ERC Starting Grant 2021
Part B2[1]
(not evaluated in Step 1)

Section a. State-of-the-art and objectives

European Family Policy has had formal childcare at its heart for the last 30 years[1]. *Formal* childcare is defined as care that is provided by an organization (public or private) with a formal arrangement with the parents and excludes childminders [2]. Formal Childcare increases social mobility[2] and improves children's cognitive and emotional development[3], and this is especially true of children from low-income backgrounds[4] and when children are enrolled early in their development[5]. The European Social Investment Model states that high quality, affordable childcare increases female employment, allows couples to realise their fertility intentions and leads to better and more egalitarian outcomes for children themselves[6–8]. Such compelling evidence led to the creation of the Barcelona Targets at the European Council in 2002 and a significant expansion of formal childcare facilities. The Barcelona target stated that 90% of children aged between 3 and mandatory school age, and 33% of those aged under three, should be in formal childcare of high or low intensity.

Despite extensive growth in the availability and use of formal childcare in most countries, the diffusion of formal childcare use has been very uneven[9,10]. High-income households are twice as likely to develop childcare strategies that make intensive and early use of formal childcare as low-income households, raising concerns about a Matthew effect, increasing and reinforcing inequalities rather than reducing them as intended[11]. To explain why observed income gradients in formal childcare use persist even when childcare is heavily subsidized[11], sociological research points to institutional barriers, stubborn gender inequalities and low levels of trust[12] that act as a obstacles to the use of formal childcare and prevent low-income households from accessing its benefits[13]. But these theories are largely speculative and have not been fully tested. It is not well understood *why* low-income households use formal childcare less.

This project answers this question by examining ***Childcare Strategies,*** a broader concept than the cross-sectional definition of formal childcare use. Childcare strategies describe the hours of formal childcare a household uses month-to-month as a child grows from 0 to 5, rather than through a one-time measure. Childcare use cannot be understood at singular points in time, but instead must be viewed within the dynamic context of the household, the parents' employment and the child's own development. I propose a highly ambitious overhaul of the existing research agenda to better describe how childcare strategies based on intensive use of formal childcare diffuse across society and why that diffusion appears to be weaker amongst low-income segments of the population. I deploy an entirely new conceptual framework of ***'complex contagions'*** from network theory and use it to synthesise labour market, social policy and demographic perspectives to describe how childcare strategies are associated with fertility and female employment as described by the European Social Investment model. The re-conceptualisation is enabled by unprecedented, linked network data that draws from administrative records and survey data. Complex, interlinked data enables the network analysis methods to be deployed to better understand inequalities in childcare strategies. The project is structured around three objectives:

1. ***To describe childcare strategies of parents with children aged 0 to 5 in Europe***
2. ***To identify the degree to which childcare strategies are dependent upon the childcare strategies of colleagues, neighbours and families***
3. ***To identify the degree to which the childcare strategies of colleagues, neighbours and families are associated with differences in fertility behaviour and employment trajectories.***

STATE OF THE ART

Formal childcare for young children is central to the social investment model which has dominated social policy discourse in Europe for the last two decades[16]. Yet despite being heralded as a strategy to reduce inequalities, childcare and other family policies disproportionately benefit those who are not socially excluded more than those who are[17–19]. One consequence has been the reversal in the socio-economic gradient in fertility

[1] Instructions for completing Part B2 can be found in the '*Information for Applicants to the Starting and Consolidator Grant 2021 Calls'*.

[2] For Eurostat definition of Formal Childcare see: https://ec.europa.eu/eurostat/web/products-datasets/-/tps00185

such that high educated couples are now having more children than their lower educated peers[20]. Shifts in fertility behaviours have been brought about by family policies that are especially supportive of relatively high income, university educated couples[21]. The absence of appropriate social policies leads low income couples to defer parenthood or opt out altogether[22]. Esping-Andersen and Billari[13] explain low fertility levels by integrating gender equality theory in social policy and second demographic transition theory. They argue that individuals adapt their norms to a gender equal, dual earner household but institutions and policies lag behind[23,24]. Institutions and policies prevent low-income households from realizing gender egalitarian norms, with childcare a particular obstacle for low-income couples.

The mismatch between gender egalitarian norms and institutions creates significant strains in organising care for young children and trust in childcare strategies that are reliant on formal childcare is low[12]. Poor access to formal childcare leads to either deferred fertility or significant well-being or career impacts on the parents, particularly mothers[25]. When formal childcare is available, gender equality can be achieved, childcare strategies become sustainable, and couples actively try to become parents or have further children[26]. The qualitative evidence on childcare strategies points to diverse practical obstacles that prevent lower income households from using formal childcare[27,28]. Childcare strategies for low-income households are particularly complex, expensive and fragile. The nature of work conducted by lower income households ,which is more commonly orientated around shift-work, irregular work patterns and atypical schedules, is particularly problematic[29,30]. Access to quality, affordable childcare is also regularly cited [31,32]. Quantitative analysis supports this and there is a large body of evidence suggesting that childcare strategies differ greatly by occupation. Location, costs and quality of childcare are all positively associated with usage, as well as fertility and female employment levels[33,34].

The literature is now highly saturated and has spawned a plethora of policy recommendations and subsequent initiatives[35]. Whilst there is a strong consensus that lowering costs is necessary for increasing use of formal childcare by low-income households, it does not appear to be sufficient. If it was a matter of costs, then there would be no income gradient in childcare use in countries where it is highly subsidised, but these gradients persist even in Nordic countries where subsidies are high. In addition, when low-income households use formal childcare, children start to attend at a much later age than those from high income households. These patterns cannot be fully explained by cost barriers. Usage of formal childcare remains stubbornly low amongst low-income households in a large and diverse number of European Countries[10,36].

To complicate the picture, there has been a significant fall in fertility in the years leading up to the onset of the pandemic in Northern European countries that were renowned for their high fertility until recently. In Norway for example, the TFR fell from 1.95 in 2010 to just 1.56 in 2018. The falls have been particularly concentrated in lower educated groups[37]. The shift in fertility creates a potentially striking hole in our existing understanding of childcare strategies as fertility falls in spite of good childcare provision. Nordic childcare policy was seen as an ideal in which work-life balance and gender equality were promoted. There are now urgent questions as to what these falls in fertility mean for the underlying social model that was widely regarded as the cause of high fertility rates through the 1990's and 2000's[38] and whether they are associated with changing childcare strategies.

Current methods and data appear unable to provide sufficient insights on why low-income households are opting for the childcare strategies that they are and the current state of the art needs to be disrupted[37]. The existing research has clearly identified this persistent income gradient and this project sets out to test a compelling theory on why such a gradient is so stubbornly persistent and how it might be mitigated. To overcome the shortcomings in the literature and address these new challenges, this project radically reframes our understanding using complex contagions of childcare strategies and uses new perspectives, data and methods to advance the demographic and sociological literature and deliver novel solutions and practical policy interventions.

COMPLEX CONTAGIONS

Network theory suggests that ideas spread through the population just like a virus[38]. Ideas can easily become pervasive as they spread rapidly through the 'small worlds' created by the long weak ties in society[40]. But new 'ideas' only lead to a new equilibrium if behaviour and institutions also change[13]. This idea is not new, second demographic transition theory [39] and gender equity theory[23] describe value changes spreading through the population as people embrace ideas of gender equality and dual earner households.

Behaviours move across networks very differently to ideas. Behaviours are generally only adopted after multiple exposures in what is called ***'complex contagion'***[41]. With complex contagions an individual only adopts the behaviour if exposed via multiple relationships, multiple times or through multiple types of relationships (i.e. through friends, colleagues and family) so that the behaviour is reinforced. This is commonly seen in hard to adopt ideas or behaviours that come with considerable cost such as new technologies or unorthodox approaches[42]. When contagion is complex like this, the likelihood of an individual exhibiting a new behaviour, such as changing their childcare strategy, is dependent on the structure of their local network and institutions. Behaviours spread more slowly than ideas and find it hard to penetrate some sub-populations. The differing speed in diffusion between ideas and behaviours is why 'the Gender Revolution' is incomplete[21]. Individuals of all income levels change their own attitudes about gender equality, but adapting careers, fertility plans and childcare providers is harder unless such changes are pervasive in one's own personal network. Diffusion of new behaviours into various neighbourhoods of a network can be limited by the topography of the network and specific characteristics of local subpopulations [43]. This project examines whether Low-income households have network structures that prevent such diffusion.

