.9991 to 1.0042)
Number of previous pregnancies			
0	60,580 (33.26)	0.9625 (0.8662 to 1.0695)	1.0006 (0.9989 to 1.0024)

Table 21 Interrupted time series models for subgroup analyses in the evaluation of all-cause infant hospital admissions (general/acute inpatient and day-case) within 26 weeks of birth.

s = adjusted for seasonality. All Rate Ratios (RR) and confidence intervals (95% CI) for level and trend are derived from quasi-Poisson models, allowing for over-dispersion.

SIMD-2016 quintile	Mean incidence rate x 1000			
	Pre-introduction	Post-introduction	Difference (post - pre)	Ratio (post / pre)
1 (most deprived)	11.10	13.09	2	1.2
2	10.78	12.69	1.9	1.2
3	9.99	10.86	0.9	1.1
4	9.55	10.78	1.2	1.1
5 (least deprived)	8.71	9.42	0.7	1.1

Table 22 Mean aggregated incidence rate x 1000 for all-cause infant hospital admissions (general/acute inpatient and day-case) within 26 weeks of birth by SIMD-2016 quintile.

Comparison between pre- and post-introduction periods. 1 = most deprived, 5 = least deprived.

6.3 Infant admissions within 52 weeks

In this section I detail the findings from the analysis of the incidence rate for all-cause *infant* hospital admissions (general/acute inpatient and day-case) occurring within *52 weeks of birth*. As before, the full study population was used (n of observations = 182,122).

6.3.1 Main analysis

There was no major divergence between pre- and post-introduction periods in number of admissions and incidence rates (*Table 23* below). Looking at *Figure 17* above, there are neither any values of concern nor seasonality in the outcome trend. With respect to the latter, this suggests that the seasonality observed for the shorter follow up period of 26 weeks did not persist over time.

After adjusting for over-dispersion, the introduction of SBBS was not associated with either a change in the level (RR = 0.9990, 95% CI: 0.9426 to 1.0588) or trend (RR = 0.9996, 95% CI: 0.9987 to 1.0006) of all-cause infant hospital admissions occurring within 52 weeks of birth (model 2; *Table 24*).

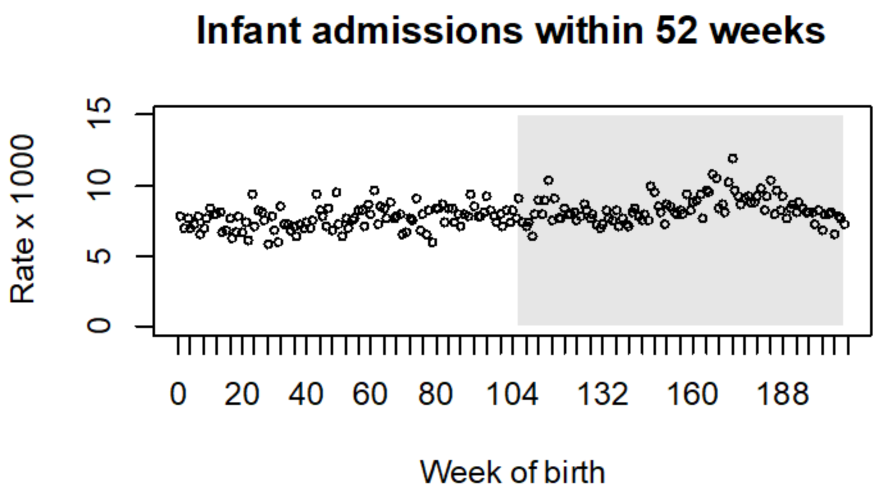

Figure 17 Incidence rate x 1000 of all-cause infant hospital admissions (general/acute inpatient and day-case) within 52 weeks of birth.

Aggregated by week of birth, over the study time period (week of birth 1 to 207). The pre- and post-introduction periods are indicated by the unshaded (week of birth 1 to 104) and shaded (week of birth 105 to 207) areas, respectively.

Measure	Study period	Min.	1st Quartile	Median	3rd Quartile	Max.
Number of admissions	Pre-introduction	-	337.0	370.0	366.9	-
	Post-introduction	-	329.0	361.0	363.9	-
Incidence rate x 1000	Pre-introduction	5.90	7.07	7.72	8.23	9.73
	Post-introduction	6.38	7.69	8.17	8.91	11.90

Table 23 Descriptive statistics relating to the outcome measure of all-cause infant hospital admissions (general/acute inpatient and day-case) within 52 weeks of birth.

Comparison aggregated values between pre- and post-introduction periods for both number of admissions and incidence rates x 1000.

	RR (95% CI)	
	Model 1	Model 2
level	0.9990 (0.9711 to 1.0277)	0.9990 (0.9426 to 1.0588)
trend	0.9996 (0.9992 to 1.0001)	0.9996 (0.9987 to 1.0006)
Dispersion	1	4.22

Table 24 Interrupted time series models for all-cause infant hospital admissions (general/acute inpatient and day-case) within 52 weeks of birth.

Rate ratios (RR) and confidence intervals (CI) for an unadjusted Poisson model (model 1) and a quasi-Poisson model adjusting for over-dispersion (model 2). *Dispersion* refers to the dispersion parameter for each model, where a value >1 indicates the degree to which the model adjusts for over-dispersion in the outcome measure. Residual, ACF, and P-ACF plots for model 2 provided in Appendix 7.

6.3.2 Subgroup analyses

The introduction of SBBS was not associated with any clear differential effects on the outcome measure by maternal age or area deprivation (*Table 25*). Among mothers who had no previous pregnancies, the introduction of SBBS was associated with a notable level decrease of 11.1% (RR = 0.8894, 95% CI: 0.8114 to 0.9749) in all-cause infant hospital admissions. This may indicate an effect of SBBS, however this association of this size was not observed for this subgroup with the shorter follow up period of 26 weeks. Considering the pathways underpinning the social determinants of health discussed previously in Section 2.2.1, it is possible that SBBS as a non-monetary transfer could have an impact on the general health of infants and consequently on rates of all-cause infant hospital admissions. However, in this instance, it is not clear why this benefit would only be present for infants of mothers who have had no previous pregnancies. The mean incidence rate per 1000 again exhibited a gradient by SIMD-2016 quintile (see Appendix 7). However, as before, SBBS introduction did not appear to have an effect on these inequalities.

Subgroup	Observations (%)	RR for level (95% CI)	RR for trend (95% CI)
Maternal age (years)			
<25	33,122 (18.19)	0.9753 (0.8732 to 1.0895)	1.0000 (0.9981 to 1.0018)
25-38	138,132 (75.85)	0.9992 (0.9357 to 1.0670)	0.9996 (0.9985 to 1.0007)
>38	10,868 (5.967)	1.0837 (0.8289 to 1.4168)	0.9994 (0.9949 to 1.0039)
Area deprivation (SIMD-2016 quintile)			
1 (most deprived)	44,818 (24.61)	0.9946 (0.9002 to 1.0989)	0.9997 (0.9980 to 1.0014)
2	38,584 (21.19)	1.0090 (0.9012 to 1.1298)	0.9997 (0.9978 to 1.0016)
3	33,210 (18.24)	0.9775 (0.8713 to 1.0966)	0.9979 (0.9959 to 0.9998)
4	34,052 (18.7)	1.0668 (0.9527 to 1.1945)	1.0003 (0.9984 to 1.0022)
5 (least deprived)	31,458 (17.27)	0.9523 (0.8219 to 1.1032)	1.0009 (0.9985 to 1.0033)
Number of previous pregnancies			
0	60,580 (33.26)	0.8894 (0.8114 to 0.9749)	0.9997 (0.9981 to 1.0012)

Table 25 Interrupted time series models for subgroup analyses of all-cause infant hospital admissions (general/acute inpatient and day-case) within 52 weeks of birth.

All rate ratios (RR) and confidence intervals (95% CI) for level and trend are derived from quasi-Poisson models, allowing for over-dispersion.

6.4 Maternal admissions within 26 weeks

In this section I detail findings from the analysis of the incidence rate for all-cause *maternal* hospital admissions (general/acute inpatient and day-case) occurring within *26 weeks of birth*. The full study population was used (n of observations = 182,122).

6.4.1 Main analysis

Descriptive statistics for number of admissions and incidence rates per 1000 showed no notable divergence between pre- and post-intervention periods (*Table 26* below). Looking at *Figure 18*, the outcome trend does not appear to exhibit any seasonality. It can be noted that incidence rates are low across the whole study timeframe.

After adjusting for over-dispersion, SBBS was associated with a small level increase of 0.1% (RR = 1.0012, 95% CI: 0.8788 to 1.1405) and a small trend increase of 0.2% (RR = 1.0022, 95% CI: 1.0000 to 1.0043) in all-cause maternal hospital admissions occurring within 26 weeks of birth (model 2; *Table 27*). Owing to their size and direction (i.e., it is unclear how SBBS would increase maternal hospital admissions), these estimates are unlikely to indicate an effect.

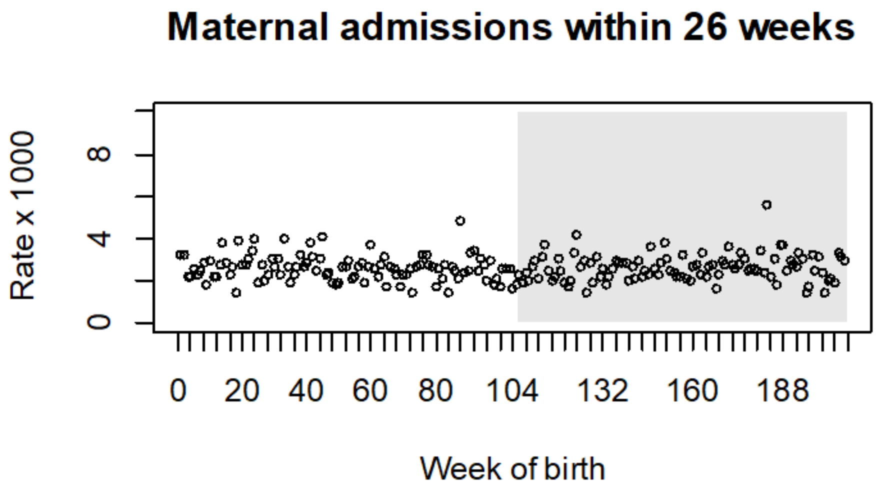

Figure 18 Incidence rate x 1000 of all-cause maternal hospital admissions (general/acute inpatient and day-case) occurring within 26 weeks of birth.

Aggregated by week of birth over the study time period (week of birth 1 to 207). The pre- and post-introduction periods are indicated by the unshaded (week of birth 1 to 104) and shaded (week of birth 105 to 207) areas, respectively.

Measure	Study period	Min.	1st Quartile	Median	3rd Quartile	Max.
Number of admissions	Pre-introduction	-	52.75	62.50	62.63	-
	Post-introduction	-	47.00	56.00	57.28	-
Incidence rate x 1000	Pre-introduction	1.42	2.24	2.62	2.90	4.84
	Post-introduction	1.40	2.21	2.58	3.01	5.57

Table 26 Descriptive statistics relating to the outcome measure of all-cause maternal hospital admissions (general/acute inpatient and day-case) within 26 weeks of birth.

Comparison of aggregated values between pre- and post-introduction periods for both number of admissions and incidence rates x 1000.

	RR (95% CI)	
	Model 1	Model 2
level	1.0012 (0.9325 to 1.0749)	1.0012 (0.8788 to 1.1405)
trend	1.0022 (1.0010 to 1.0033)	1.0022 (1.0000 to 1.0043)
Dispersion	1	3.36

Table 27 Interrupted time series models used to evaluate all-cause maternal hospital admissions (general/acute inpatient and day-case) within 26 weeks of birth.

Rate ratios (RR) and confidence intervals (CI) for an unadjusted Poisson model (model 1) and a quasi-Poisson model adjusting for over-dispersion (model 2). *Dispersion* refers to the dispersion parameter for each model, where a value >1 indicates the degree to which the model adjusts for over-dispersion in the outcome measure. Residual, ACF, and P-ACF plots for model 2 available in Appendix 8.

6.4.2 Subgroup analyses

The introduction was not associated with any differential effects on the outcome measure by maternal age, area deprivation, or number of previous pregnancies (*Table 28*). A gradient in mean incidence rates was again observed by SIMD-2016 quintile, however these analyses do not suggest SBBS had any narrowing effect with respect to these inequalities (see Appendix 8).

Subgroup	Observations (%)	RR for level (95% CI)	RR for trend (95% CI)
Maternal age (years)			
<25	33,122 (18.19)	1.1099 (0.8982 to 1.3715)	1.0016 (0.9981 to 1.0052)
25-38	138,132 (75.85)	0.9604 (0.8213 to 1.1231)	1.0021 (0.9995 to 1.0047)
>38	10,868 (5.967)	0.9812 (0.5530 to 1.7409)	1.0059 (0.9967 to 1.0152)
Area deprivation (SIMD-2016 quintile)			
1 (most deprived)	44,818 (24.61)	1.0387 (0.8532 to 1.2646)	1.0028 (0.9996 to 1.0061)
2	38,584 (21.19)	1.0427 (0.8256 to 1.3167)	1.0011 (0.9972 to 1.0049)
3	33,210 (18.24)	0.9596 (0.6858 to 1.3428)	1.0030 (0.9975 to 1.0085)
4	34,052 (18.7)	0.9360 (0.6954 to 1.2598)	1.0012 (0.9962 to 1.0061)
5 (least deprived)	31,458 (17.27)	0.9944 (0.6534 to 1.5134)	1.0027 (0.9958 to 1.0096)

Number of previous pregnancies			
0	60,580 (33.26)	0.9222 (0.7382 to 1.1521)	1.0013 (0.9976 to 1.0050)

Table 28 Interrupted time series models for subgroup analyses all-cause maternal hospital admissions (general/acute inpatient and day-case) within 26 weeks of birth.

All rate ratios (RR) and confidence intervals (95% CI) for level and trend derived from quasi-Poisson models allowing for over-dispersion. For SIMD-2016 quintile, 1 = most deprived and 5 = least deprived.

6.5 Maternal admissions within 52 weeks

In this section I detail findings from the analysis of the incidence rate for all-cause *maternal* hospital admissions (general/acute inpatient and day-case) occurring within *52 weeks after birth*. The full study population was used (n of observations = 182,122).

6.5.1 Main analysis

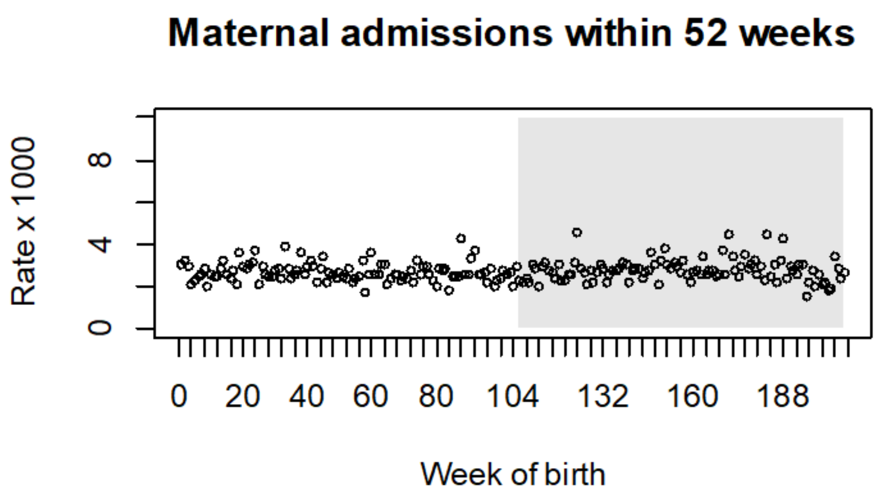

Figure 19 Incidence rate x 1000 of all-cause maternal hospital admissions (general/acute inpatient and day-case) occurring within 52 weeks of birth.

Aggregated by week of birth over the study time period (week of birth 1:207). The pre- and post-introduction periods are indicated by the unshaded (week of birth 1:104) and shaded (week of birth 105:207) areas, respectively.

Descriptive statistics for number of admissions and incidence rates were largely similar between pre- and post-introduction periods (see *Table 29*). *Figure 20* above highlights that incidents rates are low, as was the case for the shorter follow up period of 26 weeks. The outcome trend does not exhibit seasonality.

Measure	Study period	Min.	1st Quartile	Median	3rd Quartile	Max.
Number of admissions	Pre-introduction	-	115.8	126.0	128.8	-
	Post-introduction	-	101.0	118.0	121.1	-
Incidence rate x 1000	Pre-introduction	1.75	2.42	2.61	2.92	4.28
	Post-introduction	1.54	2.45	2.76	3.02	4.53

Table 29 Descriptive statistics for outcome measure of all-cause maternal hospital admissions (general/acute inpatient and day-case) within 52 weeks of birth.

It compares aggregated values between pre- and post-introduction periods for both number of admissions and incidence rates per 1000.

After adjusting for over-dispersion, the introduction of SBBS was associated with a level increase of 6.4% (RR = 1.0636, 95%: CI 0.9649 to 1.1726) in maternal hospital admissions occurring within 52 weeks of birth (model 2; *Table 30*). However, as this estimate lacked precision and its direction was contrary to what would have been expected, it is unlikely to indicate an effect of SBBS. The introduction of SBBS was also associated with a marginal trend increase (RR = 1.0006, 95% CI: 0.9989 to 1.0022).

	RR (95% CI)	
	Model 1	**Model 2**
level	1.0636 (1.0131 to 1.1167)	1.0636 (0.9649 to 1.1726)
trend	1.0006 (0.9998 to 1.0014)	1.0006 (0.9989 to 1.0022)
Dispersion	1	4.00

Table 30 Interrupted time series models used to evaluate all-cause maternal hospital admissions (general/acute inpatient and day-case) within 52 weeks of birth.

Rate ratios (RR) and confidence intervals (CI) for an unadjusted Poisson model (model 1) and a quasi-Poisson model adjusting for over-dispersion (model 2). *Dispersion* refers to the dispersion parameter for each model, where a value >1 indicates the degree to which the model adjusts for over-dispersion in the outcome measure. Residual, ACF, and P-ACF plots for model 2 provided in Appendix 9.

6.5.2 Subgroup analyses

The introduction of SBBS was not associated with any clear differential effects on the outcome measure by maternal age, area deprivation, or number of previous pregnancies (*Table 31*). As with all other analyses relating to hospital admissions, a gradient by SIMD-2016 quintile was observed within the population (see Appendix 9). However, SBBS introduction was not associated with any narrowing of these inequalities.

Subgroup	Observations (%)	RR for level (95% CI)	RR for trend (95% CI)
Maternal age (years)			
<25	33,122 (18.19)	1.1182 (0.9404 to 1.3296)	1.0016 (0.9988 to 1.0045)
25-38	138,132 (75.85)	1.0518 (0.9362 to 1.1817)	0.9999 (0.9979 to 1.0018)
>38	10,868 (6.0)	0.9078 (0.5601 to 1.4714)	1.0054 (0.9976 to 1.0133)
Area deprivation (SIMD-2016 quintile)			
1 (most deprived)	44,818 (24.61)	1.1060 (0.9652 to 1.2672)	1.0005 (0.9983 to 1.0028)
2	38,584 (21.19)	1.1246 (0.9285 to 1.3621)	1.0015 (0.9984 to 1.0047)
3	33,210 (18.24)	1.0271 (0.7958 to 1.3257)	1.0011 (0.9968 to 1.0053)
4	34,052 (18.7)	0.9938 (0.7931 to 1.2453)	0.9988 (0.9950 to 1.0026)
5 (least deprived)	31,458 (17.27)	1.0179 (0.7198 to 1.4395)	1.0004 (0.9946 to 1.0062)
Number of previous pregnancies			
0	60,580 (33.26)	0.9941 (0.8341 to 1.1847)	0.9983 (0.9953 to 1.0013)

Table 31 Interrupted time series models for subgroup analyses of all-cause maternal hospital admissions (general/acute inpatient and day-case) within 52 weeks of birth.

All rate ratios (RR) and confidence intervals (95% CI) for level derived from quasi-Poisson models allowing for over-dispersion.

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6.6 Chapter summary

In this chapter I detailed findings relating to all-cause infant and maternal hospital admissions. I used incidence rates of infant and maternal admissions, each at follow up periods of 26 and 52 weeks after birth. I viewed these measures as general indicators of infant and maternal health, whereby an associated fall in the rate of admissions would be interpreted as a beneficial effect on health. I found no evidence that the introduction of SBBS influenced either infant or maternal admissions across the Scottish population as a whole and across subgroups defined by either maternal age or area deprivation. In some instances, SBBS was associated with an increase in admissions. However, these estimates were judged to be imprecise and spurious as it was not clear how SBBS would cause a rise in all-cause hospital admissions (i.e., negatively affect general infant and maternal health). Inequalities by area deprivation were observed for all outcome measures, however there was no indication that SBBS had a narrowing effect. In the following chapter (Chapter 7) I detail findings relating to infant and maternal tobacco smoke exposure.

7 Impact of Scotland's Baby Box Scheme on infant and maternal tobacco smoke exposure

7.1 Chapter overview

In this chapter I details findings of the natural experimental evaluation of SBBS as they relate to infant and maternal tobacco smoke exposure. ITS models were used to evaluate the following outcome measures:

1) Prevalence of primary carers currently smoking

2) Prevalence of infants exposed to second-hand smoke

3) Prevalence of mothers currently smoking at booking

4) Prevalence of mothers smoking during pregnancy

Main and subgroup analyses are detailed in Sections 7.2, 7.3, 7.4 and 7.5 for each of the four outcome measures above. The latter two outcomes were treated as negative controls (see Section 5.3.5.4). ITS models assessed both the impact of SBBS immediately following its introduction (level change) and across the study timeframe (trend change).

7.2 Primary carers currently smoking

In this section I detail findings from the analysis of the prevalence of primary carers currently smoking, as recorded during the 10-day CHSP-PS review. The main analysis used 177,363 observations, with 4759 (2.61%) observations dropped due to missingness.

7.2.1 Main analysis

Descriptive statistics did not indicate any notable divergence between pre- and post-introduction periods in either the number of cases or prevalence (*Table 32*). The outcome trend did not exhibit any outlying values but indicated the presence of seasonality (*Figure 20* above).

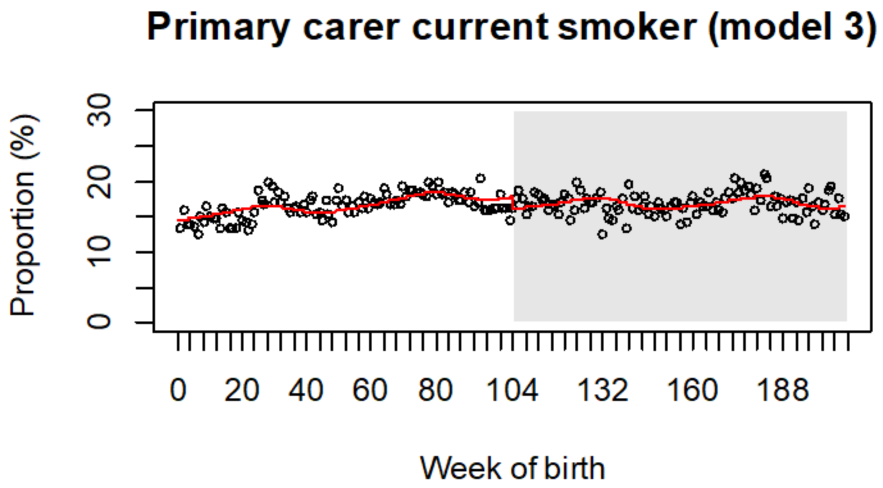


Figure 20 Proportion (%) of primary carers currently smoking as recorded during the 10-day CHSP-PS review.

Aggregated by week of birth, over the study time period (week of birth 1 to 207). The pre- and post-introduction periods are indicated by the unshaded (week of birth 1 to 104) and shaded (week of birth 105 to 207) areas, respectively. The solid red line represents the predicted trend of a model adjusted for seasonality (model 3).

After adjusting for over-dispersion and seasonality (model 3; *Table 33*), the introduction of SBBS was associated with a level decrease 9.5% (RR = 0.9051, 95% CI: 0.8623 to 0.9501) alongside a smaller trend decrease of 0.2% (RR = 0.9982, 95% CI: 0.9974 to 0.9990) in the prevalence of primary carers smoking. The predicted trend of this model is presented visually in *Figure 21* above.

This analysis suggests a beneficial effect of SBBS introduction. I used a model adjusted for over-dispersion but not seasonality (model 2; *Table 33*) to understand this effect in absolute terms. A month following SBBS introduction (109th week of birth), the prevalence of primary carers smoking was predicted to be 16.85% (95% CI: 16.30 to 17.42) compared to a baseline prevalence of 18.47% (95% CI: 17.83 to 19.17). A year following introduction (157th week of birth), prevalence was predicted to be 16.90 (95% CI: 16.60 to 17.21) compared with a baseline prevalence of 20.23 (95% CI: 19.01 to 21.52). These absolute values highlight both the immediate fall and fall over time in the prevalence of primary carers smoking.

Looking at *Figure 21* above, however, it can be seen that the actual trend falls beneath the predicted trend of the seasonally adjusted model (model 3; *Table 33*) shortly before the point of SBBS introduction. This may indicate the presence of history bias (i.e., some other event causing prevalence to fall shortly before SBBS introduction).

Measure	Study period	Min.	1st Quartile	Median	Mean	3rd Quartile	Max.
Number of cases	Pre-introduction	-	141.0	150.5	148.4	159.2	-
	Post-introduction	-	128	140	139	151	-
Prevalence (%)	Pre-introduction	12.5	15.7	16.8	16.7	18.0	20.6
	Post-introduction	12.4	15.9	17.0	16.9	17.8	21.0

Table 32 Descriptive statistics for outcome measure of primary carers currently smoking as recorded during the 10-day CHSP-PS review.

Comparison of aggregate values between pre- and post-introduction periods for both number of cases and proportion (%).

	RR (95% CI)		
	Model 1	**Model 2**	**Model 3**
level	0.9200 (0.8764 to 0.9658)	0.9200 (0.8762 to 0.9661)	0.9051 (0.8623 to 0.9501)
trend	0.9982 (0.9973 to 0.9990)	0.9982 (0.9973 to 0.9991)	0.9982 (0.9974 to 0.9990)
Dispersion	1	1.20	1.07

Table 33 Interrupted time series models used to evaluate primary carers currently smoking as recorded during the 10-day CHSP-PS review.

Relative risk (RR) and confidence intervals (CI) for an unadjusted Poisson model (model 1), a quasi-Poisson model adjusting for over-dispersion (model 2), and a quasi-Poisson model adjusting for seasonality using harmonic terms (model 3). *Dispersion* refers to the dispersion parameter for each model, where a value >1 indicates the degree to which the model adjusts for over-dispersion in the outcome measure. Residual, ACF, and P-ACF plots for models 2 and 3 are presented in Appendix 11.

7.2.2 Subgroup analyses

The introduction of SBBS was associated with level and trend decrease in the outcome across all subgroups defined by maternal age and area deprivation (*Table 34*). Prevalence exhibited a marked gradient by SIMD-2016 quintile (*Table 35*). The SBBS does not appear to have narrowed these inequalities in relative terms, however, with the associated decrease in prevalence largest among the least deprived SIMD-2016 quintile with a level decrease 20.2% (RR = 0.7981, 95%

CI: 0.6549 to 0.9725) and smallest among the most deprived quintile with a level decrease of 3.3% (RR = 0.9766, 95% CI: 0.9197 to 1.0370).

Subgroup	Observations (%)	RR for level (95% CI)	RR for trend (95% CI)
Maternal age (years)			
<25	32,203 (18.16)	0.9637 (0.8932 to 1.0398)	0.9982 (0.9969 to 0.9995)
25-38[s]	134,564 (65.87)	0.8768 (0.8287 to 0.9277)	0.9982 (0.9972 to 0.9991)
>38[d]	10,596 (5.97)	0.8676 (0.6861 to 1.0972)	0.9995 (0.9956 to 1.0035)
Area deprivation (SIMD-2016 quintile)			
1 (most deprived)	43,645 (24.61)	0.9766 (0.9197 to 1.0370)	0.9991 (0.9981 to 1.0001)
2	37,586 (21.19)	0.9205 (0.8566 to 0.9891)	0.9982 (0.9969 to 0.9995)
3	32,341 (18.23)	0.8845 (0.7970 to 0.9817)	0.9970 (0.9952 to 0.9988)
4[d]	33,154 (18.69)	0.9086 (0.7753 to 1.0649)	0.9967 (0.9939 to 0.9996)
5 (least deprived)	30,637 (17.27)	0.7981 (0.6549 to 0.9725)	0.9982 (0.9950 to 1.0015)
Number of previous pregnancies			
0	58,879 (33.20)	0.9663 (0.8763 to 1.0655)	0.9965 (0.9949 to 0.9980)

Table 34 Interrupted time series models for subgroup analyses of primary carers currently smoking, as recorded during the 10-day CHSP-PS review.

[s] = adjusted for seasonality, [d] = adjusted for over-dispersion. Unless otherwise indicated, all relative risks (RR) and confidence intervals (95% CI) were derived from Poisson models.

SIMD-2016 quintile	Mean prevalence (%)			
	Pre-introduction	Post-introduction	Difference (post - pre)	Ratio (post / pre)
1 (most deprived)	28.4	28.9	0.5	1
2	21.3	21.5	0.2	1
3	14.4	15.0	0.6	1
4	8.8	9.3	0.5	1.1
5 (least deprived)	4.8	4.9	0.1	1

Table 35 Mean aggregated prevalence (%) of primary carers currently smoking as recorded during the 10-day CHSP-PS review, stratified by SIMD-2016 quintile.

Comparison between pre- and post-introduction periods. 1 = most deprived, 5 = least deprived.

7.2.3 Sensitivity analyses

A truncated analysis was performed to account for pronounced missingness at the beginning of the study timeframe (see Appendix 10). This excluded the first 24 weeks but, after adjusting for over-dispersion and seasonality, had no major effect on the association observed in the main analysis (level RR = 0.9389, 95% CI: 0.8952 to 0.9847; trend RR = 0.9998, 95% CI: 0.9989 to 1.0007).

7.3 Exposure to second-hand smoke

In this section I detail findings from the analysis of the prevalence of infants exposed to second-hand tobacco smoke, as recorded during the 10-day CHSP-PS review. The main analysis used 176,864 observations, with 5,258 (2.9%) dropped due to missingness.

7.3.1 Main analysis

Descriptive statistics did not reveal any major divergence between pre- and post-introduction periods with respect to number of cases and prevalence (*Table 36*). Nonetheless, both the mean and median prevalence is slightly lower in the post-introduction period. The outcome trend exhibited some seasonal variation (*Figure 21*).

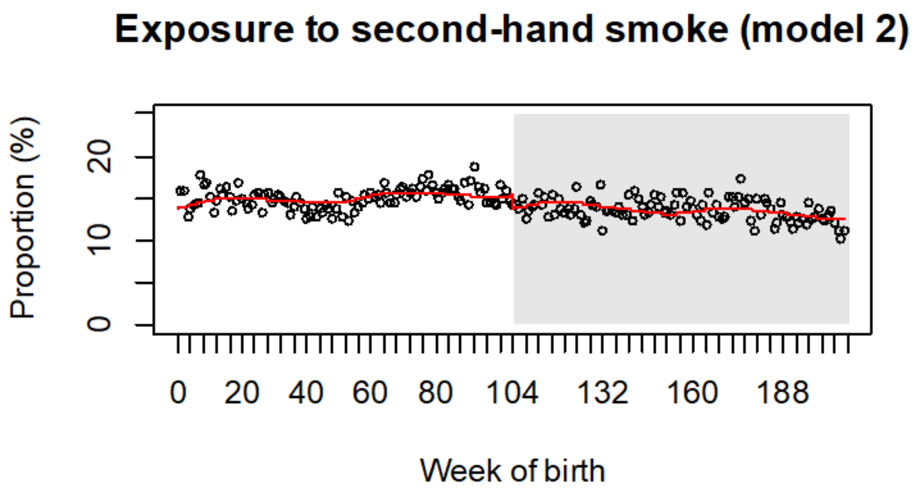


Figure 21 Proportion (%) of infants exposed to second-hand tobacco smoke as recorded during the 10-day CHSP-PS review.

Aggregated by week of birth, over the study timeframe (week of birth 1 to 207). The pre- and post-introduction periods are indicated by the unshaded (week of birth 1 to 104) and shaded (week of birth 105 to 207) areas, respectively. The solid red line represents the predicted trend of a model adjusted for seasonality (model 2).

