Work-Family Reconciliation and Use of Parental Leave in Luxembourg

Empirical Analysis of Administrative Records

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Part I

Introduction and Preliminaries

CHAPTER 1

Introduction

1.1 Work-family reconciliation on the policy agenda

Work-family reconciliation policies are gaining priority on the social policy agenda of industrialized countries. The arrival of a new child in the family places a significant strain on parents' time and resources. Newborns require continuous care, which means that working schedules need to be reorganized and/or external providers of care must be found and often paid for. Governments can assist parents in the important task of combining caring and professional responsibilities through a set of policy instruments, such as provision of public childcare services, leave provisions, regulations concerning flexible working arrangements, as well as measures aimed at supporting parents financially.

Work-family reconciliation policies do not concern only women. In his book - *Why we need a New Welfare State* Esping-Andersen (2009) develops the idea that welfare states find themselves in the present day low fertility - low female employment conundrum because of the changing gender relations in modern societies. The post-war assumption that work and family life will be organized along the gendered divide of the male-breadwinner model where men would be employed in continuous full-time paid work, while women would provide all household and care-related unpaid activities no longer holds. Equalizing educational levels of men and women [1] as well as

[1] While the enrolment rate of men and women in education is not yet equal in all countries, there is a trend of rapidly increasing rate of enrolment of women and men. For example, the report of UNESCO Institute for Statistics (2010) indicates that in almost

a change in women's preferences in favour of employment make it necessary that the entire underpinning of the welfare states of the 21st century be re-thought in terms of a more gender-egalitarian model for the distribution of paid and unpaid work. Along this line of thought, this thesis looks at work-family reconciliation policies not only in terms of to what extent they allow women to continue their employment after motherhood, but in terms of the extent to which they enable *both* mothers and fathers to engage in *both* family and professional activities.

Parental leave is considered one of the work-family reconciliation measures with the greatest potential to bring about a more equal distribution of paid and unpaid work between men and women. Therefore, it is positioned in the centre of the analysis of this thesis. Parental leave is generally conceptualized as a work-family reconciliation measure, which provides a (brief) period of time for parents to spend caring for a newborn child without jeopardizing their career continuation. The goal of parental leave is specifically to provide time for care, which makes parental leave different from other family-related forms of leave, such as maternity leave or family leave. Maternity leave is a benefit related to the health needs of the mother and the newborn, while family leave entitlements allow parents to take a few days off from work in cases of sickness or other emergencies related to their children. Although parental leaves are often accompanied by a government-funded financial benefit, they are not the same as childcare allowances or other kinds of cash-for-care benefits. Although both kinds of measures may provide financial compensation to parents, parental leave is different from child care allowances as it also guarantees the right of parents to return to work after a career interruption.

Parental leave can be seen as a work-family reconciliation measure with a very high potential to achieve gender equality for at least two reasons. First, as the primary users of parental leave are women (Bruning and Plantenga, 1999; Hardy and Adnett, 2002), the job-protection mechanism allows many women to return to the same positions they held before giving birth (Waldfogel, Higuchi, and Abe, 1999) and thus it may reduce the gender-pay gap through minimizing the loss of firm-specific human capital (Baum, 2002; Han, Ruhm, and Waldfogel, 2009; Lalive and Zweimüller, 2007). Second, as parental leave is gender-neutral, it has the potential to contribute towards convergence of time spent by men and women in non-paid work. For example, in their analysis of the Communication proposing an out-

all countries with relatively high levels of GDP per capita the enrolment rate of women in tertiary education is higher than the enrolment rate for men.

line for revision of the European Employment Strategy (EES) Lewis and Giullari (2005) explicitly make a reference to the text "encouraged take up of parental and other leave schemes by men" (European Commission, 2003, p.15), arguing that the EES guidelines recognize the importance of supporting gender equality in unpaid, as well as paid work.

If one can assume that both men and women will continue to desire participation in paid work, one should expect to see changes in the life courses of both genders. Esping-Andersen (2009) notes that one of the changes that are expected is that the career biographies of women should tend to become more "masculine", as many more women make the choice of entering full-time employment. However, there is a limit to the extent to which female biographies can become fully the same as these of men. This limit stems from the desire of both men and women to have children. According to Esping-Andersen (2009), the desired number of children by both men and women on average has remained constant overtime. This means that both men and women continue to want to have children. As women are the ones who can give birth to these children, their trajectories can never become the same as the male ones. This implies that if the life courses of men and women are to become more equal, converging towards the "masculine model" of continuous full-time employment is not the answer. Rather, the potential for change lies in the male trajectories: namely a greater level of involvement of men in unpaid activities. This should manifest itself in a greater number of male biographies, which become "feminized". In other words, we should expect to start seeing male work trajectories, which diverge from the continuous full-time employment pattern. In the words of Esping-Andersen (2009, p.95): "Remaining at the level of pure abstraction, we must conclude that true gender equality will not come about unless, somehow, men can be made to embrace a more feminine life course."

Imagining the life courses of men and women in a society where paid and unpaid work is more equally distributed also means imagining multiple transitions in and out of employment. Parental leave, therefore, must be re-thought in terms of ensuring that it enables men and women to make such transitions. This idea fits well within the overall political and academic discourse focusing on re-designing social policy measures so that flexibility and security can be ensured throughout the entire life course. Klammer (2004) argues that shifting the focus of social policy from coping with one-time risks in the life of individuals toward encompassing the whole life course requires a new way of thinking. The main transitions, which were previously thought of as single-time points, such as labour market entry and retirement, would, increasingly, need to be seen as phases of labour

market participation on their own, requiring their own special provisions and interventions. At the same time, discontinuities in the employment phase of individuals in the labour market, such as time for care of young children or the elderly, must be anticipated and provided for, so that they do not result into long-term involuntary interruptions of labour market participation. One of the main challenges for policy-makers is how to design social security systems, which can ensure continuity of work and upward mobility. Another one is to guarantee life-long learning opportunities and a continuous preservation and upgrade of human capital (Klammer, 2004).

From a broader, macro-level of socio-economic analysis of social policy, it is also important to see work-family reconciliation as an issue stretching well beyond time-targeted policies, such as parental leave or child care (Bovenberg, 2008). Bovenberg (2008) argues that work-family reconciliation stretches over the entire life course of the individual and even touches the previous and the next generations. The previous generation is affected by the work-family reconciliation experiences of the cohort, which is presently at work through the pension systems designed as PAYG (Pay As You Go) structures[2]. At the same time, however, the cohort of present workers is also responsible for the investment in the human capital development of their children, which, in turn, are the future generation of workers.

In order to maintain social cohesion and ensure growth through continuous development and utilization of human capital, Bovenberg (2008) writes that policies should maintain a longitudinal perspective and focus towards ensuring a longer and deeper attachment to the labour market. Longer attachment would mean that retirement age is raised, deeper would mean that individuals would be allowed to have a career development and learning even if they are combining their paid work with other activities, such as raising children. Both labour markets and work places must be designed with flexibility and individuals must have more control over the construction of their careers through individual social policy accounts. Only then, the so-called "summer" (p.608) of the working life will be "decompressed" (p.624), and the pressures currently experienced by individuals to raise children and invest in their career at the same time will be relieved.

The underlying idea of this thesis is that if social policies are to make such a shift towards encompassing life phases or even the whole life course, then

[2]PAYG implies that pensions are paid out directly through the contributions of those presently in the labour force with the state being the guarantor of the inter-generational contract and ensuring that the presently working cohort will receive its pensions from the contributions of the next in turn.

policy analysis should also adopt a more holistic approach. The life course perspective developed by Elder, Johnson, and Crosnoe (2003) has been chosen as a theoretical framework for reconciling the policy-making discourse with academic analysis (McDaniel and Bernard, 2011). From a methodological point of view, the analysis is based on the two main approaches to studying the life course: the holistic approach aimed at reconstructing entire life histories and analyzing them as a whole and the event-based approach concerned with modelling duration until specific life-significant events (Billari, 2005). As argued by Billari (2005), the two approaches are seen as complementary and they have been used next to each other, as they are suited to answer different research questions, which can reveal different aspects about the life course. Based on data from the Grand Duchy of Luxembourg, the two parts of the thesis form a complete picture of how working mothers and fathers in Luxembourg reconcile their work and family responsibilities.

1.2 Understanding the life course perspective

The life course perspective is definitely not new within the policy-making discourse (Klammer, Keuzenkamp, Cebrian, Fagan, and Moreno, 2005) and it has already been available as a theoretical perspective for a number of decades. However, it is only recently beginning to emerge as a framework for policy evaluation studies. For this reason, a brief summary of the perspective and how it can be applied for policy analysis is provided below.

Elder et al. (2003) describe the life course perspective as a theoretical framework which can provide guidance for scholarly analysis at the descriptive and explanatory level. The choice of research questions, research design and analysis tools in a life-course-based study can thus be based on one of the five main principles of the life course paradigm. The first principle emphasizes the longitudinal dimension of human lives, or, in other words, the fact that life courses emerge as products of continuous development through time. The second principle establishes that individuals are active agents in the construction of their own life courses, i.e. life courses emerge as a result of continuous interactions between individuals and the social and institutional systems around. The third principle is that life courses are realized within the contexts of their historical time and geographical location. The context can change the meaning and outcomes of similar events across the life courses of different generational cohorts or residents

in different countries. The fourth principle stresses the importance of timing of events occurrence within the life course. The same event experienced at an earlier or later point in life may have a dramatically different effect on an individual's future path. Finally, the fifth principle emphasizes the importance of other people in the shaping of one's own life course. Lives are not lived in isolation; they develop as a result of multiple interactions with others.

Bernard (2007) shows how the life course perspective developed by Elder et al. (2003) can guide the dialogue between researchers from various disciplines as well as between policy makers and academics. In his analysis Bernard (2007) reduces the principles of the life course perspective to four and explains how each of them can be applied to the understanding of people's lives and their interaction with the broader context.

First, Bernard (2007) discusses the longitudinal dimension of human lives, which corresponds to the first and second principles of the life course perspective presented in Elder et al. (2003). The decision-making process of individuals can be conceptualized in terms of not only evaluating future outcomes, but also in terms of the extent to which they are bound to certain courses of action based on previous choices.

Second, Bernard (2007) explains that life courses are multi-faceted. In other words, individuals contribute to or derive resources from multiple institutions, such as human capital (education system), health capital (health system), economic capital (employment and labour markets), social capital (formal and informal relationships or networks; family). The life course is a product of recursive causal relationships between these different dimensions. In each and every stage a gap in one of these areas may lead to gaps in other areas. This process may further undermine the potential of individuals to improve their situation in the future. For example, a period of prolonged unemployment may also undermine one's health and, as a result, further reduce the potential earning capacity of that person.

Third, Bernard (2007) points towards the last principle presented by Elder et al. (2003): the principle that lives are interlinked. This principle stipulates that decisions an individual makes do not affect only his or her own life course, but also the life courses of those around him or her, being family members, co-workers or even members of the general public. At the same time, the life course of each individual is affected by events in the lives of others. The illness of a parent, for instance, the birth of child or the unemployment of a spouse would all have profound consequences for

one's decision regarding their labour force participation and allocation of time or other resources.

Finally, Bernard (2007) discusses the importance of the broader context within which the human life course unfolds, which corresponds to the third principle outlined by Elder et al. (2003).

In addition to these four principles, Bernard (2008) identifies two cross-cutting themes in the life course perspective, which are interlinked with the principles. The first theme refers to the idea of cumulative disadvantage. Even small initial differences in terms of opportunities or constraints can magnify over the life course and lead to huge disparities later on in life. For example, two children with the same learning disability will experience very different outcomes in their educational attainment later on if in one of them the disability is discovered after entry into the formal educational system and not before that. The second underlining theme is the idea of scenarios. The main idea is that people are provided with scenarios that define what actions are appropriate or not. Those can have a descriptive and/or prescriptive nature. Either way these are powerful frameworks that have an influence on the individual decision making and preferred choice of actions.

McDaniel and Bernard (2011) outline how the life course perspective can provide new insights for policy analysis and for policy-making. In particular, the authors stress the importance of understanding that human lives are more than the consecutive events that take place in each life trajectory. Further, the life course perspective can enable policy makers to understand the interconnectedness of the various domains within which human life unfolds. Additionally, the concept of cumulative disadvantage allows policy makers to see how inequalities are shaped and could provide a useful tool for identifying the most appropriate points for intervention - i.e. early on in the life course, when small initial differences are still present and would be much easier to correct than later in life when they may turn into unsurmountable disparities. Furthermore, the life course perspective as an analytical tool provides a powerful insight into the complex interaction between individual agency and social institutions, which can lead to varying outcomes at the end of the life course. Finally and most importantly, the life course perspective allows for a shift in the policy paradigm as a whole, where policy design moves towards comprehensive long-term policies, allowing for the building and preserving of the various forms of social, health and human capital through all life stages.

1.3 Background

Adopting the life course perspective defined by Elder et al. (2003) as the guiding theoretical framework for this thesis has necessitated the use of longitudinal data at the individual level. For the empirical analysis, the opportunity to work with anonymous administrative records has been presented by the *Inspection Générale de la Sécurité Sociale (IGSS)*. The availability of detailed and accurate longitudinal data has made it possible to investigate work-family reconciliation and use of parental leave within the broader scope of working parents' career trajectories.

The availability of administrative records for the analysis makes this thesis one of the first systematic attempts to examine the work-family strategies of parents in Luxembourg and their use of parental leave. Previous empirical data on these topics for Luxembourg are found predominantly in comparative reports and in smaller-scale analyses including qualitative methods, or studies with small sample size. The analysis in this thesis builds on previously available information by using a large and reliable sample size of over 10 000 persons and a substantial time span of eight years. The information analysed reflects actual behaviour. In the administrative records the use of social security benefits by individuals is recorded with greater accuracy than what could be found in self-reported data. This is of particular relevance for the study of parental leave as survey respondents have been shown to not always accurately report their parental leave status (Chan, Hamplová, and Bourdais, 2012).

Using administrative records for academic analysis, however, has a number of limitations. Records are available only for persons formally engaged with the social security system. This results in selected samples leaving out groups that may be particularly vulnerable such as illegal immigrants or these engaged in long-term labour inactivity. Additionally, a number of variables with documented importance for work-family reconciliation, such as education, could not be included in the analysis.

A relevant question to ask is to what extent the results obtained from Luxembourg can be generalized to other countries? Luxembourg has a rather small population size and its labour force has a rather specific composition with over 60 per cent foreign workers (OECD, 2003). While the situation in Luxembourg can reasonably be considered to differ from other countries on average, it has been pointed out that it is comparable to a number of European regions, especially around large cities (Brosius and Ray, 2012).

This point is further elaborated in chapter 2.

Previous analyses have classified Luxembourg's overall work-family related welfare regime as corporatist or conservative (Hantrais, 1997; Meulders and O'Dorchai, 2004; Valentova, 2006, 2011). Typically, such regimes are considered to support the traditional division of labour, i.e. the male-breadwinner model. They are characterized by the provision of long, low-paid parental leaves and insufficient provision of child care or other services and a trend to provide financial support to families (Thévenon, 2011). Valentova (2011) suggests that there are several features of the work-family context of Luxembourg that support this classification. To begin with, in Luxembourg there is still the joint taxation system whereby a married couple is taxed as one unit, rather than as two individuals. At the same time, there are very low levels of enrolment of children in public childcare and a very high number of women who are inactive on the labour market due to family responsibilities (Valentova, 2006; Hardarson, 2007).

Parental leave was introduced in Luxembourg only in 1999, in accordance with Council Directive (96/34/EC) of 1996. At that time Luxembourg, alongside Ireland and the UK, was amongst the few countries in the EU 15 that still had no parental leave measures (Hall, 1998). Interestingly, however, unlike the UK and Ireland, where leaves complying only with the minimal provisions of the directive were introduced, Luxembourg introduced a much more thorough parental leave scheme. The minimal requirements of the directive were for an unpaid leave of three months with a job guarantee at the end of the period. Luxembourg introduced a more generous paid parental leave scheme, where both parents could take leave of six months full-time or twelve months part-time up to the fifth birthday of their child. Although double in length than the minimum requirements, this scheme was nowhere close to the long leaves available to mothers in other countries classified as pro-male breadwinner regimes such as Germany or Austria.

The parental leave scheme of Luxembourg has been ranked as one of the best in Europe in terms of its potential to achieve gender equality (De Henau, Meulders, and O'Dorchai, 2007). What makes the policy design particularly interesting is that Luxembourg is one of the few countries in Europe which provides completely equal entitlement to *paid* parental leave for both mothers and fathers. This means that all working fathers in Luxembourg are entitled to a six-month paid parental leave, which cannot be transferred to the mother of the child. The non-transferable leave entitlement for men in Luxembourg can be compared to the highly successful "daddy months" in Sweden (periods of the paid parental leave reserved only

for fathers without the right to transfer to the mother), which raised the participation of Swedish fathers in parental leave at least in the short term (Ekberg, Eriksson, and Friebel, 2013).

Although some other scholars have been critical of the extent to which the parental leave scheme in Luxembourg is attractive for fathers (Haas, 2003; Saxonberg, 2013), the number of men using parental leave has been increasing steadily. Figures published in the report of the Luxembourg Ministry of Family and Integration (2012) suggest that since the introduction of the scheme the number of men using leave has jumped over ten times from only 90 at the end of 1999 to 927 in 2012. In a comparative report Plantenga and Remery (2005) mention Luxembourg as the country where the number of fathers taking parental leave is among the highest in Europe, based on data from 2001, only two years after the introduction of the policy. De Henau et al. (2007) suggest that the policy design of the parental leave scheme in Luxembourg can explain the relatively high shares of male users.

Another interesting point about the introduction of the parental leave in Luxembourg is the fact that it did not replace the old system, but was introduced as a new measure complementing it. Therefore, Luxembourg is now a country where the new and the old systems co-exist and parents have a choice to make regarding taking care of children at home. On the one hand, there is the parental leave available as a block for six months and compensated at about 1800 € per month and an employment guarantee at the end of the period. On the other hand, parents have the option of taking a child-raising allowance for the duration of 24 months full-time and compensated at about 25 per cent of the parental leave (so that the total amount of the compensation at the end of the two years equals the amount of compensation for parental leave for six months) which, however, does not guarantee any re-employment afterwards. It is interesting to trace what choices parents make in this context and under what conditions they prefer the old or the new provision.