The first feature that can limit diffusion is when a subpopulation's ***long ties are weak*** [42]. A tie between two people is *long* if they otherwise have very few contacts in common. For example, if you meet someone through work, that tie is long if you have no other contacts in common and there are high degrees of separation between you and them. The ties are *short* if, for example, your children go to the same school, your cousin is their neighbour or you both know people who went to a particular university. The strength of a tie is determined by the frequency and intensity of contact. People who work in the same branch as you are likely to be a strong tie whereas people who simply work in the same organisation as you are more likely to be weaker ties. Duncan Watts famously argued that long, weak ties were great for spreading ideas but because the transmission of new behaviours requires multiple exposures, an individual's local network is far more important than their long weak ties[40]. It matters less if they infrequently meet with someone from a different network component as that is not sufficient to transmit complex behaviours. When low-income individuals have long ties, they are much more likely to be weak. Higher income people are exposed to a more diverse social group, primarily through the higher education system and associated labour market, and so have stronger, long ties that help new behaviours like childcare strategies spread[44].

The second feature that prevents diffusion is the ***clustering*** of local communities. Clustering is when people are intensively linked to their local community and other people like them, rather than relative strangers who are more likely to differ from them. If clustering is high, it is difficult for complex contagions to take hold[45]. The third feature is the related concept of ***multi-layered clustering.*** This is clustering across multiple types of relationship. If you work in the same place that you live, then there is a higher chance that your colleagues will either be your neighbours, or close contacts of your neighbours. If a complex contagion requires reinforcement from multiple types of relationship, such interdependency and clustering across relationship types can severely insulate a community from the spread of a new behaviour [46].

Long, weak ties, clustering and *multi-layered clustering* are common features of low-income households due to their low mobility and extensive social segregation[47]. This increases clustering, especially multi-layered clustering and contacts with individuals from outside of that network tend to be 'weak'[48]. The use of a complex contagions approach offers three potential new insights by: **1)** establishing whether social segregation and exclusion inhibits changes in childcare strategies; **2)** incorporating the diffusion process described in gender equity theory to more accurately describe which groups will take up new childcare strategies and why; **3)** using network dynamics and micro-level processes of childcare strategies to explain and describe aggerate level outcomes and trends. Unprecedented, linked administrative and survey data is required for this project to systematically address these hypotheses and reinvigorate the literature on childcare strategies and applied social network theory more generally.

CONCEPTUAL FRAMEWORK

The conceptual framework used in the project is at its core an extension of existing research on childcare strategies. Fertility decisions, childcare availability, employment histories and household circumstances are all determinants of childcare strategies and these are consistently re-evaluated as circumstances change. The innovation in this project is the extension of this conceptual framework to incorporate the childcare strategies of others within an individuals' personal network (colleagues, neighbours and family member). Conceptually, the set of strategies that are open to those developing childcare strategies is dependent on such a strategy being prevalent within their network. Empirically this means that childcare strategy formation is moderated by the

local network context, both in terms of the pervasiveness of particular strategies within the network but also dependent on the network topography itself.

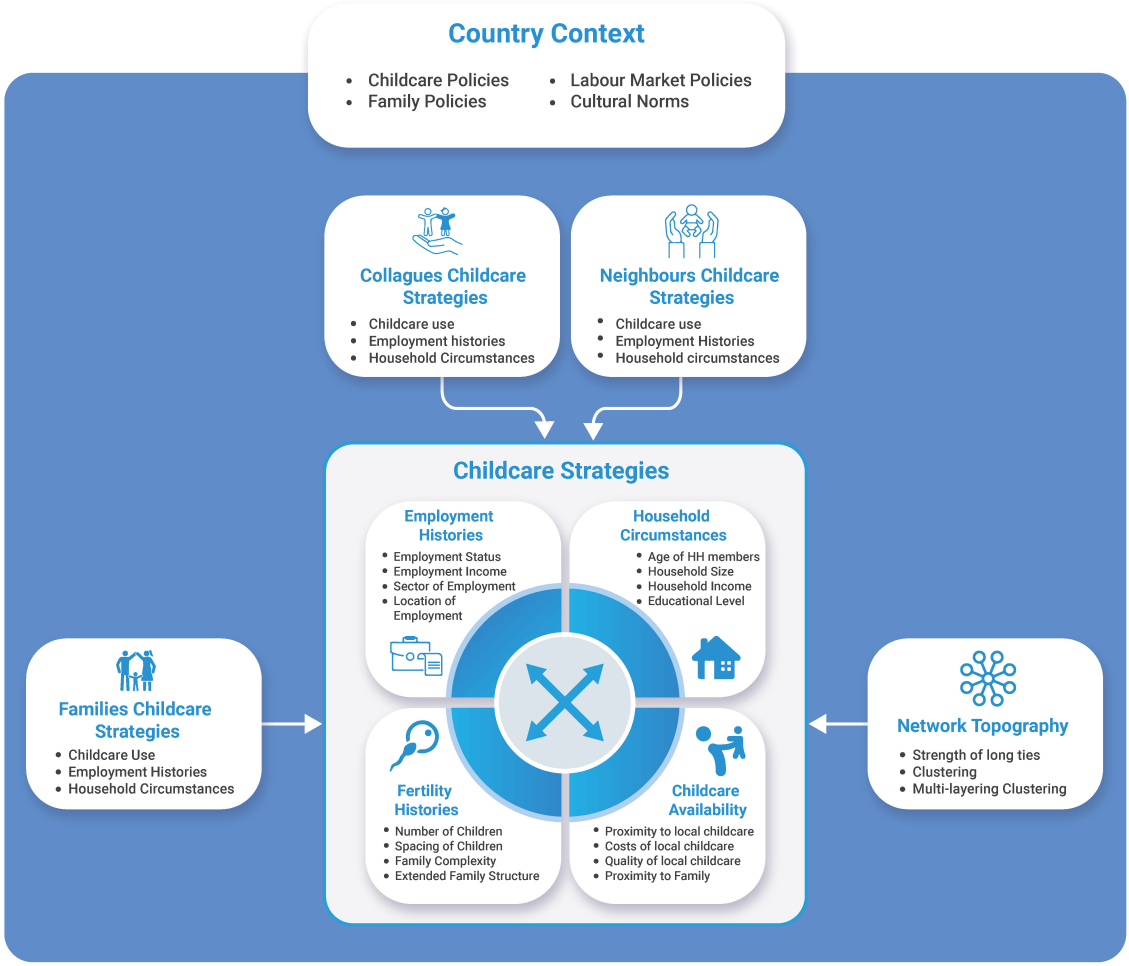

Figure 1 - Conceptual Framework

BEYOND THE STATE OF THE ART

There is a clearly defined societal problem such that formal childcare is used least by those that could benefit most. This project proposes a bold new conceptual framework that aims to understand *why* this is the case. Costs and persistent inequalities do play a role, but it is clear that this not merely a matter of costs. The conceptual framework here offers 4 new insights into childcare strategies.

1) Unlike current analysis, childcare strategies are formed in an intermate context incorporating a complex meso layer that incapsulates institutional and cultural constraints on behaviour. Childcare strategies have already been shown to be sensitive to employment context, neighbourhood context and geospatial constraints. These are too often lacking in analyses of childcare in the general population.

2) The conceptual framework is highly dynamic and reflects that there is significant endogeneity and path dependency in childcare strategies as they evolve over the child's early life (0-5). This dynamic approach is exceptionally important as it is known that lower income households encounter greater uncertainty and instability, and it has been observed that they defer use of formal childcare until later and use it less intensely.

3) The conceptual framework, as with all network analysis, is appealing because it reflects a general truth about social behaviour in that it is learnt and adapted from others. Empirically this truth has been masked by random samples in surveys and the assertion in traditional frequentist statistics that all observations are independent. This is commonly known as the Stable Unit Treatment Value Assumption (SUTVA). The complex contagions framework corrects this and recognises the interdependency between individuals.

4) The conceptual framework inherits a further advantage from network analysis in that its dynamic nature allows for the modelling of population dynamics such that thresholds can be identified at which behaviours can be become pervasive and reproduce themselves within a population. Such a conceptual framework has high potential for policy analysis as it allows for targeted and efficient policies that ensure certain behaviours

to become established and widespread. It is a conceptual framework that allows for analysis that ascends the other side of Coleman's Boat [51].