Measure	Study period	Min.	1st Quartile	Median	Mean	3rd Quartile	Max.
Number of cases	Pre-introduction	-	125.0	135.0	132.8	139.2	-
	Post-introduction	-	102.5	110.0	112.2	122.5	-
Prevalence (%)	Pre-introduction	12.4	14.3	15.1	15.1	15.9	18.7
	Post-introduction	10.1	12.8	13.6	13.6	14.5	17.4

Table 36 Descriptive statistics for infants exposed to second-hand tobacco smoke, as recorded during the 10-day CHSP-PS review.

Comparison of aggregated values between pre- and post-introduction periods for both number of cases and proportion.

After adjusting for seasonality (model 2; *Table 37*), the introduction of SBBS was associated with a level decrease of 9.6% (RR = 0.9044, 95% CI: 0.8649 to 0.9457) and a marginal trend decrease of 0.2% (RR = 0.9981, 95% CI: 0.9974 to 0.9989) in the prevalence of infants exposed to second-hand smoke. The predicted trend of model 2 is plotted in *Figure 22* above. This analysis suggests that SBBS introduction had a beneficial effect on the prevalence of infants exposed to second-hand smoke.

In a model unadjusted for seasonality (model 1; *Table 37*), at a month following SBBS introduction (109th week of birth), this association corresponded to a predicated prevalence of 14.37% (95% CI: 13.93 to 14.83) compared to a baseline prevalence of 15.63% (95% CI: 15.11 to 16.16). At a year following introduction (157th week of birth), this association corresponded to a predicted prevalence of 13.58 (95% CI: 13.34 to 13.82) compared with a baseline prevalence of 16.17 (95% CI: 15.27 to 17.12).

	RR (95% CI)	
	Model 1	Model 2
level	0.9282 (0.8897 to 0.9684)	0.9044 (0.8649 to 0.9457)
trend	0.9981	0.9981

	(0.9973 to 0.9989)	(0.9974 to 0.9989)

Table 37 Interrupted time series models used to evaluate infants exposed to second-hand tobacco smoke, as recorded during the 10-day CHSP-PS review.

Relative risk (RR) and confidence intervals (CI) for an unadjusted Poisson model (model 1) and a Poisson model adjusted for seasonality using harmonic terms (model 2). Residual, ACF, and P-ACF plots for model 1 and 2 are presented in Appendix 13.

7.3.2 Subgroup analyses

The association observed in the main analysis held across all subgroups, with the exception of SIMD quintile 3 and 4 (*Table 38*). While the association was largest among the least deprived SIMD quintile with a 14.5% level decrease (RR = 0.8550, 95% CI: 0.6878 to 1.0627), SIMD quintiles 1 and 2 also exhibited a notable association with level decreases of 8.4% (RR = 0.9155, 95% CI: 0.8569 to 0.9781) and 10.2% (RR = 0.8978, 95% CI: 0.8306 to 0.9705). The prevalence of infant exposure to second-hand smoke showed a clear gradient by area deprivation among the study population (Table 39). Thus these estimates may indicate that the introduction of SBBS had a narrowing effect on health inequalities in both relative and absolute terms for infants exposed to second-hand smoke.

Subgroup	Observations (%)	RR for level (95% CI)	RR for trend (95% CI)
Maternal age (years)			
<25	32,017 (18.1)	0.9318 (0.8720 to 0.9958)	0.9974 (0.9961 to 0.9987)
25-38	134,277 (75.92)	0.9217 (0.8697 to 0.9769)	0.9987 (0.9977 to 0.9997)
>38	10,570 (5.98)	0.9060 (0.7234 to 1.1347)	0.9968 (0.9928 to 1.0008)
Area deprivation (SIMD-2016 quintile)			
1 (most deprived)	43,584 (24.64)	0.9155 (0.8569 to 0.9781)	0.9981 (0.9969 to 0.9993)
2	37,493 (21.2)	0.8978 (0.8306 to 0.9705)	0.9986 (0.9971 to 1.0000)
3	32,231 (18.22)	1.0337 (0.9285 to 1.1507)	0.9973 (0.9954 to 0.9992)
4[d]	33,043 (18.68)	1.0258 (0.8800 to 1.1957)	0.9991 (0.9964 to 1.0018)
5 (least deprived)	30,513 (17.25)	0.8550 (0.6878 to 1.0627)	0.9972 (0.9938 to 1.0007)

Number of previous pregnancies			
0	58,766 (33.23)	0.9224 (0.8510 to 0.9999)	0.9964 (0.9950 to 0.9979)

Table 38 Interrupted time series models for subgroup analyses of infants recorded as exposed to second-hand smoke.

[d] = adjusted for over-dispersion. Unless otherwise indicated, all relative risks (RR) and confidence intervals (95% CI) were derived from unadjusted Poisson models.

SIMD-2016 quintile	Mean prevalence (%)			
	Pre-introduction	Post-introduction	Difference (post - pre)	Ratio (post / pre)
1 (most deprived)	24.8	22.6	-2.2	0.9
2	19.2	17.6	-1.6	0.9
3	13.1	12.4	-0.7	1
4	8.4	7.6	-0.8	0.9
5 (least deprived)	4.9	4.2	-0.7	0.9

Table 39 Mean aggregated prevalence (%) of infants exposed to second-hand smoke as recorded during the 10-day CHSP-PS review by SIMD-2016 quintile.

Comparison between pre- and post-introduction periods. 1 = most deprived, 5 = least deprived.

7.3.3 Sensitivity analysis

A truncated analysis, excluding the first 24 weeks, was performed to address the missingness at the start of the study timeframe. Similar to the association observed in the main analysis, a truncated model adjusted for seasonality estimated a level decrease of 11.2% (RR = 0.8881, 95% CI: 0.8488 to 0.9292) alongside a trend decrease of 0.3% (RR = 0.9972, 95% CI: 0.9963 to 0.9981).

7.4 Smoking at booking (negative control)

The outcome measure used here was the prevalence of mothers currently smoking at booking. As this measure is derived from an SMR-02 variable, the full study population is used for this analysis (n=182,122). Descriptive statistics did not indicate any major divergence between pre- and post-introduction periods for both number of cases and proportion (*Table 40*).

Measure	Study period	Min.	1st Quartile	Median	Mean	3rd Quartile	Max.

Number of cases	Pre-introduction	-	128.8	138.5	138.4	146.0	-
	Post-introduction	-	112.5	121.0	122.0	131.5	-
Prevalence (as %)	Pre-introduction	12.0	14.2	15.0	15.1	16.1	18.9
	Post-introduction	11.3	13.5	14.4	14.6	15.6	18.4

Table 40 Descriptive statistics for mothers currently smoking at booking.

Comparison of aggregated values between pre- and post-introduction periods for both number of cases and proportion.

After adjusting for over-dispersion and seasonality (model 3; *Table 41*), the introduction of SBBS was associated with a level decrease (RR = 0.9902, 95% CI: 0.9385 to 1.0446) alongside a trend decrease (RR = 0.9992, 95% CI: 0.9984 to 1.0001) in the prevalence of smoking at booking. However, as these estimates are small and imprecise, they are not indicative any effect.

	RR (95% CI)		
	Model 1	**Model 2**	**Model 3**
level	1.0079 (0.9542 to 1.0645)	1.0079 (0.9539 to 1.0649)	0.9902 (0.9385 to 1.0446)
trend	0.9992 (0.9983 to 1.0001)	0.9992 (0.9983 to 1.0001)	0.9992 (0.9984 to 1.0001)
Dispersion	1	1.24	1.07

Table 41 Interrupted time series models used to evaluate mothers currently smoking at booking.

Relative risk (RR) and confidence intervals (CI) for an unadjusted Poisson model (model 1), a quasi-Poisson model adjusting for over-dispersion (model 2), and a quasi-Poisson model adjusting for seasonality using harmonic terms (model 3). *Dispersion* refers to the dispersion parameter for each model, where a value >1 indicates the degree to which the model adjusts for over-dispersion in the outcome measure. Residual, ACF, and P-ACF plots for models 2 and 3 are presented in Appendix 14.

7.5 Smoking during pregnancy (negative control)

This outcome measure for this analysis is the prevalence of mothers currently smoking during pregnancy. This analysis also uses the full study population (n=182,122). Descriptive statistics did not indicate any major divergence between pre- and post-introduction periods for either number of cases or proportion (*Table 42*).

Measure	Study period	Min.	1st Quartile	Median	Mean	3rd Quartile	Max.
Number of cases	Pre-introduction	-	137.0	148.5	147.4	157.0	-
	Post-introduction	-	135.5	144.0	144.1	154.0	-
Prevalence (as %)	Pre-introduction	12.6	15.1	16.0	16.0	17.0	20.3
	Post-introduction	13.5	16.1	17.1	17.3	18.5	21.9

Table 42 Descriptive statistics for mothers currently smoking at booking.

Comparison of aggregated values between pre- and post-introduction periods for both number of cases and proportion.

After adjusting for over-dispersion and seasonality (model 3; *Table 43*), the introduction of SBBS was associated with level increase of 6% (RR = 1.0597, 95% CI: 1.0083 to 1.1137) alongside a marginal trend decrease of 0.2% (RR = 0.9984, 95% CI: 0.9975 to 0.9992). This level increase is not indicative of bias, as it is in the opposite direction to the associations observed between SBBS introduction and the prevalence of primary carers smoking (Section 7.2), and SBBS introduction and the prevalence of infants exposed to second-hand smoke (Section 7.3).

	RR (95% CI)		
	Model 1	Model 2	Model 3
level	1.0744 (1.0208 to 1.1307)	1.0744 (1.0205 to 1.1311)	1.0597 (1.0083 to 1.1137)
trend	0.9984 (0.9975 to 0.9992)	0.9984 (0.9975 to 0.9992)	0.9984 (0.9975 to 0.9992)
Dispersion	1	1.23	1.09

Table 43 Interrupted time series models used to evaluate mothers smoking during pregnancy.

Relative risk (RR) and confidence intervals (CI) for an unadjusted Poisson model (model 1), a quasi-Poisson model adjusting for over-dispersion (model 2), and a quasi-Poisson model adjusting for seasonality using harmonic terms (model 3). *Dispersion* refers to the dispersion parameter for each model, where a value >1 indicates the degree to which the model adjusts for over-dispersion in the outcome measure. Residual, ACF, and P-ACF plots for models 2 and 3 are presented in Appendix 15.

7.6 Chapter summary

This chapter details the findings from the natural experimental evaluation of SBBS as they relate to infant and maternal tobacco smoke exposure. The introduction of SBBS was associated with a decrease, both immediately (level) and across time (trend), in the prevalence of primary carers smoking and infants exposed to second-hand smoke. Both of these measures were recorded during the initial CHSP-PS review, approximately ten days after birth. These associations were observed across all subgroups defined by maternal age and number of previous pregnancies.

Stark inequalities by area deprivation (SIMD-2016 quintiles) in prevalence were observed for both primary carers smoking and infants exposed to second-hand smoke. The introduction of SBBS was associated with both level and trend decreases in prevalence across all SIMD quintiles for primary carers smoking. However there was no indication that the scheme narrowed relative inequalities. For infants exposed to second-hand smoke, SBBS introduction was associated with both a level and trend decrease in prevalence for the two most deprived quintiles and the least deprived quintile. This may indicate a narrowing of relative inequalities by area deprivation, although this requires further investigation.

The two outcome measures used as negative controls – the prevalence of maternal smoking at booking and prevalence of maternal smoking during pregnancy – did not indicate that the associations observed for the other two outcome measures were biased. These results suggest that the introduction of SBBS had a beneficial effect on infant tobacco smoke exposure, reducing the prevalence of both primary carers smoking and infants exposed to second-hand tobacco smoke. In the next chapter I detail findings from the natural experimental evaluation of SBBS relating to exclusive breastfeeding (Chapter 8).

8 Impact of Scotland's Baby Box Scheme on exclusive breastfeeding

8.1 Chapter overview

In this chapter I detail the findings of the natural experimental evaluation of SBBS as they relate to exclusive breastfeeding. Two outcomes were analysed, concerning the prevalence of exclusive breastfeeding in the study population at two different time points after birth:

1) Prevalence of exclusive breastfeeding *on discharge*

2) Prevalence of exclusive breastfeeding *at initial CHSP-PS review*

Main and subgroup analyses for each outcome are detailed in Section 8.2 and Section 8.3. ITS models evaluated both the impact of SBBS immediately following introduction (level change) and across the study timeframe (trend change).

8.2 Exclusive breastfeeding on discharge

In this section I detail findings relating to prevalence of exclusive breastfeeding on discharge. The main analysis used the full study population (n = 182,122).

8.2.1 Main analysis

Descriptive statistics did not indicate any major divergence between pre- and post-introduction periods for either number of cases or prevalence (*Table 44*), although the median and mean prevalence was slightly lower in the post-introduction period. Visual inspection of the outcome trend suggested seasonal variation (*Figure 22*).

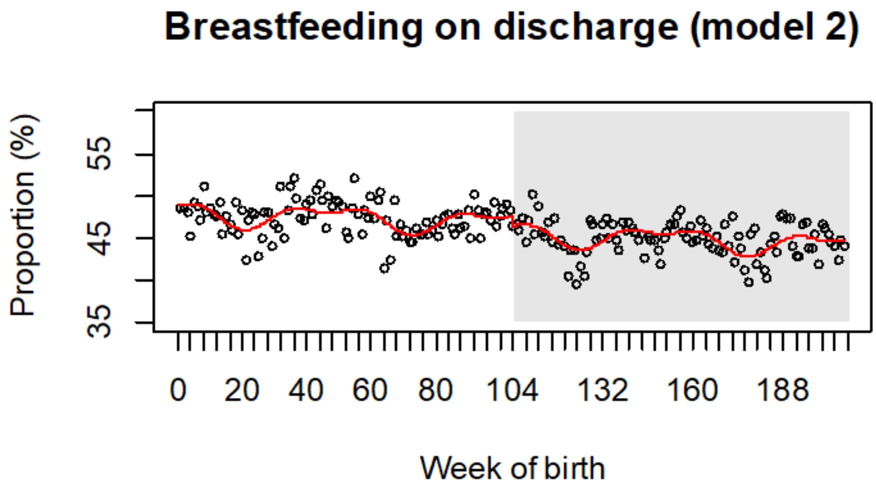


Figure 22 Proportion (%) of mothers exclusively breastfeeding on discharge.

Aggregated by week of birth, over the study time period (week of birth 1 to 207). The pre- and post-introduction periods are indicated by the unshaded (week of birth 1 to 104) and shaded (week of birth 105 to 207) areas, respectively. The solid red line represents the predicted trend of a model adjusted for seasonality (model 2).

Measure	Study period	Min.	1st Quartile	Median	Mean	3rd Quartile	Max.
Number of cases	Pre-introduction	-	415.8	434.5	436.8	465.2	-
	Post-introduction	-	354.0	377.3	377.3	408.0	-
Prevalence (%)	Pre-introduction	41.5	46.0	47.6	47.4	48.7	52.0
	Post-introduction	39.4	43.8	45.0	44.9	46.6	50.1

Table 44 Descriptive statistics for mothers exclusively breastfeeding on discharge.

Comparison of aggregated values between pre- and post-introduction periods for both number of cases and proportion (%).

After adjusting for seasonality (model 2; *Table 45*), the introduction of SBBS was associated with a level decrease of 2.3% (RR = 0.9765, 95% CI: 0.9552 to 0.9982) and a marginal trend decrease (RR = 0.9999, 95% CI: 0.9996 to 1.0003). If this association was causal, it would suggest that SBBS introduction had a negative impact on exclusive breastfeeding on discharge. The predicted trend for model 2 is presented in *Figure 22* above.

	RR (95% CI)	
	Model 1	Model 2

level	0.9705 (0.9489 to 0.9926)	0.9765 (0.9552 to 0.9982)
trend	0.9999 (0.9996 to 1.0003)	0.9999 (0.9996 to 1.0003)

Table 45 Interrupted time series models used to evaluate mothers exclusively breastfeeding on discharge.

Relative risk (RR) and confidence intervals (CI) for an unadjusted Poisson model (model 1) and a Poisson model adjusting for seasonality using harmonic terms (model 2). Residual, ACF, and P-ACF plots for model 1 are presented in Appendix 16.

8.2.2 Subgroup analyses

The introduction of SBBS was associated with an immediate increase in the prevalence of exclusive breastfeeding on discharge among mothers aged <25 years and mothers in SIMD quintile 3, however both estimates lacked precision (*Table 46*). Mirroring the main analysis, SBBS introduction was associated with an immediate fall in prevalence for the remainder of the subgroups. For example, prevalence fell by 3.1% among mothers aged 25-38 years (RR = 0.9685, 95% CI: 0.9446 to 0.9930), 8% among mothers in the second most deprived SIMD quintile (RR = 0.9197, 95% CI: 0.8782 to 0.9633), and 4.4% among mothers with no previous pregnancies (RR = 0.9555, 95% CI: 0.9246 to 0.9874). Prevalence of exclusive breastfeeding at discharge exhibited a clear gradient by area deprivation in the study population, with the mean prevalence among the least deprived quintile twice that of the most deprived quintile in both pre- and post-intervention periods (*Table 47*). The is no indication that the introduction of SBBS narrowed these inequalities.

Subgroup	RR for level (95% CI)	RR for trend (95% CI)
Maternal age (years)		
<25	1.0222 (0.9565 to 1.0925)	0.9997 (0.9985 to 1.0009)
25-38	0.9685 (0.9446 to 0.9930)	0.9999 (0.9996 to 1.0003)
>38	0.9765 (0.9070 to 1.0515)	1.0000 (0.9988 to 1.0012)
Area deprivation (SIMD-2016 quintile)		
1 (most deprived	0.9913 (0.9399 to 1.0455)	1.0003 (0.9993 to 1.0012)
2	0.9197 (0.8782 to 0.9633)	1.0002 (0.9994 to 1.0010)
3	1.0167 (0.9744 to 1.0609)	1.0000 (0.9993 to 1.0007)
4	0.9489 (0.9116 to 0.9877)	0.9996 (0.9989 to 1.0002)
5[s] (least deprived)	0.9658 (0.9312 to 1.0016)	0.9997 (0.9992 to 1.0002)
Number of previous pregnancies		

0s	0.9555 (0.9246 to 0.9874)	1.0003 (0.9999 to 1.0008)

Table 46 Interrupted time series models for subgroup analyses of mothers exclusively breastfeeding on discharge.

s = model adjusted for seasonality. All relative risks (RR) and 95% confidence intervals (95% CI) derived from unadjusted Poisson models.

SIMD-2016 quintile	Mean prevalence (%)			
	Pre-introduction	Post-introduction	Difference (post - pre)	Ratio (post / pre)
1 (most deprived)	30.5	28.9	-1.6	0.9
2	40.5	37.6	-2.9	0.9
3	49.8	48.2	-1.6	1
4	58.9	55.1	-3.8	0.9
5 (least deprived)	65.7	61.8	-3.9	0.9

Table 47 Mean prevalence of mothers exclusively breastfeeding at discharge by SIMD-2016 quintile.

Comparison between pre- and post-introduction periods. 1 = most deprived and 5 = least deprived.

8.3 Exclusive breastfeeding at 10-days

In this section I detail findings relating to the prevalence of exclusive breastfeeding, as recorded during the 10-day CHSP-PS review. The main analysis used 178,546 observations, with 3,576 (1.96%) dropped due to missingness.

8.3.1 Main analysis

Descriptive statistics were similar between pre- and post-intervention periods for both number of cases and prevalence (*Table 48*), while inspection of the outcome trend indicated possible seasonality (*Figure 23*).

After adjusting for seasonality (model 2; *Table 49*), the introduction of SBBS was not clearly associated with a level (RR = 1.0041, 95% CI: 0.9778 to 1.0312) or trend (RR = 1.0002, 0.9997 to 1.0006) change in the prevalence of exclusive breastfeeding.

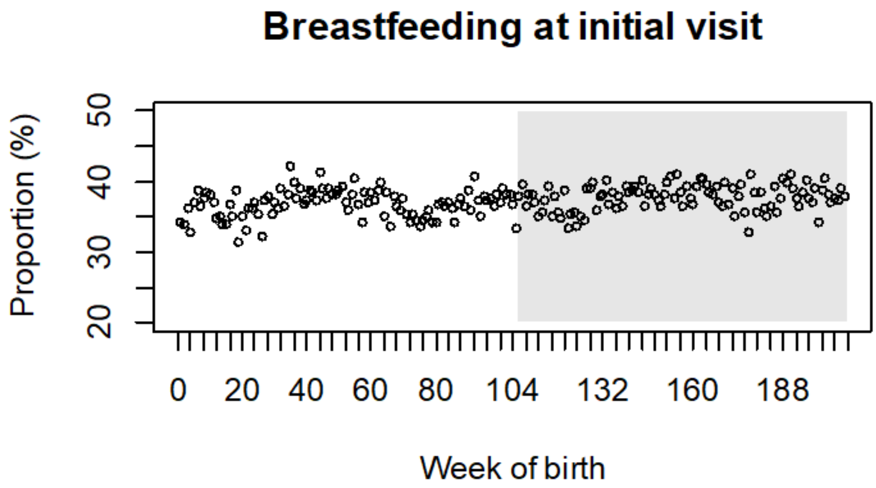


Figure 23 Proportion (%) of mothers exclusively breastfeeding at the 10-day (initial) CHSP-PS visit.

Aggregated by week of birth, over the study time period (week of birth 1 to 207). The pre- and post-introduction periods are indicated by the unshaded (week of birth 1 to 104) and shaded (week of birth 105 to 207) areas, respectively.

Measure	Study period	Min.	1st Quartile	Median	Mean	3rd Quartile	Max.
Number of cases	Pre-introduction	-	315.5	332.5	332.3	350.2	-
	Post-introduction	-	291.5	315.0	311.6	339.0	-
Prevalence (%)	Pre-introduction	31.4	35.5	37.0	36.9	38.2	42.2
	Post-introduction	32.8	36.4	38.1	37.8	39.2	41.1

Table 48 Descriptive statistics for mothers exclusively breastfeeding at the 10-day CHSP-PS review.

Comparison of aggregated values between pre- and post-introduction periods for both number of cases and proportion.

	RR (95% CI)	
	Model 1	Model 2
level	0.9929 (0.9678 to 1.0187)	1.0041 (0.9778 to 1.0312)
trend	1.0002 (0.9997 to 1.0006)	1.0002 (0.9997 to 1.0006)

Table 49 Interrupted time series models used to evaluate exclusive breastfeeding at the 10-day CHSP-PS review.

Relative risk (RR) and confidence intervals (CI) for an unadjusted Poisson model (model 1) and a Poisson model adjusting for seasonality using harmonic terms (model 2). Residual, ACF, and P-ACF plots for models 1 and 2 are presented in Appendix 17.

8.3.2 Subgroup analyses

The introduction of SBBS exhibited no clear association with the outcome measure in subgroups defined by area deprivation or number of previous pregnancies, with estimates lacking precision (*Table 50*). Inequalities by area deprivation were observed, however there is nothing to suggest these were narrowed by the scheme (see Appendix 17). With respect to subgroups defined by maternal age, SBBS introduction was associated with a 9.5% level increase (RR = 1.0951, 95% CI: 1.0040 to 1.1945) in the prevalence of exclusive breastfeeding among mothers aged <25 years. This association was not observed in other age groups. Viewing this association in absolute terms, the predicted prevalence (20.99, 95% CI: 19.68 to 22.38) a month following SBBS introduction was not substantially higher than the baseline prevalence at the same point in the post-introduction period (19.19, 95% CI: 17.84 to 20.65). It is unclear if this association represents an effect of SBBS but could potentially have important implications for inequalities, as the prevalence of exclusive breastfeeding was observed to exhibit a gradient by age group (*Table 51*).

Subgroup	Observations (%)	RR for level (95% CI)	RR for trend (95% CI)
Maternal age (years)			
<25	29,466 (17.84)	1.0951 (1.0040 to 1.1945)	0.9997 (0.9982 to 1.0012)
25-38[s]	125,789 (76.16)	0.9907 (0.9627 to 1.0194)	1.0002 (0.9997 to 1.0006)
>38	9,902 (6.00)	0.9923 (0.9108 to 1.0810)	1.0003 (0.9989 to 1.0018)
Area deprivation (SIMD-2016 quintile)			
1 (most deprived)	40,229 (24.36)	0.9923 (0.9350 to 1.0533)	1.0002 (0.9992 to 1.0013)
2	34,981 (21.18)	0.9418 (0.8834 to 1.0039)	0.9997 (0.9986 to 1.0008)
3	30,234 (18.31)	1.0250 (0.9753 to 1.0773)	0.9998 (0.9989 to 1.0006)
4	31,029 (18.79)	0.9861 (0.9409 to 1.0335)	1.0005 (0.9997 to 1.0012)
5 (least deprived)	28,684 (17.37)	0.9894 (0.9474 to 1.0332)	1.0004 (0.9997 to 1.0011)
Number of previous pregnancies			
0	54,929 (33.26)	0.9758 (0.9291 to 1.0249)	1.0007 (0.9999 to 1.0014)

Table 50 Interrupted time series models for subgroup analyses of exclusive breastfeeding on discharge.

[s] = model adjusted for seasonality. All relative risks (RR) and 95% confidence intervals (95% CI) derived from Poisson models.

	Mean prevalence (%)

Maternal age (years)	Pre-introduction	Post-introduction	Difference (post - pre)	Ratio (post / pre)
<25	12.9	14.8	1.9	1.1
25-38	34.1	35.4	1.3	1
>38	39.3	40.6	1.3	1

Table 51 Mean prevalence of mothers exclusively breastfeeding at discharge by maternal age. Comparison between pre- and post-introduction periods.

8.4 Chapter summary

In this chapter I detailed findings as they relate to the prevalence of exclusive breastfeeding at two separate time points. The introduction of SBBS was associated with a small decrease in prevalence on discharge across the Scottish population as a whole and across the majority of subgroups as defined by area deprivation, maternal age, and number of previous pregnancies. While it has been hypothesised that baby boxes could have a negative effect on breastfeeding through promoting certain behaviours such separate sleeping (Blair et al., 2010; Bartick et al., 2018), it is unlikely that SBBS would have an effect on these behaviours prior to any use of the box at home. This association with exclusive breastfeeding was also not observed on either whole population or subgroup levels when measured at the initial CHSP-PS review – at which point infants had been at home for approximately ten days – suggesting the association may be spurious. Inequalities by area deprivation were observed for both outcome measures, however there was no evidence that the introduction of SBBS had any narrowing effect. Inequalities were also observed by maternal age. SBBS introduction was associated with an immediate increase in the prevalence of exclusive breastfeeding among young mothers (aged <25 years) at the initial CHSP-PS visit. However, being an isolated association, it is questionable whether this reflects an effect of the scheme. In summary, there is no clear evidence of an effect of SBBS introduction on exclusive breastfeeding. In the next chapter I detail findings of the natural experimental evaluation of SBBS as they relate to infant sleeping position (Chapter 9).

9 Impact of Scotland's Baby Box Scheme on infant sleeping position

9.1 Chapter overview

In this chapter I detail findings of the natural experimental evaluation of SBBS relating to infant sleeping position. ITS models were used to analyse two outcome measures:

1) Prevalence of infants sleeping in supine position *only*

2) Prevalence of infants sleeping in supine position

Main and subgroup analyses for each outcome are detailed in Section 9.2 and Section 9.3. The analysis of supine plus in Section 9.3 is treated as a sensitivity analysis. ITS models evaluated both the impact of SBBS immediately following its introduction (level change) and across the study timeframe (trend change).

9.2 Supine only

In this section I detail findings relating to the prevalence of infants sleeping in supine position only, as recorded during the 6-8-week CHSP-PS review. The main analysis used 161,108 observations, with 21,014 (11.54%) excluded due to missingness.

9.2.1 Main analysis

Descriptive statistics did not indicate any major divergence between pre- and post-introduction periods for number of cases and prevalence (*Table 52*). The median prevalence was slightly higher in the post-introduction period, while the range of prevalence was largely similar. Prevalence was notably high (>90%). There was no indication of seasonality in the outcome trend (*Figure 24*).

As there was no evidence of either over-dispersion or seasonality, this analysis involved a single unadjusted model (model 1; *Table 53*). The introduction of SBBS was not clearly associated with any level (RR = 1.0044, 95% CI: 0.9989 to

1.0099) or trend (RR = 0.9999, 95% CI: 0.9998 to 1.0000) change in the prevalence of supine sleeping following SBBS introduction.

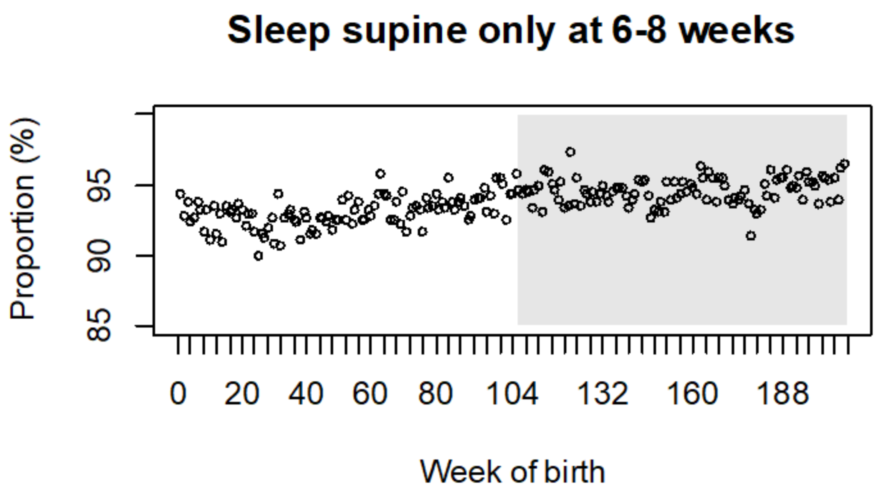


Figure 24 Proportion (%) of infants sleeping in supine position only at the 6-8-week CHSP-PS review.

Aggregated by week of birth, over the study time period (week of birth 1 to 207). The pre- and post-introduction periods are indicated by the unshaded (week of birth 1 to 104) and shaded (week of birth 105 to 207) areas, respectively.

Measure	Study period	Min.	1st Quartile	Median	Mean	3rd Quartile	Max.
Number of cases	Pre-introduction	-	725.2	752.0	751.9	775.0	-
	Post-introduction	-	676.5	725.0	708.6	753.0	-
Prevalence (%)	Pre-introduction	90.3	92.5	93.1	93.1	93.9	95.8
	Post-introduction	91.4	94.0	94.7	94.6	95.4	97.3

Table 52 Descriptive statistics for infants sleeping in supine position only at the 6-8-week CHSP-PS review.

Comparison of aggregated values between pre- and post-introduction periods for both number of cases and proportion.

	RR (95% CI)
	Model 1
level	1.0044 (0.9989 to 1.0099)
trend	0.9999 (0.9998 to 1.0000)

Table 53 Interrupted time series model used to evaluate the prevalence of infants sleeping in the supine position only, as recorded at the CHSP-PS 6-8-week review.

Relative risk (RR) and confidence intervals (CI) for a single unadjusted Poisson model (model 1). Residual, ACF, and P-ACF plots for model 1 are presented in Appendix 18.

9.2.2 Subgroup analyses

There was no clear indication that the introduction of SBBS affected the prevalence of supine sleeping across subgroups defined by maternal age, area deprivation, or number of previous pregnancies (*Table 54*). Unlike other outcome measures used in this evaluation, there was no obvious gradient in prevalence by area deprivation (see Appendix 18).

Subgroup	Observations (%)	RR for level (95% CI)	RR for trend (95% CI)
Maternal age (years)			
<25	28,682 (17.8)	1.0059 (0.9939 to 1.0180)	1.0000 (0.9998 to 1.0002)
25-38[s]	122,749 (76.2)	1.0010 (0.9946 to 1.0074)	0.9998 (0.9997 to 0.9999)
>38	9,677 (6.0)	0.9933 (0.9748 to 1.0121)	0.9997 (0.9994 to 1.0001)
Area deprivation (SIMD-2016 quintile)			
1	39,270 (24.4)	1.0038 (0.9940 to 1.0137)	0.9999 (0.9997 to 1.0001)
2	34,134 (21.2)	1.0037 (0.9933 to 1.0142)	0.9999 (0.9997 to 1.0000)
3	29,473 (18.3)	1.0016 (0.9899 to 1.0134)	0.9999 (0.9997 to 1.0001)
4	30,209 (18.7)	1.0051 (0.9922 to 1.0181)	0.9999 (0.9997 to 1.0001)
5	28,022 (17.4)	1.0083 (0.9964 to 1.0205)	0.9998 (0.9996 to 1.0000)
Number of previous pregnancies			
0	53,605 (33.3)	1.0008 (0.9935 to 1.0082)	0.9998 (0.9997 to 0.9999)

Table 54 Interrupted time series models for subgroup analyses of infants sleeping in supine position only at the 6-8-week CHSP-PS review.