1.4 Thesis outline

The content of the dissertation is organized in three major parts. Apart from the introductory chapter, Part I presents in detail the data used for the analysis. As data have been made available from the Grand Duchy of Luxembourg, a chapter is also devoted to the presentation of the work-family

reconciliation context in Luxembourg, with explanations of the major relevant policies and a summary of previous research. Next, in parts II and III, four chapters based on empirical analysis are presented.

The empirical analysis has been split in two separate parts of thesis because of the different methods on which the analysis is based. In part II parents' work-family reconciliation trajectories are reconstructed on the basis of their administrative records and are then analysed holistically. The analysis takes a step back from the decision points concerning labour-market participation or use of leave after the arrival of a child in the family. Instead, the analysis investigates the entire segment of the life course of individuals surrounding the birth of a child and how leave policies are positioned within this segment. In part III the analysis takes a more traditional approach and focuses on the transitions in and out of employment for women and to parental leave for men. The second part of the thesis can be seen as taking a closer look into critical time points in the work-family trajectory.

Chapter 4 describes the methodological approach applied for the analysis in part II of the thesis. In particular, chapter 4 explains in detail how the trajectories of parents have been reconstructed. The choice of states to be included in the analysis, as well as their detailed description and relationship to the broader question of work-family reconciliation, has been presented. Finally, the chapter explains how trajectories have been further compared through Optimal Matching (OM). Although OM is one of the most commonly used approaches in sequence analysis, it has received some criticism in the literature. A summary of the scientific debate surrounding OM is included in chapter 4.

A visual representation of all trajectories is presented in chapter 5. The collective pattern of the reconstructed trajectories reveals that the birth of a child is a turning point for a large part of women's trajectories, whereby it is very likely that women reduce their labour force participation afterwards. In contrast, men's labour participation appears to remain constant before and after the arrival of the child in the family. The analysis further suggests that women's career trajectories are considerably more diverse than men's trajectories. When the role of parental leave within those trajectories is specifically investigated, it turns out that men and women use parental leave rather differently in terms of when they choose to take it and whether they use it part time or full time.

The analysis of trajectories in part II continues with the goal of discovering and explaining the presence of typical patterns of work-family recon-

ciliation. This analysis relates to the idea of "scenarios" that are present in individuals' lives as outlined in the life course perspective (McDaniel and Bernard, 2011). Dominant patterns carry information about common strategies parents are able to apply to deal with the increased demand for their time in the period of arrival of a new child. They also carry information on what younger generations and future parents see as feasible or appropriate patterns of behaviour.

In chapter 6 a clustering algorithm is applied to group similar trajectories together. The algorithm identifies nine groups of parents. The gender difference is apparent in the varying male-to-female ratios in each cluster. Almost 90 per cent of the male trajectories are classified in the career types described by continuous full-time or overtime employment, both before and after the birth. In comparison, only slightly over a third of women's trajectories are classified in such clusters. Slightly more than a quarter of the mothers are classified in the trajectory types where labour participation is reduced after the birth (either by changing from full-time to part-time hours or by withdrawing from the labour market). Another quarter of trajectories appears to be dominated by continuous part-time employment. Linking available explanatory variables to career profiles lends partial evidence to the idea that women's decisions to reduce labour market participation are based on an economic comparison of the value of their time at home and the opportunity cost of leaving work.

Among the main policy implications of the analysis in part II is that flexibility in use of parental leave[3] may be essential for fathers. As shown in chapter 5, while mothers are most likely to take full-time parental leave after maternity leave, fathers seem to place it throughout the eligibility period of five years and are more likely to use it part time. This information may be especially important for policy-makers concerned with increasing the share of fathers using parental leave. Another policy implication of the analysis is that although the majority of women in Luxembourg return to employment after having a child, it should not be assumed that the majority of working families with children consist of two full-time workers. Both the collective analysis of trajectories in chapter 5 and the gender distribution of the clusters obtained in chapter 6 reveal that the majority of mothers in the labour force do not work full-time. It appears that the situation of working families is closer to what Lewis, Campbell, and Huerta (2008) call the "one-and-a-half" (p.28) earner model, rather than to the dual-earner

[3]Flexibility of parental leave use refers to whether parents can choose when to take the leave (usually within a given time frame), to use the leave full time or part time, etc.

model. Assuming one model or the other has important implications on how other aspects of the welfare state are designed, such as the pension system.

While part II investigates the use of parental leave within the work-family trajectories of working parents in Luxembourg, part III is concerned specifically with the decisions to use parental leave or not. The overview of career trajectories in part II demonstrates that there are two critical points where women may exit the labour force: immediately after maternity leave or after taking parental leave. The analysis presented in chapter 7 has thus tried to integrate both decision points. The male work-family trajectories show that the majority of fathers have stable and continuous working careers. Therefore it is more interesting to analyse whether and when men use parental leave. This has been analysed via a duration model in chapter 8.

The analysis in chapter 7 decomposes women's decisions after birth into three subsequent steps. The first step is deciding whether to remain in the labour force or to transition to inactivity after the compulsory period of postnatal maternity leave. Women who decide to remain in the labour force then make a second decision: to return to work immediately or to return after the period of parental leave. Finally, women who take parental leave make a third decision: to return to work or not. The analysis is performed via a sequential logit (nested dichotomies) model, as it could incorporate the sequential nature of the decisions. The results are partially consistent with an economic framework of analysis. As expected, opportunity cost in terms of foregone monthly earnings is negatively associated with probability of dropping out of the labour force at the first and the third step in the decision process. Higher-earning women are also less likely to use parental leave. However, the last result must be interpreted with caution because a sensitivity check exploring the potential effect of unobserved heterogeneity in the model indicates that the coefficient may, in fact, have the opposite sign.

The analysis in chapter 8 is based on a duration model. Men's decisions to use parental leave are analysed at the individual level. As in chapter 7 the analysis is based on an economic framework. Opportunity cost of using parental leave is conceptualized in two different ways: a direct opportunity cost, which equals foregone monthly salary and an opportunity cost measuring forgone promotion opportunities proxied via averaged salary growth. As expected, the results suggest a negative relationship between salary-related earnings and taking parental leave. However, surprisingly, increasing salary

growth is associated with higher probability to use parental leave.

One of the main policy implications of the results obtained in part III is that salary-related earnings are among the main predictors of remaining in the labour force after maternity and after parental leave. This means that lower-earning (and presumably lower-qualified) workers are more likely to remain outside the labour force for a prolonged period of time. This situation has implications for increasing earning inequality over time between women and between families.

Another potential policy implication stems from the somewhat unexpected negative relationship between salary growth of fathers and their probability to take parental leave in chapter 8. One possible interpretation of salary growth could be that it reflects a promotion within the fathers' organization. Therefore, it could be that fathers take parental leave when they reach a higher level of job security within their organization. This claim needs to be investigated further with more accurate data. However, if it is correct, this would mean ensuring job stability would be essential for enabling more parents to take advantage of the possibility to use parental leave.

The analysis in this thesis has several major limitations, which means the results should be interpreted with caution. To begin with, there is omitted variable bias in the models, as some important factors could not be included in the model due to lack of data. Perhaps the most important such factor is education. It is also possible that individuals' personal preferences and values, which could not be measured or included, are an additional source of unobserved heterogeneity. In addition, the analysis is not performed on a random sample. Persons who do not have an administrative record or who were not eligible for parental leave are not included in the analysis. This automatically excludes people who are not in the labour market or who work less than 20 hours per week.

Several other interesting questions that could be investigated further concerned the return of women to work and whether this work would be full time or part time. Further, it would be interesting to consider if and under what conditions using parental leave induces a wage penalty. This would be especially interesting to do on the male sample as there is very little research concerning the career-related outcomes for men using leave. With the rich administrative data available, it would also be interesting to explore the combined strategies for working couples and how they make decisions on when and how to take parental leave.

The thesis shows how administrative records can be used for the extraction of valuable information on the long-term work-family reconciliation strategies of parents. As the availability of computer-collected data is increasing, it would be interesting if data-mining techniques such as clustering of sequence data are applied for the understanding of how citizens interact with social security systems across their life course. It would be particularly interesting if such developments are investigated within a comparative framework whereby differences produced by different institutional and policy arrangements can become apparent.

CHAPTER 2

Work-family context in Luxembourg

2.1 Overview

It is important to have an understanding of the broader context within which parents in Luxembourg make decisions about their work family reconciliation decisions and/or about using parental leave. This section contains all information relevant to understanding the broader work family context of Luxembourg, which has been repeated in less detailed form in the background sections of each empirical chapter. The section provides a detailed overview of the presently available parental leave policy in Luxembourg, as well as a summary of other relevant information available in older literature.

2.2 The Luxembourg labour force

Luxembourg is a rather small country located in the heart of Western Europe. It borders Germany, France and Belgium. The total population of Luxembourg is about half a million people. The size of the population of Luxembourg has been steadily rising in the last decade. More precisely during the time span corresponding to the years of data available for analysis in this thesis, the population of Luxembourg has grown from 436 000 (in 2000) to 489 000 (in 2008). This positive trend has continued and as of the end of 2012 the population has already crossed half a million at 537 000 persons (Le Portail des Statistiques, 2014b).

The population of Luxembourg and its workforce have a very specific composition, as the country is an attractive destination for international labour migrants. In the period 2000 - 2007, Luxembourg had the highest employment growth in the EU at over 26 per cent (Margherita, D'orchai, and Bosch, 2009). Therefore it is not surprising that Luxembourg has the highest percentage of migrants as a share of the total population among OECD countries (OECD, 2003). Foreign nationals constitute around 60 per cent of the Luxembourgish labour force and more than a third of the total population (OECD, 2003). Although findings from Luxembourg could be difficult to compare to averages for other European countries, the size and the composition of the workforce can be seen to be comparable to the workforce in a number of European regions, especially around large cities (Brosius and Ray, 2012).

About a third of the labour force of Luxembourg consists of workers who commute daily from one of the neighbouring countries: Germany, France or Belgium (OECD, 2003). The OECD report of 2003 indicates a trend of increasing growth in the number of such cross-border workers or "frontaliers". In a report for the European Commission Nerb, Hitzelsberger, Woidich, Pommer, Hemmer, and Heczko (2009) classify Luxembourg and Monaco as the two countries with an "extremely high"(p. 21) ratio of in-commuters. However, in the same report a number of other European countries also have high and very high in-commuting workers: Andorra, Switzerland, Austria, Finland, Ireland, Belgium, the Netherlands, Norway, Denmark and the Czech Republic. While the ratio of in-commuters is lower in other European countries, the situation in Luxembourg can be comparable to the situation in some of the large cities close to the borders of these countries. For example, an OECD report from 2011 indicates that as of 2009, the labour force of three cities in Switzerland consisted of more than 20 per cent cross-border commuters: Geneva (22 per cent, mostly commuting from France), Ticino (27 per cent, mostly commuting from Italy) and Basel (20 per cent, mostly commuting from Germany). While the OECD report points out that these are relatively high figures, they already show that the labour force in Luxembourg is different from average but not entirely unique.

Another feature of Luxembourg is the high share (about one third) of non-nationals residing permanently in the country. This situation is again rare but not unique when cities and not countries are considered. For example, as of 2001 over 30 per cent of the people living in Brussels were born in another country (Deboosere, Eggerickx, Van Hecke, and Wayens, 2009). However, a distinct feature of the Luxembourgish foreign population is that

there is a high share of non-nationals of predominantly European origin (OECD, 2003). Apart from citizens of the neighbouring countries, other large fractions of immigrants come from Portugal and Italy (Le Portail des Statistiques, 2014a).

It is important to be aware of the population composition in Luxembourg when analyzing work-family outcomes for nationals and natives. Mainly one must be aware of that labour migrants are a self-selected group of individuals, which should be expected to have a stronger labour market attachment than the native population on average. It is also possible that they have lower reservation wages than natives (Brosius and Ray, 2012). Some reports on the gender composition of the Luxembourg labour market, also point out differences between native and foreign Luxembourgish women workers. Blond-Hanten (2008) cites figures based on IGSS from 2006 data, according to which the wage gap between men and women was lower for cross-border female workers in Luxembourg than for resident female workers. In addition, as of 2006 foreign women living in Luxembourg had higher employment rates than female Luxembourgish nationals.

The OECD report of 2003 highlights some additional differences between the labour market activities of Luxembourgish nationals, cross-border workers and immigrants that are relevant for this analysis, as it includes both resident and non-resident workers. To begin with, about 40 per cent of Luxembourgish nationals work in the public sector. This translates into a labour market segregation where about 80 per cent of employees in the public sector are Luxembourgish, while 80 per cent of the employees in the private sector are foreign workers. The OECD report of 2003 describes the labour market as three-tier system, where Luxembourgish nationals are more likely to be employed in the relatively well paid and secure employment provided by the public sector while foreign workers tend to be concentrated either in low-paid jobs or to take highly specialized positions for which the numbers of qualified nationals are not enough. These differences tend to be somewhat systematic by nationality, as the report shows that educational attainment of foreign residents in Luxembourg differs considerably by nationality. Workers from the neighbouring countries (Germany, France and Belgium) tend to have higher shares of individuals with above lower-level secondary education than Luxembourgish workers, whereas immigrants from Portugal and Italy tend to have lower shares of highly educated workers.

2.3 Work family reconciliation in Luxembourg

Typically previous studies have classified Luxembourg's overall work-family related welfare regime as corporatist or conservative (Hantrais, 1997; Meulders and O'Dorchai, 2004; Valentova, 2006, 2011). In the typology developed by Esping-Andersen (2002), such regimes are considered to implicitly or explicitly reinforce the traditional gender division of labour. Typically such regimes are characterized by the provision of long, low-paid parental leaves and insufficient provision of child-care or other services and a marked trend to provide financial support to families (Thévenon, 2011). Those arrangements are very different from the Scandinavian model where work-family reconciliation is brought to the forefront of the political arena and parents have a wide variety of policy instruments to assist them in raising their children and pursing careers at the same time.

Valentova (2011) suggests that there are several features of the work family context of Luxembourg that support this classification. To begin with, in Luxembourg there is still the joint taxation system whereby a married couple is taxed as one unit, rather than as two individuals. At the same time there are very low levels of enrolment of children in public child care facilities and a very high number of women who are inactive on the labour market due to family responsibilities (Valentova, 2006; Hardarson, 2007).

Comparative figures on Luxembourg show that work family reconciliation is somewhat problematic for women. Data from the Labour Force Survey suggest that in 2006 employment rates for women with children were only 65.4 per cent, while for women without children they were as high as 82.8 per cent. When the number of children is taken into account, the employment rates of women with three or more children drop to as low as 51.1 per cent. The negative association between number of children and participation in the labour force is very strong in Luxembourg, also when compared to other EU countries (Margherita et al., 2009).

Although for the period $2000 - 2006$, Luxembourg had one of the highest GDP growth rates in the EU (an increase of over 6 per cent), the total employment rate still remained slightly below European average. In addition, it seemed to be accounted for by women working part time, as Luxembourg had an above-average rate of part time employment as of 2006. More than two thirds of female part-time employees indicated child care or other family responsibilities as the reason for their part time employment (Margherita et al., 2009).

The situation for men in Luxembourg seems to be the opposite of that of women. Employment rates of men for the same period remained above 90 per cent, regardless of whether the number or ages of children were taken into account. Given the high levels of female labour market inactivity this is not surprising, especially, considering that in Luxembourg there is one of the highest percentage of couples following the traditional male-breadwinner model where one person is employed and one is not (Margherita et al., 2009).

2.4 Introduction of parental leave in Luxembourg

After the adoption of the Parental Leave framework in 1996, Council Directive (96/34/EC) mandated that all member states introduce the necessary legislation changes to comply with it before June 1998. At that time, Luxembourg, alongside Ireland and the UK, was amongst the few countries in the EU 15 that had still no parental leave measures and where the Directive resulted in a substantial change of the national legislation (Hall, 1998). Hall (1998) reports that prior to 1998, women employed in the private sector could take a year off for the reasons of raising a young child, however, they were not guaranteed re-employment, but merely a priority in case suitable positions were free. In the public sector female employees could take up to two years of parental leave and request unpaid leave or reduced working hours until their children reach the age of 15, however, their return to work was based on the availability of suitable vacancies.

Prior to introducing the parental leave in the Grand Duchy of Luxembourg, there was no work-family reconciliation leave available, which meant that the Directive necessitated not simply the upgrade of existing legislation, but the introduction of a completely new legal provision. It is for this reason, that Falkner, Hartlapp, Leiber, and Treib (2002) call the introduction of Parental leave in Luxembourg "a novelty without pre-conditions" (p.9). According to the same authors, it is because of the discrepancy between the pre-existing legislation and the requirements from the directive that the administration of Luxembourg mobilized itself and was able to implement the Directive in due time (Falkner et al., 2002).

Still, upon its introduction in Luxembourg, the parental leave was not explicitly framed as a gender-equality measure. In fact, it was announced as a work-family reconciliation measure and even a measure aimed at reliev-

ing unemployment. There was even clearly made the assumption that the positions of women on parental leave would be filled by temporary workers, who would otherwise be unemployed. Even today, in 2011, the same justification of the parental leave policy is stated on the formal website of the National Family Fund of Luxembourg (Caisse Nationale des Prestations Familiales), where one may read the following:

> "Le congé parental qui représente un droit personnel pour chaque parent qui travaille est, d'un côté, une mesure de conciliation la vie familiale et la vie professionnelle et de l'autre côté, un moyen de lutte contre le chômage."

> The parental leave, which represents a personal right for each parent who works, is on the one hand a measure for reconciling the family life and the professional life, and on the other hand a way to combat unemployment[1].