To achieve these innovations, four work streams will be developed that will deliver the projects objectives. The final work stream ***initiates and integrates*** the other work streams by defining and operationalising childcare strategies, integrating methodological innovations and synthesising the results of analyses. The second work stream will look at how ***neighbourhoods*** shape childcare strategies. Neighbourhoods are more than geospatial entities and reflect shared communities that reflect and reinforce social inequalities[52]. Existing research views childcare access as a geospatial issue but here access is reconceptualised as having neighbours that also access that facility, helping identify invisible social barriers to childcare. The third work stream will examine ***labour market trajectories*** impact on childcare strategies and the degree to which specific childcare strategies spread across various organisations using advanced social network analytics. In the fourth work stream the dynamic relationship between ***fertility decisions*** and prevailing childcare strategies will be explored, examining the extent to which the diffusion of specific childcare strategies through a network are associated with fertility intentions and behaviour.

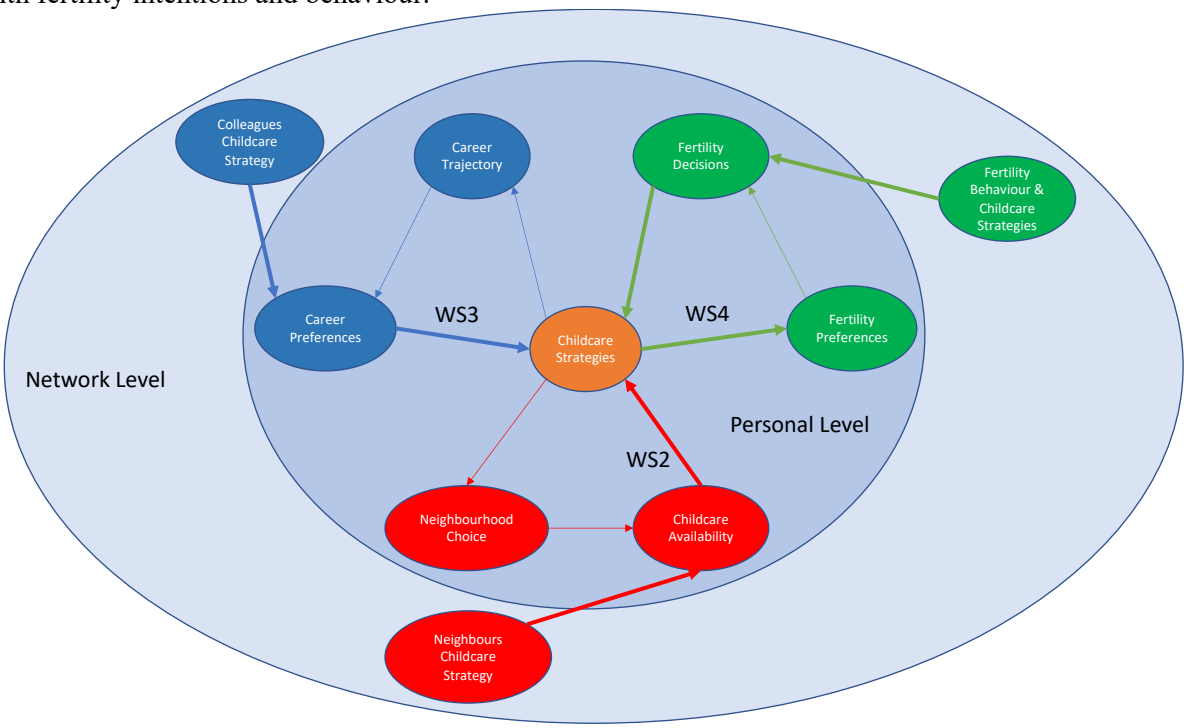

Figure 2 - Dynamic Model of Childcare Strategies

This project takes advantage of the increasing interdisciplinarity in social science[53] and the data revolution which has enabled social scientists to rapidly move beyond the state of the art. It does so with a clear societal question at its heart that has long term consequences for gender equality, child outcomes, social mobility and inequality.

Section b. Methodology

DATA

This project is exceptionally ambitious and stands on the cutting edge of social science, utilising new data and methodologies brought about by the computational turn in social science. The data to be used in the analysis are derived from administrative data and survey data and are combined in way that makes the diffusion of childcare strategies possible.

Administrative Data: ***Measuring Childcare Strategies:*** Monthly data on childcare hours is available for France[3], the Netherlands[4], Sweden and the UK[5]. *These countries were selected as representing four distinct*

[3] https://www.casd.eu/en/source/social-and-fiscal-localized-incomes/
[4] https://www.cbs.nl/nl-nl/onze-diensten/maatwerk-en-microdata/microdata-zelf-onderzoek-doen/microdatabestanden/kinderopvang-kindgegevens-kosten-en-toeslag-aanvrager
[5] https://www.gov.uk/government/organisations/hm-revenue-customs/about/research

welfare regimes and childcare systems[54]. In each country, childcare is treated as tax exempt to some degree and childcare usage is therefore imprinted within the tax records. From this it is possible to derive when formal childcare services are being engaged and with regards to which child, which is crucial for understanding the dynamic and perpetually revaluated nature of childcare strategies. Nevertheless, each country has a markedly different childcare regime[35]. Each administrative data source allows for the basic demographic and household structure variables to be added including the number and age of children, parental marital status, parental age and household income. Across these four countries, childcare strategies can therefore be operationalised through monthly data for each individual child aged 0-5 (i.e. 60 months). This will provide high frequency, comparative data on childcare strategies which will allow for more accurate measures of how childcare usage varies across households. The project will utilise existing infrastructure provided by ***ODISSEI (NL)***[6], the ***ONS/ADR (UK)***[7]***, MONA (SE)***[8] and ***CASD (FR)***[9] and the ***IDAN***[10] network which supports cross-national analysis of such data. The administrative data also provides information on employment trajectories that are required for works stream 3 and fertility and relationship histories that are required in work stream 4. Access to and alignment of this data is the biggest challenge within this project, and this is reflected in the risk management. As the Deputy Director of a national data infrastructure for analysing administrative data and experience in large scale, cross-national infrastructure projects I am uniquely positioned to achieve this.

Creating Networks: To capture people's networks in a way that will allow for the measurement of their personal networks, a ***Whole Population Network File*** will be used which links all individuals in a population with all their current and former neighbours, colleagues, classmates, family members and housemates. These are generated using the persistent identifiers inherent in the administrative data so that anybody working within the same organisation or attending the same school is linked as a colleague and anyone living within 50m is considered a neighbour. In addition, all people within the same household are linked as household members and all legal relatives (through blood or marriage) are linked as family members. Such a network file has already been constructed and used by the PI for analysis in the Netherlands[55] where it consists of 17 million individuals and more than 1.4 billion ties between them[15]. The median number of links for each individual is 86 and reflects the dense and multi-layered nature of the network constructed. As part of the project, the approach will be extended to administrative data facilities in Sweden, France and the UK using the same framework. This work will be completed across the first two years of the project. The whole population network file allows for behaviour to be observed moving across the latent structural networks within society for the first time. The development and application of whole population networks is truly ground-breaking, and the project will document and publish the applications of social network methodologies to whole population networks. The approach allows for the description of each individual's network topography in detail including the strength of their long ties, the degree of clustering and multi-layer clustering. The network file can also be used to link independent individuals within the population and observe whether the behaviour of one individual is conditional on the behaviour of individuals in their local network.

Survey Data: The theoretical framework in this project is concerned with how strategies are formed and adapted over time and to do this it is necessary to use survey data which allows attitudes, intentions and behaviour to be explicitly measured rather than simply inferred from administrative data. There are three main sources of survey data which will be used to conduct analysis. 1) The ***EU-SILC***[11] contains cross-sectional data on formal childcare usage and is currently used to provide aggerate EU statistics. The data contains around 130,000 households form all 27 member states, with respondents indicating whether each child spends more or less than 30 hours per week in formal childcare. It includes detailed data on the households financial and employment situation and has also been used for fertility research. The data is available for the EU-27 but is limited in its temporal coverage and measures of preferences and intentions.