[s] = adjusted for seasonality. All relative risk (RR) and 95% confidence intervals (95% CI) derived from Poisson models. For SIMD-2016 quintile, 1 = most deprived and 5 = least deprived.

9.3 Sensitivity analysis

Sleep binary variables	Yes	No	Proportion (%)
Supine only	151,186	9,922	93.8
Supine plus	153,904	7,204	95.5

Table 55 Number of cases and proportion (%) within the study population reporting supine only versus those reporting supine in addition to another sleeping position (supine plus).

Proportion derived from total study population (n=161,108).

I viewed this analysis as a sensitivity to the one prior (Section 9.2), as it includes observations who reported supine sleeping in addition to another position (*Table 55*). After adjusting for seasonality, the introduction of SBBS was not observed to be associated with any noteworthy change in the level (RR = 1.0021, 95% CI: 0.9972 to 1.0071) or trend (RR = 0.9999, 95% CI: 0.9998 of 1.0000) of prevalence. In line with the previous analysis, this suggests that the introduction of SBBS had no effect on infant sleeping position.

9.4 Chapter summary

In this chapter I detailed findings of the natural experimental evaluation of SBBS relating to infant sleeping position. The introduction of SBBS was not associated with any change in the prevalence of sleeping position (measured approximately six to eight weeks after birth) among the Scottish population as a whole or among subgroups defined by maternal age, area deprivation, or number of previous pregnancies. Prevalence was observed to be notably high (>90%) and, unlike previous outcome measures used in this evaluation, there was no indication of inequalities by area deprivation. I will now present the final findings chapter (Chapter 10) in which I detail findings as they relate to infant immunisation uptake. Following this, I will provide a discussion of both the findings from the natural experimental evaluation of SBBS and of the thesis as a whole (Chapter 11).

10 Impact of Scotland's Baby Box Scheme on infant immunisation uptake

10.1 Chapter overview

In this chapter I detail findings from the natural experimental evaluation of SBBS relating to infant immunisation uptake. ITS models were used to evaluate two outcome measures:

1) Prevalence of complete infant immunisation uptake by eight weeks

2) Prevalence of complete infant immunisation uptake by twelve weeks

Main and subgroup analyses for each are detailed in 10.2 and 10.3. ITS models estimated both the impact of SBBS immediately following its introduction (level change) and across the study timeframe (trend change). Main analyses for both outcome measures used 176,473 (96.90%) observations with 3,905 (2.14%) excluded due to missingness, 436 (0.24%) excluded as their 1st dose was received at less than six weeks after birth, and 1,308 (0.71%) excluded on the basis that their 2nd dose was received less than four weeks after the 1st.

10.2 Complete immunisation by eight weeks

In this section I detail findings relating to the prevalence of complete immunisation by the scheduled immunisation point of eight weeks after birth.

10.2.1 Main analysis

The median and mean prevalence were notably higher in the post-introduction period (*Table 56*). The range of prevalence was right-skewed and, looking at a plot of the outcome trend, it can be seen that there are a number of outlying values (*Figure 25*). These outliers appear to occur on an annual basis, but do not exhibit the classic waveform of seasonality (investigated in Section 10.2.3); aside from these outliers, the outcome trend appears linear.

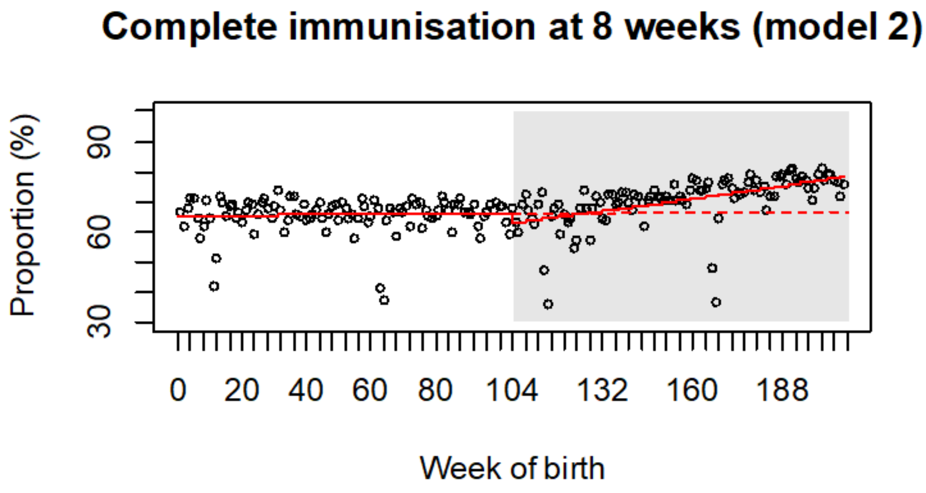


Figure 25 Proportion (%) of complete infant immunisation uptake by the scheduled by eight weeks.

Aggregated by week of birth, over the study time period (week of birth 1 to 207). The pre- and post-introduction periods are indicated by the unshaded (week of birth 1 to 104) and shaded (week of birth 105 to 207) areas, respectively. The solid red line represents the predicted trend of a model adjusted for over-dispersion (model 2), with the dashed red line representing the corresponding counterfactual trend.

Measure	Study period	Min.	1st Quartile	Median	Mean	3rd Quartile	Max.
Number of cases	Pre-introduction	-	569.0	595.0	587.2	619.0	-
	Post-introduction	-	523.0	584.0	571.7	635.0	-
Proportion (%)	Pre-introduction	37.8	64.5	66.9	65.7	69.3	73.7
	Post-introduction	36.1	68.0	71.8	70.5	76.0	81.2

Table 56 Descriptive statistics for infants receiving complete uptake by the scheduled time point of eight weeks.

Compares aggregated values between pre- and post-introduction periods for both number of cases and proportion (%).

After adjusting for over-dispersion (model 2; *Table 57*), the introduction of SBBS was associated with a level decrease of 4.5% (RR = 0.9548, 95% CI: 0.9060–1.0063) alongside a minor trend increase of 0.2% (RR = 1.0020, 95% CI: 1.0012–1.0028) in the prevalence of infants receiving complete immunisation by eight weeks. Looking at the dispersion parameter for this model, it appears that the data were highly over-dispersed (*Table 57*). This is likely due to the outlying values observed in *Figure 25* above. The predicted trend for model 2 is plotted in *Figure 28*. These findings do not give a clear picture, suggesting that SBBS introduction had an immediate negative effect on prevalence while having a beneficial effect across the post-introduction period as a whole. In absolute terms, at a month following introduction (109th week), the predicted prevalence (63.74%, 95% CI: 61.58 to 65.97) was lower than the baseline prevalence (66.09%, 95% CI: 63.62 to 68.65). However, at a year following introduction (157th week), the predicted prevalence (70.52%, 95% CI: 69.26 to 71.82) was higher than the baseline prevalence (66.39%, 95% CI: 62.24 to 70.82).

	RR (95% CI)	
	Model 1	**Model 2**
level	0.9548 (0.9063–1.0059)	0.9548 (0.9060–1.0063)
trend	1.0020 (1.0012–1.0028)	1.0020 (1.0012–1.0028)
Dispersion	1	5.0

Table 57 Interrupted time series models used to evaluate complete infant immunisation uptake by eight weeks.

Relative risk (RR) and confidence intervals (CI) for an unadjusted Poisson model (model 1) and a quasi-Poisson model adjusting for over-dispersion (model 2). *Dispersion* refers to the dispersion parameter for each model, where a value >1 indicates the degree to which the model adjusts for over-dispersion in the outcome measure.

10.2.2 Subgroup analyses

The association observed in the main analysis was observed across all subgroups defined by maternal age, area deprivation, and number of previous pregnancies (*Table 58*). While a gradient in prevalence by area deprivation was observed (*Table 59*), it is not clear from these analyses what effect if any the introduction of SBBS had on such inequalities owing to the conflicting direction of the level and trend estimates. For example, the most deprived SIMD quintile simultaneously exhibits both the largest level decrease and largest trend increase in prevalence (*Table 58*).

Subgroup	Observations (%)	RR for level (95% CI)	RR for trend (95% CI)
Maternal age (years)			
<25[d]	32,130 (18.21)	0.9464 (0.8890 to 1.0075)	1.0020 (1.0010 to 1.0030)
25-38[d]	133,835 (75.84)	0.9551 (0.9057 to 1.0073)	1.0020 (1.0012 to 1.0028)

>38	10,508 (5.95)	0.9819 (0.9146 to 1.0541)	1.0023 (1.0012 to 1.0034)
Area deprivation (SIMD-2016 quintile)			
1 (most deprived)	43,414 (24.6)	0.9315 (0.8722 to 0.9948)	1.0026 (1.0016 to 1.0036)
2[d]	37,316 (21.15)	0.9538 (0.8997 to 1.0112)	1.0017 (1.0008 to 1.0026)
3[d]	32,144 (18.21)	0.9563 (0.9054 to 1.0101)	1.0018 (1.0009 to 1.0027)
4[d]	33,003 (18.7)	0.9554 (0.9008 to 1.0133)	1.0019 (1.0010 to 1.0028)
5[d] (least deprived)	30,596 (17.34)	0.9830 (0.9325 to 1.0363)	1.0019 (1.0011 to 1.0027)
Previous pregnancy			
No[d]	58,820 (33.33)	0.9588 (0.9079 to 1.0127)	1.0024 (1.0015 to 1.0032)

Table 58 Interrupted time series models for subgroup analyses of complete infant immunisation uptake by eight weeks.

[d] = quasi-Poisson model adjusted for over-dispersion. Unless otherwise indicated, relative risk (RR) and 95% confidence intervals (95% CI) are derived from unadjusted Poisson models.

SIMD-2016 quintile	**Mean proportion (%)**			
	Pre-introduction	**Post-introduction**	**Difference (post - pre)**	**Ratio (post / pre)**
1 (most deprived)	63.01	69.38	6.4	1.1
2	65.33	69.50	4.2	1.1
3	65.43	69.15	3.7	1.1
4	67.92	71.39	3.5	1.1
5 (least deprived)	68.19	74.21	6	1.1

Table 59 Mean aggregate proportion (%) of infants receiving complete immunisation by the scheduled immunisation point of eight weeks by SIMD-2016 quintile.

Comparison between pre- and post-introduction periods.

10.2.3 Sensitivity analysis

The source of the outliers in the outcome trend for the main analysis was not definitively established. As would be expected, the number of observations by week of birth (the denominator) exhibited seasonal variation (see Appendix 21). While there was a corresponding seasonal variation in the number of episodes (the numerator), outlying values appear to closely precede the trough of this variation in each instance (see Appendix 21). These outliers occur on an annual basis around the last week of October and first week of November. It was suggested by eDRIS (who provided the data) that the roll out of the flu vaccination around this time may cause a de-prioritisation in delivering or offering infant immunisations. A sensitivity analysis was conducted excluding these outliers to determine their effect on the main analysis. Outliers were identified with a lower bound defined by Tukey's fences: $1st\ Quartile\ -$

$1.5 \times (3rd\ Quartile - 1st\ Quartile)$ (Tukey, 1977). This lower bound is visualised in *Figure 26*. A model adjusted for over-dispersion excluding these outliers was consistent with the main analysis, estimating a level decrease (RR = 0.9815, 95% CI: 0.9491 to 1.0150) and trend increase (RR = 1.0020, 95% CI: 1.0014 to 1.0025) in prevalence following the introduction of SBBS. However, outliers had a measurable downward influence on the level estimate, which was reduced from 4.5% to 1.8% following their exclusion. The dispersion parameter for this model was 1.9, indicating that the outliers were the source of the high over-dispersion observed in the main analysis.

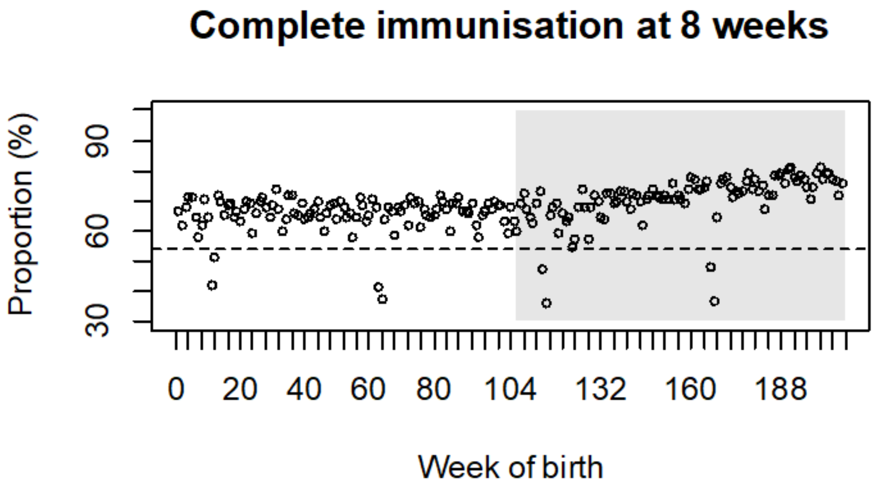


Figure 26 Proportion (%) of complete infant immunisation uptake by eight weeks.

Aggregated by week of birth, over the study time period (week of birth 1 to 207). The pre- and post-introduction periods are indicated by the unshaded (week of birth 1 to 104) and shaded (week of birth 105 to 207) areas, respectively. Horizontal dashed line indicates lower bound identifying outlying values.

10.3 Complete immunisation by twelve weeks

In this section I detail findings relating to the prevalence of infants receiving complete immunisation by the scheduled time point of twelve weeks.

10.3.1 Main analysis

As with the previous analysis (Section 10.2.1), descriptive statistics indicated that prevalence was right-skewed and that the median prevalence was higher in the post-introduction period (*Table 60*). Likewise, the outcome trend exhibited a number of abnormally low values which were more numerous than in the previous analysis (*Figure 27*).

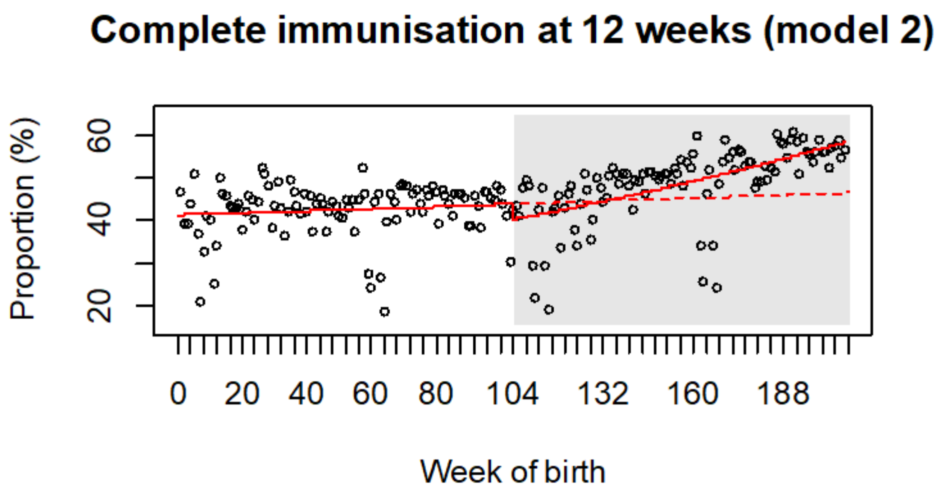


Figure 27 Proportion (%) of complete infant immunisation uptake by twelve weeks.

Aggregated by week of birth, over the study time period (week of birth 1 to 207). The pre- and post-introduction periods are indicated by the unshaded (week of birth 1 to 104) and shaded (week of birth 105 to 207) areas, respectively. The solid red line represents the predicted trend of a model adjusted for over-dispersion (model 2; *Table 59*), with the dashed red line representing the corresponding baseline trend.

Measure	Study period	Min.	1st Quartile	Median	Mean	3rd Quartile	Max.
Number of cases	Pre-introduction	-	361.5	391.5	380.5	409.0	-
	Post-introduction	-	353.0	407.0	396.2	457.0	-
Proportion (%)	Pre-introduction	18.3	40.5	44.0	42.6	46.3	52.7
	Post-introduction	18.9	46.4	50.9	49.0	54.5	60.8

Table 60 Descriptive statistics as they relate to the outcome measure of infants receiving complete immunisation by the scheduled time point of twelve weeks.

Comparison of aggregated values between pre- and post-introduction periods for both number of cases and proportion (%).

After adjusting for high over-dispersion (model 2; *Table 61*), the introduction of SBBS was associated with a notable level decrease of 8.3% (RR = 0.9167, 95% CI: 0.8404 to 1.0000) alongside a trend increase of 0.3% (RR = 1.0031, CI: 1.0017 to 1.0044) in prevalence of complete uptake. The predicted trend for this analysis is plotted in *Figure 27* above. These findings mirror the previous analysis and, similarly, do not give a clear picture of SBBS' impact on infant immunisation uptake. At a month following SBBS introduction the predicted prevalence is lower than baseline prevalence (40.96, 95% CI: 38.78 to 43.27; versus 44.00, 95% CI: 41.40 to 46.77), while at a year following introduction it is higher (48.8%, 95% CI: 47.4 to 50.2; versus 45.2%, 95% CI: 40.8 to 50.2).

	RR (95% CI)	
	Model 1	**Model 2**
level	0.9167 (0.8408 to 0.9995)	0.9167 (0.8404 to 1.0000)
trend	1.0031 (1.0017 to 1.0044)	1.0031 (1.0017 to 1.0044)
Dispersion	1	8.4

Table 61 Interrupted time series models used to evaluate complete immunisations uptake at twelve weeks.

Relative risk (RR) and confidence intervals (CI) for an unadjusted Poisson model (model 1) and a quasi-Poisson model adjusting for over-dispersion (model 2). *Dispersion* refers to the dispersion parameter for each model, where a value >1 indicates the degree to which the model adjusts for over-dispersion in the outcome measure.

10.3.2 Subgroup analyses

Estimates across all subgroups defined by maternal age, area deprivation, and number previous pregnancies were consistent with the association observed in the main analysis (*Table 62*). While a gradient in prevalence by area deprivation was observed (*Table 63*), the impact of SBBS on these inequalities is unclear as it was with complete immunisations at eight weeks (Section 10.2.2). That is, the most deprived SIMD quintile experienced both one of the largest level decreases (RR = 0.8900, 95% CI: 0.8004 to 0.9897) and the largest trend increase (RR = 1.0040, 95% CI: 1.0024 to 1.0056) in prevalence of complete immunisation at the scheduled time point of twelve weeks.

Subgroup	**Observations (%)**	**RR for level (95% CI)**	**RR for trend (95% CI)**
Maternal age (years)			
<25[d]	32130 (18.21)	0.9008 (0.8122 to 0.9991)	1.0029 (1.0013 to 1.0046)
25-38[d]	133835 (75.84)	0.9198 (0.8427 to 1.0039)	1.0031 (1.0018 to 1.0045)
>38	10508 (5.95)	0.9314 (0.8246 to 1.0520)	1.0025 (1.0006 to 1.0043)
Area deprivation (SIMD-2016 quintiles)			
1[d] (most deprived)	43414 (24.6)	0.8900 (0.8004 to 0.9897)	1.0040 (1.0024 to 1.0056)

2[d]	37316 (21.15)	0.9328 (0.8426 to 1.0326)	1.0025 (1.0010 to 1.0041)
3[d]	32144 (18.21)	0.8838 (0.8051 to 0.9701)	1.0026 (1.0011 to 1.0042)
4[d]	33003 (18.7)	0.9354 (0.8551 to 1.0232)	1.0028 (1.0014 to 1.0043)
5[d] (least deprived)	30596 (17.34)	0.9450 (0.8648 to 1.0327)	1.0031 (1.0017 to 1.0045)
Previous pregnancies			
None[d]	58820 (33.33)	0.9226 (0.8420 to 1.0109)	1.0034 (1.0020 to 1.0048)

Table 62 Interrupted time series models for all subgroup analyses of infants receiving complete immunisation by the scheduled time point of twelve weeks.

Aggregated by week of birth. [d] = quasi-Poisson adjusted for over-dispersion. Unless otherwise indicated, relative risk (RR) and 95% confidence intervals (95% CI) derived from unadjusted Poisson models.

SIMD-2016 quintile	**Mean prevalence (%)**			
	Pre-introduction	**Post-introduction**	**Difference (post - pre)**	**Ratio (post / pre)**
1 (least deprived)	40.13	48.12	8	1.2
2	42.09	47.66	5.6	1.1
3	42.76	47.86	5.1	1.1
4	44.89	50.03	5.1	1.1
5 (most deprived)	44.44	51.80	7.4	1.2

Table 63 Mean aggregate proportion (%) of infants receiving complete immunisation by the scheduled time point of twelve weeks stratified by SIMD-2016 quintile.

Comparison between pre- and post-introduction periods.

10.3.3 Sensitivity analysis

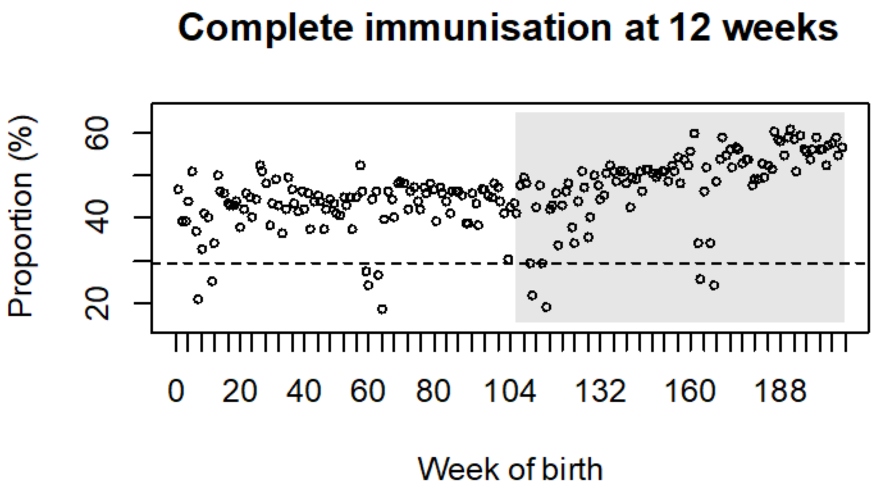


Figure 28 Proportion (%) of complete infant immunisation uptake by twelve weeks, aggregated by week of birth, over the study time period (week of birth 1 to 207).

The pre- and post-introduction periods are indicated by the unshaded (week of birth 1 to 104) and shaded (week of birth 105 to 207) areas, respectively. Horizontal dashed line indicates lower bound identifying outlying values.

Low outliers were again identified using Tukey's lower fence, as described previously in Section 10.2.3 (*Figure 28*). A model adjusted for over-dispersion estimated a level decrease of 4.1% (RR = 0.9586, 95% CI: 0.9034 to 1.0171) alongside a trend increase of 0.3% (RR = 1.0027, 95% CI: 1.0018 to 1.0036). As before, the removal of outliers reduced the size of the level decrease from 8.3% to 4.1%.

10.4 Chapter summary

In this chapter I detailed the findings of the natural experimental evaluation of SBBS relating to infant immunisation uptake. These findings did not paint a clear picture. The introduction of SBBS was associated with an immediate decrease in uptake alongside an increase in uptake across the post-intervention period at both scheduled points of immunisation (eight and twelve weeks postpartum). This association was observed among the Scottish population as a whole and among subgroups defined by maternal age, area deprivation, and number of previous pregnancies. While a gradient in uptake by SIMD quintile was observed, it was not clear whether the introduction of SBBS narrowed these inequalities. The outcome trends for both scheduled points of immunisation exhibited an annual pattern of outliers but lacked the waveform variation typically resulting from seasonality. The source of these outliers was not definitively established however they were observed to have a measurable downward effect on the level estimate of models. In summary, these analyses suggested that the introduction may have had an immediate negative effect on infant immunisation uptake but that this transformed into a positive effect over time. However, owing to unexplained variation there is cause to question the quality of the data used.

This chapter stands as the final findings chapter from the natural experimental evaluation of SBBS (Chapters 5-10). This evaluation followed an analysis of the political discourse surrounding the introduction of the scheme (Chapter 3) and a natural experimental evaluation of the Finnish Maternity Grant's impact on infant mortality (Chapter 4). Findings for the thesis are whole are summarised and discussed in the next and final chapter (Chapter 11).

11 Discussion

11.1 Chapter overview

This chapter brings the thesis to a close. I begin with a summary of the findings from each chapter (Section 11.2) before discussing these findings in relation to the wider evidence and research on the subject (Section 11.3). I then reflect on the methodological approach taken in this thesis, considering the strengths and limitations (Section 11.4). Following from this, I discuss the policy implications of the finidngs in this thesis (Section 11.5) and avenues for future research (Section 11.6). The chapter ends with a conclusion summarising the thesis as a whole (Section 11.8).

11.2 Summary of findings

Chapter 3 aimed to critically examine the political discourse that has been publicly expressed by key political actors in relation to SBBS. Using a theoretically derived approach in which political discourse is understood to fundamentally involve practical argumentation, Chapter 3 answered the following research questions:

1. What practical argumentation was publicly expressed by key political actors in relation to SBBS?
2. How did this practical argumentation represent the policy issue?
3. What tensions are present between representations of the policy issue?

Chapter 4 aimed to investigate the impact of the Finnish Maternity Grant's introduction in 1938 and its subsequent universalisation in 1949 on Finnish infant mortality rates. Using natural experimental methods, this chapter addressed the following research questions:

4. Did the introduction of the Maternity Grant in 1938 reduce infant mortality rates in Finland?

5. Did the universalisation of the Maternity Grant in 1949 reduce infant mortality rates in Finland?

6. How robust are any indications of impact?

Chapters 5 to 10 aimed to investigate the impact of SBBS on infant and maternal health. Using natural experimental methods, these chapters addressed the following research questions:

7. What impact did the introduction of SBBS have on infant hospital admissions, exposure to tobacco smoke, feeding, sleeping, and immunisations?

8. What impact did the introduction of SBBS have on maternal hospital admissions?

9. Did the impact of SBBS' introduction on these outcomes differ by maternal age, number of previous pregnancies, and SIMD-2016 quintile?

11.2.1 Political discourse surrounding Scotland's Baby Box Scheme

In Chapter 3, I described the values, goals, and circumstances drawn upon by political actors in support of SBBS. Prominent values included fairness, equality, universalism, and an opposition to child poverty. The representation of equality as a value often closely resembled equality *of opportunity*, which values competition on 'equal terms' as a mechanism of assignment within social hierarchies. The stated goals of SBBS introduction often directly extended from these values. Other goals included tackling deprivation, supporting parents, improving health, and reducing health inequalities. SBBS was at times explicitly represented as a symbolising certain values and goals. The purported impact of the Finnish Baby Box on infant mortality was a prominent circumstantial claim given in support of SBBS introduction. Other circumstances drawn upon in support of SBBS included the importance of the early years of life and child poverty in Scotland. SBBS was represented as a constituent means of achieving goals and values (i.e., as one action of many) by proponents of the scheme.

Practical argumentation given in opposition to SBBS was sparse, possibly indicating that the policy was viewed as uncontentious. Opposition voices represented SBBS as overbudget, not wanted by parents, and as an insufficient means of addressing wider societal challenges (i.e., a 'window dressing').

There were possible tensions between the symbolic and instrumental representations of the scheme, however I reasoned that the symbolism of SBBS could also benefit health (e.g., by influencing the behaviour of both parents and healthcare practitioners). A tension was present between the value of equality of opportunity and the goal of reducing health inequalities. I suggested that, despite this, SBBS as an intervention would be more likely to have a positive effect on health inequalities than a negative effect. There was a minor tension between the blanket universalism of SBBS and the proportionate universalism advocated for by public health. Finally, I questioned the truthfulness of the circumstantial claim that the Finnish Baby Box reduced infant mortality.

11.2.2 Impact of Finnish Maternity Grant on infant mortality

In Chapter 4, I found no clear evidence that the Finnish Maternity Grant – the broader policy of which the Finnish Baby Box is a component – had an impact on infant mortality following both its introduction in 1938 and subsequent universalisation in 1949. The introduction of the Maternity Grant was associated with an immediate increase in IMRs, although this was likely biased by the events of the Second World War between 1939 and 1945. The universalisation of the Maternity Grant was associated with an immediate fall in IMRs. However, several possible sources of history bias were unaccounted for. For example, child and maternity clinics were introduced across Finland between 1945 and 1949. This was followed by an increase in the number of mothers attending antenatal care. The number of mothers giving birth at home also steadily declined over this period. The Child Allowance System, introduced in 1948, is another possible source of bias. Thus, it is unclear to what extent, if any, the associated decline in IMRs following the universalisation of the Maternity Grant in 1949 can be interpreted as an effect of the policy change.

11.2.3 Impact of Scotland's Baby Box Scheme on all-cause hospital admissions

In Chapter 6, I found that the introduction of SBBS had no measurable impact on either infant or maternal all-cause hospital admissions. This absence of effect was observed both among the Scottish population as a whole and among subgroups defined by maternal age, SIMD quintile, and having had no previous pregnancy. Inequalities by SIMD quintile were observed for both infant and maternal admissions.

11.2.4 Impact of Scotland's Baby Box Scheme on tobacco smoke exposure

In Chapter 7, I found evidence that the introduction of SBBS had a beneficial impact on the prevalence of primary carers' smoking and infant exposure to second-hand tobacco smoke (both outcome measures were recorded approximately ten days after birth).

For primary carers' smoking, SBBS introduction was associated with a decline in prevalence both immediately and over time among the Scottish population as a whole and across subgroups defined by maternal age, SIMD quintile, and no previous pregnancy. However, while inequalities by SIMD quintile were observed, there was no indication that SBBS had a narrowing effect on either relative or absolute scales.

For infants exposed to second-hand smoke, SBBS introduction was similarly associated with a decline in prevalence both immediately and over time among the Scottish population as a whole. This association was also observed across subgroups defined by maternal age and no previous pregnancy. Inequalities in prevalence by SIMD quintile were again observed. The immediate decrease in prevalence associated with SBBS introduction was only present among the two most deprived quintiles and the least deprived quintile. This may suggest that SBBS introduction had a narrowing effect on these inequalities on the relative scale.

The introduction of SBBS was not associated with any decline in prevalence of either smoking at booking or smoking during pregnancy. These outcome measures were used as negative controls. It was assumed that, while not affected by SBBS introduction, they would be responsive to other events or phenomena influencing infant and maternal tobacco smoke exposure around the time of SBBS introduction. As such these findings lend support to the notion that SBBS introduction had a beneficial impact on the prevalence of primary carers smoking and infants exposed to second-hand smoke.

11.2.5 Impact of Scotland's Baby Box Scheme on exclusive breastfeeding

In Chapter 8, I found no evidence that the introduction of SBBS had a beneficial population-level impact on exclusive breastfeeding. Unexpectedly, SBBS introduction was associated with a fall in the prevalence of exclusive breastfeeding on discharge. This association was observed on both population- and subgroup-levels. Conversely, the introduction of SBBS was not associated with any meaningful population-level change in the prevalence of exclusive breastfeeding recorded during the initial CHSP-PS review (approximately ten days postpartum). This was also the case on the subgroup-level, with the exception of young mothers (aged <25 years old). Introduction was associated with an increase in the prevalence of exclusive breastfeeding among this subgroup. However, as an isolated association, it is unclear whether this indicated an effect of SBBS. There was no indication that SBBS narrowed observed inequalities (by SIMD quintile) in either the prevalence of exclusive breastfeeding on discharge or as recorded during the initial CHSP-PS visit.

11.2.6 Impact of Scotland's Baby Box Scheme on infant sleeping position

In Chapter 9, I found no evidence that the introduction of SBBS had any population- or subgroup-level impact on the prevalence of supine sleeping among infants. Prevalence of supine sleeping was notably high among the population and there were no inequalities observed by SIMD quintile.

11.2.7 Impact of Scotland's Baby Box scheme on infant immunisation uptake

In Chapter 10, I found no clear indication that the introduction of SBBS had a beneficial impact on infant immunisation uptake. On both population- and subgroup-levels, SBBS introduction was associated with an immediate decline in uptake, alongside an increase in uptake over time. Interpretation of findings was challenged by variation in the data. There was no clear indication that SBBS introduction narrowed observed inequalities in infant immunisation uptake by SIMD quintile.