This formulation of the goals of the introduction of Parental Leave in Luxembourg is in line with the argument of Stratigaki (2004), who develops the concept of a "cooptation" of the gender equality rhetoric with the broader work-family reconciliation framework, or, in other words, bundling the equality goals within economic and employment outcomes. Considering the overall country-context of Luxembourg, however, it is hardly surprising that the policy goals are formulated in this way, as otherwise they would have not resonated well with the general social framework.

2.5 A closer look at the parental leave system in Luxembourg

Detailed information on the parental leave scheme in Luxembourg updated annually is available in Zhelyazkova, Loutsch, and Valentova (2013). Since the introduction of the parental leave policy in Luxembourg in 1999 working parents in Luxembourg have had the right to take either a block of six months full-time parental leave or a block of twelve months part-time leave for the purposes of caring for a young child at home. The leave can be

[1] Author's translation.

used up to the fifth birthday of the child. Luxembourg is one of the few countries in Europe where leave is an individual entitlement: both parents have the right of leave (if they meet the eligibility conditions), however, they cannot transfer it to each other. In addition, there is the requirement that the first leave in a two-parent family must be taken immediately after the maternity leave (the period immediately before and after birth, which in Luxembourg is equal to four or five months fully compensated from the health care fund). If a parental leave is not taken immediately after the maternity leave the right of the leave is forfeited, however, the second leave (in a case of family of two parents) can still be used until the child turns five.

Parents who take parental leave are compensated on a flat-rate basis at 1778 € per month full-time in 2013 and half of the amount in case the leave is taken part-time. The eligibility requirements for the leave are a minimum of one year employment with the same employer prior to the start of the leave and a reduction of at least 50% of working hours in the case of taking the leave part-time. In accordance with the European Directive of 96/34/EC of 3 June 1996, the leave is fully job-protected and parents are guaranteed the right to return to the same or an equivalent working position at the end of the leave.

An alternative for parents in Luxembourg is also to use the child-rearing allowance (l'allocation d'éducation). In 2012, the compensation figures are 485.01 € full time and 242.51 € part time. Every person in Luxembourg raising a child under two years is eligible for the allowance, however it cannot be combined with parental leave. The duration of the allowance is 22 months full time, which means that the total compensation received for the full duration is equal to the one for parental leave. The main difference between the two measures is that the child-rearing allowance does not entail any sort of job-guarantee or preservation of professional rights.

2.6 Assessments of the Luxembourg parental leave system in previous literature

The parental leave system of Luxembourg has received mixed reviews in the literature. One of the most positive evaluations of the scheme is found in the comparative evaluation by De Henau et al. (2007), where the Luxembourg parental policy scores very high Europe in terms of its potential to achieve

gender equality based on a composite ranking index. Adding the second dimension of the policy design evaluation - an index of attractiveness of the scheme, De Henau et al. (2007) classify the Luxembourg parental leave scheme as one of the best in the EU 15. In another evaluation based on a composite ranking system by (Gornick and Meyers, 2003), Luxembourg receives a score of 4 points, which positions it equal to Finland and Belgium and right behind the leading Scandinavian countries and ahead of other countries considered to belong to the conservative welfare regime, such as Germany or France.

These positive evaluations reflect the fact that Luxembourg provides a fully individual, non-transferable right to paid parental leave for both parents. Essentially this makes the leave policy comparable to systems where periods of parental leave are "earmarked" for fathers. Such systems have proven effective in increasing the total numbers of fathers participating in parental leave in Sweden (Ekberg et al., 2013), Germany (Kluve and Tamm, 2012) and other countries. Typically the duration of such periods is one or two months. In Luxembourg, however, fathers are entitled to six months of paid leave, which is relatively long for a non-transferable scheme. In a related note Marshall (2008) mentions Luxembourg as a notable example of a non-transferable leave for fathers. De Henau et al. (2007) suggest that the policy design can explain the relatively high share of male users of parental leave for 2002.

Other authors, however have been more critical of the Luxembourg policy design. Saxonberg (2013) develops a work-family regime typology based exclusively on the policies of parental leave and provision of public child care. Luxembourg (together with Belgium) has been classified as a member of the "explicitly genderized" systems, albeit as a "borderline case" (p.39). The main reason for this result is the flat-rate nature of the compensation for parental leave, which makes it less likely for men to use it (as men's higher earnings translate into a higher opportunity cost of using the leave relative to women).

Another critical evaluation is found in Haas (2003). The Luxembourg parental leave is grouped together with leaves provided by Austria, France, Belgium and Germany. Even though the parental leave in Luxembourg is relatively shorter than the long leaves provided in the majority of these countries, the Luxembourg parental leave has been criticised for its lack of flexibility. Haas (2003) suggests that the fact that parents must choose between not using the leave or taking it in a block of six months could be a reason why male take up remains low.

2.7 Sources of information on parental leave use in Luxembourg [2]

At the time of writing this thesis only limited information on the fraction of eligible parents using parental leave in Luxembourg has been available. The first available source of take up rates is the evaluation of the parental leave in Luxembourg completed by KPMG Assurance Advisory Luxembourg in November 2002. The estimated number of potential beneficiaries who used their right to parental leave in 1999-2001 (the two years after the introduction of the parental leave scheme in Luxembourg) is 30 per cent. When the take up rate is calculated by gender of the recipients, 5.3 per cent of eligible fathers and 68 per cent of eligible mothers have used leave. Both Luxembourgish residents and cross-border workers are included.

Use of the parental leave is provided annually in the report of the Luxembourg Ministry of Family and Integration (2012). The data available for the period of 1999 - 2012 have been presented in Table 2.1. The figures recording the numbers of users are not the same as take up rates. The numbers of users record the total number of people benefitting from a policy scheme in a particular year, while take up rates are calculated as the fraction of users of all potentially eligible beneficiaries. Both types of figures can provide important insights into the extent to which people are using a particular policy. Table 2.1 shows the total number of users of parental leave for each year and the proportion of users who take the leave full or part time, and the proportion of users who take the first or the second leave in their family. In addition, the proportions are broken down by gender.

Even a quick look at the total number of users of parental leave shows a marked increase in the course of the last thirteen years. Only 1433 parents used parental leave by the end of 1999 (the first year the policy provision was available). At the end of 2012 this figure was more than three times larger with 4025 parents using parental leave. The absolute number of both female and male users has been increasing, however, the number of men using leave has jumped over ten-times from only 90 at the end of 1999 to 942 in 2012. Overall the share of male users increased from 6.3 per cent at the end of 1999 to 23.4 per cent in 2012. Nevertheless women remain the majority of leave users, as they used on average 80.1 per cent of all parental leaves throughout the period.

[2] Some parts of this section are based on Zhelyazkova et al. (2013).

Year	% Women First Leaves	% Men First Leaves	% Women Second Leaves	% Men Second Leaves	% Women part-time	% Men part-time	% Women full-time	% Men full-time	Total Women Users	Total Men Users	Total Users
1999	98.5	66.7	1.5	33.3	25.5	34.4	74.5	65.6	1343	90	1433
2000	96.1	33.6	3.9	66.4	34.1	46.0	65.9	54.0	1776	235	2011
2001	95.2	23.8	4.8	76.2	37.2	52.7	62.8	47.3	1982	315	2297
2002	94.1	20.9	5.9	79.1	36.7	51.2	63.3	48.8	2073	498	2571
2003	93.1	14.9	6.9	85.1	36.9	54.1	63.1	45.9	2301	612	2913
2004	92.7	16.5	7.3	83.5	37.7	54.6	62.3	45.4	2325	648	2973
2005	92.6	13.6	7.4	86.4	35.9	58.4	64.1	41.6	2511	707	3218
2006	92.3	14.0	7.7	86.0	36.4	57.3	63.6	42.7	2588	749	3337
2007	92.7	15.8	7.3	84.2	36.5	53.1	63.5	46.9	2466	702	3168
2008	91.1	15.1	8.9	84.9	38.2	61.9	61.8	38.1	2774	821	3595
2009	91.8	11.9	8.2	88.1	40.6	61.3	59.4	38.7	2922	894	3816
2010	92.7	11.3	7.3	88.7	39.9	62.9	60.1	37.1	3152	976	4128
2011	91.8	12.3	8.2	87.7	38.7	62.3	61.3	37.7	2953	968	3921
2012	93.4	12.3	6.6	87.7	38.5	63.7	61.5	36.3	3083	942	4025
Average	93.4	20.2	6.6	79.8	36.6	55.3	63.4	44.7	2446	654	3100

Table 2.1: Users of parental leave by gender, year and type of leave.
Notes: This table presents author's own calculations based on the information provided in the annual report of the Luxembourg Ministry of Family and Integration (2012)

The Luxembourg system provides an individual right to parental leave for each parent in the family (see Section 2.5). Therefore, it is relevant to talk about "first" and "second" leaves in the family. When this information is considered a gendered pattern emerges. Mothers are more likely than men to be using the first leave available for the child. On average for the period of 1999-2012, over 90 per cent of female users of parental leave were taking the "first" leaves. Fathers were more likely to be using the second leave. On average 79.8 per cent of the second leave users were men, compared to only 6.6 per cent of women.

Considering whether the leave is used full-time or part-time also reveals a gender difference. Men accounted for more than half of the users of part-time parental leave and for less than half of the users of full-time leaves on average for the period. The general trend for both genders has been an increase in the percentage of part-time users and a decrease in the percentage of full-time users.

A very relevant source of preliminary information is the study on anticipated parental leave take up by women in Luxembourg by Valentova (2011). The study uses data from EU-SILC/PSELL3 where economically active women who indicated that they planned to have children in the near future were interviewed in detail about their labour market strategies after giving birth and, if applicable, after parental leave. The study was conducted in 2003, which is the same year as the year taken as a pivotal point for the analysis in this thesis. The results of Valentova (2011) are based on anticipated rather than actual behaviour. Therefore these results present not only an important bench mark for the analysis carried forward in the thesis, but also an opportunity to compare the extent to which anticipated behaviour corresponds to actual behaviour.

There are several important conclusions from the analysis of Valentova (2011). Descriptive analysis of anticipated parental leave after birth reveals that about 60 per cent of respondents indicated that they would like to take parental leave after birth. This is roughly similar to the findings in Chapters 3 and 5 in this thesis. Another important highlight, which is highly relevant for the structure of the analysis in Chapter 5 of this thesis is that the women who do not take parental leave constitute a very heterogenous group. The majority of them do not wish to take parental leave because they are too strongly attached to the labour market and would like to return to work as soon as possible after maternity leave. Another group of women, however, is not using parental leave because they plan to withdraw from the labour force. Chapter 5 of this thesis builds upon these insights by making a

specific distinction between women who do not use parental leave and return to work and those who leave the labour market.

The findings of Valentova (2011) also suggest, which variables play a role in the decision to use leave. She finds that Portuguese women were less likely than Luxembourgish nationals to use leave. In addition, married women and women who already had children were less likely to use leave (however the results were not statistically significant). Women were more likely to plan to use leave if they were working part-time and if they had secondary education (relative to post-secondary education).

Another source of information on parental leave is the report compiled by Plasman and Sissoko (2005) as part of the work of the European Commission's Expert Group on Gender, Social Inclusion and Employment(EGGSIE) funded by the European Commission. The report provides a summary of all relevant empirical studies on work family recollection in Luxembourg at the time of its completion. In terms of parental leave usage and take up rates, the report mentions the same statistics already presented her: the initial take up rates estimations by KPMG Assurance Advisory Luxembourg and the figures presented in the reports of the of the Luxembourg Ministry of Family and Integration (2012).

The report of Plasman and Sissoko (2005) has been a very rich source of information on the broader picture of work-family reconciliation in Luxembourg. Plasman and Sissoko (2005) mention the reduction of labour market hours and leaving the labour market after birth as two major strategies for women who have children. These results have also emerged in the cluster analysis of this thesis presented in Chapter 3 and 4. Among the factors important for leaving the labour market Plasman and Sissoko (2005) mention a strong preference for parents to care for their children themselves rather than use the services of a nanny or nursery. In addition, Plasman and Sissoko (2005) emphasize the importance of the child care allowance (l'allocation d'éducation), which has continued to exist in parallel with parental leave in Luxembourg. In their report they stress that as of 2003 more than 10000 households in Luxembourg were benefitting from this kind of allowance compared to less than 3000 households using parental leave. Another strategy for work-family reconciliation addressed by Plasman and Sissoko (2005) concerns the reduction of working hours. Although the total share of part-time workers in Luxembourg was less than the European average, the total share of women working part-time (26 per cent) in 2000 was closer to European average (33.7 per cent). Plasman and Sissoko (2005) note that both strategies: labour market inactivity or part-time work are

more likely to be used by mothers in couples. Single mothers remained more active than mothers in couples. At the same time, the working hours of men tended to increase when children were present.

CHAPTER 3

Data

3.1 Overview

This section describes the data used for the analysis in this thesis. Data for the analysis are extracted from anonymous social security records provided by the *Inspection Générale de la Sécurité Sociale (IGSS)* Luxembourg. Records are provided for all employed persons in the country except for these working in the structures of the European Union such as the European Commission or the European Court of Justice, because they do not participate in the national social security system. Residents of other countries working in Luxembourg (cross-border workers) have social security records in Luxembourg and therefore can also be included in the analysis.

The IGSS provided two major data files for this analysis. The first file contains annualized information on individuals and artificially reconstructed fiscal households from the beginning of 2000 until the end of 2007. Sociodemographic characteristics, such as age, nationality and place of residence could be extracted from this file. The file also contains annualized information on employment characteristics, such as size of the enterprise and the employment sector. The second file contains monthly information on the employment status, use of social security provisions, such as sick leave, working hours and salary-related income. This information is available from the beginning of 2000 to the end of 2008.

For the analysis in this thesis it is important to analyse both the presence and absence of a social security record. The IGSS records used for the

analysis are maintained only for persons who are working in Luxembourg. It is important to identify and include in the analysis periods when individuals do not have social security records, because it is possible that during these periods individuals have been inactive on the labour market. Figures available on labour market inactivity due to family responsibilities show that this is an issue in Luxembourg (Valentova, 2006) and in the European Union in general (Eurostat, 2007).

However, labour market inactivity could not be immediately assumed from the absence of a record, because it would be possible that the individual is working in another country. Therefore, information on missing records is supplemented with information on co-insurance. In Luxembourg all working persons have their own individual social security insurance (Portail Sante.lu, 2014). This means that if someone is insured as the dependent of someone else (co-insured), it would be possible to assume with some confidence that this person is in fact not working.

3.2 Sample selection

Records were included in the analysis if there was a child born in the fiscal household in 2003 and the worker was eligible for parental leave following the birth[1]. The final data set used for the analysis contains the employment histories of 5827 men and 4481 women, who all had a child born in their household in 2003. Characteristics of the parents included in the final sample for the analysis are summarized in Table 3.1. More information on the steps in the sample selection is available in Appendix 3.A.

[1]Eligibility for the leave was defined according to the parental leave eligibility rules of Luxembourg. Fathers and mothers who worked for the same employer for a minimum of one year and for over 20 hours per week were considered eligible for taking parental leave.

	Women		Men	
	count	per cent	count	per cent
Nationality				
Luxembourg	1408	31%	1762	30%
Belgium	650	14%	815	14%
France	1137	25%	1432	25%
Germany	216	5%	364	6%
Portugal	593	13%	754	13%
Other	492	11%	710	12%
Missing Values	3	-	2	-
Country of residence in 2003				
Luxembourg	2818	63%	3464	59%
Belgium	457	10%	595	10%
France	825	18%	1097	19%
Germany	176	4%	269	5%
Missing Values	205	5%	402	7%
Birth cohort				
<1964	213	5%	932	16%
1965-1969	975	22%	1759	30%
1970-1974	1884	42%	2231	38%
1975+	1418	32%	911	16%
Missing Values	3	-	4	-
Birth order in 2003				
First	2618	54%	2710	40%
Second+	2063	42%	3497	53%
Missing Values	200	4%	380	7%
Total				
	4481	100%	5827	100%

Table 3.1: Sample characteristics.

3.3 Advantages and disadvantages of using administrative data

3.3.1 Advantages of using administrative data

The use of administrative records for this thesis has the advantages that the different kinds of leaves and their durations are accurately recorded and there is no confusion with other social security benefits or other kinds of career interruptions. This is important to mention because there are multiple documented problems when studying parental leave on the basis of self-reported surveys. In part, such problems stem from the complexity of the legal definition of parental leave. Often, respondents, or even data preparation authorities may not be aware of the differences between parental leave and other types of career interruptions.

An example of a problem related to self-reported data is available in Chan et al. (2012). Respondents may not always be aware of exactly what parental leave means. For example, respondents might report that they never experienced a work interruption when they were on parental leave because they retained a relationship with the employer throughout the period. The study of Chan et al. (2012) shows that about half of the mothers who reported using parental leave in the *Living in Canada Survey Pilot* reported a corresponding work interruption while the others did not. This discrepancy shows that there are widespread differences between how respondents interpret their status while they were on parental leave.

Another documented problem in survey data concerns the way the information reported by survey respondents is classified by the data preparation authorities. Mikucka and Valentova (2012) point out this problem, referring specifically to the treatment of parental leave beneficiaries in some countries included in the European Union *Labour Force Survey (LFS)*. Taking the Czech Republic as a case study, they show that parental leave beneficiaries are classified as inactive on the labour market, although they are still retaining their right to return to work after the leave. This leads to inaccurate estimations of the number of women on parental leave, as well as the employment and inactivity rates of women. The authors point out that the same problem applies for other countries, such as Estonia, Hungary and Slovakia. This problem occurs due to applying not only the rules and recommendations of Eurostat but also national definitions and measurement tools.

The lack of clear distinction between different kinds of leave may lead to incorrect estimations of take-up rates and other statistics. Focusing on the Nordic country context, Haataja (2009) shows how distinguishing between fathers' use of paternity leave and parental leave can highlight important differences between countries regarding fathers' use of leave. Grouping these two types of leaves together reveals similar levels of leave use in Finland and Denmark. However, excluding paternity leave days shows that the share of fathers using parental leave is increasing more rapidly in Denmark than in Finland, even though there is no explicit fathers' quota.