2) ***The Generations and Gender Survey***[12]***,*** which is in the field at the time of writing, provides cross-national and comparative data on childcare strategies, work histories, fertility intentions and work-life balance indicators and will be used across work streams. I was the technical lead in the development of the new round of data collection in the GGS and know the data and its potential exceptionally well. The data will be available

[6] https://odissei-data.nl/nl/
[7] https://www.adruk.org/
[8] https://www.scb.se/en/services/guidance-for-researchers-and-universities/mona--statistics-swedens-platform-for-access-to-microdata/about-mona/
[9] https://www.casd.eu/en/
[10] https://idan.network/
[11] https://ec.europa.eu/eurostat/web/microdata/european-union-statistics-on-income-and-living-conditions
[12] https://www.ggp-i.org/

in early 2022 for at least the Netherlands, Germany, France, Czech Republic, Finland, Norway, Sweden and Denmark, with a sample of approximately 5,000 respondents aged 18-49 in each country. In at least the Netherlands and Sweden, the data will be linkable with the administrative data in the project. Linking to administrative data may also be possible in France. The questionnaire for the GGS includes detailed questions on the short term and long-term fertility intentions of individuals as well as detailed information on the use of both formal and informal childcare[13]. It also includes important information about perceptions of childcare and the degree to which it influences individual's fertility intentions. During the course of the project, the GGS will also conduct a second wave of data collection (2023/24) and it will be possible to incorporate this into the analysis of Work Stream 4 in the final two years of the project. In Germany, the GGS is being fielded as part of FReDA which is an open family panel. Aapplications to field questions on perceptions of childcare will be submitted to the FReDA open call[14].

3) Finally, a highly ***innovative survey experiment*** in the Netherlands will be conducted using network sampling. Network sampling means drawing a random individual from the population, and then using the whole population network and a random walk process to sample relevant individuals across the initial persons, immediate network[56,57]. In this case 750 women with children aged 0-2 will be selected in the first instance and then for each woman selected, a random walk procedure will be used to select 30 other women within their network. These additional women selected will not necessarily know the initially selected woman but will have some link, for example their children attend the same school, or their colleagues live in the same street, etc. Assuming a response rate of around 32%, the average for such an online survey in the Netherlands currently, this will provide a net sample of 2,500 women who have recently had a child and for whom we know the proximity to each other. The sampling parameters will be adjusted in the design phase to ensure that the generated network is neither too sparse nor too dense. Both the core sample of women and the network sampled women will then be approached (in Year 3 – Q1) and asked to complete a 20-minute online survey about childcare strategies. The questionnaire itself will include questions on childcare strategies including whether they perceive their colleagues, family members and neighbours as having desirable childcare strategies as well as their perceptions of childcare facilities that are closest to them.

In order to participate in the survey, respondents must consent to linkage to administrative data held at Statistics Netherlands and respondents will be provided with a full and detailed plan of analysis to ensure that consent is fully GDPR compliant (see technical annex). The resulting data will be linkable with administrative data held at Statistics Netherlands including the whole population network and data on detailed childcare histories. They will then be recontacted a year later (Year 4.- Q1) for a 10-minute follow up survey in order to assess how perceptions change across a network. The resulting data will be utilised across all four work streams with both waves being available in the final year of the project.

Contextual Data: In several parts of the project, national data will be required in order to account for differences in national level systems and macro level context. Data on family policies will be taken from the OECD family database[15], the parental leave network[16], the MISSOC database[17] and the policy coding that is embedded within EUROMOD[18]. In addition to data on policies, data on norms and attitudes towards childcare will be taken from aggerate data in the Generations and Gender Survey, the European Social Survey[19] and the European Value Study[20]. For childcare access, national registers on childcare facilities will be used which are free and open to the public in each country under study. This includes information on the location of each facility.

ANALYTICAL TECHNIQUES

Descriptive analysis will form the basis of the initial papers within the project. For the analysis of childcare strategies, monthly data on childcare usage in terms of average weekly hours will be analysed using ***sequence analysis*** to differentiate between various strategies used by parents[58]. For example, it could be that the child enters formal childcare late but uses it intensely (i.e. 30+ hours per week) from the outset or starts early and then gradually increases. There are a large number of possible strategies available given the high frequency of

[13] https://www.ggp-i.org/wp-content/uploads/2021/04/GGS-Questionnaire-3_0_7.pdf
[14] https://www.freda-panel.de/FReDA/DE/Daten/Offene-Module/Offene-Module.html
[15] http://www.oecd.org/els/family/database.htm
[16] https://www.leavenetwork.org/news/
[17] https://www.missoc.org/
[18] https://euromod-web.jrc.ec.europa.eu/about/what-is-euromod
[19] https://www.europeansocialsurvey.org/
[20] https://europeanvaluesstudy.eu/

the measures on childcare and the recording of hours used. The sequence analysis will classify these, and then multinomial regression analysis will be used to ascertain how strategy selection is associated with parity and household income. In order to describe the interaction between employment trajectories and career strategies, ***multi-state sequence analysis*** will combine this month-by-month data with details of income data on individuals and their declared working hours. Multi-state sequence analysis is useful in identifying the interdependency between two trajectories across the same time-period and has already been successfully applied to life course analysis[59]. Networks themselves will be described using a wide variety of measures available in ***network science*** such as clustering coefficients, degree correlations and a breadth-first search algorithm in order to identify the aforementioned descriptive statistics of an individual's network[60].

Establishing causality in network analysis is especially difficult without the use of experimental methods. However, given that the behaviour here is exceptionally costly and not susceptible to experimental design, we must rely on non-experimental approaches. Administrative data provides relatively rich individual level data, information on network topography and has a very high N. ***Propensity score matching*** and ***Panel Data Methods***[61] will therefore be used to estimate whether individuals network topography and exposure to specific childcare strategies are associated with adopting similar childcare strategies in WS2, WS3 and WS4. They will also be used to study how such networks are associated with labour market and fertility outcomes in WS3 and WS4. ***A Susceptible-Infected (SI) Model*** will be used to model the spread of childcare strategies and will incorporate the aforementioned network topography factors as independent variables. Such approaches have already been used in the study of other complex contagions in social behavour[62]. This will not circumvent the high degree of endogeneity and omitted variable bias as an individual's network position is highly correlated with a vast array of unobserved variables and the processes that reenforce behaviours are complex. The analysis will however provide a basis for further analysis and an understanding of the interaction between network position and individual childcare strategies. Despite the complexity of the underlying data, the causal claims of the resulting analysis will be restricted. The project aims to lay the groundwork and provide the exploratory analysis on which future causal analysis can be conducted.

WORK STREAM OVERVIEW

Work Stream 1 – Initiate and Integrate

Research Question "To describe how childcare strategies evolve between the ages of 0 to 5 for parents in Europe" [Objective 1]

The project will be initiated through an operationalisation and detailed descriptions of childcare strategies using the *linked administrative data* from four countries and validated against the *EU-SILC*. This analysis will take place in the first year of the project and will provide the methodological and technical basis for the work conducted by the PhDs'. The analysis describes childcare strategies for children aged 0-5 and how they vary by the household income of the parents, as well as across countries, parities and regions. Throughout the project, the team will synthesise the methodological innovations deployed across work streams into demonstrations and publications, especially on network sampling and whole population network analysis. Finally, this work stream will work across the project to examine how childcare strategies diffuse across networks and whether this explains the low uptake of formal childcare amongst low-income households.

Work Stream 2 - Neighbourhoods

Research Question: "Is the use of specific childcare facilities dependent on an individual's network proximity to parents who already use that facility?". [Objective 2]

The proximity to high quality and affordable childcare has been identified as the main obstacle for parents, especially those with low incomes[63–65]. This work stream builds on these findings to investigate whether an individual's network proximity to a childcare provider moderates the observed effect of geospatial proximity and determines their childcare strategy. This is vital for an understanding of 'access' as barriers to using particular facilities can be as much social as geospatial and methods of analysing access must reflect this [66]. A PhD student will use *whole population network* analysis to assess whether individuals only use childcare providers that are already used by others in their personal network. This will then be supplemented by the *innovative survey experiment* using network sampling to identify individuals within the same communities. Their preferences with regards to specific, named childcare facilities will be measured that helps identify how childcare preferences are structured by local community usage and perceptions over time.

The first analytic paper will examine the geospatial distribution of childcare facilities in the UK, France, the Netherlands, and Sweden. The degree to which they provide coverage to various subsets of the population will then be calculated through geospatial analysis using detailed microlevel population data and registers for childcare facilities which are open access, freely available and geocoded for all countries. These four countries have distinct and contrasting supply side incentives and constraints for childcare providers[67]. These supply side policy configurations are thought to determine access and subsequent uptake by parents but there is little systematic, comparative evidence of how policy translates into access provision. This analysis will address this gap in the literature for the first time. The data is taken from national registers of childcare provision and allows for the delineation between differing types of childcare providers including childminders and childcare centres. Combined with high resolution data on populations from census and administrative data, geospatial correlations between population and childcare will be estimated and childcare deserts and low access populations will be identified across all four countries.