11.3 Discussion of findings

11.3.1 Political discourse analysis

Chapter 3 found that equality of opportunity was a common value drawn upon in the practical argumentation supporting the introduction of SBBS. The link between this value and the notion of meritocracy was then highlighted, and subsequently placed in tension with the goal of reducing health inequalities. Nonetheless, it was reasoned that the introduction of SBBS would most likely exhibit a narrowing effect, if any, on health inequalities. The natural experimental evaluation of SBBS presented in Chapters 5 to 10 subsequently found, for the outcomes evaluated, little indication of any effect on socio-economic inequalities. However, it is important to distinguish between the effect of SBBS as measured by the outcomes used in the natural experimental evaluation of the scheme and any effects of the practical argumentation surrounding its introduction. That is, the former concerns phenomena to which the parents were directly exposed as a consequence of SBBS (e.g., the material and educational components of SBBS) while the latter concerns phenomena to which parents were not directly exposed as a consequence of SBBS. Thus the findings relating to each do not strictly correspond, where the effect of the scheme as measured by the outcomes used in the natural experimental evaluation likely operates through pathways distinct to any effect precipitated by the practical argumentation surrounding the scheme. This raises the prospect of future research to understand how these different pathways operate in relation to health, although the focus of this research would likely be broader than SBBS.

11.3.2 Tobacco smoke exposure

The findings presented in this thesis suggest that the introduction of SBBS had a beneficial impact on primary carers smoking and infants exposed to second-hand tobacco smoke. However, the causal mechanisms of this impact are not clear. Before discussing possible mechanisms in Section 11.3.2.2, I will first address the threat of bias to this interpretation in Section 11.3.2.1.

11.3.2.1 Threats of bias

Threats most notably include history bias, instrumentation bias, reporting bias, and bias extending from group differences. I will discuss each in turn.

History bias would include any event occurring around the point of SBBS introduction that could lead to a population-level change in these outcome measures. Possible sources of history bias were pre-emptively discussed in Section 5.3.5.3. These were fluctuations in the price of tobacco, the roll-out of the Standardised Packaging of Tobacco Products Regulation, and changes in the relationship between e-cigarette use and tobacco. However, none were considered to be major threats. The use of negative control analyses in Sections 7.4 and 7.5 can be understood as a means of empirically investigating the presence of history bias. If history bias were present, we would likely see a change in maternal smoking at booking and during pregnancy similar to that observed for the postpartum measures of primary carers smoking and infants exposed to second-hand smoke. However, this was not the case. That being said, the negative control measures used are not strictly equivalent with the measures used in the main analyses (i.e., infant exposure to second-hand smoke or primary carer smoking ≠ maternal smoking). Thus, while these negative control analyses suggest that the presence of history bias is unlikely, they do not definitively rule it out.

Instrumentation bias would involve systematic differences in the recording or definition of outcome measures between pre- and post-introduction periods. The forms used for data collection in the CHSP-PS reviews were updated in 2015 and then implemented in February 2016 (Public Health Scotland, 2022b). However, it is not clear whether this resulted in any change in either the recording or definition of the outcome measures in question. Thus instrumentation bias cannot be ruled out on the basis of this information alone.

It is possible that reporting bias may be present (e.g., SBBS could cause some parents to incorrectly report reduced second-hand smoke exposure). At present this cannot be discounted, however future research using infant respiratory admissions data could provide further insight into this form of bias (see Section 11.5).

Bias from group differences would involve the presence of systematic differences in population characteristics relevant to the outcome measure between pre- and post-introduction groups. As discussed in Section 4.4.1.2, ITS analysis is generally robust to such bias as it does not rely on a control population to estimate the counterfactual (Bernal, Soumerai and Gasparrini, 2018). However, with the evaluation of SBBS presented in this thesis, it is possible that systematic differences could arise through changes in either demographics or data coverage. The former is unlikely to be a threat owing to the relatively short timeframe used by the evaluation (i.e., approximately four years). Demographic changes would also be unlikely to occur in such a dramatic manner so as to produce a level change in an outcome measure aggregated on a weekly basis.

Group differences could also arise from changes in data coverage occurring around the point of SBBS introduction in August 2017. Looking at data published by Public Health Scotland, percentage coverage of the CHSP-PS initial review (from which the outcome measures in question were derived) increased by fiscal year from 97.0% to 97.2% between 2016/17 and 2017/18 (Public Health Scotland, 2022a). In the same period, percentage coverage increased in all SIMD quintiles with the exception of SIMD 4 where coverage decreased by 0.1% (ibid.). These figures suggest that changes in data coverage are an unlikely source of bias. Similar to history bias, we would also expect bias from group differences to be indicated by the negative control analyses.

11.3.2.2 Mechanisms

I have discussed possible threats of bias to the interpretation that the introduction of SBBS had a beneficial effect on primary carers smoking and infants exposed to second-hand smoke. I will now consider the possible mechanisms extending from SBBS. These mechanisms would likely involve a change in the behaviour of parents (or other primary carers). I will discuss four possible mechanisms which may operate in isolation or together:

a) SBBS reduced stress among parents.

b) SBBS prompted healthcare practitioners to place an additional emphasis on or prioritising tobacco smoke exposure during health promotion and engagement with parents.

c) The information on tobacco smoke exposure provided within SBBS and on the ParentClub website resulted behaviour change among parents.

d) SBBS functioned as a physical reminder or ‘signalling device’ with respect to b) and c).

Mechansim a) is hypothesised on the basis that there is an association between stress and parental smoking (Flemming *et al.*, 2015; McKenna, Law and Pearce, 2017). This effect would most likely extend from financial savings on materials provided by SBBS. For example, research from Ipsos MORI Scotland suggested that the vast majority of parents (91%) felt that SBBS had saved them money on things they would otherwise have had to buy (Bardsley *et al.*, 2021). Additionally, this research also suggested that SBBS reduced parental stress around what they needed to care for their infant (ibid.). If this mechanism were in operation, we would expect the effect to be most pronounced among the most materially disadvantaged groups. However, while there was some indication that health inequalities narrowed for infants exposed to second-hand smoke, this was not clearly demonstrated.

With respect to mechanism b), it is worth considering that both outcome measures – primary carer smoking and infants exposed to second-hand tobacco smoke – were recorded during the initial CHSP-PS review approximately ten days postpartum. That is, parents were meeting health visitors for the first time when these measures were recorded. Thus, if the beneficial impact of SBBS on these outcome measures extended from healthcare practitioners placing an additional emphasis on tobacco smoke exposure, this was likely from midwives during the antenatal period. Midwives were the main recipients of information on the scheme targeted at health practitioners (Bardsley *et al.*, 2021). However, the perceived impact of SBBS as an engagement tool among health professionals was unclear. While 50% of midwives, health visitors, and family nurses surveyed for the Ipsos MORI Scotland research said the scheme had supported engagement, 44% said that it had no effect (ibid.). Face-to-face interaction is a common component of educational interventions aimed at parental smoking cessation (Scheffers-Van Schayck *et al.*, 2021). However, the extent to which the presence, quality, and intensity of such interaction is efficacious is unclear.

Mechanism c) frames SBBS as a self-help intervention. There is evidence to suggest that self-help materials delivered during pregnancy can reduce maternal smoking (Naughton, Prevost and Sutton, 2008; Brandon *et al.*, 2012). The majority of trials underpinning this evidence compared differing degrees of self-help provision; where 'standard care' formed the control arm of these trials, this care often also involved self-help provision. Similarly, self-help materials would have been provided to mothers as standard care in Scotland prior to the introduction of SBBS or the rollout of the ParentClub website. The question then is whether the self-help materials provided within SBBS or on the ParentClub website made contribution over that of standard care in Scotland and prompted behavioural change to reduce tobacco smoke exposure. For example, the intervention evaluated by Brandon et al. (2012) involved the provision of nine information booklets that were delivered over an extended period (i.e., through pregnancy to eight months postpartum) compared to just two booklets delivered on enrolment in the control arm. In comparison, SBBS offers a low intensity of self-help provision. On this basis, while self-help materials can improve smoking cessation during pregnancy, it is doubtful that c) in isolation would be sufficient enough to cause a decrease in primary carers smoking and infants exposed to second-hand smoke.

Mechanism d) is hypothesised on the basis that signage or visual reminders are commonly used to prompt behaviour change (Meis and Kashima, 2017). This is not unprecedented in public health, with signage used to promote hygiene and, of particular relevance, visual warnings (e.g., pictures of tarred lungs) placed on tobacco packaging (Hammond *et al.*, 2006; Updegraff *et al.*, 2011). Elsewhere, health risk ‘signalling effects’ have been associated with public health policy developments (Alvarado *et al.*, 2021). It is thus plausible that SBBS could function as a persistent reminder in the home and potentiate the effects of b) and c).

11.3.3 Breastfeeding

In chapter 2, Section 2.3.4, I discussed concerns raised in the academic literature around possible negative consequences of baby boxes on breastfeeding (Blair, Heron and Fleming, 2010; Bartick and Smith, 2014; Bartick, Tomori and Ball, 2018). While this thesis observed an associated fall in exclusive breastfeeding at discharge, as it is unlikely that SBBS would have such an impact prior to any use of the scheme at home, this was judged to be spurious. Additionally, affirming the prevailing perception among healthcare practitioners in Scotland who did not anticipate that SBBS would impact breastfeeding (Bardsley *et al.*, 2021), this thesis did not find any beneficial effect among the Scottish population as a whole. That being said, these measures were recorded early in the postpartum period and as such are not indicative of long-term effects.

It is worth noting that academic concerns over the possible consequences of baby boxes on breastfeeding were specifically tied to the promotion or further normalisation of isolated infant sleep (Bartick, Tomori and Ball, 2018). While this thesis did not find any impact of SBBS on infant sleeping position, it did not evaluate the impact of the scheme on isolated infant sleep or co-sleeping. However, the Ipsos MORI Scotland research suggested that a majority (61%) of parents receiving SBBS did not use it as a sleeping space the research it does not indicate what alternatives were used (Bardsley *et al.*, 2021).

The introduction of SBBS was associated with an immediate increase in exclusive breastfeeding among young mothers (aged <25 years) at approximately ten days postpartum. Young parents often come from disadvantaged circumstances and may experience financial, housing, and employment insecurity. Additionally, as was observed in Chapter 8, of all age groups studied mothers aged <25 years exhibited the lowest mean prevalence of exclusive breastfeeding. Thus, while this association may be spurious as it was not observed for any other subgroups, it is worth considering its plausibility in more depth as it could have important implications for health inequalities.

The Scottish Family Nurse Partnership scheme (FNP) can be viewed as both a possible source of bias and a possible constituent to any effect precipitated by SBBS on breastfeeding among young mothers. While the FNP is not aimed at improving breastfeeding, it specifically targets young mothers in Scotland with regular support. This support involves specially trained family nurses who operate under a psycho-education approach focussing on positive behaviour change. There is some indication that regular support is an important aspect of effective breastfeeding interventions (Skouteris *et al.*, 2014).

The FNP is unlikely to be a source of history bias as ten of the eleven NHS Scotland health boards (representing a majority of the Scottish population) were operating the scheme by 2015 (Scottish Government, 2019). NHS Dumfries and Galloway rolled out the FNP in 2018, the year following the introduction of SBBS. However, as this represents only 2.3% of all live births in Scotland in 2019 it is unlikely to have had a measurable impact (Public Health Scotland, 2020). As was noted in Chapter 5 (Section 5.3.5.3), the Scottish Government distributed £2 million of funding for breastfeeding support in July 2018. While this may constitute another possible source of history bias, it is not clear why this funding would benefit young mothers specifically. Additionally, as this funding was distributed almost a year after the introduction of SBBS, the threat of bias is low. Conversely, it can be hypothesised that the introduction of SBBS combined with the regular support offered by the FNP resulted in an increase in exclusive breastfeeding among young mothers. However, while family nurses were included in research conducted by Ipsos MORI Scotland on behalf of the Scottish Government, it is not clear whether SBBS introduction had any bearing on their practice or approach (Bardsley *et al.*, 2021).

11.3.4 Health service engagement and infant mortality

The political discourse surrounding the introduction of SBBS represented the Finnish Baby Box as having reduced infant mortality and having done so through encouraging health service engagement. In this thesis I established that there is no clear evidence that the Finnish Baby Box reduced infant mortality in 20th century Finland. However, I did not look at the Box's relationship with health service engagement. As receipt was conditional on a pregnancy certificate, it remains a plausible hypothesis that the Finnish Baby Box did play a beneficial role in promoting health service engagement in the 20th century. There was some indication that SBBS improved infant immunisation uptake over time, representing a possible improvement in health service engagement. There is also evidence suggesting that baby boxes and in-kind benefits more generally can encourage antenatal and postpartum service engagement in low-income settings (Kirby *et al.*, 2015; Rossouw, Burger and Burger, 2017; Shapira *et al.*, 2017). However, it is worth bearing in mind that the Finnish Baby Box was introduced in a specific social-historical context and as such the relevance of claims to present day Scotland is questionable (Watson and Reid, 2021).

11.4 Methodological reflections

11.4.1 Political discourse analysis of Scotland's Baby Box scheme

In Chapter 3 I analysed the political discourse surrounding the introduction of SBBS. A particular strength of this analysis was the use of a theoretically derived framework developed specifically for the critical analysis of political discourse and policy developments (N. Fairclough & I. Fairclough, 2012). In the context of the wider thesis, this chapter provided a deeper understanding of the possible intentions and motivations behind the introduction of SBBS. It also allowed for reflection on its public health consequences. However, there were limitations to this analysis that are worth considering here.

A majority of the texts used were from either the Scottish Parliament Official Report or the Scottish Government. While these proved to be valuable sources of relevant data, it is a possible limitation of the analysis presented in this chapter that individual cases of argumentation were often sparse and did not cover all elements of the coding framework. This is not inherently an issue, as divergence in coding between participants or cases may be indicative of the very diversity that qualitative research seeks to capture (Gale *et al.*, 2013). However, Chapter 3 was concerned with the premise-conclusion structure of practical argumentation itself which was used as a coding framework. As such this sparseness may suggest a lack of diversity, whereby certain political actors disproportionately contributed to the overarching argumentation. Consequently, the analysis in this chapter may not have captured certain representations and tensions that are present in reality. This is particularly the case for practical argumentation given in opposition to SBBS which was notably absent.

That being said, as Hewitt (2009) notes, policy discourses are not static and are continually shaped and reshaped through social interaction (e.g., political debate). The sparseness of the data may simply reflect the fact that SBBS is a politically uncontentious policy and thus only underwent this process to a limited degree.

Relatedly, however, it is a limitation that the analysis did not consider non-political actors (e.g., the media, academics, and public bodies) and their role in shaping the political discourse. It also did not consider changes in the practical argumentation over time, differences in the practical argumentation between political roles (e.g., First Minister vs. cabinet minister vs. non-cabinet minister), and the presence of alternative discourses (e.g., where SBBS is drawn upon as a circumstantial premise). Incorporating these elements could have provided a fuller account of the political discourse surrounding the introduction of SBBS.

Finally, it is worth noting that the data used in this analysis extend from actors affiliated to different political parties in Scotland and the wider UK. As a result, it is possible that my own political allegiances could have had a bearing on the collection, analysis, and interpretation of these data. While I am not a member of any political party and generally do not engage with the sphere of parliamentary politics, I do have political values and assumptions that may be more or less aligned to or favour certain political parties. I have tried to be conscious of these values and assumptions throughout this chapter and reflect on how they may influence my approach to the analysis and interpretation of data. That being said, to the extent that I am unaware, this remains a source of bias.

11.4.2 Natural experimental evaluation of the Finnish Maternity Grant

Chapter 4 provided a natural experimental evaluation of the Finnish Maternity Grant. Introducing natural experimental methods and directly extending from the political discourse analysed in Chapter 3, this chapter bridged the qualitative and quantitative elements of the thesis. In some sense, given the prominence of the assumed relationship between the Finnish Maternity Package (or Baby Box) and infant mortality in public discourse more broadly, this research can be seen as an example of public health science engaging with a wider public debate. The strength of this analysis lies in the use of high-quality mortality data and robust methods of causal inference. Using two distinct natural experimental methods bolstered causal inference. Consequently, this chapter has provided the most robust empirical evaluation of the relationship between the Finnish Baby Box and infant mortality to date. However, there are several limitations that should be considered.

While the data were of high quality, they were only available at the population level. It was thus not possible to differentiate between members of the study population exposed to the Maternity Grant and indeed, of those who were, whether they received the Baby Box. As a result the effects of the Grant's introduction and universalisation were estimated among the population as a whole. However, for introduction in 1938, where around a two-thirds of mothers in Finland received the Maternity Grant, a sizeable proportion of the 'exposed' population were in fact unexposed at least until universalisation in 1949. Conversely, for the Grant's universalisation, a majority of the 'unexposed' population were indeed exposed since 1938. It was assumed that introduction and universalisation were distinct natural experimental events, however, as can be seen, this is debatable. That being said, it is likely that the Maternity Grant as it was introduced in 1938 did differ as an intervention from that universalised in 1949. For example, the cardboard box element of the Maternity Grant was not introduced until 1942. However, for introduction in particular, this suggests that exposure was not constant over time.

Other major obstacles to causal inference in this chapter included variability in the outcome trend and multiple threats of history bias. The events of the Second

World War likely had wide ranging implications for infant mortality. I did account for this where I could confidently attribute changes in the IMR to such events (i.e., the 1940 wild point). However, this was unlikely to be sufficient. Additionally, other significant social and medical developments occurred in close proximity to both the Maternity Grant's introduction and universalisation. These included legislation mandating Infant and Maternal Health clinics in 1944 and the Child Allowance System in 1948. For synthetic control analysis specifically, variability in the outcome trend prevented the good pre-intervention fit necessary for causal inference with this method; the inclusion of more geopolitically similar countries in the donor pool (e.g., Latvia, Estonia, and Lithuania) would have been beneficial, however these data do not exist. It is thus plausible that any effect of the Finnish Maternity Grant was masked by the other events of the time period.

11.4.3 Natural experimental evaluation of Scotland's Baby Box scheme

Chapters 5 to 10 built upon the wider understanding of SBBS generated through an analysis of the political discourse in Chapter 3 and the application of natural experimental methods demonstrated in Chapter 4. These chapters outline the first quantitative evaluation of SBBS. There are a number of strengths to this evaluation. Notably, it used high-quality linked administrative health data. Individual-level data allowed for the clear definition of the study population and subgroups, and transparency over data cleaning, preparation, and linkage. The use of deterministic linkage allowed for the inclusion of a range of outcome measures and covariates for each member of the study population. Additionally, data quality was generally high with low missingness and no evidence of instrumentation bias. It is also the case that these data allowed for near complete population coverage, something that would not be possible through alternative data sources (e.g., health surveys). The use of robust methods of causal inference is also a further strength of this evaluation. Interrupted time-series estimated the effect of SBBS introduction both immediately and over time. As a natural experimental event, SBBS is particularly suited to the use of these methods as it exhibits a clear point of introduction, lacks any antecedent policy equivalent, and has been available to all parents from the point of introduction. However, several aspects of this evaluation are worthy of further methodological consideration.

Poisson and quasi-Poisson models were used for all outcome measures in order to derive relative risk which is more interpretable than the odds ratio and is generally the parameter of interest in epidemiological analysis. In instances where the outcome measure was a prevalence, as opposed to an incidence rate, robust sandwich estimation was used to allow for this (Zou, 2004). However, where prevalence was high (i.e., infant sleeping position) logistic regression may have been more appropriate as it is only when the probability of the outcome is low that the difference between relative risk and odds ratios is negligible (ibid.). It is unclear how this alternative modelling approach would affect the direction of observed associations.

With respect to breastfeeding, this evaluation focussed only on exclusive breastfeeding. While this thesis sought to conduct a broad evauation of SBBS and used a wide range of outcome measures, it would have been beneficial to expand the range of measures used to include formula only and mixed. The introduction of SBBS may have had an impact on these expanded outcome measures that was not observed for the measures of exclusive breastfeeding used in this evaluation. As the measures used in this evaluation were recorded at discharge and approximately ten days following birth, this evaluation does not give any indication of SBBS' long-term impact on breastfeeding. A feeding variable was present in the CHSP-PS 6-8-week extract, however owing to missingness this was not used beyond a preliminary analysis. Nonetheless, as no association between SBBS and exclusive breastfeeding was observed among the study population as a whole, it is unlikely that one would be observed with a longer follow-up period. Considering the additional breastfeeding funding provided by the Scottish Government to NHS health boards in July 2018, in retrospect it would have been possible to model this using an additional breakpoint (Wagner *et al.*, 2002). It would be expected that this funding would have a beneficial effect, if any, on breastfeeding. However, as no association between SBBS and breastfeeding was observed across the study population as a whole, accounting for this funding in the model would likely have been unnecessary.

In relation to infant and maternal tobacco smoke exposure, the associated fall in the prevalence of primary carers' smoking and infants exposed to second-hand tobacco smoke was not anticipated. On reflection, this analysis would have been bolstered through the inclusion of infant admissions data relating to asthma and respiratory tract infection. These measures are responsive to changes in tobacco control policy (Faber *et al.*, 2017). As such, a fall in the incidence of infant admissions relating to asthma and respiratory tract infection relative to the introduction of SBBS would support the hypothesis that SBBS caused a fall in the prevalence of infants exposed to second-hand smoke.

The analysis would also have been improved by using temporal falsification, which was used as a sensitivity analysis in the evaluation of the Finnish Maternity Grant presented in Chapter 4. However, owing to limits on data access this was not possible to do within the timeframe of this thesis. Temporal falsification would test whether observed associations were specific to the point of SBBS introduction. Associations that are not specific to this point would suggest the presence of history bias.

Similar to breastfeeding, the measures of tobacco smoke exposure used in this evaluation were from early on in the postpartum period and thus do not give an indication on long-term effects. While these outcome measures were also present in the CHSP-PS 6-8-week extract, these were not used owing to high-missingness. As such, it is unclear whether the associations observed between SBBS introduction and tobacco smoke exposure persist beyond 10-days postpartum.

However, despite relatively high levels of missingness for the measure of infant sleeping position (11.5% missing; *Table 18*), this was still used in the complete-case analysis. Complete-case analysis was viewed as the most efficient way to proceed with the evaluation given the number of outcomes included and the time period available. The measure of infant sleeping position was included despite the level of missingness as it was a central measure of safe sleeping, which was indentified by the Scottish Government commissioned EA as being an intended target of SBBS (see Section 5.3.1). It is unclear whether this missingness had an effect on the observed associations. Methods such as multiple imputation could account for missing observations and provide an understanding of their impact (Hughes *et al.*, 2019), however such methods were not considered by this evaluation.

This evaluation used SIMD-2016 as the sole indicator of individual-level socio-economic position. However, as an area-based measure, individuals are likely to be misclassified (i.e., individuals who are not materially deprived may live in deprived areas and vice-versa). While it would have been beneficial to include other measures of socio-economic position (e.g., based on education, occupation, or income), these were not present within the datasets used. Other measures of socio-economic position would provide a more complete understanding of the relationship between socio-economic position and the effect of SBBS on the outcome measures included in this evaluation.

It is also worth mentioning that I did not account for the pilot that closely preceded the introduction of SBBS. The individuals in receipt of these boxes will have been misclassified by the evaluation presen as being 'unexposed'. However, as the only distributed 160 boxes (~1.28% of births over the three month period of the pilot, assuming 50,000 births within a twelve month period) and these were not around the point of SBBS intervention, the pilot is not of major concern with respect to bias.

Finally, in broader terms, it is worth discussing SBBS as a complex intervention and reflecting on the methodological implications this has for the evaluation presented in this thesis. This thesis took a straightforward approach to evaluation, viewing SBBS as a natural experimental event with clearly demarcated pre- and post-intervention periods, and conducting an intention-to-treat analysis. However, similar to SBBS, complex interventions often have multiple components and target a range of behaviours (Skivington *et al.*, 2021). As was outlined in Sections 1.25.3.1, SBBS can be thought of as both a non-monetary transfer and as an educational intervention. Additionally, the educational component is not restricted to the contents of the box itself and may operate through healthcare practitioners or indeed the ParentClub website. One shortcoming of the methodological approach taken in this thesis is that it cannot disentangle how each of these components operates in relation to infant and maternal health; doing so would be beneficial for decisions on the future implementation of the scheme. Similarly, as is clear from the logic model for

SBBS provided in the EA for the scheme (see Section 5.3.1), it sought to target a wide range of behaviours and outcomes (e.g., safe sleeping, breastfeeding, and service engagement). As the intention of the evaluation here was to provide an evaluation on these terms, outcome measures were selected on the basis that they best resembled the goals presented in the EA and that suitable routine administrative data was available. However, while the evaluation here provides an understanding of whether SBBS had an effect on these outcomes, it does not provide any information on the 'mechanisms of change' linking the scheme to these outcomes and the operation of these mechanisms in different contexts (e.g., by parents' socio-economic status or health board) (Skivington *et al.*, 2021). This also includes the operation of the more intangible aspects of the scheme, such as the symbolic function highlighted in Chapter 3. As before, such information would be beneficial to decisions on the future implementation of the scheme. Future research aimed at understanding these complex aspects of SBBS will be discussed in Section 11.6 below.

11.5 Implications for policy

Recent years have seen increasing international uptake of baby boxes as public health interventions, despite there being very limited evaluative evidence available (Bartick, Tomori and Ball, 2018; Middlemiss *et al.*, 2019). This thesis makes a substantial contribution in this regard through providing a mixed-methods evaluation of SBBS. While the implications of this evaluation are most relevant to the development and implementation of SBBS, they are also of relevance to the concept of baby boxes more generally. That being said, it is recognised that baby box interventions exhibit heterogeneity (Ball and Taylor, 2020).

The research presented in this thesis found no evidence that the Finnish Baby Box reduced Finnish infant mortality rates. As such, claims to the contrary should not be used to inform or promote the introduction of similar interventions elsewhere. Decision makers should also consider that the Finnish Baby Box was introduced in a particular socio-historical context which bears little resemblance to the present (Watson and Reid, 2021); Finnish infant mortality was higher when the Baby Box was introduced than it is in most middle- and low-income countries today. More generally, there is no evidence to date supporting the notion that baby boxes reduce infant mortality or SIDS/SUDI. That being said, interventions modelled on the Finnish Baby Box should not be discounted as means to improve antenatal and postpartum health service engagement in low-income settings (Kirby *et al.*, 2015; Rossouw, Burger and Burger, 2017; Shapira *et al.*, 2017).

The promotion of safe sleeping is important and was instrumental in the 'back to sleep' campaigns from the latter half of the 20th century (Jullien, 2021). However, returning to Pearce et al.'s (2019) model of the social determinants of infant health (Section 2.2.1), socio-economic conditions are perhaps a more worthy target for decision makers seeking to reduce infant mortality and inequalities in infant mortality at present. There is evidence to suggest that such conditions have implications for infant mortality (Stuckler *et al.*, 2017; Taylor-Robinson *et al.*, 2019; Rajmil *et al.*, 2020).

This thesis found evidence that the introduction of SBBS reduced parental and infant exposure to tobacco smoke. However, as is often the case with infant mortality, this should not be interpreted by decision makers as an inherent outcome of baby boxes. Further investigation is required to verify and establish the mechanisms behind this potential effect, and to understand whether it persists over time. This in turn may allow for modification to improve the effectiveness and targeting of the scheme. It is also important to consider the cost-effectiveness of SBBS in relation to other interventions that may reduce infant and parental tobacco smoke exposure. As before, decision makers seeking to reduce infant and maternal tobacco smoke exposure – which both exhibit clear socio-economic inequalities – should also consider action targeting socio-economic conditions (Flemming *et al.*, 2015; McKenna, Law and Pearce, 2017).

With the exception of young mothers, the research presented in this thesis did not find any evidence that SBBS increased exclusive breastfeeding. However, the long-term impact of the scheme and its impact on other measures of breastfeeding (e.g., non-exclusive breastfeeding) are not addressed in this thesis. The hypothesised interaction between SBBS and the FNP requires further investigation. If this is indeed responsible for the increase in exclusive breastfeeding observed in young mothers, it would suggest the need for more far-reaching breastfeeding support to be delivered in conjunction with SBBS. As

Brown (2017) notes, breastfeeding is affected by the knowledge, attitudes, and expectations of the society in which mothers are embedded. Consequently, they argue, policy should not solely focus on individual level interventions and responsibility should not be placed on individual mothers. The success of Brazil's National Breastfeeding Programme – which focussed on individual, local, and structural levels simultaneously - is a case in point (Boccolini *et al.*, 2017).

A final implication of the research presented in this thesis is to highlight the feasibility of quantitative outcome evaluation of policy developments that have implications for health and health inequalities. This approach is inexpensive and, in a setting such as Scotland, benefits from the availability of linked administrative health data which offers almost complete population coverage. Thus, as others have pointed out, it is not clear why the Scottish Government failed to commission such an evaluation for SBBS (McCartney, 2017). In future, decision makers should consider how to incorporate quantitative outcome evaluation to understand the short- and long-term health impact of policy developments.

11.6 Future research directions

Further research is needed to verify the effect of SBBS on infant and parental tobacco smoke exposure. A simple extension to the evaluation presented in this thesis could use cause-specific infant admissions data for asthma and respiratory tract infection, as these measures have previously been responsive to tobacco control policy (Faber *et al.*, 2017). These data are available in SMR-01. Incidence rates with different follow-up periods (e.g., 26 weeks and 52 weeks) would be used as outcome measures in ITS analyses, similar to the analyses of all-cause infant and maternal hospital admissions in Chapter 6. In addition to this, temporal falsification could be used as a sensitivity analysis whereby the point of introduction in the model is reassigned. Temporal falsification was recently used for an ITS analysis evaluating the effect advertising restrictions on public transport (Yau *et al.*, 2021).

It is also important to establish whether this effect persists over time. As has been discussed, the measures of tobacco smoke exposure used in this evaluation extended from early in the postpartum period and are therefore not indicative of long-term effects. Variables relating to primary carer smoking and infant exposure to second-hand smoke are also available in the CHSP-PS 6-8-week review extract. These were not included in the evaluation of SBBS presented in this thesis owing to high missingness. However, depending on the reasons for missingness, there may be scope to use imputation methods to allow for the analysis of these variables (Hughes et al., 2019).

It is of interest to further investigate the association between SBBS and exclusive breastfeeding among young mothers. In the first instance, ITS models could incorporate the 2018 Scottish Government breastfeeding funding as an additional break-point (Wagner *et al.*, 2002). Analyses could also be expanded to include other measures of non-exclusive breastfeeding. These are available in the CHSP-PS data. Measures of breastfeeding are also available in the CHSP-PS 6-8-week review extract and could be used to understand whether associations hold across time, while considering the impact of missingness.

It would also be worth exploring the relationship between the FNP and SBBS. There is a potential opportunity for natural experimental evaluation here. This approach could compare the effect of SBBS on breastfeeding among young mothers in two different NHS Scotland health boards, one 'exposed' to the FNP at the time of SBBS introduction and the other 'unexposed' (i.e., NHS Dumfries and Galloway, who did not begin operating the FNP until 2018). Qualitative research could also be used to understand how family nurses and mothers percieved the relationship between the FNP and SBBS. The Scottish Government has commissioned a natural experimental evaluation of the FNP which will include breastfeeding as an outcome measure (Cannings-John *et al.*, 2020). The findings of this research will be important to understanding whether SBBS could have had an interactive effect with the FNP.

Considering the complex aspects of SBBS discussed in Section 11.4.3, there are a number of possible avenues for future research. The qualitative research commissioned by the Scottish Government, notably Bardsley *et al.* (2021), concerned the views of parents and healthcare practitioners (see Section 2.3.1). This research provided useful insight into the operation of SBBS and was used to inform the discussion of this thesis' findings in Section 11.3. However, in light of the findings of this thesis, further qualitative research would be useful to understanding the specific 'mechanisms of change' underpinning the relationship between SBBS and tobacco smoke exposure or SBBS and breastfeeding, and the contextual nature of these mechanisms. This research could seek to understand the respective roles of each of the mechanisms mediating the relationship between SBBS and tobacco smoke exposure hypothesised in Section 11.3.2.2. It could also focus on the how SBBS was percieved by parents and healthcare practitioners specifically in relation to the FNP scheme, with respect to breastfeeding and other health outcomes. More broadly, and beyond an exclusive interest in the health impact of SBBS, future research could take a 'macro-approach' to evaluation and try to understand the wider societal impact of the scheme (Smith and Petticrew, 2010). For example, qualitative research could help understand how symbolic representations of the scheme, such as the values and goals expressed in the political discourse discussed in Chapter 3 (e.g., equality of opportunity and national identity), impact the perceptions of parents, healthcare practitioners, and decision makers, as well as the wider public who might not be directly targeted by SBBS. While I have given some examples here of future research directed at understanding the more complex aspects of SBBS as an intervention, it is worth noting the challenges involved. For example, the impact of SBBS may operate through non-linear pathways and change according to contextual factors (e.g., policy developments or differences in demographic characteristics). Additionally, these pathways may not resemble those hypothesised by the Scottish Government commissioned EA or indeed those hypothesised in this thesis (e.g., in Section 11.3.2.2). As such, indentifying these pathways poses a challenge to any future research aiming to capture the broader impact of SBBS and understand how the scheme operates over time and in relation to wider contextual factors.