In addition to providing accurate records of leave use, the use administrative records has the advantage of offering a greater level of detail and accuracy than what individuals can recall themselves in a self-reported survey. This is particularly relevant for analyzing the history of working hours as well as short-term career interruptions, such as sick leave or family leave, which are unlikely to be remembered over a long period of time.

The problem of recall accuracy in self-reported data on work histories is discussed in Manzoni, Vermunt, Luijkx, and Muffels (2010). The authors use the Swedish Level of Living Survey (LNU), where respondents were asked to report their employment histories in 1991 and then in 2000 spanning six and ten years prior to the interview date. This created a unique possibility to compare their reports, as in both cases the self-reported information included the period between January 1990 and the date of the interview in 1991. The analysis suggested that using self-reported data for the analysis of careers might lead to an overestimation of career stability. In particular Manzoni et al. (2010) found that respondents were more likely to make errors when reporting more complex careers and had a greater probability to inaccurately report brief career interruptions and especially unemployment (regardless of its duration).

3.3.2 Disadvantages of using administrative data

On the other hand, the use of administrative records does have its fair share of limitations. An overview of general problems related to the use of administrative data is provided in Bakker and Daas (2012). To begin with, administrative records are not necessarily fully representative of the population. Illegal persons or persons residing for a short duration are often excluded from the records. Another problem is associated with linking different records of information, which might result in missing or inaccurate

information, when the linking is not successful. A third problem, discussed by Bakker and Daas (2012), is that the data have not been collected with a research purpose and the scientific definitions of concepts may not always match the definitions used in the data collection process. Finally Bakker and Daas (2012) discuss the bias that may occur due to errors in the available information. Such bias may be especially prone to occur where the information collected is not of prime importance from an administrative point of view - such as for the calculation of certain taxes or benefits. The relevance of these problems for the present analysis is discussed below.

Coverage of the data made it necessary that the research is focused on working parents only, as inactive persons are not in the sample. By definition, only legally working persons in Luxembourg have a social security record. The exclusion of inactive persons can be assumed to concern a large number of women. For example, the Eurostat report for Luxembourg from 2007 states that in 2006, the inactivity rate for women aged 25 to 54 was 23.6% compared to 8.1% for men. However, this problem is not relevant here, as the analysis in this thesis is focused on the use of parental leave and inactive persons are not eligible to use it.

Another group excluded from the analysis due to limited coverage is the group of illegal workers. The estimated number of illegal persons in Luxembourg is rather small, although reliable information is not readily available. Levinson (2005) cites figures according to which there were 5000 estimated persons residing illegally in Luxembourg in 1999. This is about 1.2 per cent of the population of Luxembourg for the same year, which was 433 600 persons (Le Portail des Statistiques, 2014b).

The use of fiscal households for the present analysis is related to the problem of linking records identified by Bakker and Daas (2012). Fiscal households are artificially reconstructed households based on tax declarations and use of social security benefits. In reality, the persons linked to the same fiscal household may not necessarily reside together. This concerns the information on the presence of a partner and children. This point is important to understand because the starting point of the analysis is extracting a file of children born in 2003 and the matching records of their parents. In rare cases it is possible that children in the fiscal household are not only biological or adopted children, but children from a prior marriage of a spouse, grandchildren, nieces or nephews, etc.

Problems concerning the concept definition are also present. For example, according to the International Labour Organization unemployed persons

are those currently without work and actively looking for work (ILO, 2014). However, in the administrative records we can only observe receiving unemployment benefits. Therefore persons, who are without work, but are looking for it while not receiving such benefits, cannot be identified as unemployed. In a similar way, we can only observe the use of sick leave, but we cannot know much about persons who are sick and still go to work. This behaviour is termed as sickness presenteism and addressed in research publications (see Montgomery, 2014).

Another problem to be noted concerns the availability of information. Education is a variable of high importance for the analysis of labour market participation and use of parental leave. However, it is not relevant for participation in social security programs and therefore not available for use in this analysis. Another variable which would be relevant to include is the use of child care facilities. Again, such information is not recorded in the IGSS records.

Despite the aforementioned problems, the data set used for this thesis offers a unique opportunity to investigate work-family reconciliation and parental leave use. Problems related to the accuracy of the recorded information on leave use, which are often found with self-reported data are avoided. In addition, the records offer the possibility of observing individual work-family trajectories for the time span of eight years.

3.4 Description of covariates

3.4.1 Work related covariates

Monthly salary

This variable records the gross salary-related income on a monthly basis. Social security payments, such as sick leave or maternity leave are included in the total amount.

In chapters 6 and 7, where the analysis is on a cross-section of the data set, the variable is constructed by taking the average of the monthly salary-related income received twelve months prior to the start of maternity leave

/ event of birth in 2003. In chapter 8, where an event-history analysis is applied the variable is used as a time-varying covariate.

In all cases salary-related income was converted to 2005 € values using the monthly *Harmonized Consumer Price Indices (HCIP)* provided by Eurostat[2] for Luxembourg.

The variable is categorized so that non-linear effects could be captured and the effects of extreme observations can be eliminated. In each chapter the cut-off points for the dummy variables have been chosen, so that the number of observations in each category is relatively well-distributed.

Salary growth prior to the birth in 2003

This variable is constructed based on the deflated values of salary-related income over a reference time period. The geometric average of salary growth is computed using the formula in equation 3.1. Values greater than one indicate positive salary growth, while values lower than one indicate a negative salary growth.

$$\text{Average monthly growth from period } t \text{ to period } s = \left(\frac{wage_t}{wage_s}\right)^{\frac{1}{t-s}} \quad (3.1)$$

In chapters 6 and 7, where the analysis is on a cross-section of the data set, the variable is constructed by using twelve months prior to the start of maternity leave / event of birth in 2003 as a reference period. In chapter 8, the variable is used as a time-varying covariate and the reference period is six months.

Uninterrupted employment months

This variable is included in the analysis only for chapter 7. The variable represents the number of months in which the mother has a status of "employed" without any interruptions, such as sick leave, family leave, unemployment, etc. The variable counts the months with uninterrupted

[2] http://epp.eurostat.ec.europa.eu/

employment for the period of 12 months prior to the maternity leave. The lowest possible value for this variable is zero and the highest is twelve. In chapter 6 this variable is not used as a predictor because it is partially derived from the trajectories of parents.

Working hours per month

In Luxembourg the standard full time contract is considered to be 173 hours per month. Workers were defined to work standard full time, if they worked exactly 173 hours per month. Workers who work less than 173 per month were defined to work part time. If they work more than 173 hours per month, workers were defined to work overtime.

It must be noted that for blue collar workers the hours of work are usually recorded exactly, while for the others the hours reflect contractual hours and not actual hours of work. In chapters 7 and 8 the variable is used as a set of dummy variables with three categories: standard full-time employment, overtime and part-time employment. In chapter 6 this variable is not used as a predictor because it is used in constructing the trajectories of parents.

Years since entry in Luxembourg labour force

In chapter 7 this variable is used as a proxy for work experience. The variable is constructed by subtracting the year when the parent had an administrative record in Luxembourg for the first time from 2003. The variable is only a partial indicator of working experience, because it does not account for working interruptions since the first point of entry into the Luxembourgish labour force or for experience acquired in other countries.

Type of employment

This variable is constructed based on twelve months prior to the start of the maternity leave for women and twelve months prior to the birth in the household for men. In cases of multiple employers with different categories, the category reflecting longest hours worked was chosen. The variable is used as a set of dummy variables with the following categories:

- White collar
- Civil servant
- Blue collar

In chapter 6 civil servants and self-employed were grouped with the white-collar category. The reason is that there were very few cases in these categories (less than 15 per cent) and there were too few cases in many of the levels of the dependent variable.

It must be noted that since 2009, in Luxembourg there is not any more the distinction between blue and white collar workers (Association des Banques et Banquiers, Luxembourg (ABBL), 2009). However, as the data from the analysis are from an earlier time period, the distinction has been kept in this thesis.

Organization size

This variable is based on the record reflecting the number of employees in the enterprize employing the parent. The variable has been extracted from the IGSS annual-based records. Status corresponds to December in the previous year. In chapters 6 and 7 the variable reflects the value for 2003 (record from december 2002). In chapter 8 the variable is used as a time-varying covariate.

3.4.2 Family related characteristics

Marital status

Luxembourg provides a legal alternative to marriage, known as a *Partenariat (PACS)*, which provides the same tax, civil and social security rights as marriage. However, in the administrative data co-habiting couples are coded as "not married" and it is not possible to find the difference between single and cohabiting parents. In addition, Luxembourg does not recognize registered partnerships in other countries. Therefore co-habiting couples from other countries are also considered as not married.

In chapters 6 and 7 this variable is used as a categorical covariate with two levels: married and single. The administrative records provide some further distinctions, such as: divorced, separated, widowed, etc. For the analysis in chapters 6 and 7 these categories have been re-coded as single. There was an additional category called re-married. In chapters 6 and 7 this category is merged with the category married. However, in chapter 8, where the variable is entered as a time-varying covariate, there was a relatively large proportion of men in this category. Therefore re-married was kept as an additional third category in the analysis.

Other children in the household as of 2003

This variable describes whether in 2003 there were already any other children below 18 years of age living in the same household as the parent. The count excludes the baby born in 2003. The records do not distinguish between biological children or other children (e.g. step-children, siblings, etc.) living in the household.

Sex of the child born in 2003

For this variable, information from the annualized IGSS records was used. In the case of twins or triplets the sex of the child was chosen randomly.

Multiple births in 2003

For this variable, information from the annualized IGSS records was used. The variable was used as a categorical covariate with two levels: single birth and multiple births. The majority of births were single births. Twins and triplets were grouped in the multiple births category.

3.4.3 Socio-demographic controls

Nationality

This variable is constructed based on the annualized IGSS files. There were no instances of changes in nationality during the observation period. Values of 2003 were used. The nationalities that were less frequently represented were grouped in the category other.

- Luxembourg
- France
- Portugal
- Belgium
- Germany
- Other

Age

This variable was constructed using the information on year of birth for each parent. The variable is measured in years. In chapters 6 and 7 the variable reflects the age in 2003. In chapter 8 the variable is used as a time-varying covariate.

3.A Steps in the sample selection

Step	N	Selection	Notes
1	8681	Mothers matched to children born in 2003	Children not necessarily Luxembourgish or born in Luxembourg.
2	6950	Mothers with a social security record 2000 - 2008	Record appears at least once.
3	4673	Mothers who took maternity leave (or maternity leave could be assumed) around birth in 2003	This selection implies that women who drop out of the labour force prior to maternity leave are not be in the sample; it can be assumed that the percentage is not very large since the compensation of maternity leave is very high in Luxembourg.
4	4481	Mothers eligible to take parental leave	Eligibility applies only for 2003.
5	4478	Records where annualized information is available, at least for some years 2001 - 2007	
6	4281	Records where annualized information is available for 2003	

Table 3.2: Selection steps for the sample of mothers.

Step	N	Selection	Notes
1	8440	Fathers matched to children born in 2003	Children not necessarily Luxembourgish or born in Luxembourg.
2	8144	Fathers with a social security record 2000 - 2008	Record appears at least once.
3	5827	Fathers eligible to take parental leave	Eligibility applies only for 2003.
4	5825	Records where annualized information is available, at least for some years 2001 - 2007	
5	5447	Records where annualized information is available for 2003	

Table 3.3: Selection steps for the sample of fathers.

Notes on the sample selection

- The total number of children in the data exceeds the number of children born in Luxembourg in 2003 because the data set contains also the career trajectories of cross-border workers.
- The high number of parents who are matched to children born in 2003, but are not eligible to take parental leave in 2003 is not due to extremely strict eligibility rules for parental leave. For the most part these are the records of parents who started working in Luxembourg after 2003. Therefore they appear in the files for the analysis but for later years. Therefore it is not possible to use their information for 2003 and they cannot be included in the analysis.

Part II

Sequence Analysis of Work-Family Reconciliation

CHAPTER 4

Introduction to part II

4.1 Conceptual approach

The analysis in this part of the thesis has been inspired by recent developments within the political and academic discourse on social policy. In general, there is a shift of focus from how social security provisions can assist individuals in dealing with specific risks, such as illness or unemployment in the short term towards designing social security systems which can ensure flexibility and security in the longer run and even throughout the entire life course (Klammer, 2004). This shift of focus suggests that policy analysis should be concerned not only with analyzing how policies affect the behaviour of individuals at specific time points, but also with considering their implications over the longer term, as well as in conjunction with other dimensions of the individuals' life-course.

For this purpose, the analysis in this part uses the social security records of parents working in Luxembourg in order to re-construct their trajectories around the birth of a child. The social security records provide information on the employment status of individuals on a monthly basis for a period of eight years. As leave provisions are paid through the social security system, their use is also recorded. Other career-related information, such as use of unemployment benefits or sick leave is also recorded. Therefore the reconstructed trajectories provide a longitudinal account of the career developments, as well as information on other events related to parents' lives, such as illness or unemployment. The use of parental leave or periods of labour market inactivity can thus be analyzed in a broader context.

Not only their occurrence, but also their position and duration can be observed and investigated. With this approach it is possible to observe, for example, not only whether women return to work after parental leave but also whether and for how long they remain employed afterwards.

The analysis uses the tools offered by sequence analysis[1]. In short, sequence analysis is concerned with the analysis of sequences of states or events. The timing and order of occurrence, as well as durations for which individuals spend time in particular states are all possible points of interest in sequence analysis. For performing sequence analysis, one needs to be able to arrange the elements that are being studied (significant life events or career transitions, for example) along a temporal or spatial dimension (Abbott and Tsay, 2000). For example, if one tries to represent the life course of individuals in terms of education (E), working(W), and retirement (R), one could distinguish between individuals who transition directly to work after education and then retire (for example: E-W-R) and individuals who return to education one or several times throughout their working career (for example: E-W-E-W-R).

Even though the span of the data is not the entire life time, the analysis is embedded within the framework of the life-course perspective (Elder and Giele, 2009), which has been outlined in the introduction of the thesis. The analysis particularly aims at incorporating the first and second principles of the life course paradigm discussed by Elder and Giele (2009), which concern the longitudinal dimension of human lives and the fact that human lives develop as a result of continuous interaction between individuals and the social and institutional context around them. The use of administrative data and the use of sequence analysis methods have made it possible to incorporate these two principles, because it allows that social security records are traced over the time span of eight years and in that it provides a record of how individuals are using the social security arrangements available to them. Of course, there are a number of other institutions which are also important in shaping the life course. These records however, can provide at least a partial account of the interactions between individuals and the social security system.

[1]One of the earliest publications documenting the use of sequence analysis and in particular optimal matching in the social sciences is presented by Abbott (1990). Abbott and Tsay (2000) provide a review of the developments in the field a decade later. A more recent review of studies applying sequence analysis methods in the social sciences is available in Aisenbrey and Fasang (2010) and the latest available paper summarizing the state of sequence analysis research and the main scientific debates and controversies around the method is available in Gauthier, Bühlmann, and Blanchard (2014).

The analysis also makes an attempt to incorporate the principle of multidimensionality of the life course. This has been achieved by using additional information relevant for the work trajectory of individuals, such as sick leave (which also tells about the individual's health) or receiving unemployment benefits (which indicates a complete or partial loss of employment). The idea of the life course as a multifaceted phenomenon has appeared in Elder's (1985 cited in Macmillan and Eliason, 2003) characterization of the life course, as well as in Bernard (2007).

An understanding of the multidimensional nature of human lives is important in analyzing social security provisions, because the idea that a gap in one resource area for an individual must often be compensated by another resource area essentially translates into the idea that social risks, which are not effectively covered by one set of social provisions, will translate into other types of risks, which may eventually need to be covered by other social security measures and provisions (Erhel, 2007). For example, in a system where many individuals leave education early, the social costs may need to be offset by intensive career training and employment activation programs (Erhel, 2007).

With reference to work-family reconciliation, the same reasoning can be applied. For example, if parental leave is not available and women cannot reconcile work and family effectively, this might result in a large number of women dropping out of the labour force. Remaining without a source of their own income, in the long term such women and their children may be at risk of poverty, especially in the case of divorce or death of their spouse. This risk of poverty will need to be accommodated by the social security system in the form of income transfers, such as child-raising allowances.

The analysis of trajectories reconstructed from social security records can therefore provide an insight in terms of not only how parents reconcile work and family, but also in how they use support from multiple sources over time. For example, we can check whether women who do not use parental leave and drop out of the labour force first go through spells of unemployment. We can also see whether mothers who return to the labour force without using parental leave are more likely to use sick leave in the first months of their return.

4.2 Review of related literature

4.2.1 Overview

This section summarizes findings from previous studies based on sequence analysis methods in order to provide an initial idea of the kind of research questions that can be addressed in the context of gender and career development. Previous studies are found predominantly in the sociological and demographic literature. In recent years there have been several publications examining the relationships between gender, work and family in the long term. A number of scholars have pointed out the usefulness of the life course theoretical framework presented in Elder and Giele (2009), for understanding how these three dimensions and the social and institutional contexts in which they are embedded interact with each other and with the individuals' decision-making process to produce shared patterns of behaviour.

In summary, sequence analysis studies on work and family careers tend to find interdependencies between these two domains in the trajectories of women, but not of men. The employment trajectories of women tend to be more diverse and to include more career interruptions or periods of part-time work. Although gender differences can be clearly established, gender is not the only factor underlying the development of work-family trajectories. Social and institutional factors play an important role in the organization of the work and family trajectories. This is evident from the fact that the trajectories of both men and women vary across cohorts and countries. The long-term career trajectory differences have been shown to translate to long-term income inequalities throughout the life course and in the retirement stage.

The role of leave policies and other work-family reconciliation support measures is seldom incorporated in studies using sequence analysis. Often parental leave is not specifically included and women on leave are classified either as employed or not employed. The role of institutional factors is inferred indirectly by comparison of the distribution of trajectories with other countries or historical periods. Another issue is that the analysis of complete biographies automatically translates into analysis of people who are in or nearing retirement. As their life courses unfolded a substantial time period ago, it is difficult to say whether findings are still relevant in the present context.