The second analytic paper will use the whole population network file from the Netherlands to estimate the degree to which childcare access is shaped by social contacts. Using the administrative data at CBS, it is possible to identify specific childcare facilities being used by individuals. This data will enable the PhD student to use optimal matching analysis to ascertain whether an individual's choice of childcare facility is made based on price and proximity or whether the existing use of the facility by their neighbours, influences their choices. They will look not only at whether their neighbours use such a facility but also the strength of the tie to that neighbour (the degree of centrality of that individual in their network) and the number of such individuals in their network who use such a facility. Such analysis will help better evaluate whether inequalities in access are also closely related to wider processes of social segregation. The third analytical paper in this project will then replicate this analysis in France, the UK and Sweden.

The fourth analytical paper will utilise data from the innovative survey experiment to identify whether individuals are aware of specific childcare options and facilities. This will then be analysed in combination with data from actual childcare strategies within their network to determine whether knowledge of specific facilities is associated with actual usage observed amongst their neighbours and whether this varies over time. This contrasts with the 2nd and 3rd analytical paper which focus on actual usage of a childcare facility as a dependent variable. Taken together this PhD project will provide unique new insights into how observed geospatial income inequalities between neighbourhoods translates into differing childcare strategies.

Work Stream 3 - Childcare Strategies

Research Question: "To what extent do childcare strategies diffuse between colleagues and determine employment outcomes for individuals?" [Objectives 2 & 3]

Existing research on childcare strategies and their relationship with maternal and paternal employment is focused on macro and aggregate levels of analysis due to the rarity of high-frequency measures on both childcare and employment that are linkable at the individual level[68–70]. This work stream will utilise high frequency, *linked administrative data on employment and childcare usage* from four countries [FR, NL, SE, UK] using multistate sequence analysis to examine in detail for the first time how the work and childcare strategies of the parents evolve over the first five years of a child's life. These will then be combined with a *whole population network analysis* approach to examine how combined career and childcare strategies diffuse across organisations dominated by employees from low-income households such that there are established shifts in work place norms that accommodate feasible childcare strategies[35].

The PhD will use the detailed, linked administrative data across 4 analytical papers. The first paper will examine the interdependencies between employment trajectories and childcare strategies and address a major gap in the literature. To do this detailed childcare strategies data from the UK, the Netherlands, France and Sweden will be combined with detailed employment records and analysed using a multi-channel sequence analysis approach to produce classifications of combined career and childcare strategies. This descriptive paper aims to establish whether these combined strategies differ across low-income and high-income households. It will form the basis for the rest of the work stream in understanding how these combined strategies diffuse across organizations and how they effect childcare and employment outcomes.

The second paper will employ the complex contagions framework to estimate whether particular combined care and work strategies diffuse across specific work organisations and whether this process differs based on

whether the organization's employees are high-income or low-income. Specifically, longitudinal administrative data will be used to measure the prevailing career-work strategies as classified in the first paper and the extent to which their presence within an organisation increases the likelihood of a parent adopting the same strategy. It is assumed in the literature that such strategies have a strong path dependency within organisations and this paper looks to test this using administrative data from the Netherlands.

The third paper will be similar in nature to the second but will instead use career trajectory outcomes as the dependent variable rather than childcare outcomes. The prevailing childcare strategies within an organisation will be identified and then used to see whether this moderates the relationship between a parent's choice of childcare strategy and their employment outcomes (i.e., retention, wage increases, working hours). This will further test the hypothesis that the successful deployment of a childcare strategy is dependent upon how colleagues within the same organisation have deployed such strategies. Specific attention will be paid to whether particular strategies have greater negative impacts on low-income women than high income women as the literature indicates[71]. The final paper will use data from the innovative survey experiment to see whether individual's perceptions of successful childcare strategies is associated with the observed childcare strategies within their organisation, and whether this is dependent on a respondent's household income and the type of organisation the respondent work in. This will help zoom in on perceptions of successful joint childcare and employment strategies within organizations and how they shape people's own childcare strategies.

Work Stream 4 - Fertility Decisions

Research Question: "Is the presence of specific childcare strategies associated with an individual's fertility intentions and behaviour?" [Objective 3]

The decision to remain childless or to reduce the number or children is a legitimate and increasingly undertaken childcare strategy amongst Europeans[72]. Not only that but the reversal in the SES differential in fertility such that high income households have higher fertility than low-income households, suggests that high income households have identified sustainable childcare strategies whilst low-income households are deferring or reducing the number of children in the absence of credible childcare strategies[73]. To examine the relationship between childcare strategies and parity progression, this work stream will use data from the *EU-SILC*, *The Generations and Gender Survey* and *linked administrative data* to examine the extent to which fertility intentions are shaped by exposure to and complex contagion of sustainable childcare strategies.

The first paper will utilise data from the EU-SILC to replicate findings on both the use of formal childcare amongst low-income households and the parity progression of households. This will then be used to assess the degree to which differentials in childcare usage are associated with parity progression amongst certain low-income households. The second paper will then move beyond the state of the art to examine how the prevalence of childcare strategies identified across the project and individual's exposure to them, determine fertility behaviour. This will be done by using two analytical approaches. First a network approach using the whole population network analysis from Statistics Netherlands will be used to identify whether childcare strategies prevalent amongst colleagues, neighbours and extended family are associated with an individual's fertility behaviour and thus provide an extension of existing research. This differs from analysis elsewhere in the project as the dependent variable is fertility behaviour.

The second approach will be presented in the third paper and will be a comparative replication of the second paper drawing on data from France, the UK and Sweden. The third paper will also differ from the second paper by using linked survey data from the Generations and Gender Survey to look at fertility intentions indicators rather than exclusively looking at actual fertility behaviour. This is crucial as it allows distinctions to be made between ideal fertility outcomes that are described by individuals and short-term actualisation of fertility intentions. This distinction will hopefully help clarify the role played by the prevalence of childcare strategies in fertility intention formation. Linked survey data will be available for the Netherlands, Sweden and potentially France.

The final paper will use the innovative survey experiment to determine whether fertility intentions and realisation are associated with the perceived successful childcare strategies of neighbours and colleagues. This will differentiate from the second and third paper by contrasting the perceived prevalence of specific childcare strategies amongst their peers with actual recorded behaviour.

THE TEAM

WS1 will be led by me and supported by the work conducted in the three other work streams. In addition, a methodological advisory board will also be put in place to help support and guide this vital work stream. This board will help ensure the highest possible methodological standards within the project and will co-author papers with myself and the rest of the team regarding methodological and technical innovations. ***Annette Scherpenzeel*** (Statistics Netherlands) is an expert in survey methodology and administrative data linkage. She is the Manager of Microdata Services at Statistics Netherlands and has played senior development roles with the Survey of Health, Ageing and Retirement in Europe and the LISS panel. I have collaborated with Annette in various forms in the last 7 years and currently sit on the Management Board of ODISSEI alongside her. ***Peter Lugtig*** (Utrecht University) is a leading survey methodologist who specialises in innovative data collection. He will assist in the deployment of the network sampling experiment. We have collaborated and published together previously on such survey experiments and currently collaborate through ODISSEI. ***Jan van der Laan*** (Statistics Netherlands) is an expert in network analysis of administrative data and was the lead author of work establishing whole population networks. We have collaborated together via ODISSEI for several years. ***Gary Pollock*** (Manchester Metropolitan University) is the Co-Director of the Growing Up in Digital Europe Research Infrastructure (GUIDE)[21] and expert in sequence analysis who will assist in the comparative work on childcare strategies using survey and administrative data. We have collaborated through work on development of GUIDE since 2017. ***Alzbeta Bartova*** (KU Leuven) is an expert in Family Policies and specialises in innovative measures of complex policy configurations, including in collaborations with myself. She has considerable expertise in the use of EU-SILC and using panel data to study employment trajectories in the years following the transition to parenthood.

The core team will consist of 3 four-year PhD's and the PI. Each PhD student will work on one of streams 2-4. They will be co-supervised by two colleagues of the PI, one as a day-to-day supervisor and another as a remote third supervisor. WS2 on neighbourhoods will have a PhD with a background in a social science and pre-existing knowledge of social network analysis. They will be co-supervised on a daily basis by me and ***Agnieszka Kanas*** (Erasmus University Rotterdam) and ***Brienna Perelli-Harris*** (University of Southampton). Agnieszka Kanas is an expert on intergroup processes and social policy, particularly the geospatial structuring of inequalities. She has extensive experience in the application of network methods to social issues, using a diverse range of data to do so. Brienna Perelli-Harris is a leading researcher in the study of parenthood and relationships and is the Chair of the IUSSP Scientific Panel on New and Emerging Family Forms, Champion for Family in the UK's Understanding Society Study, and Associate Editor of the European Journal of Population. She has extensive experience in collaborating with ONS in the UK and has collaborated with myself through the Generations and Gender Programme for the past 7 years.