11.7 Impact of the COVID-19 pandemic

It is worth noting the impact of the COVID-19 pandemic on the research presented in this thesis. Namely, as a result of the rapid need for eDRIS to facilitate the use of data for monitoring the pandemic, there were considerable delays in access to the administrative health data needed for the natural experimental evaluation of SBBS. It is also the case that access to these data was not extended to account for these delays. Consequently, there was less time within the funding period of this thesis to undertake this evaluation.

11.8 Conclusion

This thesis has provided a mixed-methods public health evaluation of SBBS. The political discourse surrounding the scheme featured questionable argumentation. This included the claim that the Finnish Baby Box reduced infant mortality. This thesis found no clear evidence that this claim was true. SBBS was observed to have had a potential beneficial impact on the prevalence of primary carers smoking and infants exposed to second-hand smoke. It may have also had a beneficial impact on exclusive breastfeeding among young mothers. The introduction of SBBS was not associated with any effect on all-cause infant and maternal hospital admissions or infant sleeping position. Decision makers need to be cautious of health claims surrounding baby boxes that are not based in evidence and should consider outcome evaluation of policy developments where feasible. Further research is needed to establish the effects of SBBS, understand the mechanisms involved, and understand whether these effects persist over time.

Appendices

Appendix 1 – Search terms used for literature review in Chapter 2

Search terms used in Scopus by Section of Chapter 2. All searches included articles published between 2000 and 2022.

Thesis section	Search terms used in Scopus
2.4.1	TITLE-ABS-KEY (("in-kind transfer" OR "non-monetary transfer" OR "material transfer" OR "in-kind benefit" OR "non-monetary benefit" OR "material benefit" OR "in-kind gift" OR "non-monetary gift" OR "material gift") AND ("health"))
2.4.2	TITLE (("UCT*" OR "CCT*" OR "unconditional cash transfer" OR "conditional cash transfer" OR "cash transfer" OR "monetary transfer" OR "financial transfer" OR "grant" OR "benefit" OR "welfare" OR "social assistance") AND ("infant" OR "maternal") AND ("health")) **AND** KEY (("UCT*" OR "CCT*" OR "unconditional cash transfer" OR "conditional cash transfer" OR "cash transfer" OR "monetary transfer" OR "financial transfer" OR "grant" OR "benefit" OR "welfare" OR "social assistance") AND ("infant" OR "maternal") AND ("health"))
2.4.3.1	Formal search Scopus: TITLE (("breastfeed*) AND ("intervention" OR "programme" OR "scheme" OR "trial" OR "evaluation" OR “RCT”)) AND (LIMIT-TO (DOCTYPE , "re"))

	AND TITLE (("breastfeed*") AND ("self-help" OR "booklet" OR "brochure" OR "leaflet" OR "website" OR "internet"))
2.4.3.2	TITLE (("infant") AND ("sleep*") AND ("practices" OR "position" OR "supine" OR "prone" OR "side")) **AND** TITLE (("infant") AND ("sleep*") AND ("practices" OR "position" OR "supine" OR "prone" OR "side") AND ("evaluat*" OR "trial" OR "RCT"))
2.4.3.3	TITLE (("infant" OR "child*" OR "maternal" OR "parental" OR "pregnancy" OR "prenatal" OR "antenatal" OR "postnatal" OR "perinatal") AND ("tobacco" OR "smok*" OR "cigarettes") AND ("intervention" OR "programme" OR "scheme" OR "trial" OR "evaluation" OR “RCT”)) AND (LIMIT-TO (DOCTYPE , "re")) **AND** TITLE-ABS-KEY (("maternal" OR "parental" OR "pregnancy" OR "prenatal" OR "antenatal" OR "postnatal" OR "perinatal") AND ("tobacco" OR "smok*" OR "cigarettes") AND ("brochure" OR "booklet" OR "pamphlet"))

Appendix 2 - List of textual (data) sources used in Chapter 3

List of textual sources used as data for the political discourse analysis of Scotland's Baby Box Scheme in Chapter 3. All sources last accessed in July 2020.

Title	ID	Source	Type	Publication date	Available at
How does the SNP support pregnant women and new parents?	SNP1	Scottish National Party	News article	2016 (specific date not indicated)	https://www.snp.org/policies/pb-how-does-the-snp-support-pregnant-women-and-new-parents/
Our priorities for Government	SNP2	Scottish National Party	News article	25-05-2016	https://www.snp.org/our-priorities-for-government/
A precious opportunity	SG1	Scottish Government	News article	25-05-2016	https://www.gov.scot/news/a-precious-opportunity/
Priorities for Government	SG2	Scottish Government	Speech	25-05-2016	https://www.gov.scot/publications/first-minister-speech-priorities-for-government/
Our Action for Families	SNP3	Scottish National Party	News article	18-04-2016	https://www.snp.org/our-action-for-families/
Ensuring healthy pregnancies and preventing childhood poverty	SGP1	Scottish Green Party	News article	18-04-2016	https://greens.scot/news/ensuring-healthy-pregnancies-and-preventing-childhood-poverty
All pregnant women to receive vitamins	SG3	Scottish Government	News article	01-06-2016	https://www.gov.scot/news/all-pregnant-women-to-receive-vitamins/
Programme for Government 2016-2017: First Minister's statement	SG4	Scottish Government	Statement /speech	06-09-2016	https://www.gov.scot/publications/first-minister-statement-programme-government/

Meeting of the Parliament	MotP1	Scottish Parliament Official Report	Meeting transcritpt	02-06-2016	https://www.parliament.scot/chamber-and-committees/official-report/what-was-said-in-parliament
Meeting of the Parliament	MotP2	Scottish Parliament Official Report	Meeting transcritpt	15-06-2016	https://www.parliament.scot/chamber-and-committees/official-report/what-was-said-in-parliament
Meeting of the Parliament	MotP3	Scottish Parliament Official Report	Meeting transcritpt	14-09-2016	https://www.parliament.scot/chamber-and-committees/official-report/what-was-said-in-parliament
World Breastfeeding Week and how the SNP is supporting new mums	SNP4	Scottish National Party	News article	02-08-2016	https://www.snp.org/world-breastfeeding-week-snp-supporting-new-mums/
A prosperous Scotland with equal opportunities for everyone, no matter their background	SNP5	Scottish National Party	News article	06-09-2016	https://www.snp.org/nicola-sturgeon-prosperous-scotland-with-equal-opportunities/
Arctic Circle Assembly 2016: First Minister's speech	SG5	Scottish Government	Statement /speech	07-10-2016	https://www.gov.scot/publications/arctic-circle-assembly-2016-fm-speech/
Nicola Sturgeon's address to #SNP16	SNP6	Scottish National Party	Statement /speech	15-10-2016	https://www.snp.org/nicola-sturgeon-address-to-snp16/
Poverty is not inevitable - we will do all we can to eradicate it	SNP7	Scottish National Party	News	25-10-2016	https://www.snp.org/poverty-is-not-inevitable/
ALL POINTS NORTH: THE SCOTTISH GOVERNMENT'S NORDIC BALTIC POLICY STATEMENT	SG6	Scottish Government	Policy document	29-09-2017	https://www.gov.scot/publications/points-north-scottish-governments-nordic-baltic-policy-statement/

A nation with ambition: the Government's Programme for Scotland 2017-2018	SG7	Scottish Government	Policy document	05-09-2017	https://www.gov.scot/publications/nation-ambition-governments-programme-scotland-2017-18/
Baby Boxes begin	SG8	Scottish Government	News	01-01-2017	https://www.gov.scot/news/baby-boxes-begin/
Meeting of the Parliament	MotP4	Scottish Parliament Official Report	Meeting transcritpt	18-01-17	https://www.parliament.scot/chamber-and-committees/official-report/what-was-said-in-parliament
What are the details for the SNP Scottish Government's baby box scheme?	SNP8	Scottish National Party	News	2017	https://www.snp.org/policies/pb-baby-box-scheme/
Making real and lasting progress in 2017	SNP9	Scottish National Party	News	10-01-2017	https://www.snp.org/making-real-and-lasting-progress-in-2017/
Meeting of the Parliament	MotP5	Scottish Parliament Official Report	Meeting transcritpt	19-04-2017	https://www.parliament.scot/chamber-and-committees/official-report/what-was-said-in-parliament
Speech by Deputy First Minister John Swinney to SNP Spring Conference	SNP10	Scottish National Party	Statement /speech	18-03-2017	https://www.snp.org/speech-by-deputy-first-minister-john-swinney-to-snp-spring-conference/
An ambitious prospectus to fulfil Scotland's massive potential	SNP11	Scottish National Party	Statement /speech	20-04-2016	https://www.snp.org/an-ambitious-prospectus-to-fulfil-scotland-s-massive-potential/
Here's how we create healthier, wealthier children	SGP2	Scottish Green Party	News	31-03-2017	https://greens.scot/blog/here-s-how-we-create-healthier-wealthier-children

Safe sleeping	SG9	Scottish Government	News	13-08-2017	https://www.gov.scot/news/safe-sleeping/
Scotland's Baby Box available nationwide	SG10	Scottish Government	News	14-08-2017	https://www.gov.scot/news/scotlands-baby-box-available-nationwide/
Baby Box Bairns	SG11	Scottish Government	News	16-08-2017	https://www.gov.scot/news/baby-box-bairns/
Baby Box registrations reach 10,000	SG12	Scottish Government	News	20-08-2017	https://www.gov.scot/news/baby-box-registrations-reach-10-000/
Programme for Government 2017-2018: First Minister's speech	SG13	Scottish Government	Statement /speech	05-09-2017	https://www.gov.scot/publications/programme-for-government-2017-2018-first-ministers-speech/
Meeting of the Parliament	MotP6	Scottish Parliament Official Report	Meeting transcritpt	22-06-2017	https://www.parliament.scot/chamber-and-committees/official-report/what-was-said-in-parliament
Giving every child the best start in life, whatever their background	SNP12	Scottish National Party	News	13-08-2017	https://www.snp.org/giving-every-child-the-best-start-in-life-whatever-their-background/
10,000 parents register for the Baby Box in one week	SNP13	Scottish National Party	News	21-08-2017	https://www.snp.org/10-000-parents-register-for-the-baby-box-in-one-week/
Young people are our future	SNP14	Scottish National Party	News	24-09-2017	https://www.snp.org/young-people-are-our-future/
Arctic Circle Assembly 2017: First Minister's speech	SG14	Scottish Government	Statement /speech	13-10-2017	https://www.gov.scot/publications/first-ministers-speech-arctic-circle-assembly/
NHS in Scotland 2017	SG15	Scottish Government	News	26-10-2017	https://www.gov.scot/news/nhs-in-scotland-2017/

Meeting of the Parliament	MotP7	Scottish Parliament Official Report	Meeting transcritpt	14-12-2017	https://www.parliament.scot/chamber-and-committees/official-report/what-was-said-in-parliament
Nicola Sturgeon's speech to the SNP conference	SNP15	Scottish National Party	Statement /speech	10-10-2017	https://www.snp.org/nicola-sturgeons-speech-to-the-snp-conference-2017/
Laying the foundations for an inclusive, tolerant, outward-looking society	SNP16	Scottish National Party	News	18-10-2017	https://www.snp.org/an-inclusive-tolerant-outward-looking-society/
Working with our Nordic and Baltic neighbours	SNP17	Scottish National Party	News	20-11-2017	https://www.snp.org/working-with-our-nordic-and-baltic-neighbours/
9 ways we've stood up for Scotland this year	SNP18	Scottish National Party	News	28-12-2017	https://www.snp.org/9-ways-we-ve-stood-up-for-scotland-this-year/
2018: Baby boxes	SG16	Scottish Government	News	03-01-2018	https://www.gov.scot/news/2018-baby-boxes/
Scotland's International Policy Framework and priorities 2018: speech	SG17	Scottish Government	Statement /speech	16-01-2018	https://www.gov.scot/publications/external-affairs-secretary-fiona-hyslop-addresses-the-scottish-parliament-on-scotlands-international-policy/
Family nurses helping to deliver	SG18	Scottish Government	News	06-03-2018	https://www.gov.scot/news/family-nurses-helping-to-deliver/
Meeting of the Parliament	MotP8	Scottish Parliament Official Report	Meeting transcritpt	24-01-2018	https://www.parliament.scot/chamber-and-committees/official-report/what-was-said-in-parliament
Meeting of the Parliament	MotP9	Scottish Parliament Official Report	Meeting transcritpt	20-03-2018	https://www.parliament.scot/chamber-and-committees/official-report/what-was-said-in-parliament
Meeting of the Parliament	MotP10	Scottish Parliament Official Report	Meeting transcritpt	21-03-2018	https://www.parliament.scot/chamber-and-committees/official-report/what-was-said-in-parliament

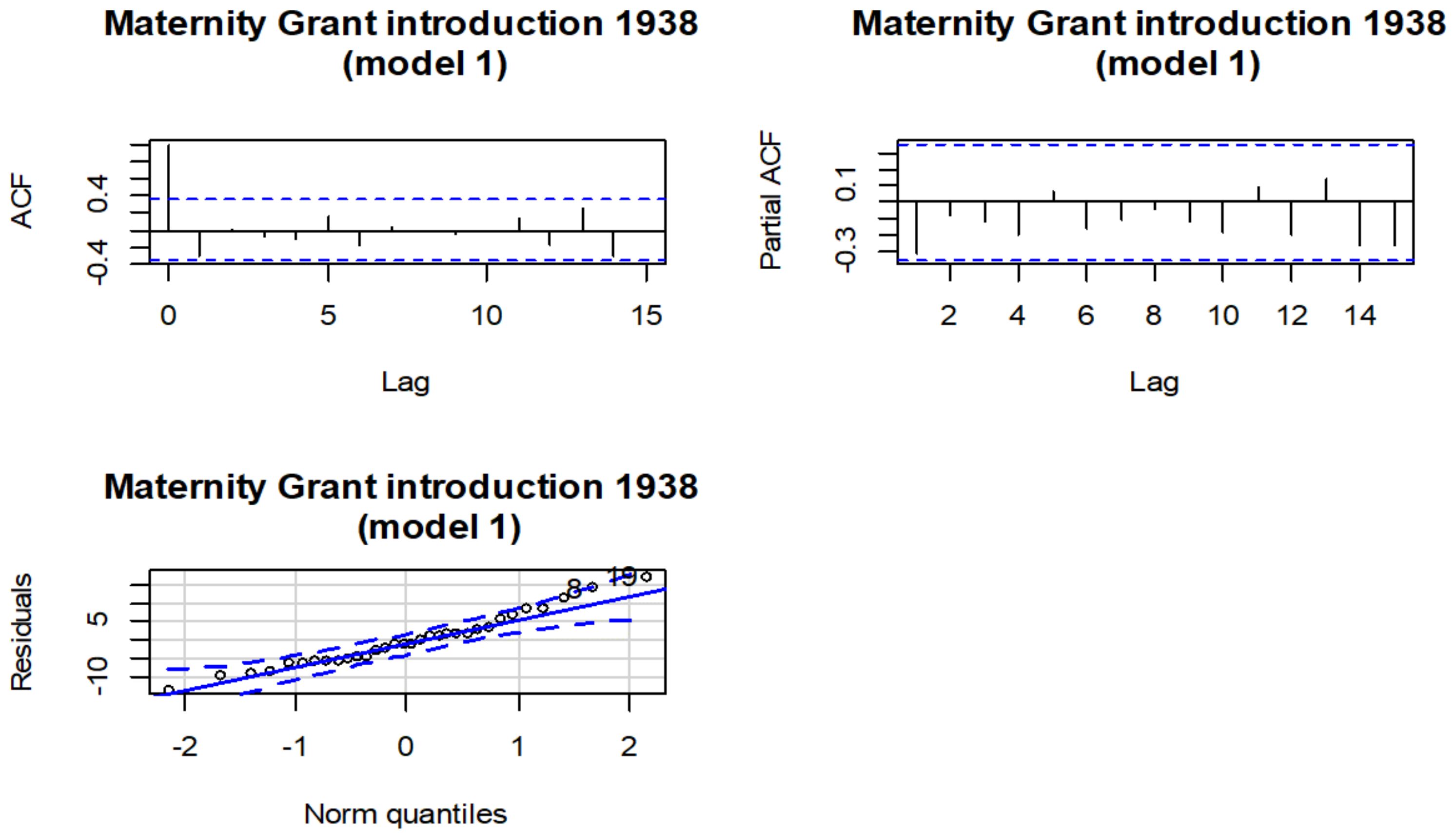
Nicola Sturgeon speech on Brexit at the David Hume Institute	SNP19	Scottish National Party	Statement /speech	17-01-2018	https://www.snp.org/nicola-sturgeon-speech-on-brexit-at-the-david-hume-institute/
Learning from the best: how we're building a fairer and more inclusive country	SNP20	Scottish National Party	News	28-01-2018	https://www.snp.org/learning-from-the-best-how-we-re-building-a-fairer-and-more-inclusive-country/
The most radical policy platform since devolution	SNP21	Scottish National Party	News	01-02-2018	https://www.snp.org/the-most-radical-policy-platform-since-devolution/
Our plan to tackle child poverty	SNP22	Scottish National Party	News	30-03-2018	https://www.snp.org/tackling-child-poverty/
First Minister's speech with UNICEF on child poverty	SG19	Scottish Government	Statement /speech	10-04-2018	https://www.gov.scot/publications/first-ministers-speech-with-unicef-on-child-poverty/
Meeting of the Parliament	MotP11	Scottish Parliament Official Report	Meeting transcritpt	03-05-2018	https://www.parliament.scot/chamber-and-committees/official-report/what-was-said-in-parliament
Our new Income Supplement will help reduce unacceptable levels of poverty	SNP23	Scottish National Party	News	03-04-2018	https://www.snp.org/our-new-income-supplement-will-help-reduce-unacceptable-levels-of-poverty-2/
Deputy First Minister John Swinney's address to SNP conference	SNP24	Scottish National Party	Statement /speech	08-06-2018	https://www.snp.org/deputy-first-minister-john-swinney-s-address-to-snp-conference/
Call for 'complete transparency' over baby box safety fears	SCP1	Scottish Conservative Party	News	03-05-2018	Webpage removed
Baby Box birthday	SG20	Scottish Government	News	15-08-2018	https://www.gov.scot/news/baby-box-birthday/
Programme for Government 2018-2019: First Minister's speech	SG21	Scottish Government	Statement /speech	04-09-2018	https://www.gov.scot/publications/programme-for-government-first-ministers-speech/

New baby benefit makes first payments	SG22	Scottish Government	News	17-12-2018	https://www.gov.scot/news/new-baby-benefit-makes-first-payments/
A healthier, wealthier and fairer Scotland: four years of Nicola Sturgeon's government	SNP25	Scottish National Party	News	24-11-2018	https://www.snp.org/a-healthier-wealthier-and-fairer-scotland-four-years-of-nicola-sturgeons-government/
20 years of devolution: First Minister's speech	SG23	Scottish Government	Statement /speech	18-06-2019	https://www.gov.scot/publications/fm-20-years-devolution/
Meeting of the Parliament	MotP12	Scottish Parliament Official Report	Meeting transcritpt	26-02-2019	https://www.parliament.scot/chamber-and-committees/official-report/what-was-said-in-parliament
Supporting young mums	SG24	Scottish Government	News	23-06-2019	https://www.gov.scot/news/supporting-young-mums/
Meeting of the Parliament	MotP13	Scottish Parliament Official Report	Meeting transcritpt	04-04-2019	https://www.parliament.scot/chamber-and-committees/official-report/what-was-said-in-parliament
Nicola Sturgeon's address to conference	SNP26	Scottish National Party	Statement /speech	28-04-2019	https://www.snp.org/nicola-sturgeons-address-to-conference/
Tory leadership 'horror show' makes the case for independence	SNP27	Scottish National Party	News	14-06-2019	https://www.snp.org/tory-leadership-horror-show-makes-the-case-for-independence/
After 20 years of devolution, it's time to complete our journey to independence	SNP28	Scottish National Party	News	01-07-2019	https://www.snp.org/after-20-years-of-devolution-its-time-to-complete-our-journey-to-independence/
'We've made a real difference' - Nicola Sturgeon reflects on 20 years of devolution	SNP29	Scottish National Party	Statement /speech	01-07-2019	https://www.snp.org/weve-made-a-real-difference-nicola-sturgeon-reflects-on-20-years-of-devolution/
We're working to build a better nation	SNP30	Scottish National Party	News	07-01-2020	https://www.snp.org/were-working-to-build-a-better-nation/

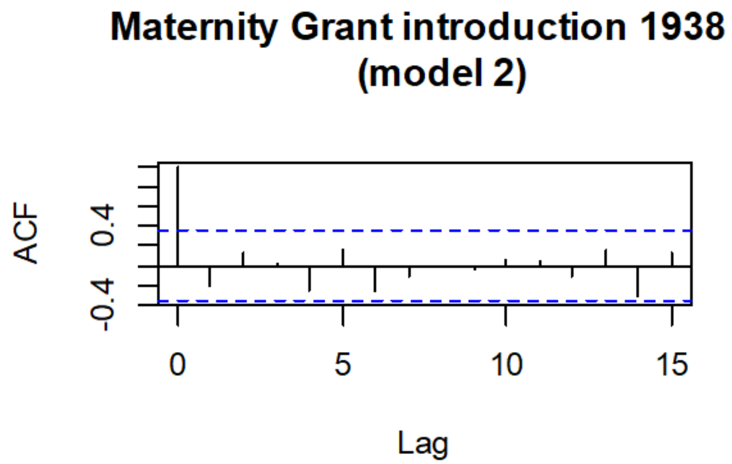
Building a fairer Scotland with wellbeing at its heart	SNP31	Scottish National Party	News	15-05-2020	https://www.snp.org/building-a-fairer-scotland-with-wellbeing-at-its-heart/

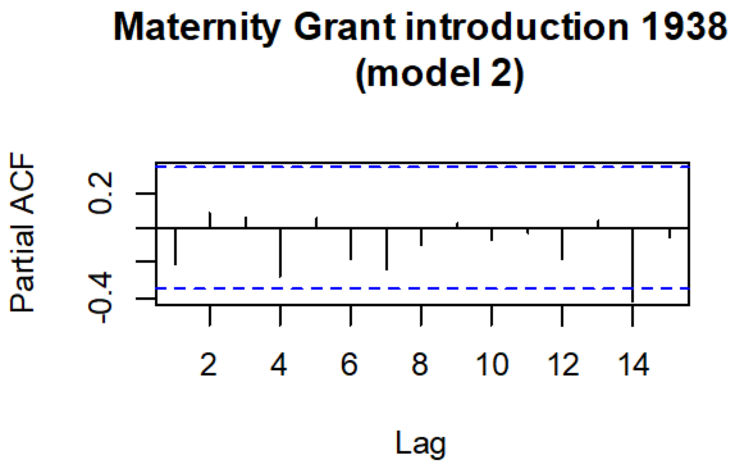
Appendix 3 – Finnish Maternity Grant introduction ITS model diagnostics

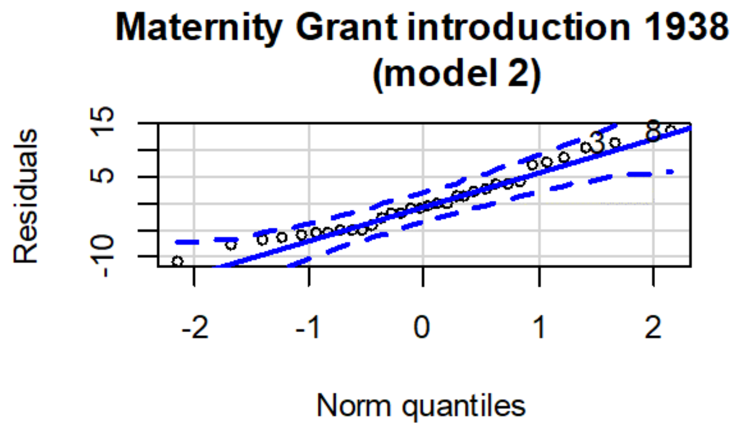
Section 4.5.1.1. From left to right: ACF plot for model 1, P-ACF plot for model 1, and Q-Q plot of residuals for model 1 (ITS analysis of Finnish Maternity Grant introduction in 1938).



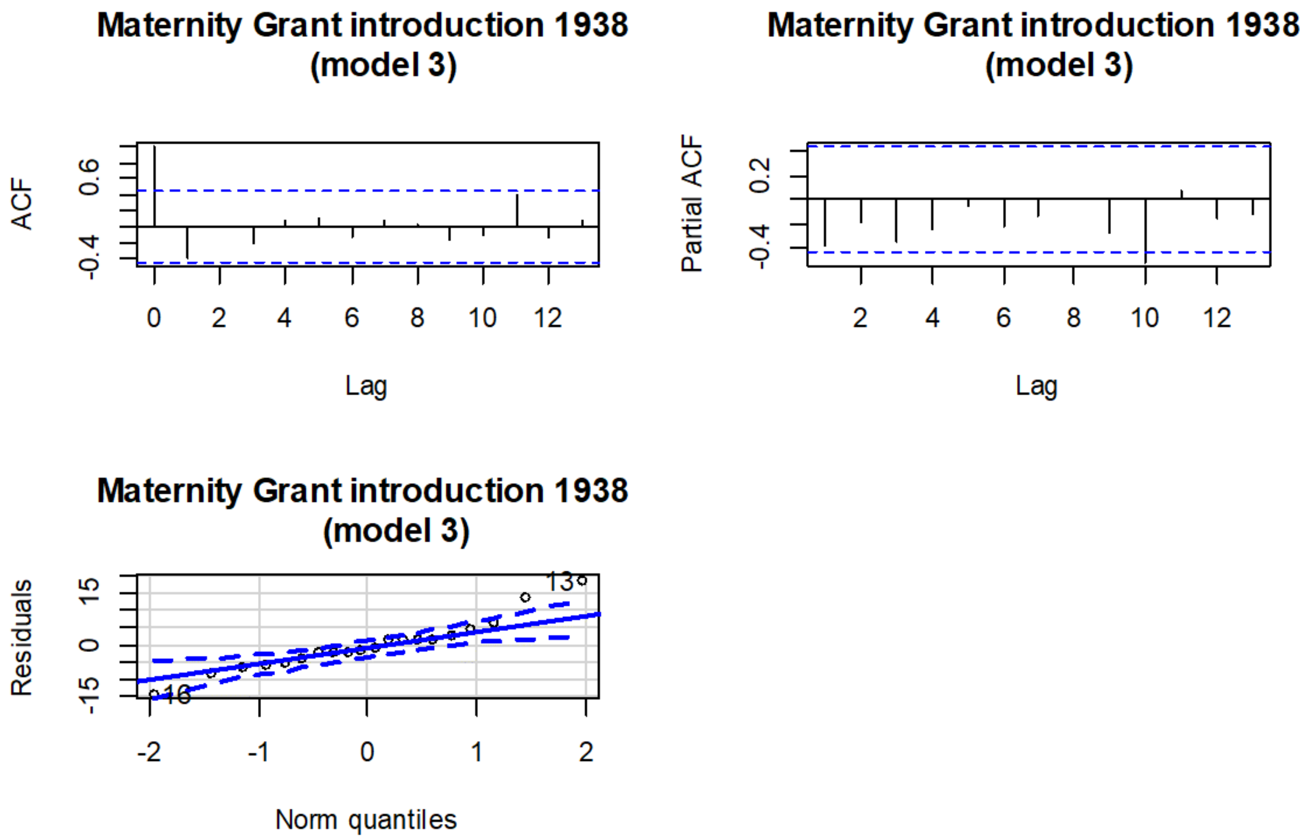
Section 4.5.1.1. From left to right: ACF plot for model 2, P-ACF plot for model 2, and Q-Q plot of residuals for model 2 (ITS analysis of Finnish Maternity Grant introduction in 1938).



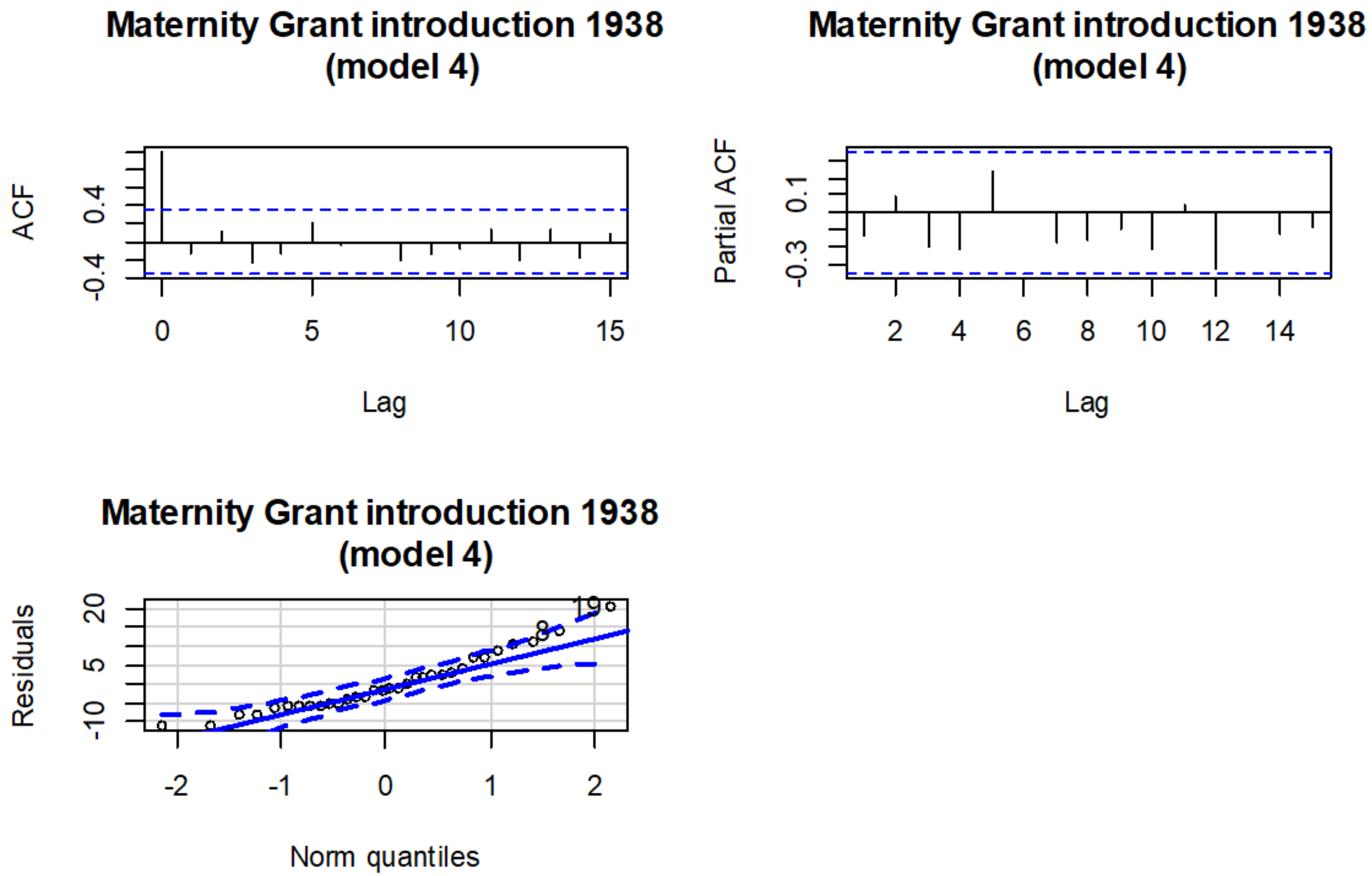




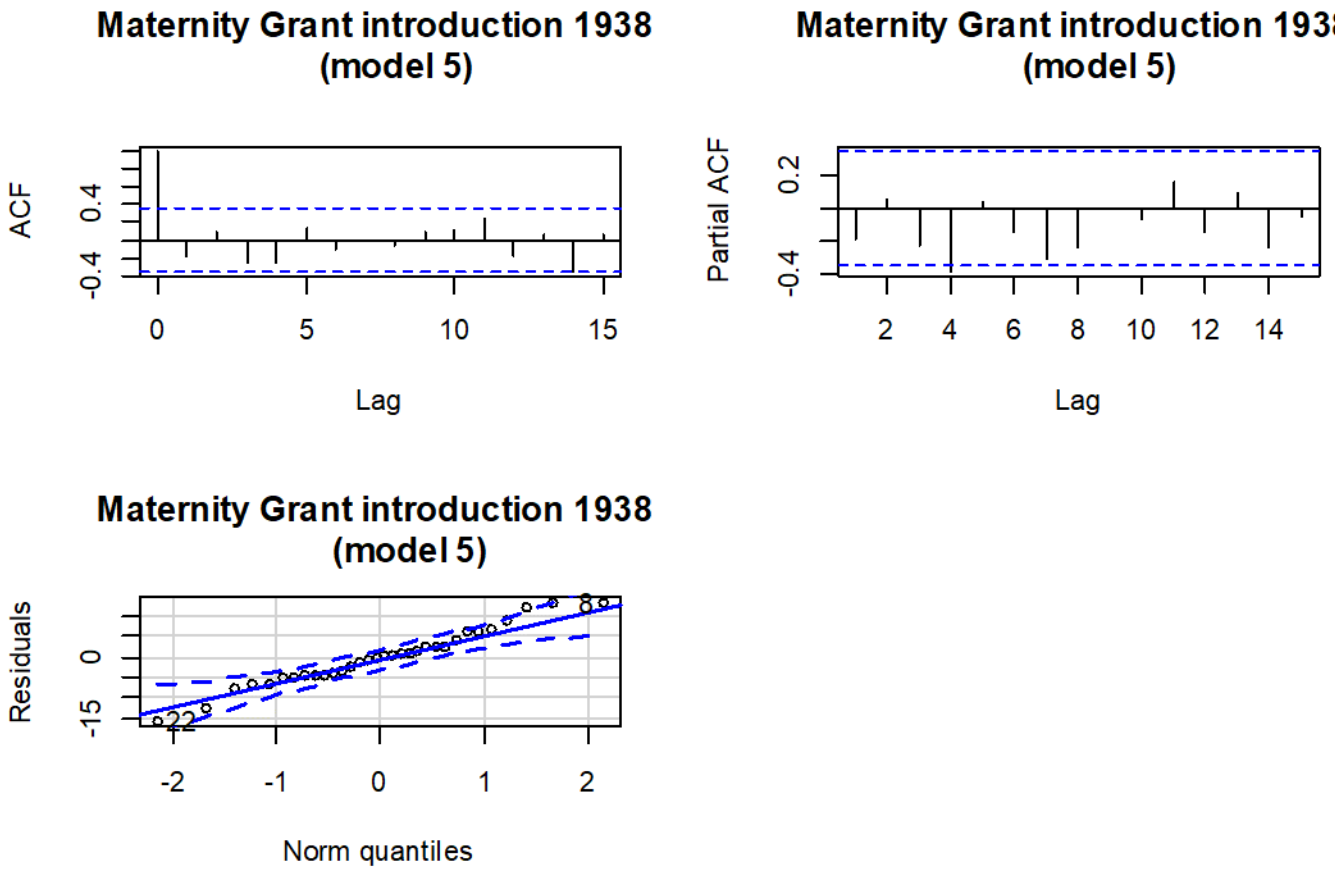
Section 4.5.1.1. From left to right: ACF plot for model 3, P-ACF plot for model 3, and Q-Q plot of residuals for model 3 (ITS analysis of Finnish Maternity Grant introduction in 1938).