The analysis presented here contributes to the literature reviewed in this section by using recent data from Luxembourg to explore the career trajectories of men and women around the time of birth of a child in the family. Apart from highlighting differences in the development of male and female trajectories over time, the analysis highlights how men and women interact differently with the social security system through tracing out their use of leave provisions and other related social security benefits.

4.2.2 Research comparing women's and men's trajectories with relation to work and family

Reconstructing and comparing the work-family trajectories of men and women has highlighted some important relationships between these two life domains and has demonstrated how these relationships tend to vary by gender. Typically men's trajectories are found to follow a course of continuous employment, while women's career paths tend to be more varied: some are similar to men's and others include short or long spells of labour market inactivity or reduced levels of labour market participation. Another finding emerging from the literature is that women's family and career trajectories tend to influence each other, while the same is not true for men.

An example of a study analysing the career data of both men and women with relation to family history is the work of Han and Moen (1999). Working with self-reported data provided by retirees from upstate New York, the authors find that men were over-represented in sequences that could be labelled as "orderly career" and "fast-track career", whereas women more frequently had "intermittent", "steady part-time" or "delayed-entry" careers. The few women whose employment careers resembled those of men, were much less likely to have a stable marriage, while the opposite was true for men. In addition, the results of Han and Moen (1999) suggest that there is a strong influence of the male career on the female career course, but not the other way around. In particular, the men whose biography followed the so-called "orderly career" (Han and Moen, 1999, p.107) were more likely to be married to a partner who never worked at all. In addition, men, in general seemed to work full-time regardless of the life-path of their partner.

Widmer and Ritschard (2009) compare the reconstructed trajectories of men and women from Switzerland born in three different cohorts (1910-1924, 1925-1945, 1946-1957). The results show that there is not a large difference between the level of diversification of family trajectories between

men and women across cohorts. However, women's family trajectories are related to their occupational trajectories in a way which seems to cause more diversity in their occupational trajectories. This diversity for the most part reflects multiple transitions between paid work and periods at home for women. In contrast, male trajectories in Switzerland have changed over time only in the period of life before age 30, reflecting increased transitions between paid work and education. In the authors' own words: "...uncertainty has become a permanent state in women's occupational trajectories, while it is only transitional in men's occupational trajectories."(Widmer and Ritschard, 2009, p.38)

Piccarreta and Elzinga (2014) use a Dutch data set to explore the associations between two life course domains: the education/employment one and the family one. Although the principal goal of Piccarreta and Elzinga (2014) is to present and critically assess the suitability of different approaches to studying the association between two domains, the findings of the paper are also relevant for understanding the relationship between work and family and how it differs across genders.

The results of Piccarreta and Elzinga (2014) show that when the trajectories in the two domains were reconstructed for each individual, for women the states of cohabitation or marriage without children in the family domain were most often experienced at the same time as a state of full-time work in the career domain. At the same time, the states of having one or more children in the family domain were most often accompanied by absences from the labour market. For men there were no such associations[2].

Piccarreta and Elzinga (2014) show that women whose career trajectories were dominated by full-time work tended to have family trajectories with fewer children compared to women whose career trajectories were characterized by working part time or not working. At the same time, the career trajectories of men were dominated by full-time work regardless of their family trajectory[3].

[2]Piccarreta and Elzinga (2014) propose that the association between the two domains can be quantified by using measures based on the extent to which knowledge of the state in one domain reduces the expected variation of states in the other domain. They find higher levels of association between the career and family trajectories of women than for men, when using case-based association measures, such as the uncertainty coefficient (Theil, 1972; Cover and Thomas, 1991 cited in Piccarreta and Elzinga, 2014) and the Gini Heterogeneity Index (Gini 1912, 1939 cited in Piccarreta and Elzinga, 2014).

[3]Piccarreta and Elzinga (2014) explore both global and local association measures to quantify this relationship. Both approaches are based on first computing dissimilarities between each pair of sequences in the data. The authors emphasize the fact that the

4.2.3 Research focusing on female trajectories

As the careers of women tend to be more varied, most analyses of work-family histories have been based on the analysis of entirely female samples. Some examples come from Sweden (Huang and Sverke, 2007; Huang, El-Khouri, Johansson, Lindroth, and Sverke, 2007; Isaksson, Johansson, Lindroth, and Sverke, 2006), the UK (Aassve, Billari, and Piccarreta, 2007; Anyadike-Danes and McVicar, 2010) and Germany (Simonson, Gordo, and Titova, 2011). A common finding in the studies of women's work-family biographies is that there is a significant diversity in the work-career patterns of women. Typically such studies apply cluster analysis techniques to group similar trajectories together and they usually find a group with continuous employment, a group with continuous non-participation and several groups in between, which combine both in different ways. The proportions of women in the different groups, however, tend to vary across institutional contexts (e.g. East and West Germany) and across generations (see Simonson et al., 2011), which reflects the importance of the context within which female careers are realized for their development.

It is also found that women with continuous careers tend to have fewer children (Huang et al., 2007) or to delay child-bearing (Aassve et al., 2007) relative to women in other clusters, whereas women who have more children tend to belong to work-family combining clusters or to be predominantly outside the labour market. These relationships again demonstrate the connection between women's working trajectories and their family life. The picture becomes even more complete when the trajectories of partners are also introduced into the analysis.

After identifying dominant patterns of female work-family reconciliation, researchers either try to explain these patterns or to relate them to outcomes later in life. One direction of research has focused on whether work-family reconciliation trajectories are a product of personal values and lifestyle preferences. Some scholars (for example: Huang and Sverke, 2007; Aassve et al., 2007; Huang et al., 2007) have related the three broad groups

results are sensitive to the dissimilarity measure chosen. The global approach is based on the principle that an association is present when sequences that are close in one domain are close also in the other and also that sequences that are distant in one domain are also distant in the other. The local approach focuses only on whether cases that are similar in one domain are also similar in the other, without considering the remote cases. Piccarreta and Elzinga (2014) consider the local approach more appropriate, because it does not make the assumption that the distances are monotonically related, although they report that both approaches performed well in their simulations.

of female trajectories to theory developed by Hakim (2002), according to which women's life-style preferences and values determine their work-family trajectories. In the theory of Hakim, women are broadly grouped into family-oriented homemakers, work-oriented and work-family combining (adaptive) types, whereby their lifestyles are a product of their personal preferences.

In Huang et al. (2007), the general findings were in line with this reasoning, as the trajectories of women were found to be in line with their values and career aspirations measured at earlier points in time: for example, women who were in the career-oriented general group scored higher on work values than women in the work-family combing groups, while career-oriented women scored somewhat lower on family-related values.

Aassve et al. (2007) emphasize that although the general patterns obtained in their data roughly correspond to the preference-based typology identified by Hakim (2002), the diversity and heterogeneity of the trajectories of women is far greater than three types and especially complex patterns are emerging in the group that is trying to combine work and family. Outside of preferences, the role of institutions must also be mentioned, as they enable women to a different extent to construct their life courses according to their preferences.

On a related note Huang et al. (2007) mention that the number of work-family combining women is very high in Sweden where the institutional setup allows for women to maintain a connection to the labour force. This is also demonstrated in Simonson et al. (2011), where the proportions of women in different general patterns are different not only across generational cohorts, but also between East and West Germany.

Another approach in the analysis of clusters of work-family trajectories is to relate cluster membership to outcomes later in life. In Huang et al. (2007) women from the career-oriented groups were found to have a higher level of socio-economic achievements, while women in the predominantly not-working group had the lowest health status. At the same time, there were no significant differences in terms of job satisfaction or general life satisfaction. The authors observe that the great diversity of women's life courses observed in the analysis, to an extent, reflects the broader institutional and societal context of Sweden, which provides support measures, such as parental leave and public child care to assist women in organizing their life courses in a multitude of ways. Nevertheless, it could be added that the differences observed in terms of socio-economic status, reveal that

even though women have the freedom to structure their work-family lives, this does not go without long-term, over-reaching consequences.

In a related study Huang and Sverke (2007) extended the analysis to account not only for the broader work-family reconciliation strategy, but to also include career developments patterns, in terms of upward or downward mobility. The study results indicated links between the occupational career trajectory and overall quality of life. Women with professional career trajectories, in particular, were more likely to experience more role conflict in general, to have less goal clarity and to find it more difficult to balance career and family.

Over the long term, implications of career profiles become even more important, especially as one begins to consider pensions and old-age income. A study by Frommert (2011) on German career histories shows that women are much more likely than men to belong to work trajectory types such as family-oriented, part-time employed or marginally employed. Women with these trajectory types are more likely to have more than two children compared to women with other trajectory types. At the same time, however, these are the trajectory types associated with the lowest projected pension income.

Another study linking gender, career trajectories and retirement is the study of Fasang (2009). The study explores the pathways to retirement in Germany and the UK. The trajectories of individuals are reconstructed as sequences of states describing their type of occupation or income (full-time work, part-time work, widow income, no own income, etc.) within the age bracket when most people experience retirement. Although gender comparisons are not the main goal of the study, the results do indicate that in both countries women tend to be over-represented in clusters characterized by non-employment or part-time employment. Personal income inequality measured by the Gini-coefficient remained higher for women than for men in both countries. Interestingly, women's individual-level inequality was shown to decrease over time in both countries (although it remained higher than for men). The author attributes this finding to the progressive redistribution of the pension system, which is able to partially level off inequalities related to prior earnings.

4.3 Analytical approach

The analysis in part II of the thesis is organized as follows. First, all trajectories have been reconstructed based on the social security records. The information corresponding to each month from each social security record has been coded as a state and the trajectories have been reconstructed as sequences of states. The description of all states included in the analysis is provided in section 4.4. The coding of states aims at incorporating all information from the social security records in order to provide a detailed and multi-faceted representation of how trajectories are unfolding over time.

After the trajectories have been reconstructed, they can be analyzed at a descriptive level. Such an analysis is performed in chapter 5. "Stacking" all trajectories together makes it possible to trace how the collective patterns unfold over time for men and women. The role of parental leave within these trajectories has been given special attention. The take-up rates are computed for both men and women and the trajectories of parents who use leave and who do not use leave are graphically compared. The main goal of this analysis is to formulate further research questions. The position of parental leave within the male and female trajectories has been of particular importance for choosing the analytical strategy for analyzing the use of parental leave in part III of this thesis.

To move the analysis to the analytical level, it is necessary to compute a distance matrix. As sequences are complex objects, comparisons between them cannot be performed directly. The typical approach is to compute a distance matrix, which represents the distances (differences) between each possible pair of sequences in the data. Each distance should be computed in such way that it would be equal to 0 if two sequences are the same and higher values should correspond to greater levels of dissimilarity.

Computing the distance matrix is one of the steps with major importance for the analysis. Depending on which measure is chosen to compare sequences, the results can be different. The same two sequences may be classified as very different and very similar to each other depending on which method for comparison is applied. The choice of distance measure in this thesis is discussed in section 4.6.3. In addition, section 4.6.2 provides a brief review of the debate surrounding the use of optimal matching in sequence analysis and draws attention to the advantages and disadvantages of applying this method.

Once the distance matrix is computed, the analysis can proceed in different directions. In this thesis, the analysis is extended first in the direction of extracting representative sequences in chapter 5 with a descriptive purpose and then in the direction of clustering in chapter 6 with the purpose of identifying parents with similar trajectories.

The cluster analysis in chapter 6 is initially performed under the assumption that the trajectories of mothers and fathers are entirely different from each other. Accordingly, the clustering is performed separately for both samples. A qualitative comparison of the obtained clusters, however, reveals that there are actually more similarities than differences in the trajectory types. The distribution of number of parents in each type is different (women, for example, were overrepresented in clusters dominated by part-time work). The types of clusters however, are not as different as expected. Therefore the analysis is performed again on the pooled sample of both types of trajectories. This has made it possible to compare directly the numbers of men and women in the same cluster.

The final step in the analysis is to try to explain who is in each cluster by using the information available from the social security records. This analysis is structured within an economic framework. The female trajectories were chosen as the focus for the analysis because the results suggested a dependency between the trajectories and the event of birth in 2003. The same analysis was performed on the sample of male trajectories with a comparative purpose.

4.4 Coding of states

This section provides an overview of the states used for the reconstruction of trajectories of the working parents. A summary of all states used in the analysis is presented in Table 4.1. The colour codes and abbreviations in Table 4.1 are the same throughout part II of the thesis. Hence Table 4.1 can be consulted when reading any of the sequence plots. In addition, Appendix 4.A provides further information on the legal regulations in Luxembourg regarding the use of certain social security provisions and methodological notes.

Colour	Code	Definition	Notes
	D	Dispense	
	B	Birth	Denotes the month when a child was born; Births after 2007 are not recorded
	ML	Maternity/adoption leave	For civil servants includes also assumed ML
	PP	Parental leave part time	
	PL	Parental leave full time	
	E<20	Employed less than 20 hours/week	
	E<39	Employed between 20 and 39 hours per week	
	E40	Standard full time contract	
	E40+	Employed more than 40 hours	
	SE	Self-employed	Includes also part-time self-employed
	S/A	Sickness or accident leave	
	F	Family leave	
	U	Unemployment	Includes also part-time unemployment
	X	No record	The individual is not working in Luxembourg. Possibly the individual is out of the country or employed at EU institutions.
	COA	Missing record with co-insurance	The individual is not working in Luxembourg. The individual is insured as the dependent of someone else and therefore can be assumed to be economically inactive.

Table 4.1: State definitions.

4.4.1 Birth of a child in the fiscal household

The starting point of the analysis is the event of birth of a child in 2003. The month when the birth occurs is important to be included in the analysis because it represents the pivotal point of the trajectory in 2003. It must be noted that birth would be more correctly considered an event and not a state[4]. However methods designed for the analysis of state sequences rather than for event sequences were considered more appropriate for the analysis in this thesis. This is due to the fact that the duration of experienced states, especially employment or labour-market inactivity, is of central importance. For this reason birth has been incorporated in the analysis as a state.

Incorporating the information on when a birth has occurred was especially important for the male trajectories. Otherwise there would be no additional information that can point to a birth of a child in a man's family. The birth of a child by employed women can be inferred on the basis of using the compulsory maternity leave. For employed men, however, there is no equivalent leave[5]. Without including the information on when a child was born in the household, it would not be possible to distinguish between men who do not have children and men who have children but do not use the parental or family leave they are entitled to.

4.4.2 Use of leave provisions

The use of leave policies is of central interest for the analysis. It is of particular interest to investigate whether and when parents use their right to parental leave. For the women's career trajectories, it is also of interest to see whether women return to work after using leave, as the issue of women being inactive on the labour market due to family responsibilities is gaining increased importance. For the male trajectories it is more interesting to find out if and when fathers take parental leave at all, as in general there are still only few fathers who use parental leave (Plantenga and Remery, 2005).

In addition to parental leave, the IGSS records provide information on the use of maternity leave and dispense leave. These are pregnancy-related

[4]The difference between event and state sequences is discussed in Ritschard, Gabadinho, Studer, and Nicolas (2009) and Ritschard, Reto, and Studer (2013).

[5]In Luxembourg male employees are entitled to a two-day long paternity leave upon birth of a child, however this leave is paid by their employer and therefore not recorded in the social security records.

leaves, which are only available to women in Luxembourg. Postnatal maternity leave is compulsory for women in Luxembourg and the compensation is very high (100 per cent of earnings), so it is assumed that all eligible women use maternity leave. Maternity leave has been coded as a separate category because it represents a career interruption in the working trajectory. For the maternity leave in 2003, the last month of the leave has also been used as an alignment point in the female trajectories. This point is elaborated further in section 4.5.2.

Dispense is a special leave provision, which pregnant women in Luxembourg can use even before they reach the latest stage of pregnancy (when they are required to take maternity leave) in cases where their employment poses a danger for their health or for the health of the unborn child. The leave is compensated from the National Health Fund of Luxembourg. Examples of situations where this is relevant are jobs requiring heavy physical activity, such as lifting heavy objects or working in hazardous atmospheric conditions (Le Portail Santé, 2014).

Dispense has been included in the analysis for several reasons. From the point of view of social security, it is important to know when and how much of it is used, as it must be compensated by the health fund. In addition, it carries important information about the job: women using dispense leave are likely to work in heavy conditions. This may affect the choice they make to continue their employment after child delivery. Large proportions of women taking dispense leave could have implications for gender inequality on the labour market, as it shows that women's capacity to perform work is already reduced several months before giving birth. It might affect employers' preferences to employ women in child-bearing age as well as the human capital of the concerned women.

Family leave is available for working parents in Luxembourg for cases when they need to care for sick children at home or other *force majeure* circumstances. Except for cases of severe health conditions of the child, the leave is available for a maximum of two days per year per child for each parent. Family leave has been incorporated in the analysis because it can provide an insight into the extent to which working parents can rely on help with child care. Ekberg et al. (2013) have suggested that the use of family leave by fathers can be used as a proxy of fathers' involvement with their children in the long term.

4.4.3 Career discontinuities

Absences from the labour market

Prolonged absences from the labour market related to child-raising are of major concern for at least several reasons. To begin with, such interruptions are disproportionably assumed by women. For example, the Eurostat report from 2007 reports that in 2006 the inactivity rate for women in the EU aged 25 to 54 was 23.6 per cent compared to 8.1 per cent for men. Almost half of the inactive women stated family responsibilities as the main reason why they are inactive. In addition, remaining outside the labour market may lead to erosion of human capital and subsequent reduction of wages, especially if the woman does not return to work with the same employer (Baum, 2002). Depending on the design of the pension system, prolonged absences from the labour market may also translate to lower pensions and further income inequalities between men and women in later life.

Periods of labour market inactivity were assumed from the IGSS records based on the absence of an administrative record. IGSS records are maintained only for persons who work in Luxembourg. Therefore, for the time when there is a missing record, it is known that the individual is not working in Luxembourg. Still, it should not be directly assumed that the individual is not working at all, because it is possible that he or she is employed in another country.