WS3 on labour market trajectories will have a PhD with a background in sociology or economics. They will be co-supervised on a daily basis by me and ***Pearl Dykstra*** (Erasmus University Rotterdam) and the third supervisor will be ***Martin Bujard*** (German Federal Institute for Population Research (BiB) in Wiesbaden). Pearl Dykstra is a leading scholar in family sociology and life-course research with extensive expertise in the use of new data forms in the study of policies and how they shape family life. Martin Bujard is the Research Director of BiB and a Co-PI of The German Family Demography Panel Study. I have collaborated with Martin extensively over the last 5 years through the Generations and Gender Programme, including on methodological experiments and data innovations. Martin Bujard is an expert in family policy and work life balance.

WS4 on fertility will have a PhD with a background in demography or a related field. They will be co-supervised on a daily basis by me and ***Jennifer Holland*** (Erasmus University Rotterdam), with ***Trude Lappegård*** (University of Oslo) acting as the senior third supervisor. Jennifer Holland has expertise in fertility transitions and family sociology. She has considerable experience with using Administrative Data and Comparative Survey data such as the GGS. Trude Lappegård is Editor in Chief of the European Journal of Population and a leader in the field of fertility research. She has extensive knowledge of administrative and survey data. I have collaborated extensively with her over the past 7 years as part of the Generations and Gender Programme.

MANAGEMENT

Erasmus and ODISSEI: The project will be hosted by the Department for Public Administration and Sociology at Erasmus University Rotterdam. There are a number of excellent scholars within the Department with relevant expertise who can provide collaborations and support to the project including Pearl Dykstra (family change and the life course), Renske Keizer (parenthood in comparative perspective), Laura den Dulk

[21] https://www.eurocohort.eu

(organisational work-life balance policies) Liesbet van Zoonen (smart cities and inequalities) and Ferry Koster (work and institutions). I am also currently supervising a PhD student regarding the decentralisation of care in the Netherlands and the CHILDCARE STRATEGIES team will actively participate in the research programme of the department.

Erasmus University Rotterdam is also the host of the Dutch National Infrastructure for Social Science, ODISSEI[22], of which I am the Deputy Director. ODISSEI brings together researchers with the necessary data, expertise and resources to conduct ground-breaking research and embrace the computational turn in social enquiry. Through ODISSEI, researchers have access to large-scale, longitudinal data collections as well as innovative and diverse new forms of data. These can be linked to administrative data at Statistics Netherlands (CBS). The ODISSEI team consists of a team of 6 at Erasmus University Rotterdam and a wider team of around 50, spread across 14 partner organisations including Statistics Netherlands. ODISSEI provides extensive computational resources through SURF[23], the Dutch national computing facility, and expert technical guidance through the eScience Centre[24]. These are necessary for the computationally demanding analysis described in this proposal. This project will make extensive use of the facilities at ODISSEI and the collaborations that ODISSEI has with international partners such as ADR (UK) and CASD (FR). These are all costed within the projects budget at the standard rate that is available.

The project will also implement a state-of-the-art Open Science Workflow. All data will be stored in secure SURFdrive storage and analytical code will be hosted on a project repository on GitHub (https://github.com/) that will be public. Upon preparation of a manuscript, this code and data will be linked to a SocArxiv project (https://osf.io/preprints/socarxiv) and all analytical code and data (where possible) will be made available as part of the peer review process. This will make all project work open, transparent and reproducible by default. All PhD's will be given data management training at the initiation of the project to ensure that all analysis abides by both the FAIR[74] and FACT principles[25]. PhD students will meet with their day-to-day supervisors every other week to discuss progress and all work will be conducted in open and collaborative tools such as Google Docs or Overleaf. A slack workspace will be created for the project and will include channels for each work stream with external collaborators invited to participate.

Risk Management: The project is exceptionally ambitious in its use of linked administrative data and this comes with potential challenges outline below. The project is designed to minimise the risk of these challenges undermining the project and mitigation strategies are in place to manage and circumvent these risks.

Table 1 - Risk Register

Risk	Prob.	Impact	Mitigation
Delayed access to administrative data files	Medium	Medium	The first year is focused on attaining access and preparatory work on the administrative data. In addition, all PhD's begin analysis using available survey data for research.
Limitations in administrative data preventing whole network analysis	High	Low	Proof of concept on Dutch data already established. NO or DE could be used as alternative countries in analysis if data for FR or UK is not linkable within a whole population network. As a last resort, a single country study of NL would still be ground-breaking.
Administrative data quality insufficient for identification of comparable childcare strategies	Low	Medium	Low comparability in childcare strategies will require a shift away from a comparative strategy to one in which data from UK and France are structured as replications of a core NL study.
Parallel access to all administrative data is restricted	Low	Medium	The existing infrastructure of IDAN will be used and where necessary, physical research stays at data centres will be financed.

[22] https://odissei-data.nl/
[23] https://www.surf.nl/en
[24] https://www.esciencecenter.nl/
[25] https://www.thedigitalsociety.info/about/data-principles/

IMPACT & VALORISATION

Each PhD is required to write four high quality, peer reviewed papers for their degree and these will be supplemented by four papers in WS1. Target journals for the papers are European Journal of Social Policy, Demography, European Sociological Review, Population, Place and Space, Social Forces, the Journal of Marriage & Family and Advances in Life Course Research, Social Science Computer Review, and Social Networks. In addition, each PhD will write their 3rd or 4th paper in the project independently of the PI during a research stay with their respective third supervisor (in Southampton, Wiesbaden and Oslo). This is costed in the budget Each PhD student will have an annual training and travel budget of €5,000 and will be actively encouraged to seek supplementary funding and network opportunities that would support new collaborations within their fourth paper.

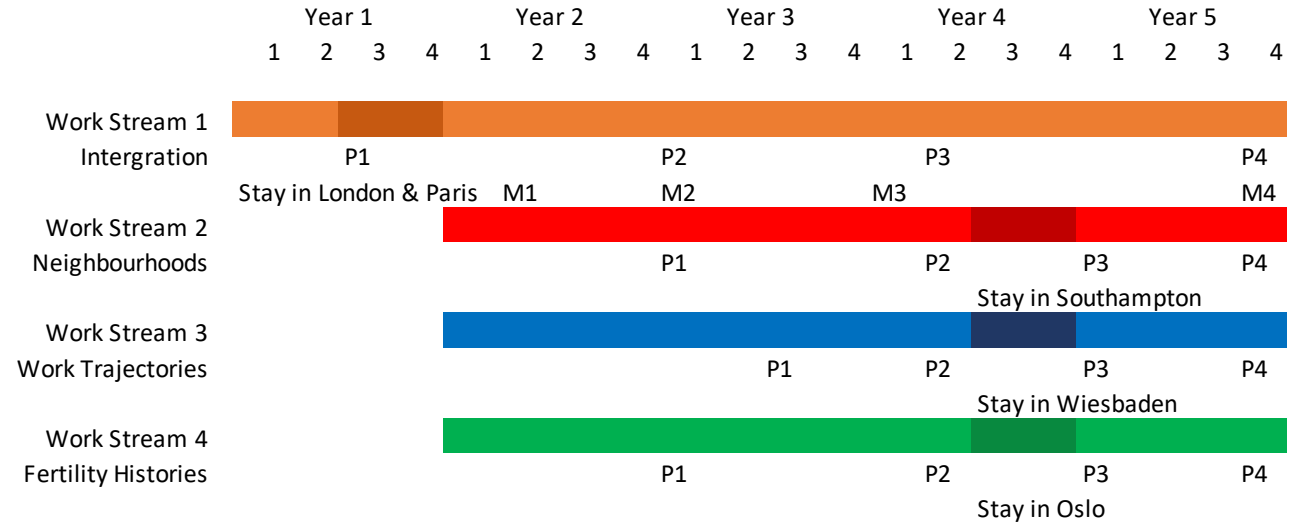

Figure 3 - Project Timetable

WS1 Papers:

1) Identifying childcare strategies in France, the Netherlands, the UK and Sweden
2) Whole population network analysis in France, the Netherlands, the UK and Sweden
3) Network Sampling methods for the study of childcare strategy diffusion
4) An integrated view of childcare strategy diffusion across networks

WS2 Papers:

1) The geospatial distribution of childcare facilities in France, The Netherlands, the UK and Sweden
2) The effect of neighbourhood childcare use on household childcare strategies
3) Comparative analysis of neighbourhood childcare use on household strategies
4) Awareness of childcare options dependent on neighbourhood context

WS3 Papers:

1) Childcare Strategies and Employment trajectories in the Netherlands, France, the UK and Sweden
2) The diffusion of childcare strategies across employers
3) The impact of childcare strategies on employment outcomes
4) Perceptions of successful childcare strategies amongst colleagues in the Netherlands

WS4 Papers:

1) Does parity progression explain inequalities in childcare strategies?
2) Peers' childcare strategies as a determinant of fertility behaviour
3) Peers' childcare strategies as a determinant of fertility intentions
4) Perceptions of successful childcare strategies amongst colleagues in the Netherlands

Milestones:

1) Presentation of the comparative data on childcare strategies in FR, NL, SE, UK
2) First wave of the Innovative Survey Experiment in the Netherlands
3) Second wave of the Innovative Survey Experiment in the Netherlands
4) Policy Event to present results of the project to stakeholders

IMPACT

The project delivers 5 significant innovations: **1)** it provides a theoretical framework that integrates multiple perspectives from sociology, economics, demographics, social policy and geography. **2)** it provides the first detailed cross-national, longitudinal analysis of childcare strategies at the microlevel. Studies have examined usage of childcare using cross-national survey data such as the EU-SILC[14] but because this stage in life is very dynamic and fluid, this study goes much further to use high-frequency measures from administrative data to see how they shift month to month, using the IDAN network (https://idan.network/) and linking it to comparative survey data. **3)** The project is the first usage of *'whole population networks'* for the study of behavioural diffusion[15]. Whole population networks are multi-layered and large-scale networks of individuals linked to their colleagues, neighbours and family through administrative data. They have huge potential for understanding the evolution of social dynamics and diffusion of behaviours and this project will break new ground in this area. **4)** The project is the first application of *'network sampling'* for the understanding of norm diffusion in society. The network sampling uses the aforementioned whole population network as a basis for sampling. An individual is sampled, and then further individuals from the initial individual's network are also sampled using a random walk approach. This is used to understand how individuals within the same work, neighbourhood, childcare nexus view obstacles to childcare and fully operationalizes sociological theories on childcare use for the first time. **5)** The project also provides a first look at how long-term childcare strategies have reacted to the punctuated equilibrium of COVID-19. Childcare practices have been dramatically affected by the pandemic and it will be vital to closely monitor how parents readjust to life post COVID as current strategies have been completely disrupted by social restrictions.

The project is highly interdisciplinary, combining theories and methods from demography, sociology, economics, network analysis and social policy. Its impact on our understanding of social policy processes will be profound and the results will be targeted at policy makers at the OECD, European Commission, as well as national and regional governments responsible for early child education. This will help transform policy practice from one that advocates for formal childcare use to one that actually enables its uptake through appropriate seeding and diffusion of new childcare strategies within the population.

The project is however merely a platform for further research to be conducted in this area. Special attention will be given to dissemination of the methods used and the data that is generated in order to stimulate a whole new research agenda in this area. The new horizons opened up within the project will be far to vast and wide ranging to explore within the project and to ensure optimal exploitation of the results it is necessary that a community evolves around the data and approach. To achieve this, the results will be widely presented at international conferences and budget has been included for external researchers to reuse and extend the analysis within administrative data. It is also hoped that an emphasis on open science and the sharing of all elements of the project workflow will facilitate the development of this new research agenda. The project will be an early demonstration of how administrative data and network analysis techniques can be combined to provide unprecedented insights into social behaviour and the degree to which it diffuses across society. Thus far, network analysis in the social sciences has been highly reliant on data from web sources or survey research which are limited by selection effects and sampling bias. This project breaks through that, using multi-dimensional data on the whole population to understand the interdependencies in our behaviour and the true ties that bind us.

I am uniquely placed to deliver this ambitious research project as I have played a leading role in the exploitation of linked administrative data using secure High Performance Computing facilities. I have a background in advanced quantitative methods, applied to complex issues of social policy and family sociology and an unparalleled knowledge of the survey data to be used in the project as architect of the new round of data collection in the Generations and Gender Survey. I have also demonstrated my ability to manage large scale, multimillion Euro projects on multiple occasions and supervise PhD students to completion whilst achieving high impact publications in leading journals.

BIBLIOGRAPHY

1. Council Recommendation of 22 May 2019 on High-Quality Early Childhood Education and Care Systems. 11.
2. Causa, O. & Johansson, Å. Intergenerational Social Mobility in OECD Countries. *OECD J. Econ. Stud.* **2010**, 1–44 (2011).
3. Heckman, J. J. & Mosso, S. The Economics of Human Development and Social Mobility. *Annu. Rev. Econ.* **6**, 689–733 (2014).
4. Datta Gupta, N. & Simonsen, M. Academic performance and type of early childhood care. *Econ. Educ. Rev.* **53**, 217–229 (2016).
5. Peter, F. H., Schober, P. S. & Spiess, K. C. Early Birds in Day Care: The Social Gradient in Starting Day Care and Children's Non-cognitive Skills. *CESifo Econ. Stud.* **62**, 725–751 (2016).
6. Saraceno, C. Childcare needs and childcare policies: A multidimensional issue. *Curr. Sociol.* **59**, 78–96 (2011).
7. Campbell, F. *et al.* Early childhood investments substantially boost adult health. *Science* **343**, 1478–1485 (2014).
8. Ferragina, E. Family policy and women's employment outcomes in 45 high-income countries: A systematic qualitative review of 238 comparative and national studies. *Soc. Policy Adm.* **54**, 1016–1066 (2020).
9. Mills, M. C. *et al.* Use of childcare in the EU Member States and progress towards the Barcelona targets. (2014).
10. Reiter, S. Provision of Childcare Facilities in the European Union–An Analysis of Member States\' Progress Towards Meeting the Barcelona Targets. *CESifo DICE Rep.* **13**, 39–42 (2015).
11. Pavolini, E. & Lancker, W. V. The Matthew effect in childcare use: a matter of policies or preferences? *J. Eur. Public Policy* **25**, 878–893 (2018).
12. Aassve, A., Biliari, F. C. & Pessin, L. Trust and fertility dynamics. *Soc. Forces* **95**, 663–692 (2016).
13. Esping-Andersen, G. & Billari, F. C. Re-theorizing Family Demographics. *Popul. Dev. Rev.* **41**, 1–31 (2015).

14. Lancker, W. V. Reducing Inequality in Childcare Service Use across European Countries: What (if any) Is the role of Social Spending? *Soc. Policy Adm.* **52**, 271–292 (2018).
15. van der Laan, J. & de Jonge, E. Producing official statistics from network data. in *BOOK OF ABSTRACTS* 288 (2017).
16. Hemerijck, A. *The Uses of Social Investment*. (Oxford University Press, 2017).
17. Solga, H. Education, economic inequality and the promises of the social investment state. *Socio-Econ. Rev.* **12**, 269–297 (2014).
18. Bonoli, G., Cantillon, B. & Van Lancker, W. Social Investment and the Matthew Effect. in *The uses of social investment* (Oxford University Press, 2017).
19. Mahon, R. Broadening the social investment agenda: The OECD, the World Bank and inclusive growth. *Glob. Soc. Policy* **19**, 121–138 (2019).
20. Wood, J., Klüsener, S., Neels, K. & Myrskylä, M. Shifting links in the relationship between education and fertility. *Popul. Space Place* **26**, e2342 (2020).
21. Esping-Andersen, G. *Incomplete revolution: Adapting welfare states to women's new roles*. (Polity, 2009).
22. Luci-Greulich, A. & Thévenon, O. L'influence des politiques familiales sur les tendances de la fécondité des pays développés. *Eur. J. Popul.* **29**, 387–416 (2013).
23. McDonald, P. Gender Equity in Theories of Fertility Transition. *Popul. Dev. Rev.* **26**, 427–439 (2000).
24. Goldscheider, F., Bernhardt, E. & Lappegård, T. The Gender Revolution: A Framework for Understanding Changing Family and Demographic Behavior. *Popul. Dev. Rev.* **41**, 207–239 (2015).
25. Brilli, Y., Del Boca, D. & Pronzato, C. D. Does child care availability play a role in maternal employment and children's development? Evidence from Italy. *Rev. Econ. Househ.* **14**, 27–51 (2016).
26. Neyer, G., Lappegård, T. & Vignoli, D. Gender Equality and Fertility: Which Equality Matters? *Eur. J. Popul. Rev. Eur. Démographie* **29**, 245–272 (2013).