Section 4.5.1.1. From left to right: ACF plot for model 4, P-ACF plot for model 4, and Q-Q plot of residuals for model 4 (ITS analysis of Finnish Maternity Grant introduction in 1938).

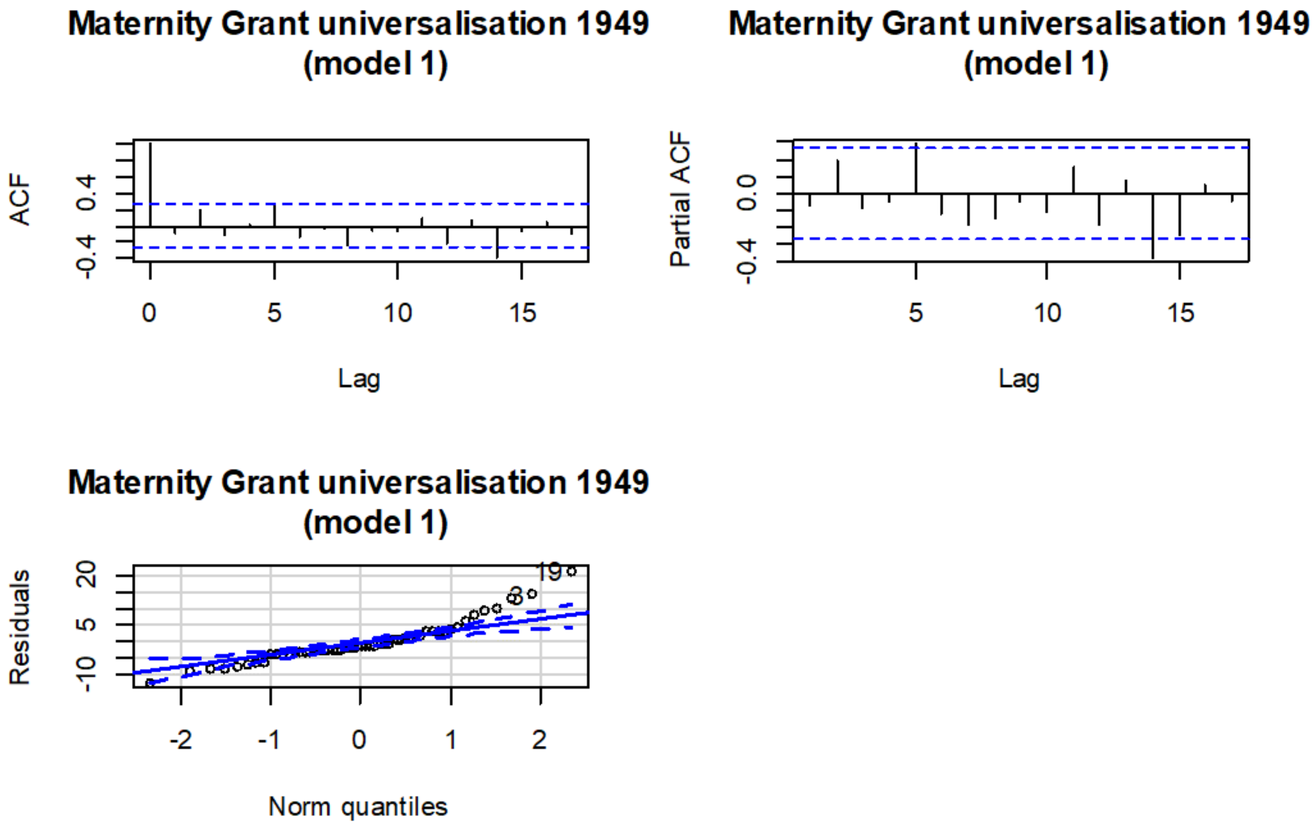


Section 4.5.1.1. From left to right: ACF plot for model 5, P-ACF plot for model 5, and Q-Q plot of residuals for model 5 (ITS analysis of Finnish Maternity Grant introduction in 1938).

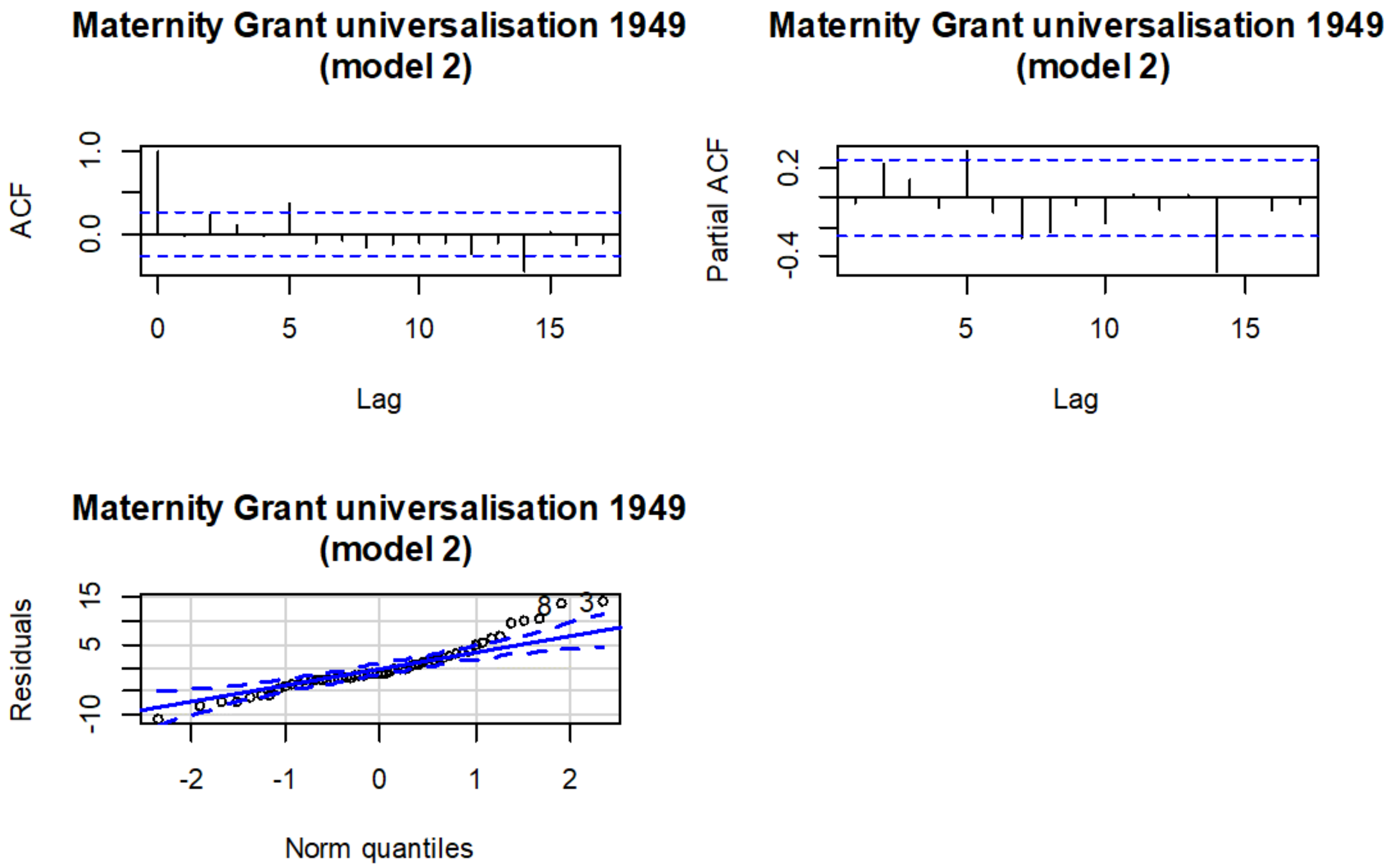


Appendix 4 – Finnish Maternity Grant universalisation ITS model diagnostics

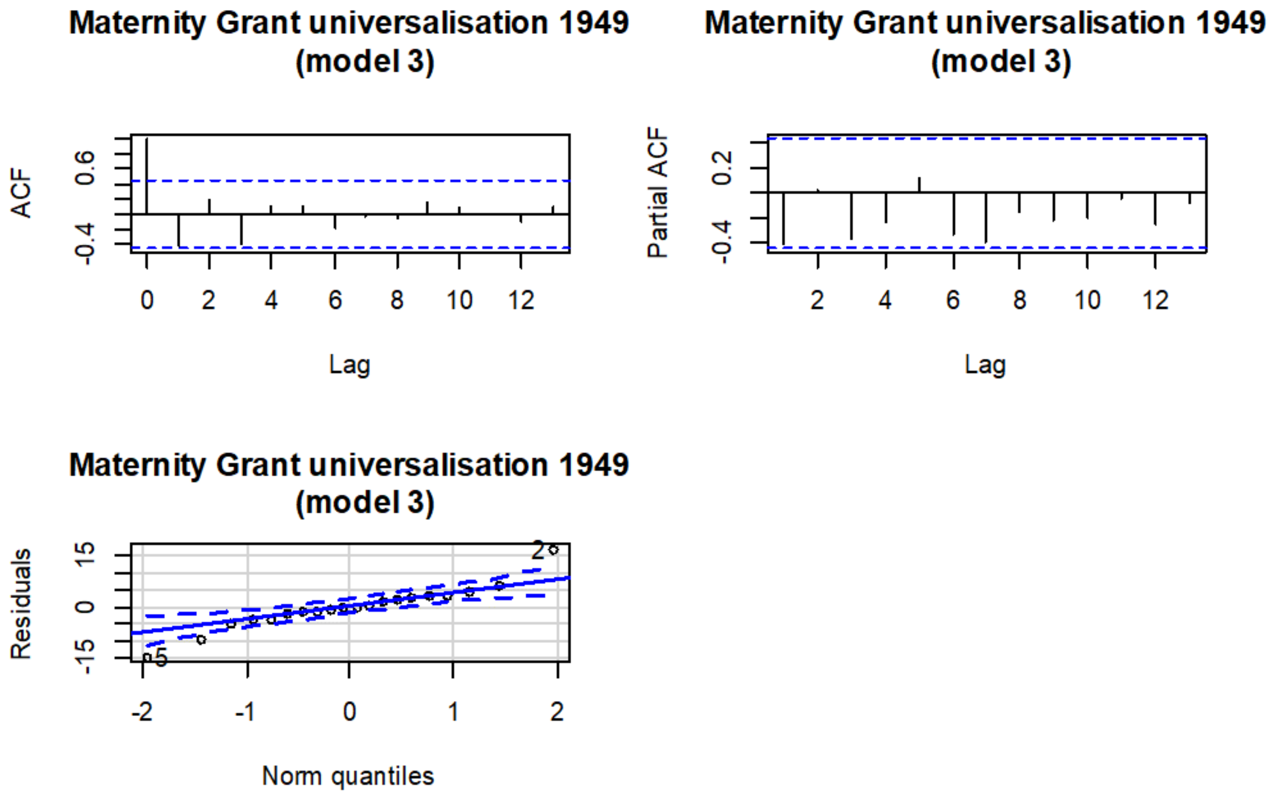
Section 4.5.2.1. From left to right: ACF plot for model 1, P-ACF plot for model 1, and Q-Q plot of residuals for model 1 (ITS analysis of Finnish Maternity Grant universalisation in 1949).



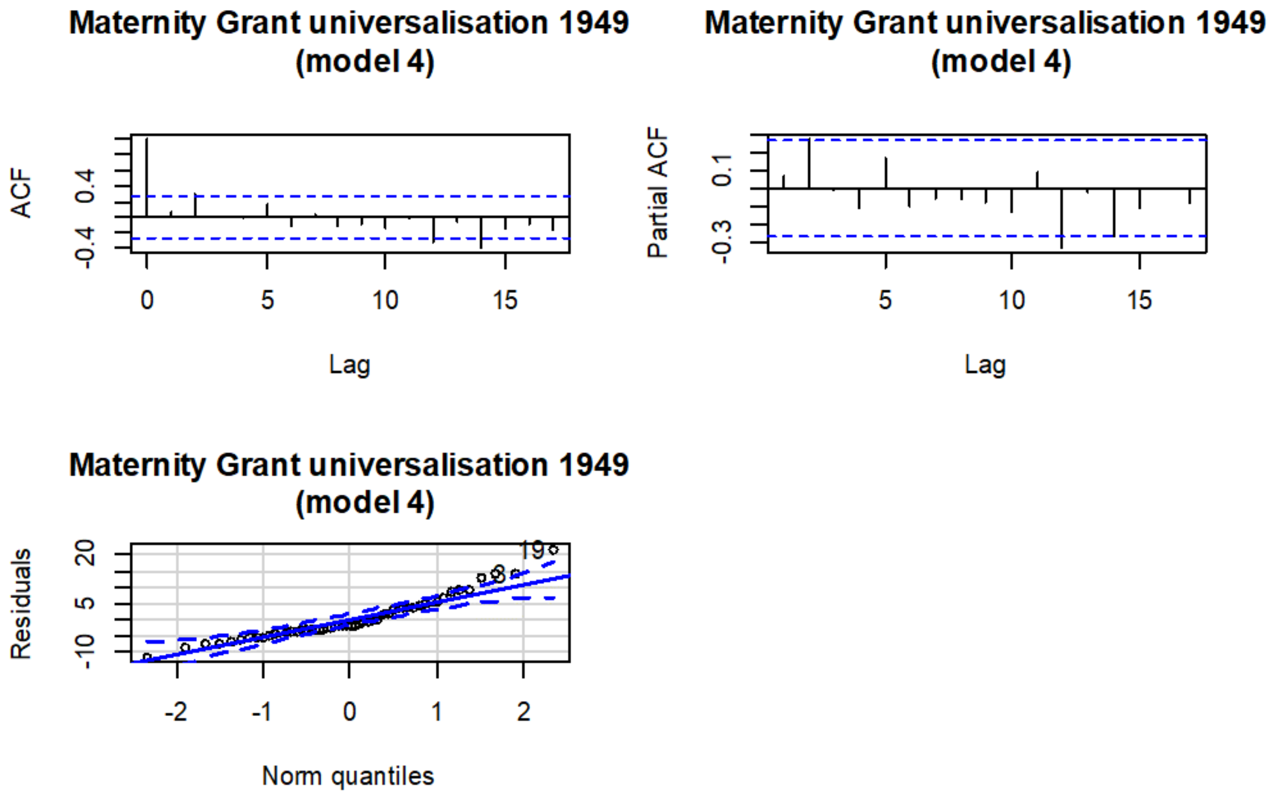
From left to right: ACF plot, P-ACF plot, and Q-Q plot of residuals for model 2 (ITS analysis of Finnish Maternity Grant universalisation in 1949).



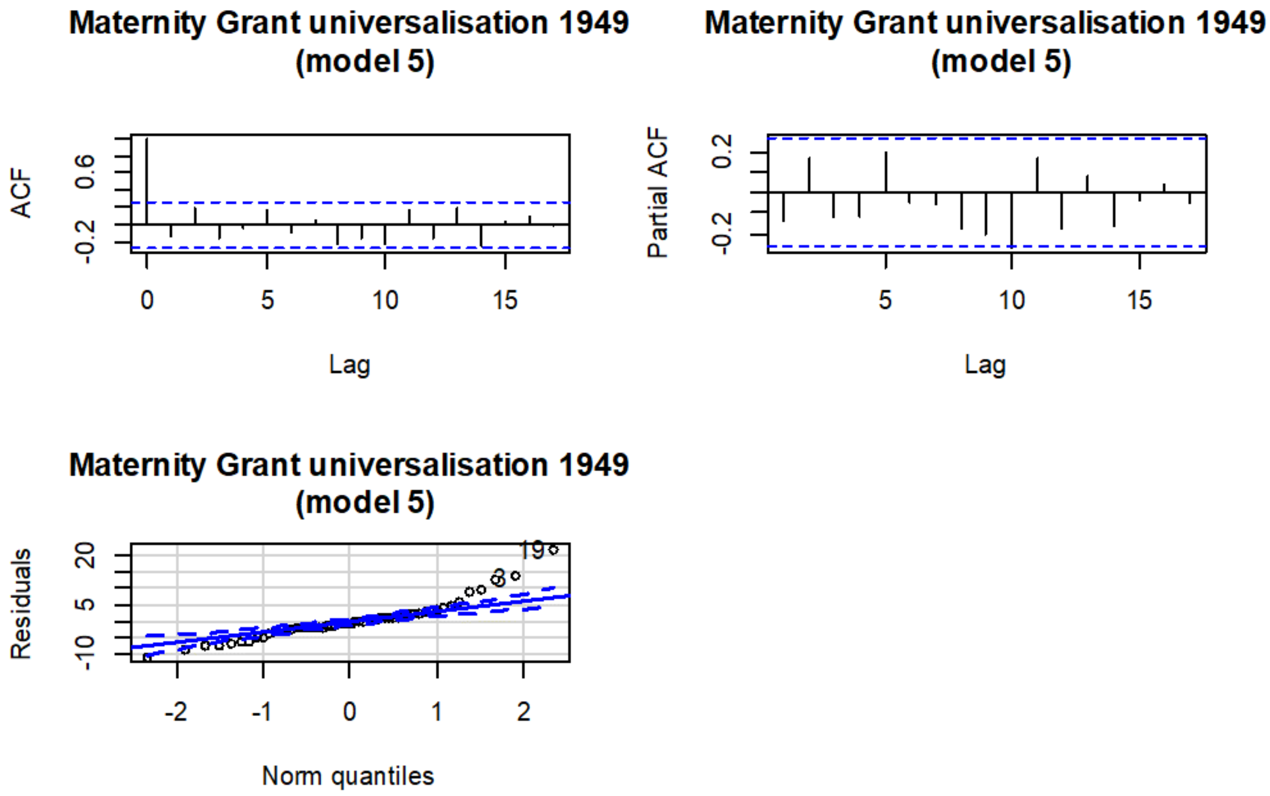
From left to right: ACF plot, P-ACF plot, and Q-Q plot of residuals for model 3 (ITS analysis of Finnish Maternity Grant universalisation in 1949).



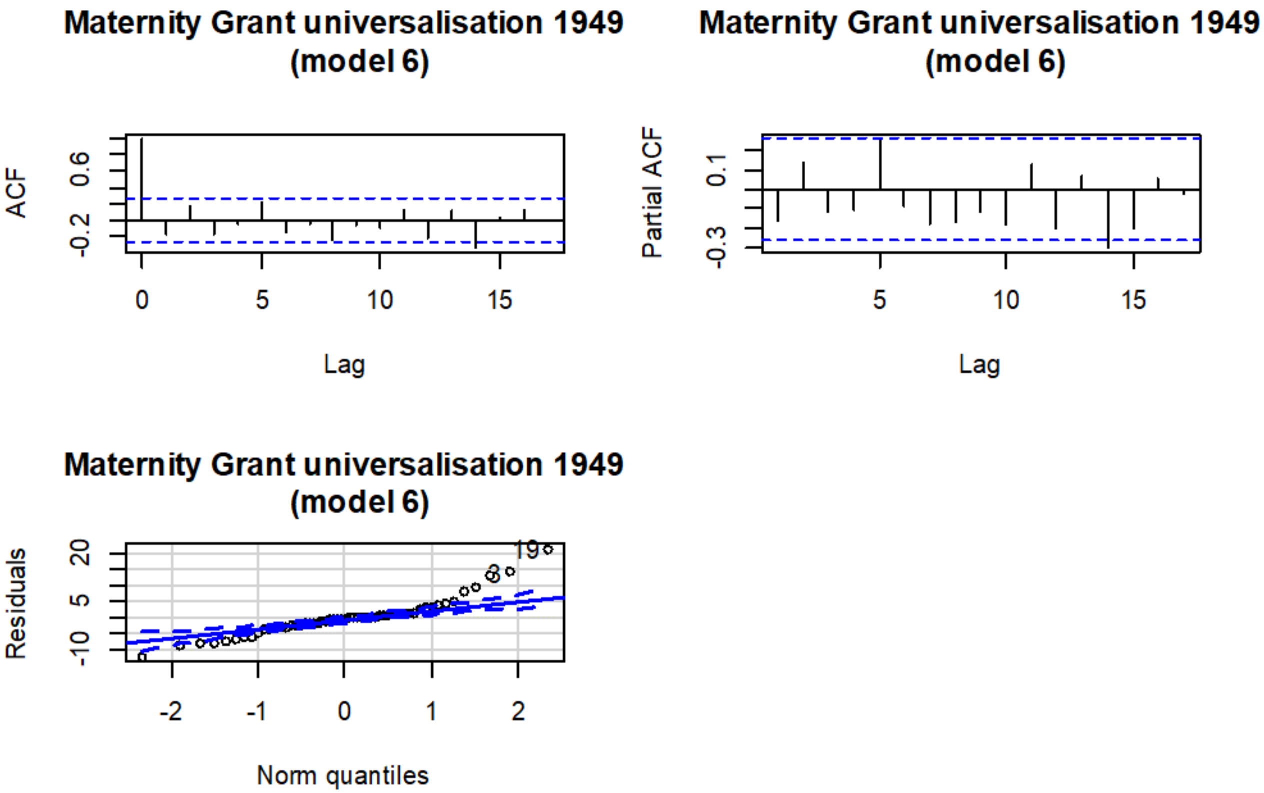
From left to right: ACF plot, P-ACF plot, and Q-Q plot of residuals for model 4 (ITS analysis of Finnish Maternity Grant universalisation in 1949).



From left to right: ACF plot, P-ACF plot, and Q-Q plot of residuals for model 5 (ITS analysis of Finnish Maternity Grant universalisation in 1949).



From left to right: ACF plot, P-ACF plot, and Q-Q plot of residuals for model 6 (ITS analysis of Finnish Maternity Grant universalisation in 1949).



Appendix 5 – Full list of items included in Scotland's Baby Box Scheme

Full list of items included in Scotland's Baby Box Scheme as of March 2022.

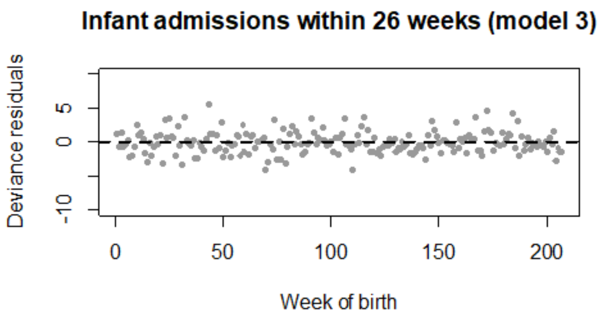
Item	Quantity
Poem written by Jackie Kay	1
Digital underarm thermometer	1
Scratch mittens (sized for new-born)	1 pair
Short-sleeved vest (sized for new-born)	1
Long-sleeved vest (sized for new-born)	1
Reusable nappies voucher (for new-born)	1
Long-sleeved side buttoning vest (sized for new-born)	1
Cotton hat (sized for 0-months old)	1
Long-sleeved sleepsuit (sized for 0-3 months old)	1
Cotton trousers (sized for 0-3 months old)	2
Socks (sized for 0-3 months old)	1 pair
Cotton day suit (sized for 3-6 months old)	1
Long-sleeved sleepsuit (sized for 3-6 months old)	1
Cotton trousers (sized for 3-6 months old)	1
Socks (sized for 3-6 months old)	1

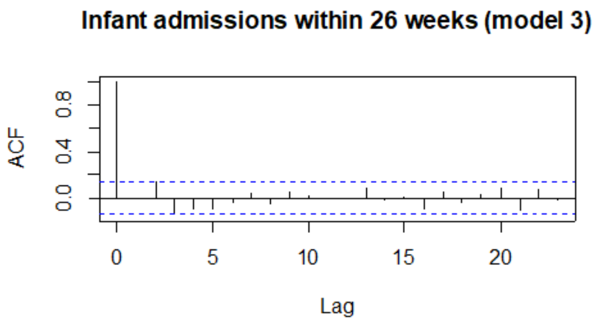
Fleece jacket with hood (sized for 3-6 months old)	1
Foam mattress and sheet	1
Cellular blanket	1
Baby wrap	1
Hooded bath towel	1
Bath sponge	1
Bath and room thermometer	1
Teething ring	1
Baby books	2
Play mat	1
Emery boards	3
Bib	1
Muslin square cloths	3
Comforter toy	1
Travel changing mat	1
Disposable nursing pads	24
Maternity towels	12
Condoms	6

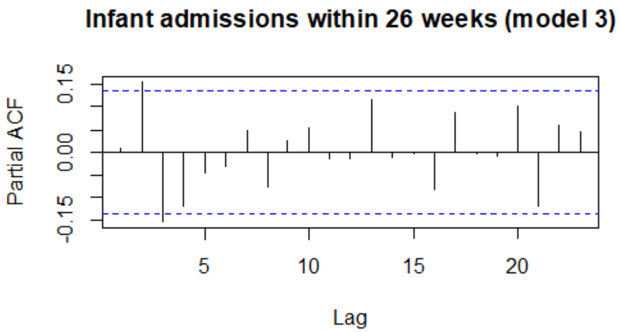
Appendix 6 – Infant admissions (26 weeks) ITS model diagnostics

Section 6.2.1. From left to right: plot of deviance residuals over time, ACF plot, and P-ACF plot for model 2.

Model plots for Section 6.2.1 from left to right: plot of deviance residuals over time, ACF plot, and P-ACF plot for model 3.

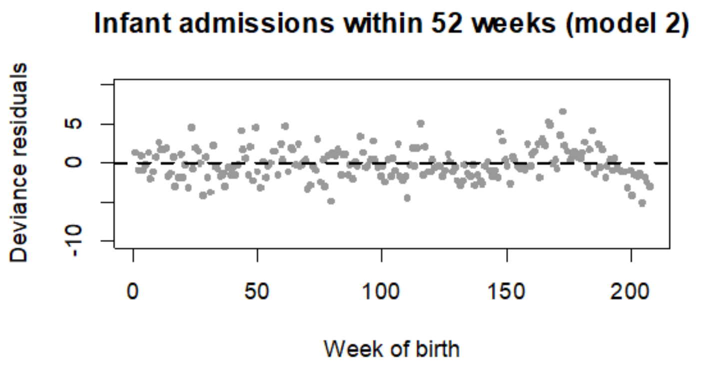


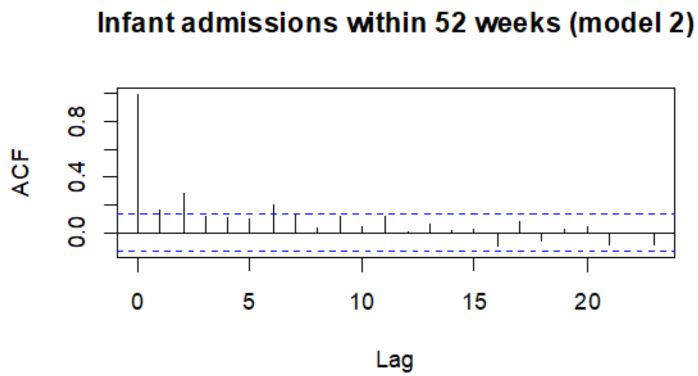


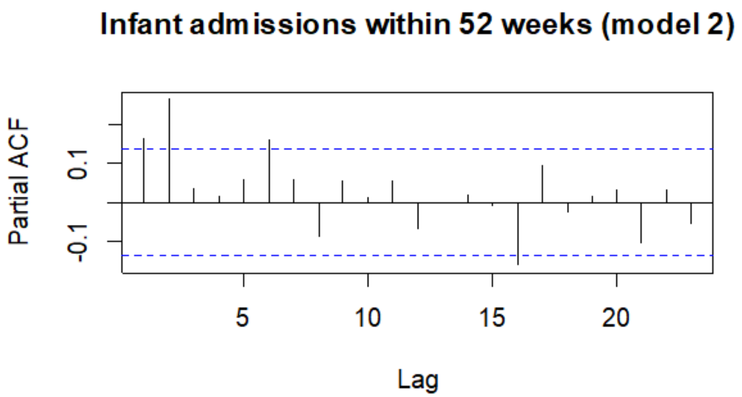


Appendix 7 – Infant admissions (52 weeks) ITS model diagnostics and output

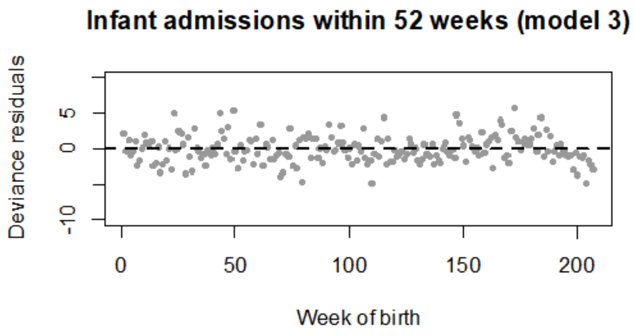
Section 6.3.1 From left to right: plot of deviance residuals over time, ACF plot, and P-ACF plot for model 2.