As a partial solution to this problem, the information on co-insurance has been used. The rule in Luxembourg is that every working person has their own health insurance. Persons can also insure their spouse if the spouse is not working or their children (see Portail Sante.lu, 2014). Therefore, the existence of both a missing record and a record of co-insurance for the same period suggests that the individual is not working and the possibility that the individual is working in another country can be excluded.

Labour market inactivity is assumed based on missing records with co-insurance. However, the state label has not been changed to 'Labour Market Inactivity', because inactivity is only an assumption. For example, the individual might be looking for a job. In this case it is more appropriate that this individual is considered unemployed. The official definition of unemployment provided by the International Labour Organization stipulates that the two main criteria to consider someone unemployed are that the

individual is currently without work and actively looking for work (ILO, 2014). As it is not possible to observe whether people are looking for work or not from the available data, it is not entirely accurate to label them as inactive on the labour market. It is also possible that these people are in education. That is why the name of the state has been kept as 'Missing with Co-Insurance' in the thesis.

A large number of missing records could not be matched to co-insurance records. It is not possible to know what the individuals are doing during this time: they could be outside the labour market, looking for a job or working in another country or for one of the European institutions in Luxembourg. Despite this ambiguity, missing records do carry some information about career discontinuity because they show that the individuals interrupt their employment in Luxembourg before they had a child in 2003.

Missing records have not been excluded from the analysis because that would mean excluding a substantial number of individuals and misrepresenting the number of persons who use parental leave or who return to employment afterwards. If the persons where a missing record is observed at least once in the observation period are excluded, the sample would become very selected: it will consist only of individuals who have been continuously employed in Luxembourg for eight years. Keeping the missing records is similar to creating a categorical variable marking the missing cases in a regression analysis instead of restricting the analysis to complete records only.

Unemployment

Unemployment is another form of career discontinuity, which could be inferred on the basis of the IGSS records. It must be noted that the records indicate unemployment only as far as the individual is receiving unemployment benefits. Persons who are not receiving such benefits but are without a job and looking for one, could not be identified on the basis of the records.

Part-time work

Career discontinuities can also take the form of reduced working hours. Observing monthly working hours, which have been recorded directly in the

IGSS records, makes it possible to trace short-term or long-term changes in the working hours and to speculate about the extent to which they are related to the arrival of a new child in the family. The report of the Corral and Isusi (2007) indicates that about one third of the women working in the European Union in 2002 were working part time, compared to 6.6 per cent of men. For the same year, 31.2 per cent of the women working part time indicate that the main reason for their choice of working hours is the need to care for children or elderly persons. In comparison, only 4.2 per cent of the men indicate the same reason.

The threshold between full-time and overtime working hours was set at 40 hours per week. This is the standard working week in Luxembourg (Portail Entreprises, 2014a). In Luxembourg there is not a specific definition of different kinds of part-time work. However, for this study, there has been made a distinction between part-time work below and above 20 hours per week, because this makes it possible to observe variation in part-time work and not only its presence. Working hours have been coded into the following four categories:

- Standard employment contract: 40 hours per week.
- Overtime: More than 40 hours per week.
- Part time I: Between 40 and 20 hours per week.
- Part time II: Less than 20 hours per week.

4.4.4 Self-employment

Self-employment is relevant for the analysis, because it may provide a greater level of flexibility than regular employment and it would be interesting to observe, both for men and women, the differences between self-employed persons and employees in terms of their work-family reconciliation strategies.

It is also interesting to analyse self-employment from a gender perspective. Even though many women are able to build and manage growing and economically profitable enterprises, there is also a greater number of women than men who are attracted to self-employment due to the flexibility of working hours and the possibility to have a better work-family balance

(Boden Jr., 1999). In recent years, the neologism "mompreneurship" is being used to refer to such female entrepreneurs who are not necessarily growth-oriented in their business strategy (Korsgaard, 2007). It would be interesting to see whether there is a trend for more women to become self-employed after having a child.

4.4.5 Sickness or accident leave

Sick leave has been incorporated in the analysis, because a person's health is related to their capacity to perform work. When health problems are brief and occasional, there will be only a few states marked by sick leave in an individual's trajectory. However, there might be people with chronic health conditions whose trajectories will be showing more frequent sick leave use. While health conditions are not the choice of individuals, they can certainly be assumed to play a role in decisions related to work-family reconciliation. If one has significant impairments performing his or her job, remaining in employment after having a child can be more difficult than for a healthy person. The relationship can also run in the opposite direction. Unstable working conditions, for example, have been shown to have adverse effect on individuals' health (Virtanen, Vahtera, Kivimäki, Liukkonen, Virtanen, and Ferrie, 2005).

Including sick leave in the analysis can also suggest something about incidence of postpartum depression (although simply observing sick leave based on the available data will not allow for any definite conclusions). Postpartum depression is a serious condition, which can negatively affect not only mothers but also their children. Postpartum depression has been estimated to affect about 13% of mothers in the US (Breese McCoy, 2011). Depressive symptoms occurring for as long as one year after birth can be labelled as postpartum depression (O'Hara 2009 cited in Breese McCoy, 2011). McGovern, Dowd, Gjerdingen, Moscovice, Kochevar, and Lohman (1997) estimate that the well-being of mothers may be diminished for as long as seven months after birth. This includes not only psychological well-being, but also physical symptoms such as infections.

4.5 Reconstruction of trajectories

The trajectories of individuals could be reconstructed using information from the administrative records, which is provided on a monthly basis. This means that for every month throughout the observation period, for all individuals it is possible to find out what social security payments they have received. However, the records are not created for research purposes and the information had to be re-structured before it was suitable for analysis.

One of the major problems that needed to be solved was how to deal with situations when an individual has received more than one social-security payment. Especially for the short-term, job-protected leaves, there were considerable overlaps: for example it is normal that a worker can take one day of sick leave and two days of family leave in the same month, all the while maintaining a state of employment. Another sort of ambiguity were states that started mid-month. For example the month where maternity leave ends and parental leave begins would have both records. However, which one should we choose to record in order to maintain consistency for the whole sample?

Due to the above-mentioned problems with states occurring in the same month or beginning mid-month, the starting point of the data preparation process was a file containing multiple records for each individual for each month. However, for sequence analysis, for each individual, there must be one and only one state for each period. To deal with overlaps and states starting mid-month, one state was selected from all states occurring in the same month in the order described below (with the top states taking priority).

The order of priority was decided based on what is of importance for the analysis. For example, if a child was born at the same time as the individual taking a day of sick leave, it is more important for the present study to know that a child is born because this is the starting point for the analysis. The use of leave policies is also essential for the analysis and that is why they were brought to the forefront. However, it is important to be aware that this means that the top states have a higher chance to be represented than the states on the bottom.

1. Birth of child
2. Maternity or adoption leave

3. Parental leave
4. Family leave
5. Dispense
6. Sick leave or accident leave
7. Unemployment
8. Self-employment
9. Employment (later broken down into categories based on monthly working hours)

It must also be noted that the procedure used for constructing the trajectories implies that the duration of some states is over-represented. For example, family leave, by definition, can last two days per year. However, as its use is important for the analysis, I mark the whole month where it occurs.

4.5.1 Example of a reconstructed trajectory

Figure 4.1 displays an example of a single re-constructed trajectory of a female working parent from the sample. Each segment of the trajectory corresponds to one month and each colour corresponds to a different state, which is considered to describe the situation of the individual for that month. The colour codes for the states are provided in the legend of the figure. More details on the coding of states have been presented in Section 4.4.

Figure 4.1 shows that the start of the observation period is 36 months prior to the last month the woman was on maternity leave. Prior to the maternity period (marked in red), this female employee was working between twenty and thirty-nine hours per week. Her trajectory appears quite steady in this period, without any interruptions, such as sick leave, family leave or unemployment periods. After her maternity leave, the employee takes full-time parental leave[6]. After her parental leave, the employee returned to the same hours of employment in the initial period, but later she switched

[6]In Luxembourg full-time parental leave must be taken at a block of six months. In this case the parental leave appears to last only five months, possibly because it overlapped with maternity leave, and the month it began was coded as maternity leave.

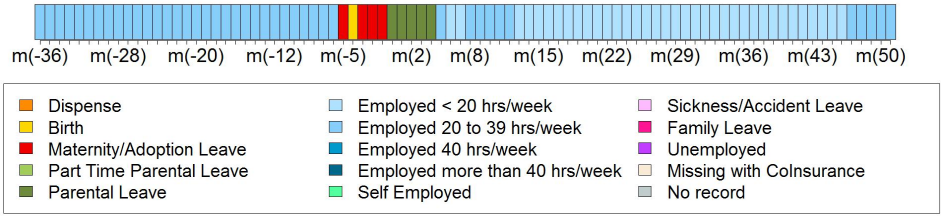


Figure 4.1: An example of a reconstructed trajectory of a woman who had a child in 2003.
Notes: Each colour segment corresponds to the state in a separate month. The horizontal axis corresponds to a relative time scale where time is measured as months before and after the end of maternity leave in 2003, which is defined as (m0).

to employment of less than twenty hours per week. At the end of the observation period, about fifty months after the end of her maternity leave, the employee resumes similar hours of employment as prior to her birth in 2003. However, as the data are cut off at this point, it is not possible to tell whether this change is permanent or not.

4.5.2 Alignment of trajectories

The year 2003 was chosen as pivotal time-frame for the analysis, as data are available until the end of 2008. Given that parental leave can be taken up to the fifth birthday of the child, observing the behaviour of workers who had a child in 2003 allows to observe the full period for which taking parental leave is possible. As the study is focused on the work interruptions due to the arrival of a new child in the family, all trajectories were aligned according to the first time-point when a decision about taking parental leave could be observed. For women, this point is the first month after the end of the maternity leave. For men, the first possible point of taking parental leave is the end of the maternity leave of their female partner. This time point is not possible to observe precisely because not all partners are included in the data set. Therefore the male trajectories were aligned at the event of birth[7].

[7]The trajectories of women were not aligned at birth, because the maternity leave has a different duration: two or three months depending on whether they breastfeed or not. Aligning women's trajectories at the month of birth resulted in messy graphs and made it difficult to see what women do immediately after maternity leave.

In all graphs in part II of the thesis the time periods of all trajectories are marked as $m(0)$ at the point of alignment. For all trajectories, 36 months prior to $m(0)$ have been included in the analysis. After $m(0)$ all months observed for everyone in the sample (51 months for women and 59 months for men) have been included. The monthly periods before the birth are marked with a negative sign. For example, $m(-6)$ stands for six months prior to the end of maternity leave in 2003 for the female trajectories and six months prior to the birth in 2003 in the male trajectories.

4.6 Distance matrix

4.6.1 An overview of Optimal Matching

One of the most common methods of computing distances between sequences is Optimal Matching (OM). Prior to its introduction in the social sciences, the method has been used in the biological sciences for the analysis of the sequencing of amino acids in DNA molecules (Aisenbrey and Fasang, 2010). Studer and Ritschard (2014) point to other fields where the method has been commonly applied, such as computer science or bioinformatics. Elzinga (2003) points out that OM has been so commonly applied in the analysis of sequences in the social sciences, that the term has often been used interchangeably with sequence analysis.

In short, comparing two sequences by OM means representing both of them as strings of states and then using the number and type of operations that would be required to convert one sequence into another in the comparisons. In OM there are two operations that are allowed: substitutions (putting one element instead of another) and indels (inserting or deleting elements). For example, if we have the sequences (1) ML-ML-W-W-W[8] and (2) ML-ML-ML-W-W, we can transform sequence (1) into sequence (2) if we directly replace the third element in sequence (1), which is W with ML or if we insert the element ML in the third position and then delete one of the repeated W elements. In the first case we would be performing a substitution operation and in the latter case we would be performing two indel operations.

In OM the choice between substitutions or indels is based on "costs" of the elementary operations, which are assigned by the researcher. The idea is

[8] In this example ML stands for maternity leave and W stands for work.

that pairs of sequences can be compared based on how costly it is to convert one into another. If the cost is low, then sequences can be considered similar to each other, while higher costs reflect greater levels of dissimilarity. Substitution and indel costs are set by the researcher and their values have an influence on the outcome. Their ratio is also important: if substitution costs are higher than twice the indel costs then the algorithm will search for a way to make the transformation, so that fewer substitutions are used and vice versa. When indels are favoured, there is a time warp being introduced in the analysis.

Substitution costs can be constant (the cost is the same regardless of which two elements are substituted with one another) or they can be set to vary by the researcher. Varying substitution costs are provided in a cost matrix and they must reflect the extent to which two states can be considered similar or different from each other. For example, if we are studying labour market participation, it might be appropriate to set lower substitution costs for replacing full-time work (FW) with part-time work (PW) than for replacing full time work with unemployment (U). This would reflect the assumption that unemployment is further away from the labour market than part-time work. The substitution costs must be symmetric. This means that the cost is the same when we are replacing FW with PW or PW with FW. The cost matrix must also respect the triangle inequality. Using the same example, if we have a higher costs to substitute FW with PW than with U, then the cost of substitution for PW with U must be lower than substitution of FW with U.

4.6.2 A brief summary of the academic debate concerning OM

In an article from 2000, which sparked much scientific debate in sociology and related sciences, Abbott and Tsay point out the usefulness of sequence analysis using OM as a method of reducing data complexity and searching for typical patterns occurring in the data. The authors also emphasize that entire sequences, rather than their separate elements, can be analyzed. Another advantage is that there is no need to make any assumptions about the independence of observations from each other, or, in the authors' own words about "what produces sequence regularity" (p.27).

Some scholars responded rather critically to the claims of Abbott and Tsay (2000) about the usefulness and validity of the OM-based sequence anal-

ysis approach. Among other critical remarks, Wu (2000) argues that the use of substitutions and indels for defining dissimilarity between sequences does not adequately describe differences between social phenomena. He gives a simple example, where two sequences consisting of the same states: employed and unemployed (which could be represented as E-U and U-E), would be considered similar by an OM algorithm, but would have very different meanings in real life (losing a job in the first case and finding a job in the second case)[9]. Another critical observation by Wu (2000) is that OM algorithms are not well suited to capture differences between sequences based on the ordering of states as different permutations of two equally long sequences would produce the same distances.

Another critical response to Abbott and Tsay (2000) came from Levine (2000), who argues that Abbott and Tsay (2000) described but did not provide a critical scientific evaluation of the work performed with OM. She maintains that for such an evaluation it would be necessary to consider "validity, falsifiability, parsimony, consistency, precision, and so on - front and center" (p.35). She argues that more OM examples are needed, which do not simply apply the technique but also demonstrate how the method performs under variations in formulations or assumptions.

Elzinga (2003) summarizes the critiques of OM put forward previously in three main points. The first point refers to the coding of sequences, which, as observed in Levine (2000), may sometimes require distinguishing between categories that do not have clear boundaries. The second point emphasizes the idea that using an OM algorithm with a pre-specified cost function is already a geometrical representation of a theoretical assumption of the relative hierarchy of the different elements in a sequence. Elzinga (2003) questions the extent to which sociological theories can in fact be represented by such geometrical models. The third point refers to the shortcomings of the method in handling sequencing, as noted by Wu (2000) and (Dijkstra and Taris 1995 cited in Elzinga, 2003).

Elzinga (2003) re-focuses the debate about the merits and demerits of sequence analysis by making the important observation that sequence analysis is not synonymous with OM, although the two terms are often used interchangeably. He points out that this terminology mix up has led to

[9]Hollister (2009) observes that this statement has later on been somewhat incorrectly interpreted in the literature to mean that in general OM is not able to distinguish between sequences where the elements are the same but the order is reversed. She clarifies that two such sequences, for example 000111 and 111000 (Stark and Vedres (2006) cited in Hollister (2009)) would not be classified as similar by an OM algorithm.

a situation where criticisms applying mainly to OM have been attributed to sequence analysis as a method in general, notwithstanding the fact the OM is merely one of the steps in the method. He suggests that rather than dismissing sequence analysis as a whole, scholarly attention must shift towards finding new algorithms for computing dissimilarity between sequences, which do not have the shortcomings of OM.

Elzinga (2003) proposes an alternative non-alignment method for computing sequence dissimilarities, which are based on four axioms put forward by Dijkstra and Taris (1995 cited in Elzinga (2003)). In short, the method takes into account the number of subsequences that appear in a pair of sequences and their frequency. Elzinga (2003) argues that his approach has the advantage over the traditional OM approach as there is no need to make any assumptions about the ordering of sequence elements (as in setting the substitution costs with the OM approach) and all the information on the order of occurrence of events within the analyzed sequences is used.

As pointed out in Gabadinho, Ritschard, Müller, and Studer (2011), in later publications the discussion of using OM shifted from substitution costs to indel costs and the ratio between both. Hollister (2009) points out what she called the "free ride problem" (p.246) - given that indel costs are always set to be the same, the OM algorithm does not distinguish between the different elements to be inserted or deleted. She proposes an alternative method based on localized indel costs. In her approach the indel cost consists of two elements: one part is a fixed cost for the operation itself and the second part varies according to how similar the states neighbouring the newly inserted state are. Thus there is a lower cost for inserting a relatively similar state between two elements than a relatively dissimilar one.

Lesnard (2010) has proposed that indels "warp time" (p.394), which is to say that the use of indels puts an emphasis on states that are coded identically regardless of the episodes between them. He proposes that for research questions where temporality is of high importance indels should not be used at all. He proposes a distance measure called Dynamic Hamming Matching (DHM), which is based on using only substitution operations and the costs are are time-varying and derived based on transition rates[10].

Tracing the available distance measures in the literature leads to the natural question of how to choose which measure to use. The answer to this question

[10]In sequence analysis, transition rates are computed as the the probability of being in a state, given being in another state before. The formula is available in Gabadinho et al. (2011).

is further complicated by the absence of clear benchmarks or criteria for a good choice (Elzinga, 2003, 2007; Hollister, 2009), which could be used to guide the decision. One clear recommendation is that the choice should depend on the specific research question at hand and it should be guided by theory (p.445, Aisenbrey and Fasang, 2010). A similar statement is found in Elzinga (2007) who writes:

> ... sequence analysis does not become arbitrary or unscientific because we have many different metrics at our disposal. On the contrary, by changing metric we change perspective on the same time series and unveil a different structure. (p.36)

In summary, OM can be said to remain one of the most traditional approaches for comparing sequences. Despite this fact, it has a number of limitations. These limitations also apply to the distance measure chosen for this analysis, because it is a special case of OM. It is also important to keep in mind that there is a variety of distance measures, which could be applied for the analysis of sequences. All of these measures have advantages and disadvantages and are suited for analyses with different purposes. Interested readers are referred to the work of Studer and Ritschard (2014) who provide a comprehensive review of a large number of distance measures and guidelines on choosing a distance measure depending on what aspects of sequences are most important in the comparison process.