27. Oh, E. Who Deserves to Work? How Women Develop Expectations of Child Care Support in Korea. *Gend. Soc.* **32**, 493–515 (2018).
28. Weber, R. B., Grobe, D. & Scott, E. K. Predictors of low-income parent child care selections. *Child. Youth Serv. Rev.* **88**, 528–540 (2018).
29. Presser, H. B. & Baldwin, W. Child Care as a Constraint on Employment: Prevalence, Correlates, and Bearing on the Work and Fertility Nexus. *Am. J. Sociol.* **85**, 1202–1213 (1980).
30. Munsch, C. L. Flexible Work, Flexible Penalties: The Effect of Gender, Childcare, and Type of Request on the Flexibility Bias. *Soc. Forces* **94**, 1567–1591 (2016).
31. Simon, A., Owen, C. & Hollingworth, K. Provision and use of preschool childcare in Britain. (2015).
32. Simon, A., Owen, C. & Hollingworth, K. Is Targeting Formal Childcare the Best Way to Meet the Needs of Families in Britain? *Am. J. Educ. Res.* **5**, 794–800 (2017).
33. Rindfuss, R. R., Guilkey, D. K., Morgan, S. P. & Kravdal, Øy. Child-Care Availability and Fertility in Norway. *Popul. Dev. Rev.* **36**, 725–748 (2010).
34. Biegel, N., Wood, J. & Neels, K. Migrant-native differentials in the uptake of (in)formal childcare in Belgium: The role of mothers' employment opportunities and care availability. *J. Fam. Res.* (2021) doi:10.20377/jfr-463.
35. Yerkes, M. A. & Javornik, J. Creating capabilities: Childcare policies in comparative perspective. *J. Eur. Soc. Policy* **29**, 529–544 (2019).
36. Krapf, S. Public Childcare Provision and Fertility Behavior. A Comparison of Sweden and Germany. 234–234 (2014).
37. Comolli, C. L. *et al.* Beyond the Economic Gaze: Childbearing During and After Recessions in the Nordic Countries. *Eur. J. Popul.* (2020) doi:10.1007/s10680-020-09570-0.
38. Esping-Andersen, G. Families in the 21st Century. *SNS Förlag* **50**, (2016).
39. Thévenon, O. The influence of family policies on fertility in France: Lessons from the past and prospects for the future. *Low Fertil. Inst. Their Policies Var. Ind. Ctries.* 49–76 (2016) doi:10.1007/978-3-319-32997-0_3.

40. Granovetter, M. S. The strength of weak ties. *Am. J. Sociol.* **78**, 1360–1380 (1973).

41. Van de Kaa, D. J. Postmodern fertility preferences: from changing value orientation to new behavior. *Popul. Dev. Rev.* **27**, 290–331 (2001).

42. Watts, D. J. *Small worlds: the dynamics of networks between order and randomness*. (Princeton university press, 2004).

43. Centola, D. & Macy, M. Complex Contagions and the Weakness of Long Ties. *Am. J. Sociol.* **113**, 702–734 (2007).

44. Centola, D. *How behavior spreads: The science of complex contagions*. vol. 3 (Princeton University Press Princeton, NJ, 2018).

45. Aral, S. & Nicolaides, C. Exercise contagion in a global social network. *Nat. Commun.* **8**, 14753 (2017).

46. McPherson, M., Smith-Lovin, L. & Cook, J. M. Birds of a feather: Homophily in social networks. *Annu. Rev. Sociol.* **27**, 415–444 (2001).

47. Törnberg, P. Echo chambers and viral misinformation: Modeling fake news as complex contagion. *PLOS ONE* **13**, e0203958 (2018).

48. Traag, V. A. Complex Contagion of Campaign Donations. *PLOS ONE* **11**, e0153539 (2016).

49. Tóth, G. *et al.* Inequality is rising where social network segregation interacts with urban topology. *Nat. Commun.* **12**, 1143 (2021).

50. Xu, Y., Belyi, A., Santi, P. & Ratti, C. Quantifying segregation in an integrated urban physical-social space. *J. R. Soc. Interface* **16**, 20190536 (2019).

51. Coleman, J. S. *Foundations of social theory*. (Harvard university press, 1994).

52. *Urban Socio-Economic Segregation and Income Inequality: A Global Perspective*. (Springer International Publishing, 2021). doi:10.1007/978-3-030-64569-4.

53. Buyalskaya, A., Gallo, M. & Camerer, C. F. The golden age of social science. *Proc. Natl. Acad. Sci.* **118**, (2021).

54. Saraceno, C. & Keck, W. The institutional framework of intergenerational family obligations in Europe: A conceptual and methodological overview. 1–87 (2008).

55. Van der Laan, Jan, Das, M., te Riele, Saskia, De Jonge, Edwin, & Emery, Thomas. Measuring educational segregation using a whole population network of the Netherlands. *SocArXiv* (2021).
56. Thompson, S. K. Adaptive and Network Sampling for Inference and Interventions in Changing Populations. *J. Surv. Stat. Methodol.* **5**, 1–21 (2017).
57. Bell, D. C., Erbaugh, E. B., Serrano, T., Dayton-Shotts, C. A. & Montoya, I. D. A comparison of network sampling designs for a hidden population of drug users: Random walk vs. respondent-driven sampling. *Soc. Sci. Res.* **62**, 350–361 (2017).
58. Ritschard, G. & Studer, M. *Sequence Analysis and Related Approaches : Innovative Methods and Applications*. (Springer Nature, 2018).
59. Studer, M., Struffolino, E. & Fasang, A. E. Estimating the Relationship between Time-varying Covariates and Trajectories: The Sequence Analysis Multistate Model Procedure. *Sociol. Methodol.* **48**, 103–135 (2018).
60. *Network Science by Albert-László Barabási*.
61. Wooldridge, J. M. *Econometrics: Panel Data Methods.* (2009).
62. Christakis, N. A. & Fowler, J. H. The Spread of Obesity in a Large Social Network over 32 Years. *N. Engl. J. Med.* **357**, 370–379 (2007).
63. Van Lancker, W. & Ghysels, J. Explaining patterns of inequality in childcare service use across 31 developed economies: A welfare state perspective. *Int. J. Comp. Sociol.* **57**, 310–337 (2016).
64. Lewis, J. & West, A. Early Childhood Education and Care in England under Austerity: Continuity or Change in Political Ideas, Policy Goals, Availability, Affordability and Quality in a Childcare Market? *J. Soc. Policy* **46**, 331–348 (2017).
65. Lauri, T., Põder, K. & Ciccia, R. Pathways to gender equality: A configurational analysis of childcare instruments and outcomes in 21 European countries. *Soc. Policy Adm.* **54**, 646–665 (2020).
66. van Ham, M., Manley, D., Bailey, N., Simpson, L. & Maclennan, D. Neighbourhood Effects Research: New Perspectives. in *Neighbourhood Effects Research: New Perspectives* (eds. van

Ham, M., Manley, D., Bailey, N., Simpson, L. & Maclennan, D.) 1–21 (Springer Netherlands, 2012). doi:10.1007/978-94-007-2309-2_1.

67. Bonoli, G. & Reber, F. The political economy of childcare in OECD countries: Explaining cross-national variation in spending and coverage rates. *Eur. J. Polit. Res.* **49**, 97–118 (2010).
68. Viitanen, T. K. Cost of childcare and female employment in the UK. *Labour* **19**, 149–170 (2005).
69. Thévenon, O. Drivers of Female Labour Force Participation in the OECD. (2013) doi:10.1787/5k46cvrgnms6-en.
70. Emery, T. Private Childcare and Employment Options: The Geography of the Return to Work for Mothers in the Netherlands. in *The Palgrave Handbook of Family Policy* 511–532 (Palgrave Macmillan, Cham, 2020).
71. Budig, M. J. & Hodges, M. J. Differences in Disadvantage: Variation in the Motherhood Penalty across White Women's Earnings Distribution. *Am. Sociol. Rev.* **75**, 705–728 (2010).
72. Kreyenfeld, M. & Konietzka, D. *Childlessness in Europe : Contexts, Causes, and Consequences*. (Springer Nature, 2017).
73. Wood, J., Neels, K. & Kil, T. The educational gradient of childlessness and cohort parity progression in 14 low fertility countries. *Demogr. Res.* **31**, 1365–1416 (2014).
74. Wilkinson, M. D. *et al.* The FAIR Guiding Principles for scientific data management and stewardship. *Sci. Data* **3**, 1–9 (2016).