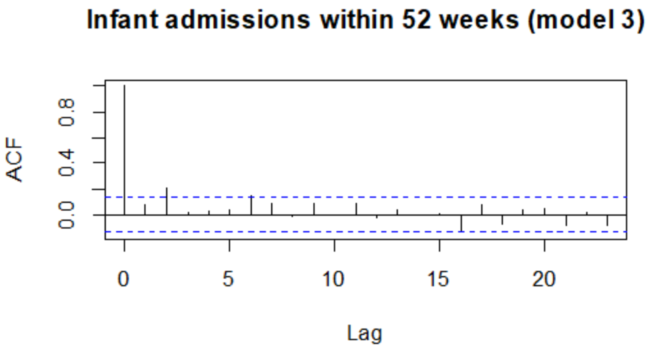






Model plots for Section 6.3.1 From left to right: plot of deviance residuals over time, ACF plot, and P-ACF plot for model 3.





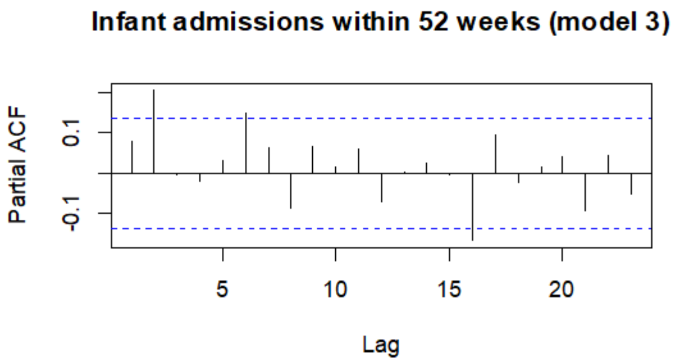
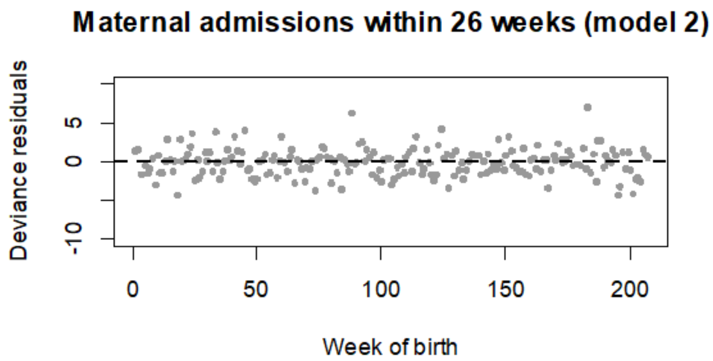


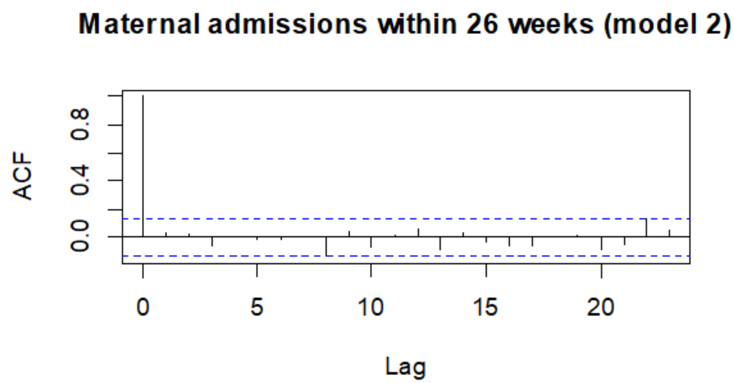
Table (below) showing mean aggregated incidence rate x 1000 for all-cause infant hospital admissions (general/acute inpatient and day-case) within 52 weeks of birth, stratified by SIMD-2016 quintile. Comparison between pre- and post-introduction periods. 1 = most deprived, 5 = least deprived.

SIMD-2016 quintile	Mean incidence rate x 1000			
	Pre-introduction	Post-introduction	Difference (post - pre)	Ratio (post / pre)
1	8.5	9.6	1.1	1.1
2	8.3	9.2	0.9	1.1
3	7.5	8.0	0.5	1.1
4	7.1	7.8	0.7	1.1
5	6.5	6.7	0.2	1

Appendix 8 – Maternal admissions (26 weeks) ITS model diagnostics and output

Section 6.4.1 From left to right: plot of deviance residuals over time, ACF plot, and P-ACF plot for model 2.





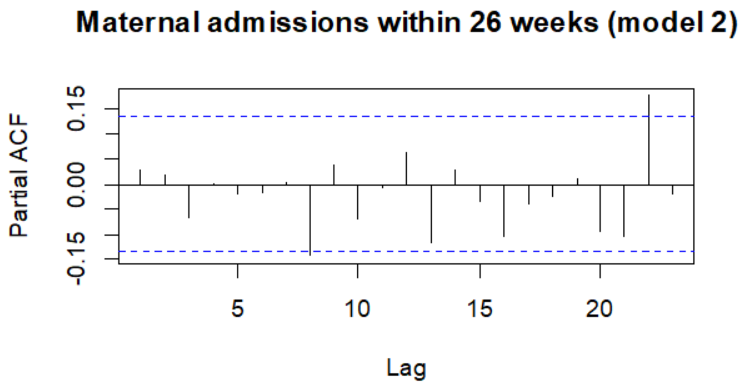
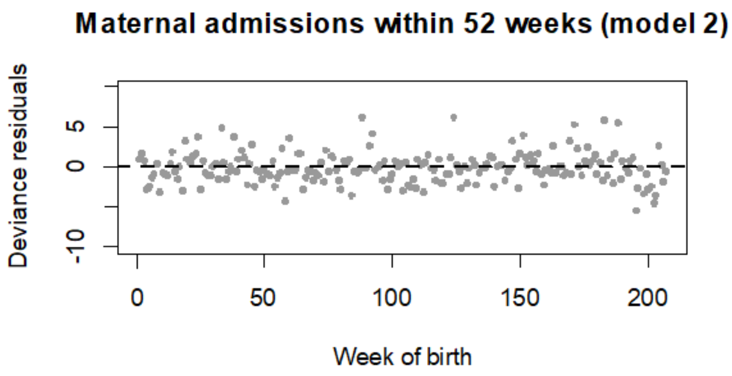


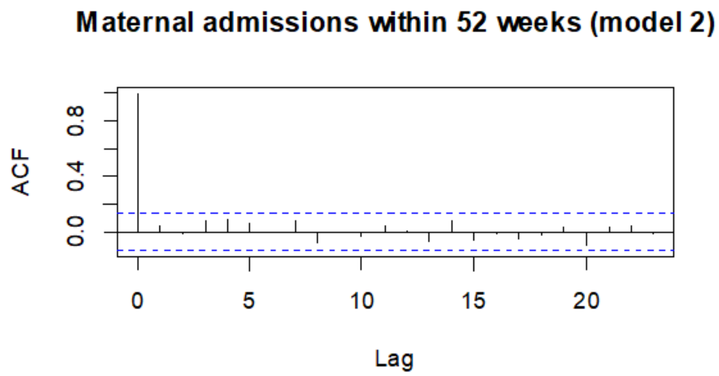
Table (below) showing mean aggregated incidence rate x 1000 for all-cause maternal hospital admissions (general/acute inpatient and day-case) within 26 weeks of birth, stratified by SIMD-2016 quintile. Comparison between pre- and post-introduction periods. 1 = most deprived, 5 = least deprived.

SIMD-2016 quintile	Mean incidence rate x 1000			
	Pre-introduction	Post-introduction	Difference (post - pre)	Ratio (post / pre)
1	3.6	3.5	-0.1	1
2	2.8	3.1	0.3	1.1
3	2.4	2.3	-0.1	1
4	2.1	2.0	-0.1	1
5	1.8	1.9	0.1	1.1

Appendix 9 – Maternal admissions (52 weeks) ITS model diagnostics and output

Section 6.5.1 From left to right: plot of deviance residuals over time, ACF plot, and P-ACF plot for model 2.





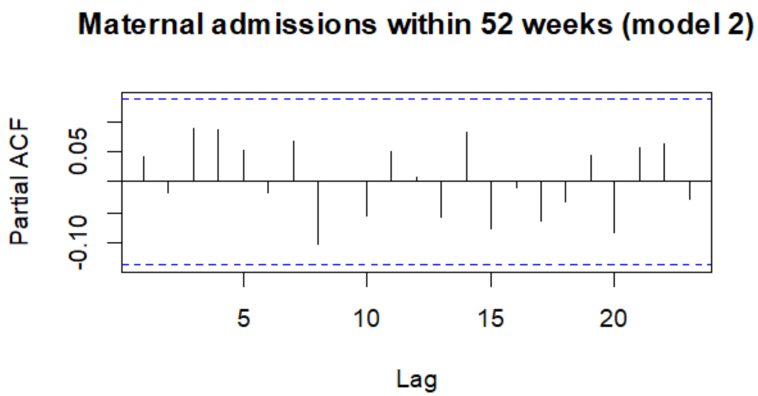
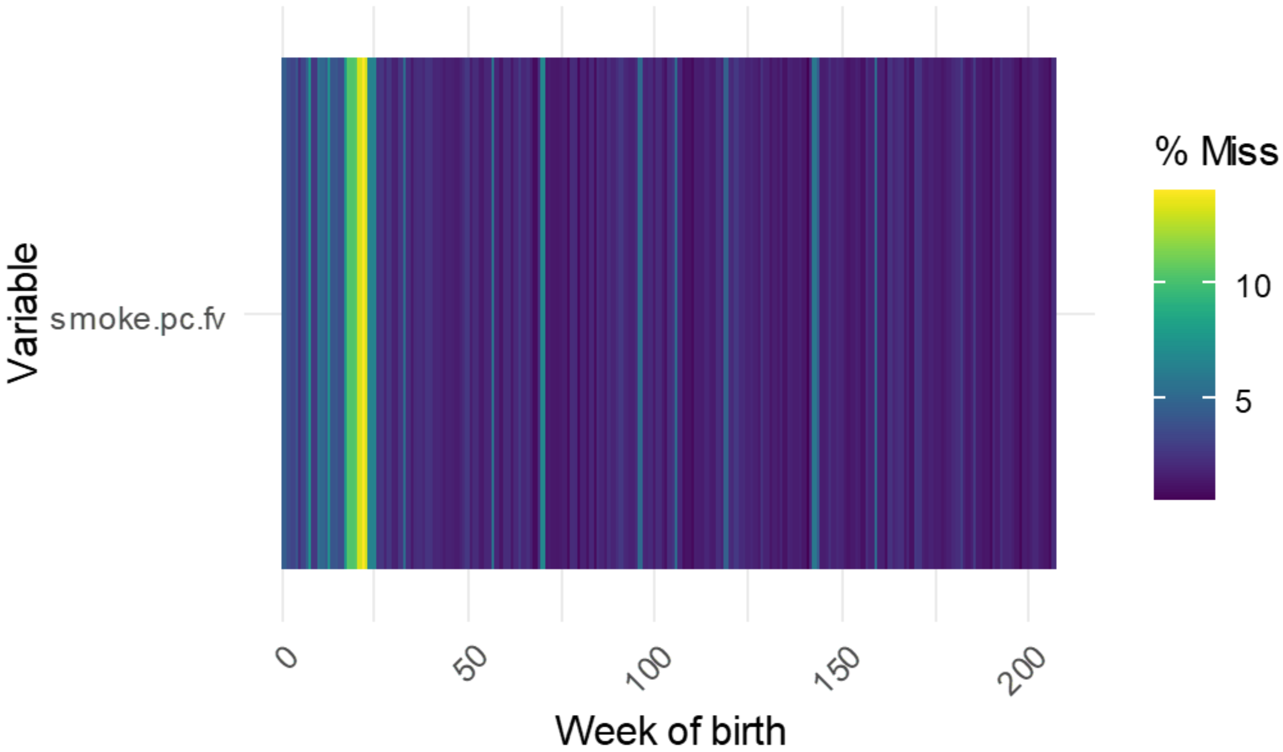


Table (below) showing mean aggregated incidence rate x 1000 for all-cause maternal hospital admissions (general/acute inpatient and day-case) within 52 weeks of birth, stratified by SIMD-2016 quintile. Comparison between pre- and post-introduction periods. 1 = most deprived, 5 = least deprived.

SIMD-2016 quintile	Mean incidence rate x 1000			
	Pre-introduction	Post-introduction	Difference (post - pre)	Ratio (post / pre)
1	3.6	3.7	0.1	1
2	3.0	3.2	0.2	1.1
3	2.5	2.5	0	1
4	2.2	2.2	0	1
5	1.8	1.9	0.1	1.1

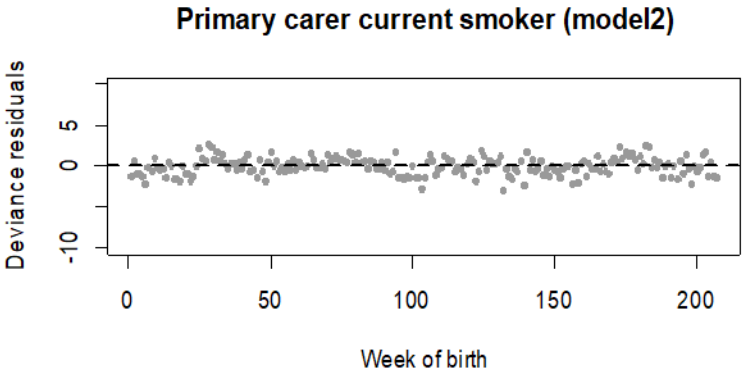
Appendix 10 – Missingness in primary carer current smoker variable

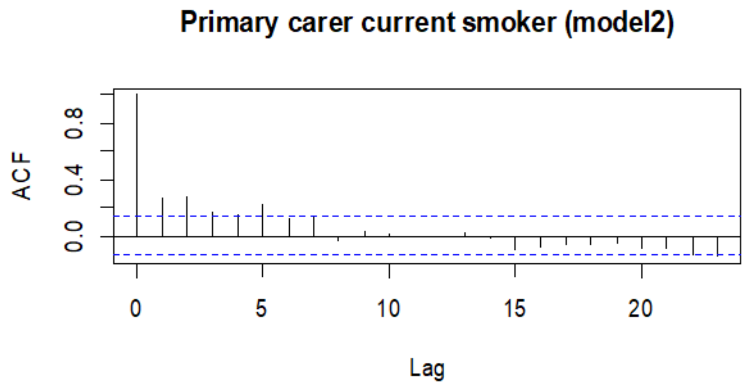
Section 7.2.1. Proportion (%) missing over time for outcome variable primary carer current smoker (*smoke.pc.fv*).

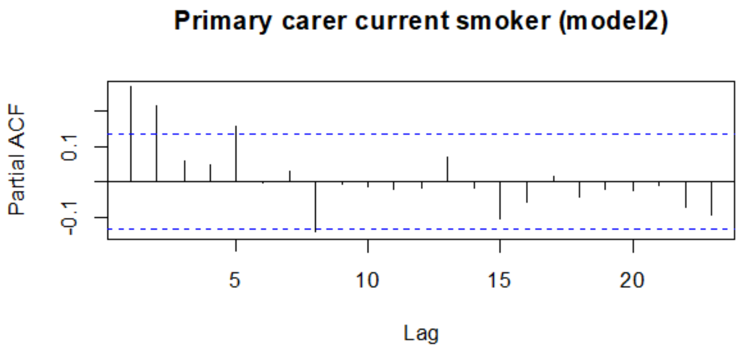


Appendix 11 – Primary carer current smoker ITS model diagnostics

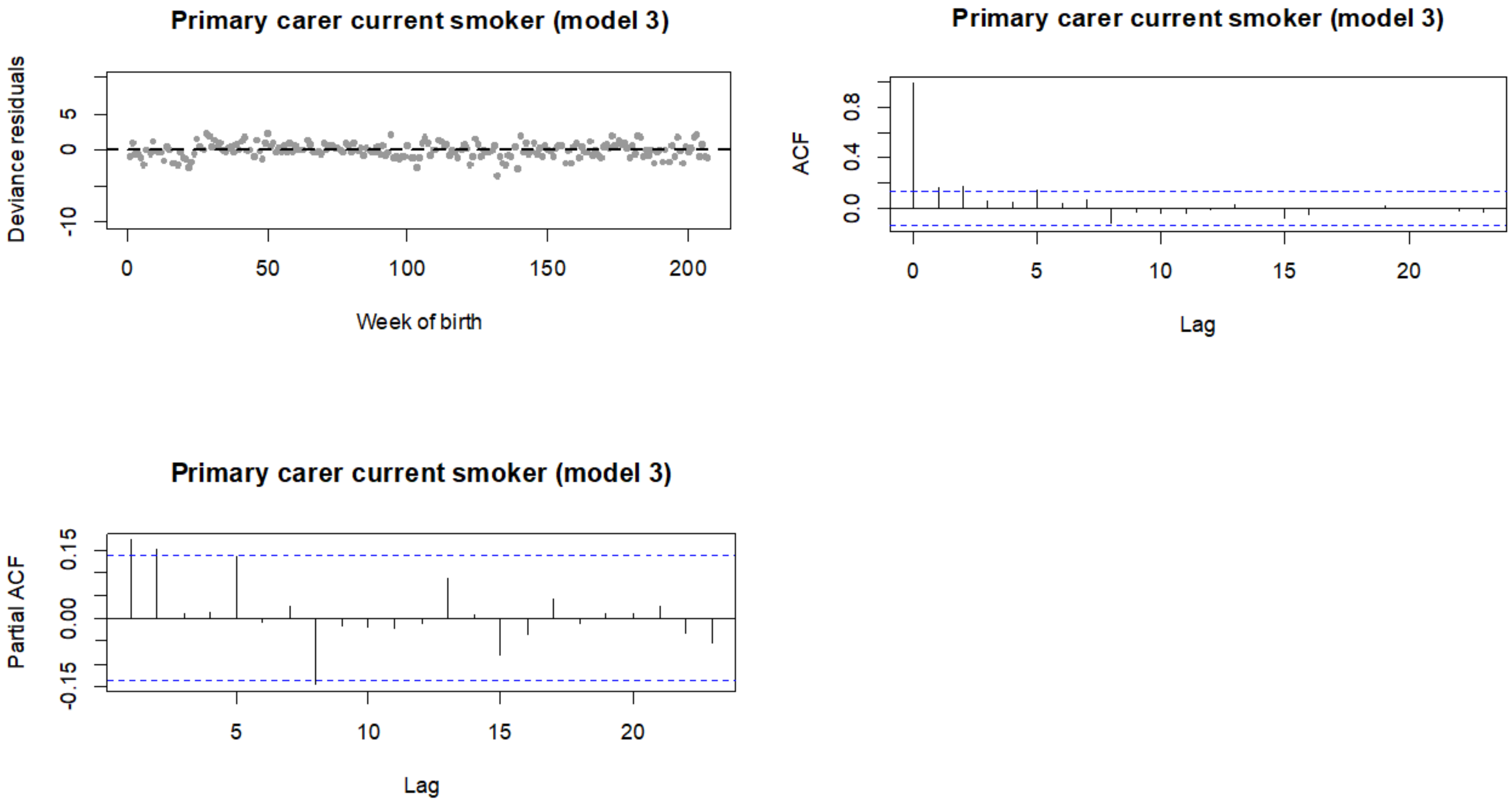
Section 7.2.1. From left to right: plot of deviance residuals over time, ACF plot, and P-ACF plot for model 2.





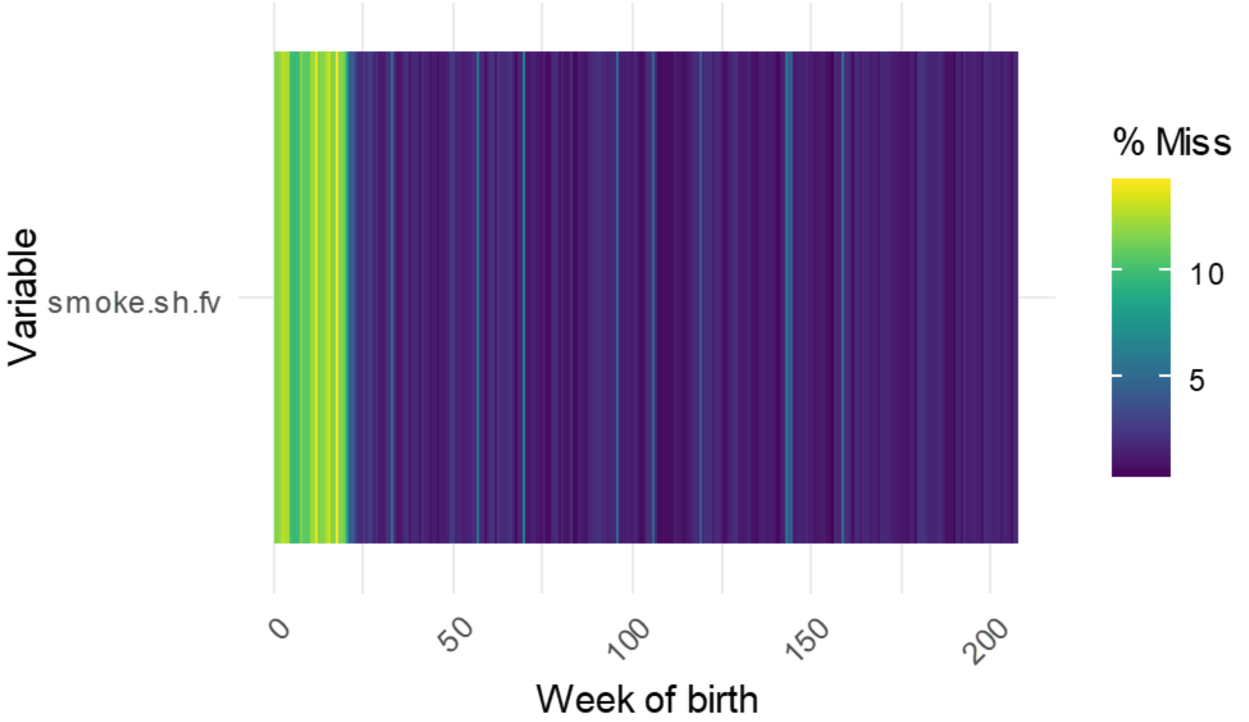


Model plots for Section 7.2.1 From left to right: plot of deviance residuals over time, ACF plot, and P-ACF plot for model 3.



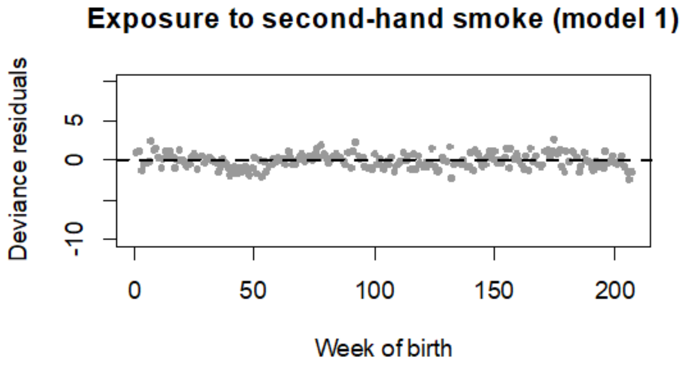
Appendix 12 – Missingness in infant exposure to second-hand smoke exposure

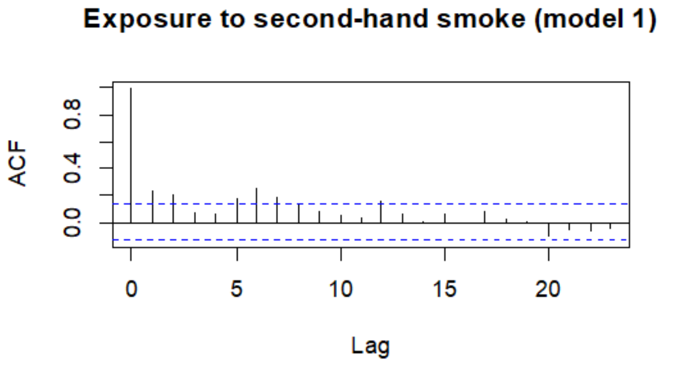
Section 7.3.1. Proportion (%) missing over time for outcome variable infant exposure to second-hand smoke (*smoke.sh.fv*).

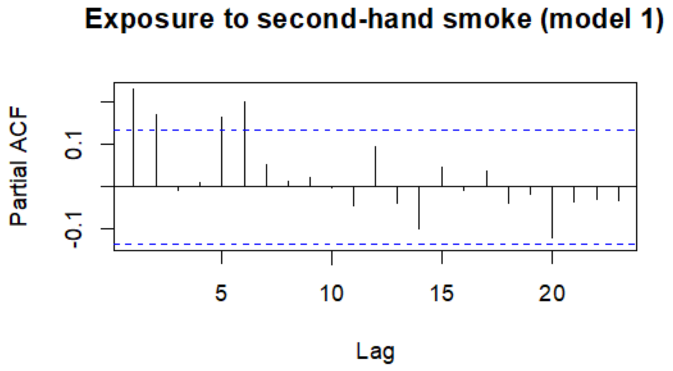


Appendix 13 - Infant exposure to second-hand smoke ITS model diagnostics

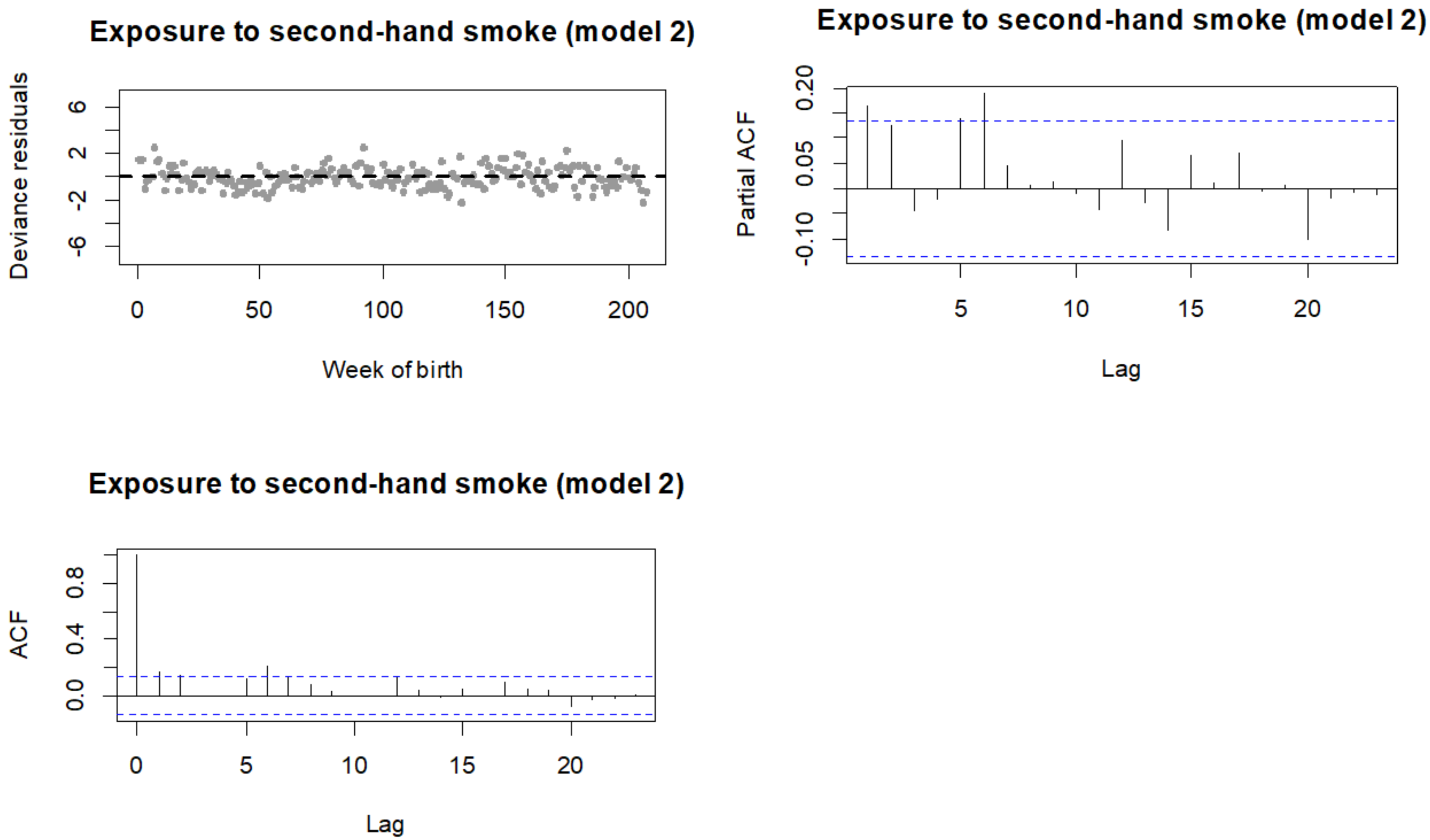
Section 7.3.1. From left to right: plot of deviance residuals over time, ACF plot, and P-ACF plot for model 1.





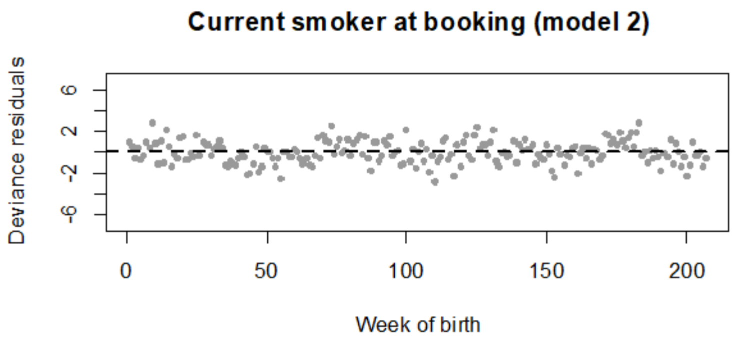


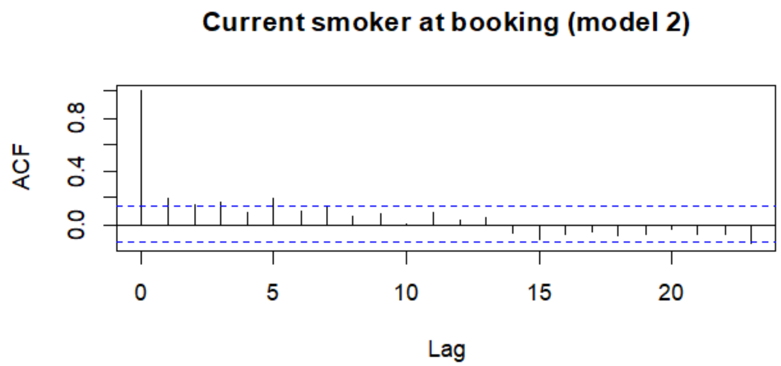
Model plots for Section 7.3.1 From left to right: plot of deviance residuals over time, ACF plot, and P-ACF plot for model 2.