4.6.3 Choice of distance measure for this study

For the analysis presented in part II of the thesis, the distance matrix has been computed using the Longest Common Subsequence (LCS). Elzinga (2007) (in Gabadinho et al., 2011, p.28) shows that using LCS is equivalent to using OM with constant indel costs (1) and substitution costs (2). LCS was chosen because it is more sensitive to duration than to sequencing. From a social security point of view it is most important to identify long-term trends, such as long-term transition to part-time hours of work or long spells outside the labour market. Whether individuals entered these states exactly in the same months or a few months apart from each other is of secondary importance.

LCS is more sensitive to duration than to sequencing, as it ensures that indels are preferred over substitutions. This is because the substitution

cost (2) is higher than the indel cost (1). As explained in Lesnard (2010) and in Gabadinho et al. (2011), when substitutions are used more often than indels, similarity is based more on experiencing the same states or events at the same time points. On the other hand, when indels are used more often, similarity is based on experiencing the same states or events even if this occurs at different time points in the trajectory. A simulation-based comparison of distance measures performed by Studer and Ritschard (2014) shows that when OM is used, lowering the indel costs relative to the substitution costs increases the sensitivity to duration and at the same time reduces the sensitivity to sequencing.

An additional advantage of LCS is that it is relatively easy to understand conceptually even without using the notion of the substitution cost matrix. In short, the LCS method classifies as more similar these sequences, which have a larger number of elements appearing in the same order in both of them. One must note that a common subsequence can "skip" some elements of the main sequence. For example in the sequence $W-W-ML-ML-U$[11], both $W-ML$ and $W-U$ would be considered subsequences. In the latter case, the important factor is that the two elements appear in the same order.

It is important to note that using the LCS method is based on a constant substitution and indel cost. In other words, the cost of substitutions between any two states is the same. Similarly, inserting a state has the same cost regardless of what states it is inserted next to. This implies an assumption that all states are equally different from each other.

While the assumption of a constant difference between all states in the analysis can be considered a limitation of LCS, it must be noted that the alternative (using a substitution cost matrix with varying costs) would also not be problem-free. To begin with, the relatively large number of states (15) in the analysis makes it hard to design a matrix, which at the same time respects the triangle inequality *and* reflects a logical way of ordering the states. The situation is especially complicated when one takes into account the legal job-protection rules many of the states come with. This means that most assumptions made about which state is further or closer away from the labour market would be subject to debate[12].

[11] In this example ML stands for maternity leave, W stands for work and U stands for unemployment.

[12] Preliminary versions of the analysis on a smaller sub-sample and with simplified sequence alphabets, resulted in similar results to the ones presented here also when using a substitution-cost matrix with varying costs.

4.A Further notes on states construction

4.A.1 Birth of the child

Births are recorded only until the end of 2007.

4.A.2 Use of leave policies

Maternity leave

All persons who belong to a social security scheme for six months or more are eligible to use maternity leave (congé de maternité). The duration of the leave is 16 weeks, with eight weeks to be taken before the birth and eight weeks to be used after the birth. In case of multiple births, premature birth or breastfeeding the length of the postnatal leave can be extended to twelve weeks. The leave is compensated at 100 per cent of earnings up to a ceiling of five times the minimum salary (see Zhelyazkova et al., 2013).

In the IGSS records maternity leave is not explicitly coded for civil servants and self-employed persons, because it is compensated by a different fund. As maternity leave is compulsory in Luxembourg, it can be assumed that everyone uses maternity leave. Therefore maternity leave was assumed for women who were employed as civil servants and who had a child born in their fiscal household in 2003. The duration of the leave was assumed at the theoretical maximum of 12 weeks.

In case of adoption, adoption leave (congé daccueil) is available, which is of equivalent pay and duration as the post natal maternity weeks. For the analysis adoption leave has been labelled as maternity leave. A very small number of men in the data set had taken adoption leave. In these case adoption leave was grouped with sick leave.

Parental leave

Parental leave (congé parental) can be used for six months full time or for twelve months part time. Parental leave is an individual right for both

mothers and fathers and cannot be transferred from one parent to another. The first leave in a two-parent family must be used immediately after the maternity leave of the mother, while the second leave can be used until the child turns five. Single parents can use their leave until the child turns five. Parental leave is paid on a flat-rate basis, which means the payment is the same for all parents regardless of their prior income. As of 2013 the parental leave full time benefit amounted to 1778€ per month (see Zhelyazkova et al., 2013).

Family leave

Family leave (congé pour raisons familiales) can be used when a child is sick and must be cared for at home. Every parent is granted two days per year per child. The leave is paid and compensated by the National Health Fund. In extraordinary circumstances, such as very serious illness of the child, the leave can be extended (see Zhelyazkova et al., 2013).

Sick leave and accident leave

In Luxembourg employees are required to inform their employer from the first day of incapacity to work due to illness. If the duration of the illness is more than two days, a medical certificate is required. The employee is protected from dismissal for 26 weeks from the first day of the illness (see Portail Entreprises, 2013).

Sick leave is recorded for all groups of workers except for civil servants who continue to be paid from the same fund as their salary during periods of illness. For 2003 civil servants were 10.2 per cent of the women and 9.9 per cent of the men in the sample.

The IGSS records also provide information about accident leave. In cases when the employee is unable to work due to a work-related accident or an occupational disease, the cash benefits are the same as for the sick leave. Additional income-replacement benefits are available if the recovery takes longer than the maximum duration of the sickness benefits (European Commission, 2013). For the analysis accident leaves have been grouped with sick leaves because they constitute a very small percentage (less than five per cent) of all sickness or accident related leaves.

Unemployment

Persons in Luxembourg who have lost their employment in Luxembourg are eligible to receive unemployment benefits if they have worked in Luxembourg for at least 26 weeks in the previous year. They must also be registered as persons looking for work (see European Commission, 2013).

Unemployment benefits amount to 80 per cent of previous earnings for persons without children and 85 per cent for persons with children. The ceiling is equal to two and a half times the minimum wage for the first six months in a twelve-month period and drops to twice the minimum wage afterwards. Unemployment benefits can be received for a maximum duration of twelve months over a 24-month period. Their duration should also not exceed the duration of employment in the year prior to registering as unemployed.

Self-employment

Self-employed persons in Luxembourg are required to affiliate with a social security scheme if their income exceeds one third of the minimum annual social wage (Portail Entreprises, 2014b). The social security scheme includes access to maternity and parental leave policies and thus self-employed persons have been included in the analysis. The difference in the records of self-employed persons is that working hours are not recorded for them. For this reason it was not possible to group self-employed persons with the groups of employees.

Self-employed persons can be both self-employed professional workers (skilled craftsmen, manufacturers, farmers, etc.) or self-employed intellectual workers (liberal professions such as lawyers, doctors, architects, etc.). Members of the board of directors of companies or partners holding more than 25 per cent of shares are also considered self-employed, but they can also register for the employers' mutual insurance scheme (Portail Entreprises, 2014b).

In some cases the IGSS include records of part-time self-employment. This means that the persons actually have two (or more) records: one (or more) as an employee and another as a self-employed persons. For these cases, the self-employment state was chosen. This means that some of the persons classified as self-employed are actually only part-time self-employed.

Working hours

In the IGSS data standard working hours per month are counted as 173 and not as 160. This is because there are some months when there are more than four weeks and the hours are averaged over a full year ($173 = 40 * 52/12$). In the same way, the threshhold for part-time work in this analysis has been defined as 87 hours per week, based on working 20 hours per week ($86.7 = 20 * 52/12$).

It is important to note that actual hours of work are recorded only for blue-collar workers, while for white-collar workers the recorded hours correspond to their contract hours and overtime is not reported[13].

There were also some months where there were 0 hours of employment recorded. It is not clear what these records represented. It is possible that the hours were not recorded or that the periods correspond to unpaid leave.

[13]Since 2008, Luxembourg does not make the distinction between blue-collar and white-collar workers (Association des Banques et Banquiers, Luxembourg (ABBL), 2009).

CHAPTER 5

Descriptive analysis of reconstructed trajectories

5.1 Overview

This chapter presents the explorative part of the analysis of the reconstructed work-family trajectories of parents in Luxembourg. It presents an overview of the collective work-family patterns over the course of eight years: three years before a child was born in the family and five years afterwards. The chapter answers two main questions: what are the broader work-family trajectories of parents and what is the role of parental leave within these trajectories. Based on the findings in this chapter, research questions to be explored in subsequent chapters have been formulated.

The analysis reveals that there is a large difference in the way the event of a child born in the family affects the career trajectories of mothers and fathers. The work-family trajectories of mothers take a dramatic turn with the event of birth. For the majority of mothers, the event is immediately followed by a short-term absence from the labour force in the form of parental leave. In addition, there are visible longer-term changes - some women reduce their working hours and some women leave the employment they held prior to the birth. In contrast, for men, the event of a birth of a child in the household does not represent a disruption in their overall work-family trajectory, as fewer fathers than mothers take parental leave or reduce their work-force participation after they have a child.

The analysis of parental leave in the longer term has highlighted additional

gender differences. Mothers are more likely to use their right to parental leave immediately after maternity leave. Fathers are more likely to use their leave later after the birth of their child. Mothers are also more likely to use the leave full time, while fathers are more likely to use it part time. These findings are consistent with the information presented in the report of the Luxembourg Ministry of Family and Integration 2012.

Working fathers in Luxembourg are very unlikely to experience a transition to labour market inactivity. For working mothers in Luxembourg, however, this is more likely. The descriptive analysis of the trajectories reveals that women can transition to inactivity either directly after maternity leave or after parental leave. Nevertheless the large majority of working mothers in Luxembourg retain their relationship to the labour market after having a child.

The chapter is organized as follows. First the trajectories of working parents are reconstructed based on the information provided in the IGSS records. For every month in the observation period, each parent is coded to be in a given state, which represents his or her relation to the labour market as shown from their IGSS record. Next, the trajectories of all parents are reconstructed and analysed collectively on their transversal dimension. As a third step take-up rates of parental leave have been computed and the use of parental leave has been explored in more detail. As a final step, the strategies of parents have been described by using representative sequences. The analysis using representative sequences in section 5.5 suggests that the trajectories of working mothers are more diverse than the trajectories of working fathers in Luxembourg.

5.2 What should we expect based on what we know about work-family reconciliation in Luxembourg?

Information on work family reconciliation in Luxembourg has been provided in Chapter 2 of the thesis. Based on previously available sources, we can expect to see a relevant proportion of women to leave the labour market after having a child (Valentova, 2006; Plasman and Sissoko, 2005) or to reduce their working hours (Plasman and Sissoko, 2005).

In addition, we can expect that more women than men will be using parental

leave. The first evaluation of parental leave in Luxembourg carried out by KPMG Assurance Advisory Luxembourg in 2002 found that for the period of 1999-2001, only 5.3 per cent of the fathers who were eligible to use parental leave used it, compared to 68 per cent of mothers. Based on information for 2004, however, the proportion of eligible fathers using parental leave was already reported to be over ten per cent (Plantenga and Remery, 2005), which positioned Luxembourg among the four countries in Europe with the highest rate of fathers' take-up of leave. The report of the Luxembourg Ministry of Family and Integration (2012) also shows that the number of male users has been increasing throughout 1999 - 2012.

The moment at which parents choose to use the leave is also likely to vary by gender. We can expect that women will be more likely to use parental leave immediately after their maternity leave. This expectation is based on the higher share of women using the first leave than the second, as indicated in the report of the Luxembourg Ministry of Family and Integration (2012). Based on the same information, we can expect that women will be using parental leave full time more often than part time, while the opposite will be true for men.

Regarding strategies after parental leave, we can form some expectations based on the study on anticipated use of parental leave carried out by Valentova (2011)[1], who finds that about 60 per cent of working women in Luxembourg plan to use parental leave after birth. In addition, Valentova (2011) points out that women who do not take parental leave are a very heterogeneous group. Some of them do not use parental leave because they prefer to stop working after having a child. Others do not use it because they prefer to return directly to work after maternity leave.

Knowing that the majority of men who use parental leave take the second leave in the family, we can expect that there should be higher numbers of men using parental leave around the time when the first parental leave in the family would finish. This would be around the eighth or ninth month after the birth of the child if the mother was using full-time leave and around the 14th or 15th month after the birth if the mother was using part-time parental leave. This expectation would apply for men in couples where the mother is also working and eligible to use parental leave in Luxembourg.

[1]The results of Valentova (2011) are not partially comparable because the sample is based only on Luxembourg nationals and cross-border workers (who represent a significant percentage of the Luxembourg labour force) are not included. In addition, the data are not based on actual behaviour but on anticipated behaviour. Still, we can use the findings to formulate some expectations.

5.3 What are the work-family reconciliation patterns for working mothers and fathers in Luxembourg?

To answer this question, a graphical visualization technique from sequence analysis has been used. It consists in "stacking" all individual trajectories together and grouping the states from each time point, which results in the so-called *cross-sectional state distribution plot* (Gabadinho et al., 2011). This kind of plot can also be called a *chronogram*. The chronograms are displayed in Figure 5.1[2] and provide a visual summary of the proportions of the parents in the sample in each state during each of the months composing the period of observation.

To interpret Figure 5.1, note that the horizontal axes corresponds to time (in months), while the vertical axes correspond to proportions. Each of the adjacent vertical bars of the graph displays the relative proportions of individuals in each state at any of the months of observation. In Figure 5.1a all trajectories are aligned at the last month of maternity leave (for the birth in 2003). That is why the 36th month is a red vertical line - at this time point, all women in the sample are on maternity leave. In a similar way, the trajectories of fathers in Figure 5.1b are aligned at the month of the birth in 2003. In Month 0 (m0) all men have a child born, thus we see a vertical yellow line.

The two time points were chosen because of the focus on parental leave in the analysis. The first possible time period for both mothers and fathers to take parental leave is the period following the maternity leave. Thus in Figure 5.1a it is enough to take a quick look to Month 1 (the month appearing after m(0) on the graph) to gain an immediate idea of the proportion of women taking parental leave full time or part time, returning to work or dropping out of the labour force. For men, as they do not take maternity leave, and information on their female partners' leave is not always available, the alignment is at the month of birth.

An analysis of Figures 5.1a and 5.1b reveals some interesting work-family

[2] An alternative representation of the trajectories is presented in Figure 5.10 in appendix 5.A. With this representation, which is called an *index-plot* (Scherer, 2001), the trajectories are "stacked" together without re-arranging the states at each time point. Index-plots are easier to read when similar trajectories are grouped together. In Figure 5.10 the trajectories have been sorted according to number of states spent in standard full-time employment.

reconciliation patterns in Luxembourg. To begin with, the arrival of a child in the family is clearly a turning point in the work-family trajectories of women in Luxembourg. This is evident from a marked overall reduction of working hours in the period after the birth. In the state definitions used for constructing the sequences, the lighter shades of blue represent fewer hours of employment. In Figure 5.1a, we see a very clear reduction of the two darkest shades in favour of the two lighter shades. In contrast, Figure 5.1b shows that for men, the hours of labour-market participation remain constant before and after the birth.

The working trajectories of women seem to be affected also in the period prior to the birth, as the proportions of women on sick/accident leave (pale pink colour) tend to increase dramatically, especially in the six-month period preceding the start of their maternity leave. The cross-sectional representation of sequences used for Figure 5.1a does not make it clear if this is due to a small number of women taking a long period of sick/accident leave or all women increasing their number of sick leaves for small periods. Next to an increased probability of sick leave, a large proportion of women experience a discontinuity of their career due to being on dispense leave, a leave granted during pregnancy earlier than maternity leave in cases when working during the pregnancy would endanger the health of the mother or of the unborn child.

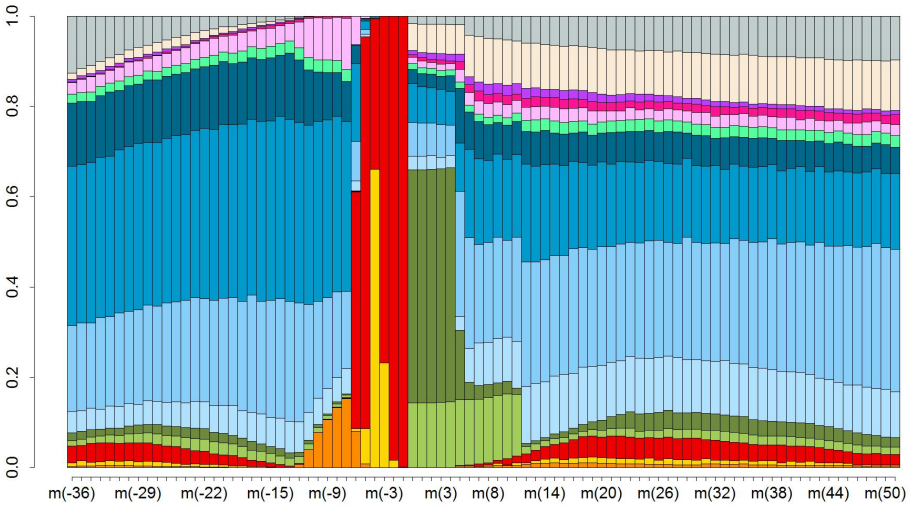
In the last month before maternity leave, it seems that women have more than 20 per cent chance to be on sick leave or on dispense leave, or in other words, to not be working. Both the accident leave and the dispense leave are job-protected, which means they cannot be considered career break periods in the formal sense of the term. However, it is an interesting and important finding to observe such periods. From a social policy point of view, these leaves are compensated from the social security system, therefore it is important to be aware of their total costs. From the point of view of the individual, these experiences may exert an influence in the decisional process regarding use of parental leave or return to work in subsequent periods. Finally, this finding is important from the point of view of employers. It shows that employers already have to accommodate for frequent absences from work of pregnant women even before the start of their maternity leave. In the long run, this may have implications for the willingness of employers to hire women in general or to assign them to important projects and contribute to occupational segregation and the gender pay gap.