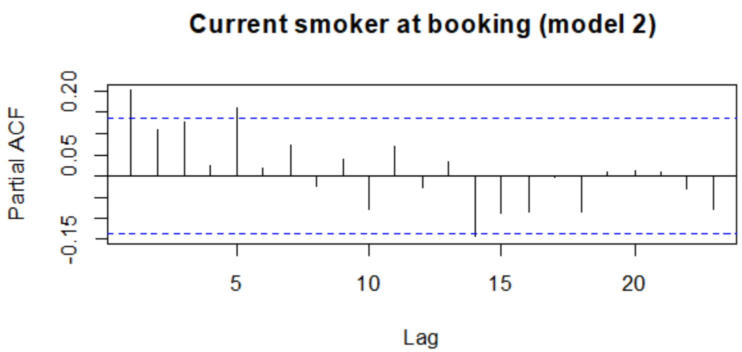


Appendix 14 – Current smoker at booking ITS model diagnostics

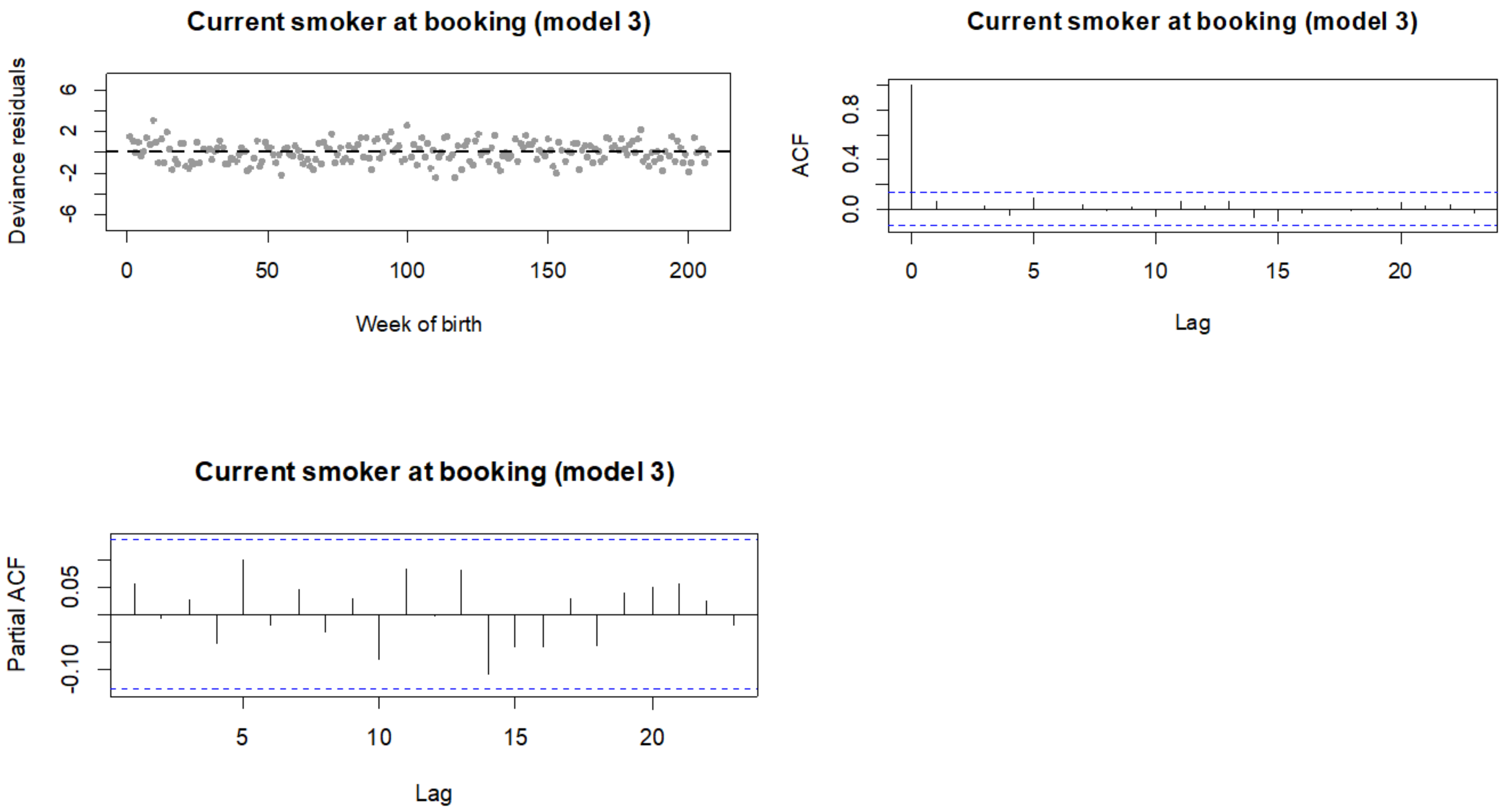
Section 7.4. From left to right: plot of deviance residuals over time, ACF plot, and P-ACF plot for model 2.





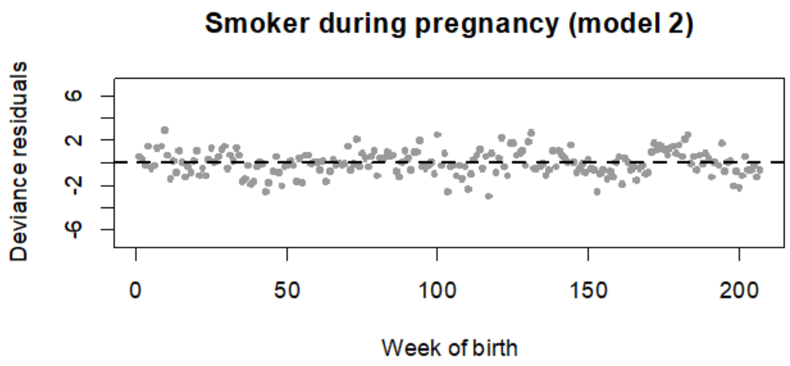


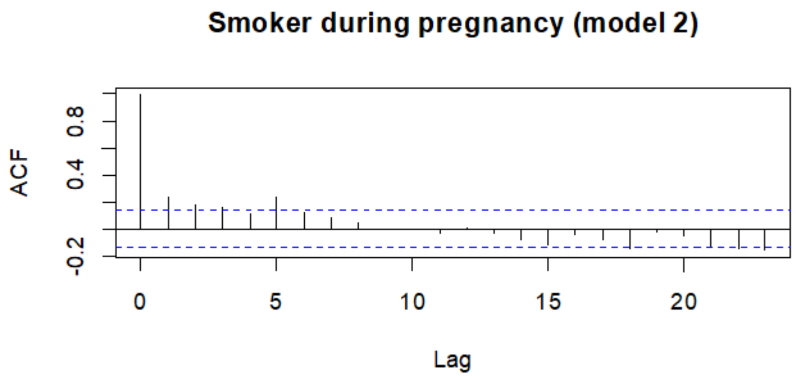
Model plots for Section 7.4. From left to right: plot of deviance residuals over time, ACF plot, and P-ACF plot for model 3.

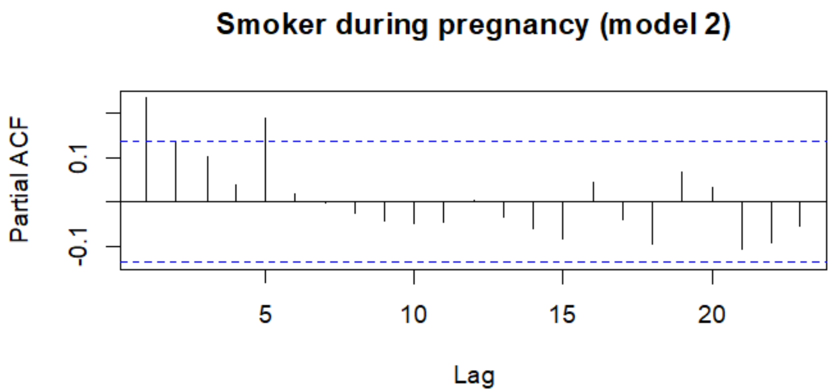


Appendix 15 - Smoking during pregnancy ITS model diagnostics

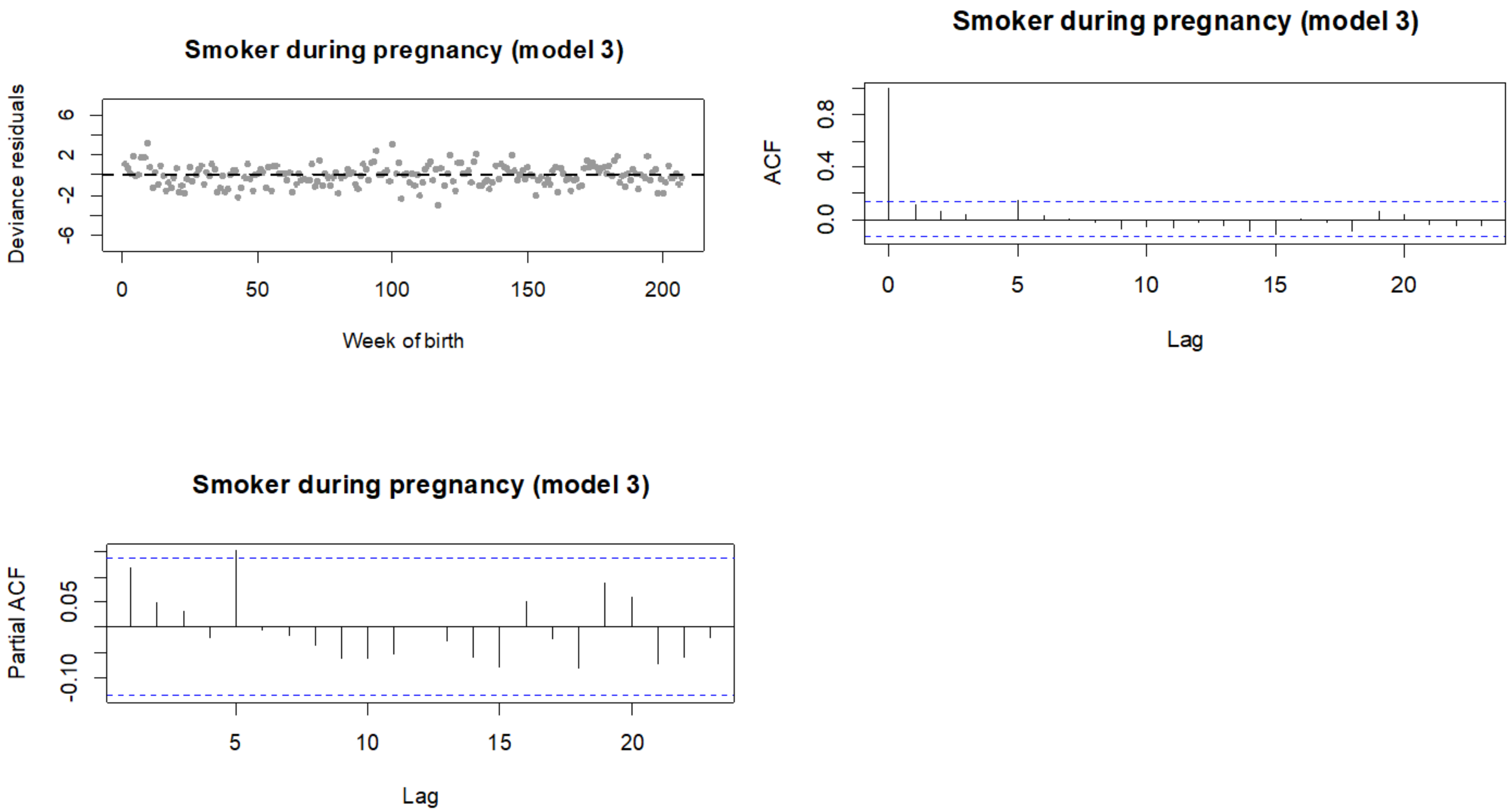
Section 7.5. From left to right: plot of deviance residuals over time, ACF plot, and P-ACF plot for model 2.





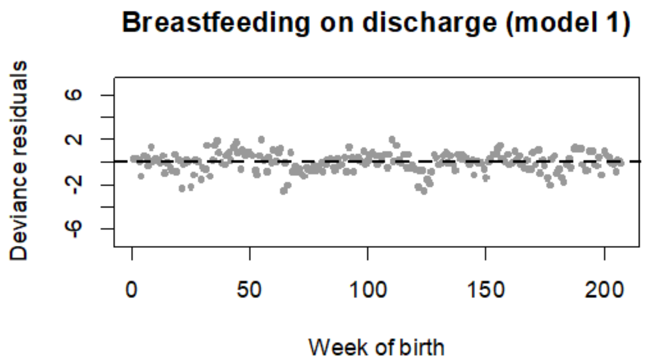


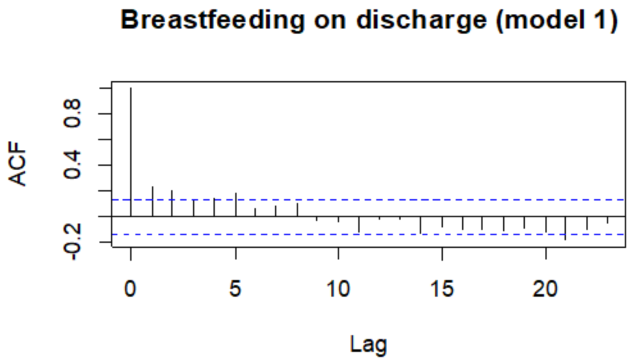
Model plots for Section 7.5. From left to right: plot of deviance residuals over time, ACF plot, and P-ACF plot for model 3.

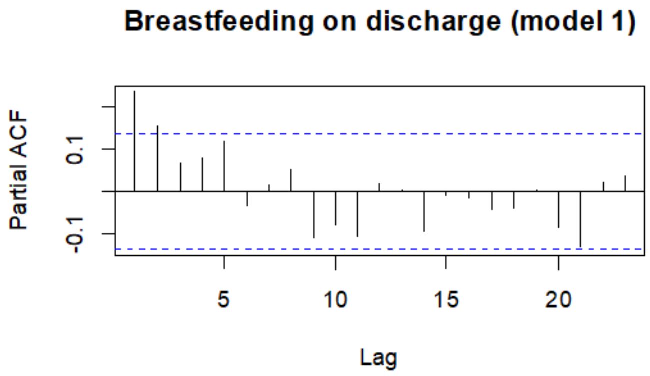


Appendix 16 – Exclusive breastfeeding on discharge ITS model diagnostics

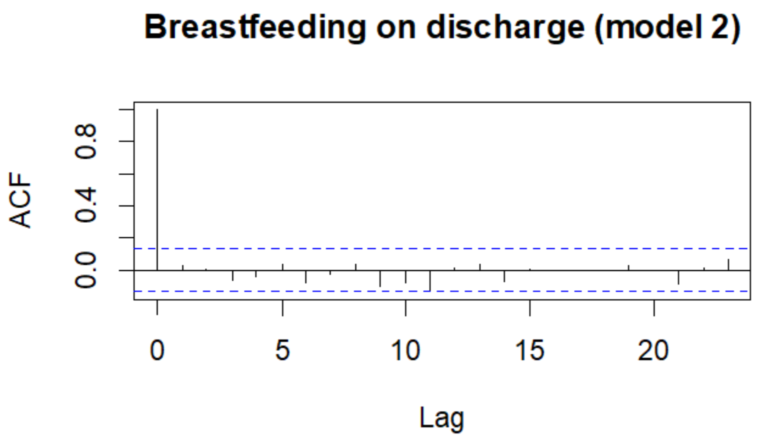
Section 8.2.1. From left to right: plot of deviance residuals over time, ACF plot, and P-ACF plot for model 1.

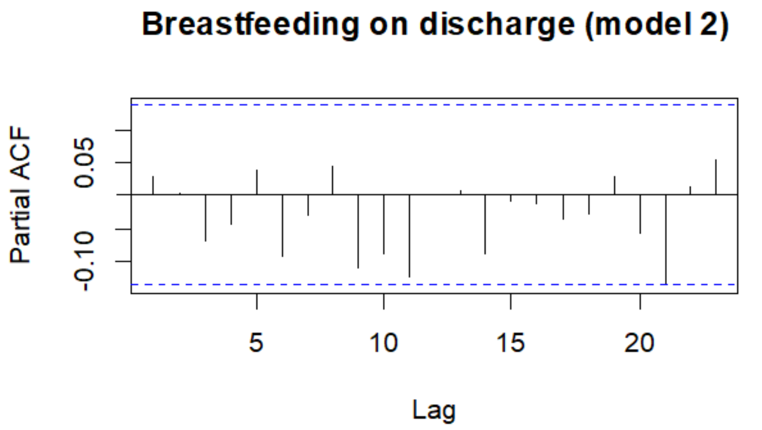






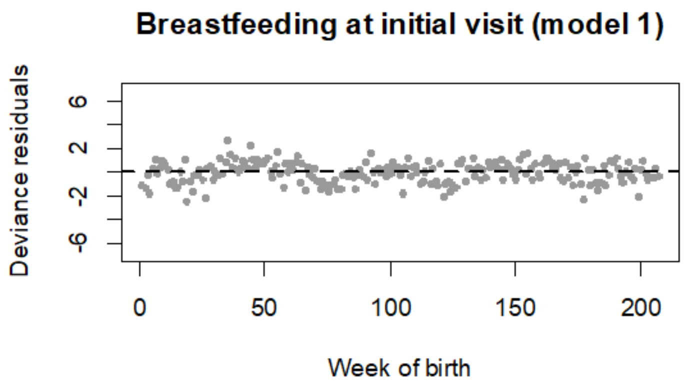
Model plots for Section 8.2.1. From left to right: ACF plot and P-ACF plot for model 2.

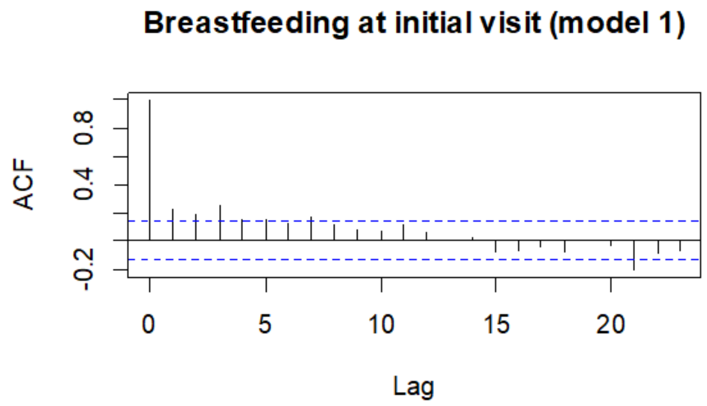


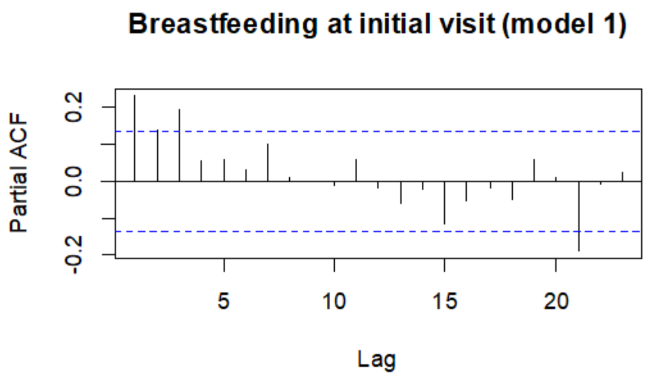


Appendix 17 - Exlcusive breastfeeding at initial visit ITS model diagnostics and output

Section 8.3.1. From left to right: plot of deviance residuals over time, ACF plot, and P-ACF plot for model 1.







Model plots for Section 8.3.1. From left to right: ACF plot and P-ACF plot for model 2.

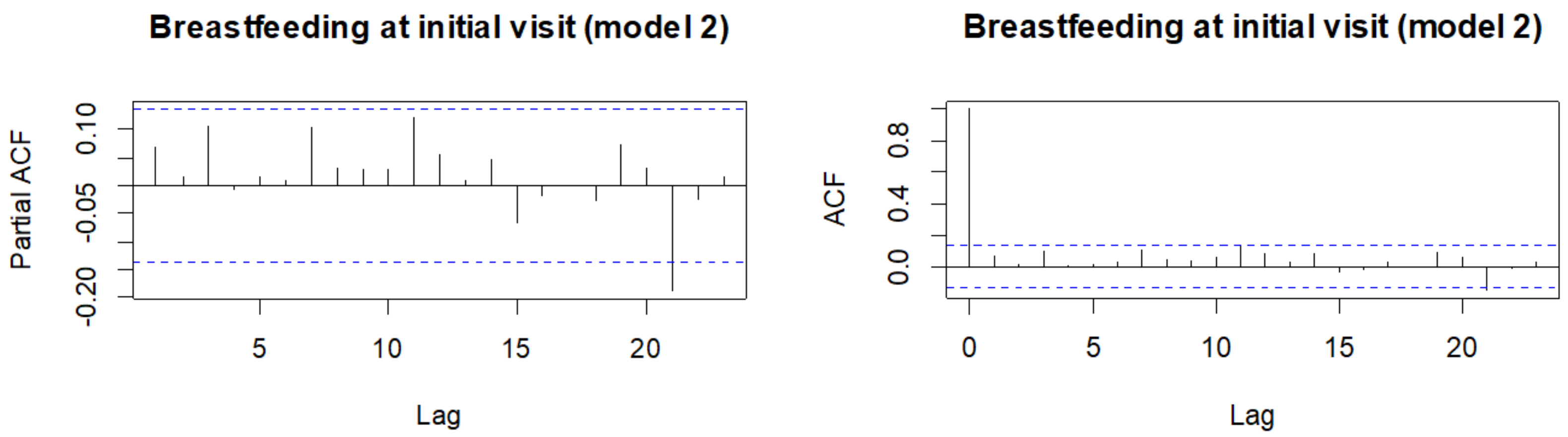
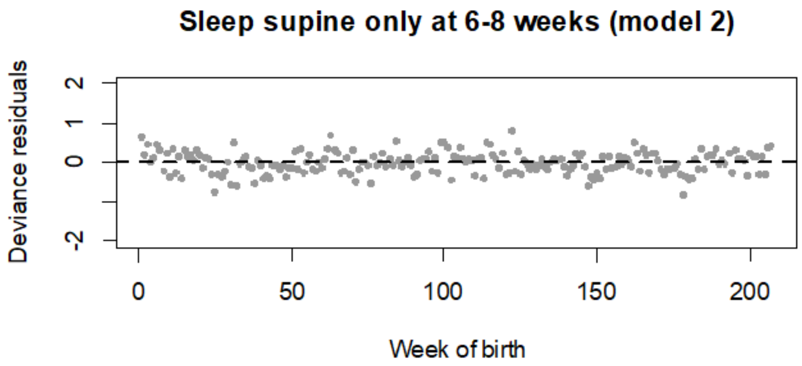


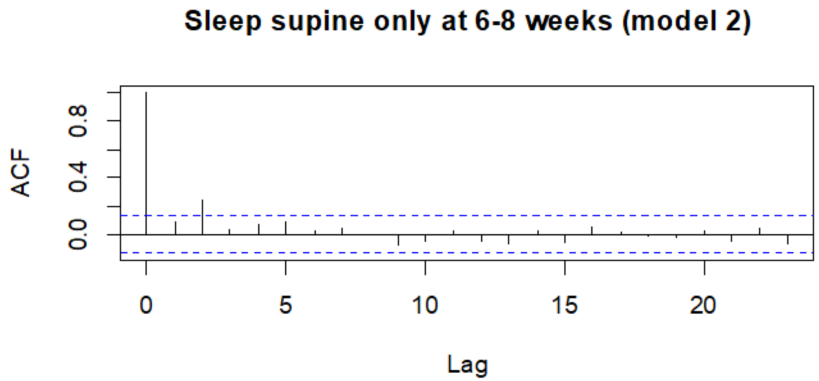
Table below: mean prevalence of mothers exclusively breastfeeding at initial (10-day) CHSP-PS visit, stratified by SIMD-2016 quintile. Comparison between pre- and post-introduction periods. 1 = most deprived and 5 = least deprived.

SIMD-2016 quintile	Mean prevalence (%)			
	Pre-introduction	Post-introduction	Difference (post - pre)	Ratio (post / pre)
1	22.93	23.66	0.7	1
2	29.39	30.26	0.9	1
3	39.21	40.24	1	1
4	46.83	47.12	0.3	1
5	53.2	54.0	0.8	1

Appendix 18 - Infant sleeping position ITS model diagnostics and output

Section 9.2.1. From left to right: plot of deviance residuals over time, ACF plot, and P-ACF plot for model 2.





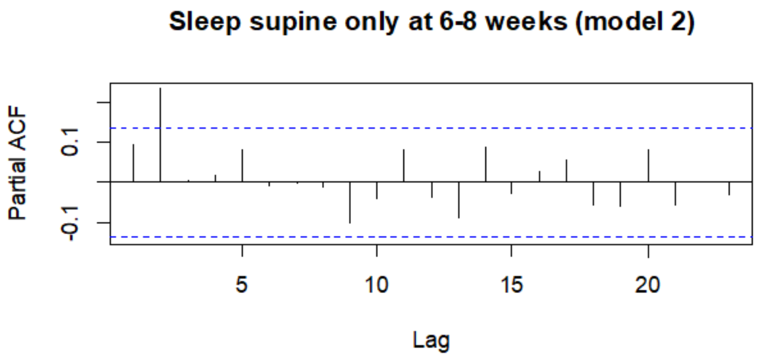
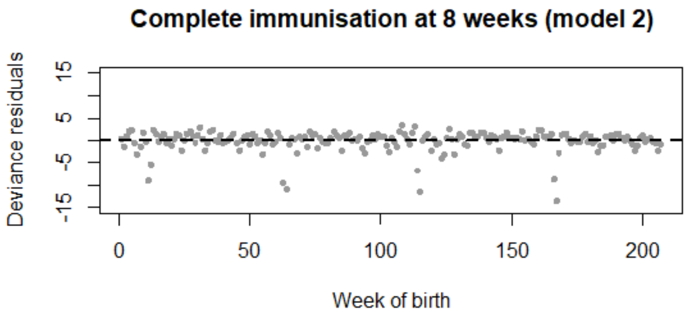


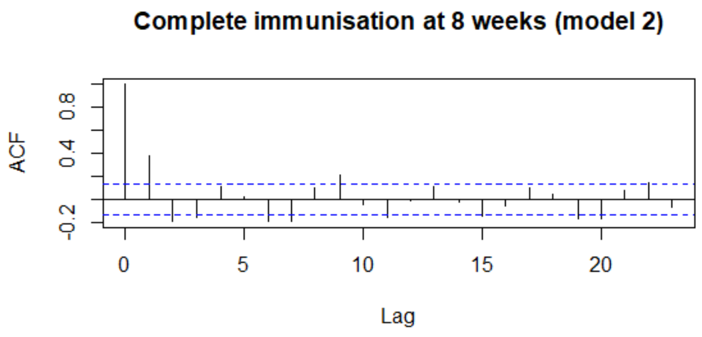
Table below: mean prevalence of supine sleeping at 6-8-week CHSP-PS visit, stratified by SIMD-2016 quintile. Comparison between pre- and post-introduction periods. 1 = most deprived and 5 = least deprived.

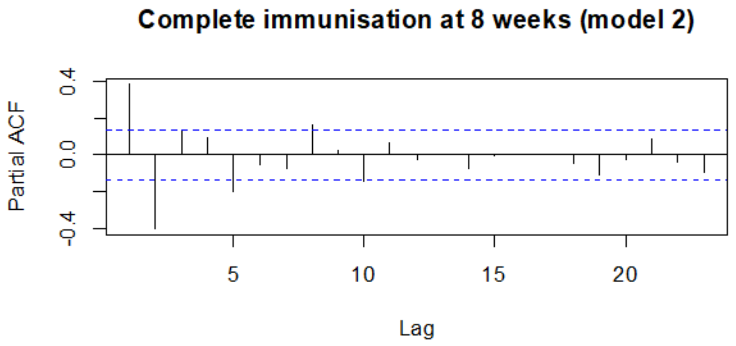
SIMD-2016 quintile	Mean prevalence (%)			
	Pre-introduction	Post-introduction	Difference (post - pre)	Ratio (post / pre)
1	93.28	94.44	1.2	1
2	92.88	94.38	1.5	1
3	92.85	94.6	1.8	1
4	93.08	94.84	1.8	1
5	93.31	94.97	1.7	1

Appendix 19 - Infant immunisation uptake (8 weeks) ITS model diagnostics

Section 10.2.1. From left to right: plot of deviance residuals over time, ACF plot, and P-ACF plot for model 2.

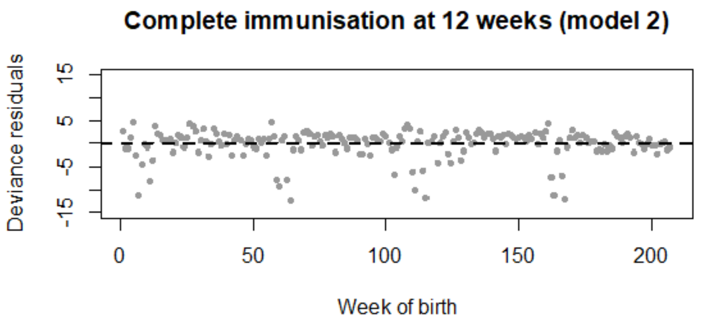


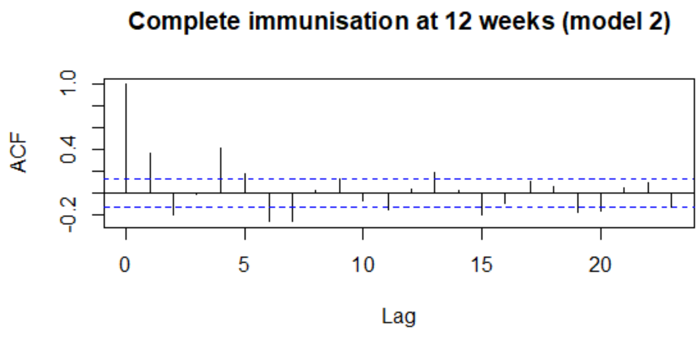


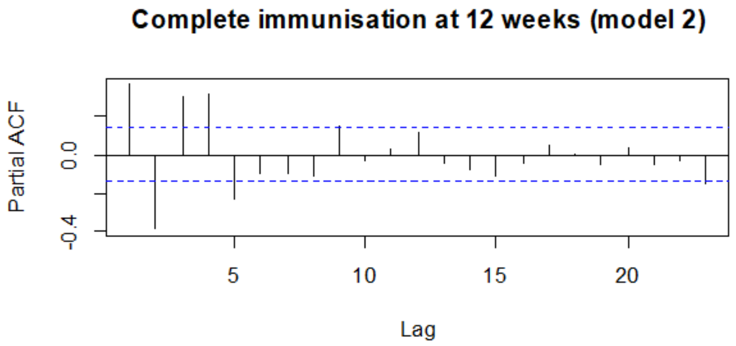


Appendix 20 - Infant immunisation uptake (12 weeks) ITS model diagnostics

Section 10.3.1. From left to right: plot of deviance residuals over time, ACF plot, and P-ACF plot for model 2.

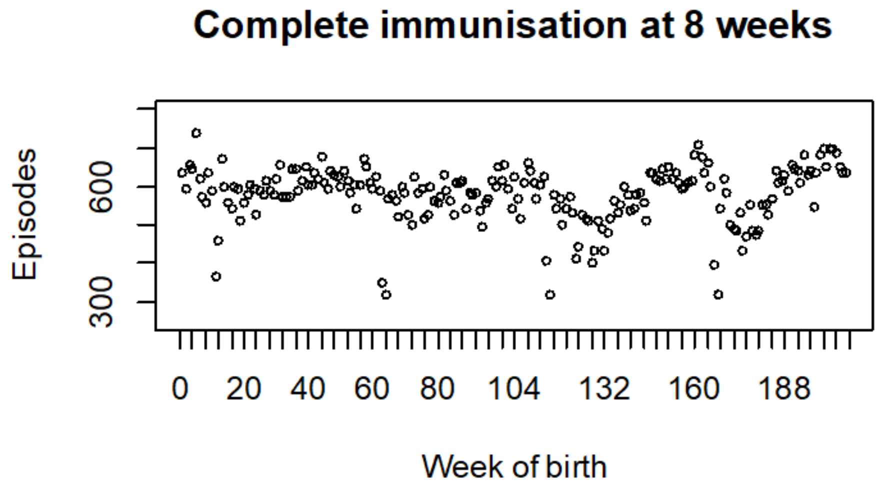


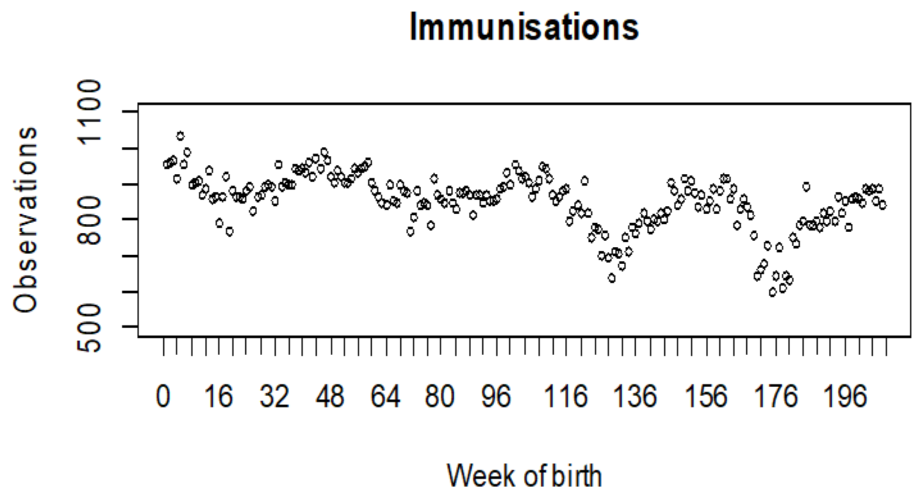




Appendix 21 – Infant immunisation outliers

Section 10.2.3. From left to right: weekly aggregated count of episodes for complete infant immunisation uptake by eight weeks (numerator) and weekly aggregated number of observations used for analyses of infant immunisation uptake (denominator).





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