Parental leave is used very differently by working mothers and working fathers in Luxembourg. A quick look at the dark green colour (full-time

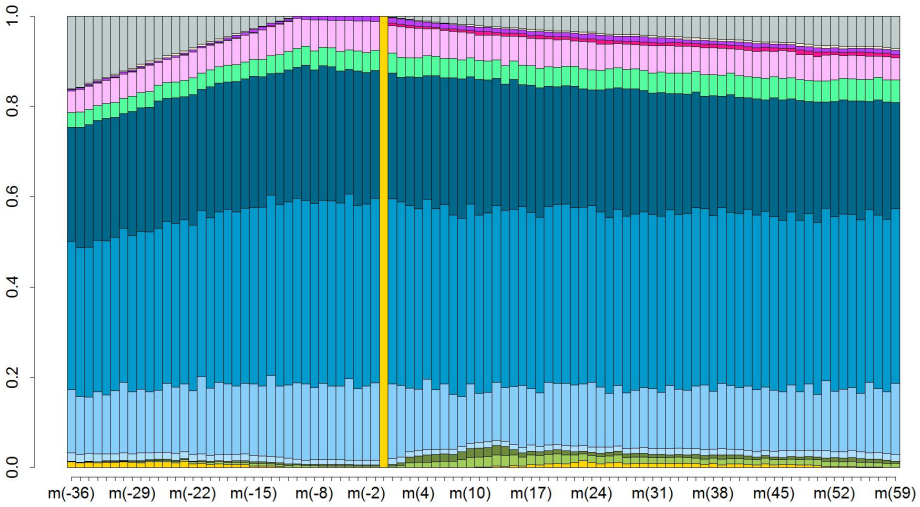
parental leave) and lighter green colour (part-time parental leave) in Figures 5.1a and 5.1b reveal that the majority of women use their right to parental leave immediately after the end of their maternity leave. For fathers, on the other hand, there does not appear to be a clear time after the birth of the child when they are more likely to use leave, except perhaps a slightly higher probability at the end of the first year after the child is born. The take-up patterns over time for men and women are discussed in more details in Section 5.4.

Working fathers experience virtually no periods of absence from the labour market where inactivity can be assumed, while about 10 per cent of mothers are inactive on the labour market throughout the five years of observation after the birth of a child. As explained in chapter 4, periods of inactivity are assumed based on two factors: not having a social security record and being insured as the dependent of someone else.

Some trajectories of both mothers and fathers contain periods when there is no social security record and no co-insurance record. As explained in chapter 4, the only thing known for sure for the months marked as *missing* is that individuals are not working in Luxembourg and the possibility that they work in another country cannot be excluded. However, it is still preferable to keep the sequences containing such states in the analysis for at least two reasons: first, months with missing social security records signify an interruption in the career the parent had prior to the birth and second, excluding these sequences would introduce a bias in the analysis as the sample would be selected conditional on having a continuous social security record in Luxembourg for a period of eight years.



(a) Mothers.



(b) Fathers.

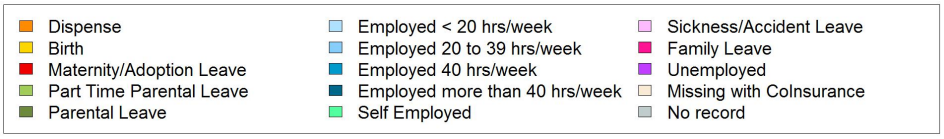


Figure 5.1: Cross-sectional state distributions of the trajectories of working parents in Luxembourg who had a child in 2003.
Notes: The horizontal axis represents time in months. Each vertical bar represents one month and each colour segment within that bar represents the proportion of people in the sample who are in the respective state.

5.4 What is the role of parental leave in the work-family trajectories of working parents in Luxembourg?

5.4.1 Take up of parental leave over time

Tables 5.1 and 5.2 show the proportions of mothers and fathers who have taken at least one parental leave at three time points. The first time point is the first possible point when parental leave could theoretically be taken. For women this is immediately after maternity leave, while for men it is assumed that this is in the third month after the birth. The next two points are twelve months after the first point and the last point of the observation period, which is about five years in total.

Only parents eligible for parental leave are in the sample selected for the analysis, therefore the figures correspond to take-up rates in the first time point. The main finding is that parental leave take-up patterns are very different for men and women. The difference is very pronounced, with only 34 per cent of mothers not using leave, and 98 per cent of fathers. There is a very small increase in the proportion of women using parental leave in the coming periods. By the end of the observation period the total proportion of women leave-takers increases only by 6 per cent. That is, only 6 per cent of the women who do not use parental leave immediately are likely to use it at a later time point.

These findings are consistent with figures published by the Luxembourg Ministry of Family and Equality (2012), which show that women are much more likely than men to be using the "first" parental leave in the family from the two that would be available for each two-parent family for one child. For the fathers, Table 5.2 reveals that by the end of the observation period, about 13 per cent of fathers would take at least one parental leave. A slight majority (8 per cent) use it full time, while the rest take the leave part time.

	1 Month	%	12 Months	%	5 Years	%
Full Time PL	2313	51.6	2332	52.0	2442	54.5
Part Time PL	643	14.3	673	15.0	791	17.7
No PL	1525	34.0	1476	32.9	1248	27.9

Table 5.1: Parental leave take-up by mothers.
Notes: The table shows what percentage of mothers in the sample have taken parental leave up to selected time points from the observation period after the birth of the child in 2003.
PL = parental leave.

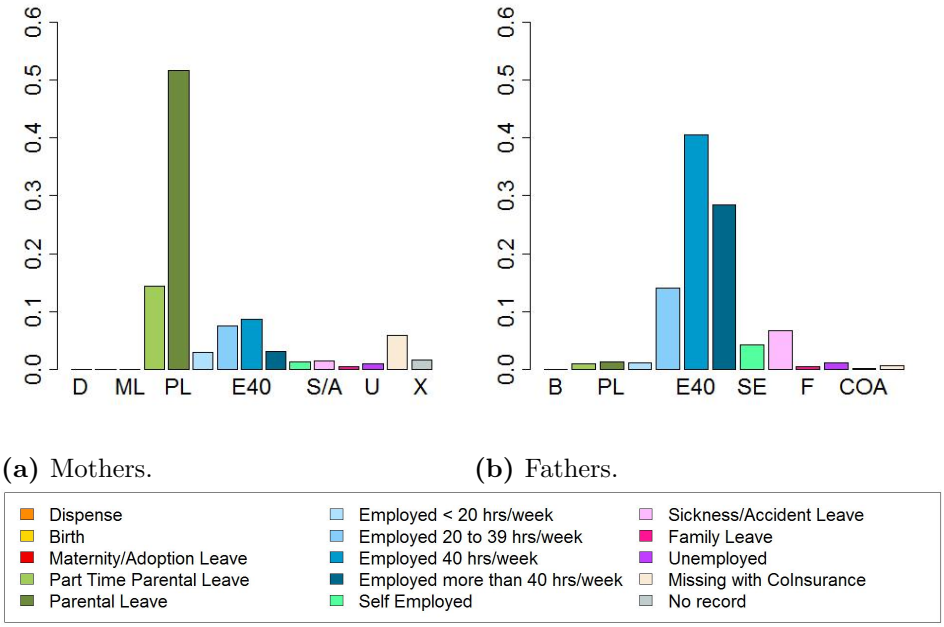
	3 Months	%	15 Months	%	5 Years	%
Full Time PL	76	1.3	241	4.1	442	7.6
Part Time PL	61	1.0	172	3.0	334	5.7
No PL	5690	97.6	5414	92.9	5051	86.7

Table 5.2: Parental leave take-up by fathers.
Notes: The table shows what percentage of fathers in the sample have taken parental leave up to selected time points from the observation period after the birth of the child in 2003.
PL = parental leave.

5.4.2 What do parents who do not take parental leave do?

Figure 5.2 displays the state of working mothers and fathers in Luxembourg at the first time point they can be assumed eligible to take parental leave. As the percentages of take-up rates are already discussed, the purpose of the figure is to illustrate the activities of these parents who do not take parental leave. In the case of men, the majority who do not take parental leave tend to remain in employment. For women, however, not taking parental leave could result either in return to employment (23 per cent) or in transition to labour market inactivity (6 per cent) as defined by the absence of an employment record and a co-insurance in Luxembourg. Although the fraction of women who transition to inactivity is relatively small, the question why they do not take parental leave is quite interesting. It is given further consideration in chapter 7.

It is also interesting that about 12 per cent of women resume immediately full-time or even overtime employment. The absolute number of these women (524) is larger than the absolute number of fathers in parental leave (137) at the same time. Although their partners could be on leave in an-



(a) Mothers. **(b)** Fathers.

Figure 5.2: States of women and men after the birth in 2003.
Notes: For women states are displayed for the month following their maternity leave. For men states are displayed three months after the birth. Both of these are the first months when parental leave could be taken. The vertical axis represents the proportion of individuals in a given state.

other country, it is quite interesting what resources these families use in order to cope with the increased demands of time after the arrival of the newborn. There is no data available for this question to be investigated in this analysis, but it is a possible direction for future research.

5.4.3 Trajectories of parents according to leave-taking

Figures 5.3 and 5.4 show the trajectories of mothers and fathers in Luxembourg split according to their leave-taking behaviour. In Figure 5.3, the trajectories of working mothers are grouped according to whether they took full-time, part-time or no leave in the first month after maternity leave. Split in this way, the figure provides an insight into the long-term consequences of each of these three choices. The split was chosen based on the fact that the majority of women take parental leave at this time point, as shown in Table 5.1.

For fathers, Figure 5.4 is split according to taking at least once full-time, part-time or no leave for the whole period after the birth of the child in 2003. The reason for this split is that, unlike mothers, fathers who take leave tend to do it at very different points in their trajectories. Therefore, disaggregating the trajectories of fathers in the same way as for mothers would not be very informative.

The main finding from Figure 5.3 is that part-time parental leave seems to be often followed by part-time work, although the majority of women are in full-time employment prior to the birth of the child. It is difficult to make conclusions about causality based on the available data. On the one hand, it could be that women in this group decide to switch to part-time employment and use the part-time parental leave as part of their overall strategy of reducing working hours. On the other hand, it could also be that, at the end of the parental leave period, they find that returning to their previous level of employment would not be easy for them and decide to remain in part-time employment, as their employer obviously has already been able to arrange this change.

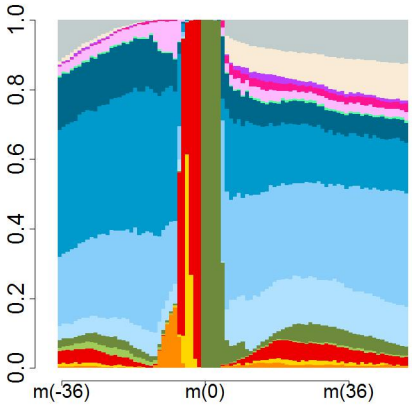
Women who take full-time parental leave seem to also reduce their working hours after the end of the leave, however, to a lower extent than women who take part-time leave. A group of about 10 per cent transition to inactivity after the full-time parental leave. With the available data, it is not possible to find out whether this is due to their change of mind at the end of the leave period, the employers not respecting the right of return to work after the leave or another reason.

In the group where no parental leave is taken, there is a large fraction of mothers (over 20 per cent) who do not return to employment after parental leave. At the same time, a relatively large fraction of women seem to return to work immediately and to maintain their full-time or overtime hours of employment.

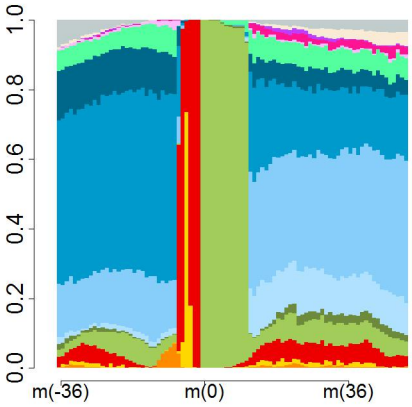
An analysis of the trajectories of fathers in Figure 5.4 shows that transition to inactivity is negligible in the male trajectories. Similarly, an overall tendency to reduce working hours is not observed and the trajectories of fathers seem to remain stable over time in the three cases. In parallel with the female trajectories, some trajectories also appear to represent leaving Luxembourg in the period after 2003. However, the fraction of men in this group appears somewhat smaller than for women. Fathers who take part-time parental leave seem to be least likely to work overtime, and at the same time, they are more likely to be self-employed. Interestingly, fathers taking

full-time parental leave tend to have more periods of sickness or accident leave. They are also the group more prone to leave their employment in Luxembourg, with close to 20 per cent of them not working in Luxembourg at the end of the observation period.

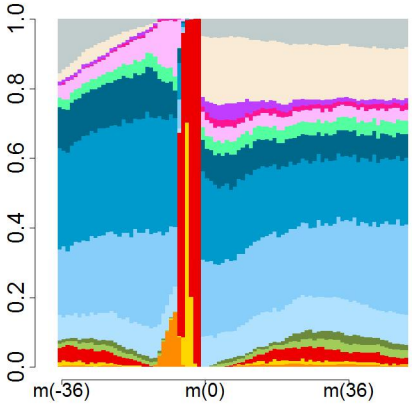
In both figures there seems to be a relationship between the type of leave taken by a parent in a given period and the type of leave taken by the same parent in previous or subsequent periods (to take care of other children in the family). Mothers taking full-time parental leave after their maternity leave in 2003 seem to be more likely to take full-time leave in previous and subsequent periods, while mothers who took part-time leave seem to have been taking mostly part-time leave before and after 2003. In parallel, the fathers who took no parental leave in the period after the birth of their child in 2003, are less likely to have taken parental leave before 2003.



(a) Full time parental leave ($N = 2313$).

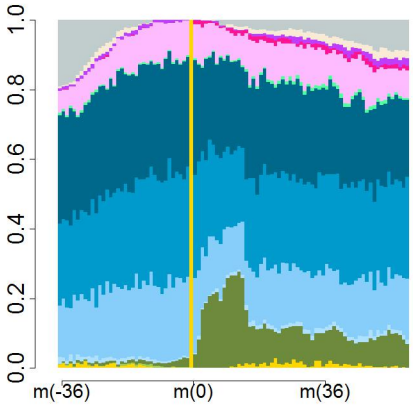


(b) Part time parental leave ($N = 643$).

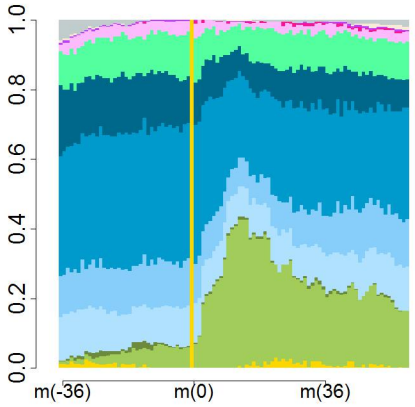


(c) No parental leave ($N = 1525$).

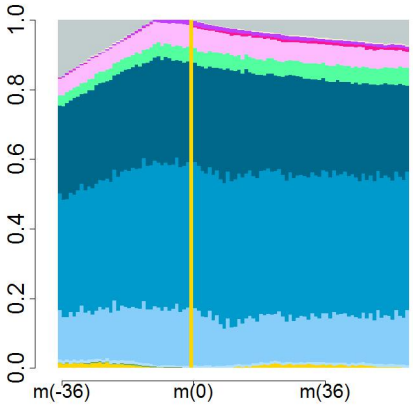
Figure 5.3: Transversal view of the trajectories of working mothers by leave-taking in first month after maternity leave in 2003.
Notes: The horizontal axis represents time in months. The vertical axis represents proportions.



(a) Full time parental leave ($N = 442$).



(b) Part time parental leave ($N = 334$).



(c) No parental leave ($N = 5051$).

Figure 5.4: Transversal view of the trajectories of working fathers by leave-taking after the birth in 2003 until end of 2008.
Notes: The horizontal axis represents time in months. The vertical axis represents proportions.

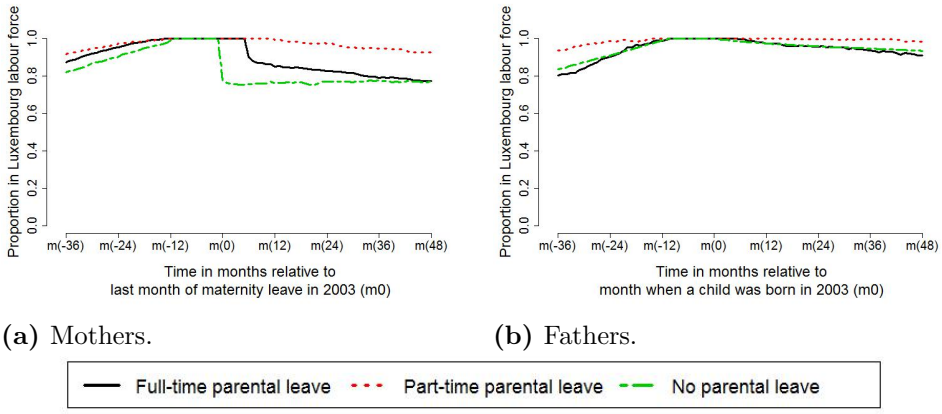
5.4.4 Are the trajectories of leave-takers different from the trajectories of non-leave-takers?

Figures 5.3 and 5.4 suggest that there are some differences in the trajectories of parents according to their use of parental leave. However, other than assessing these differences visually, it is important to find a way to quantitatively compare the trajectories of these different groups of parents. For this purpose, this section presents and discusses the following statistics: percentage of parents remaining in the labour force, average number of supplied working hours and the transversal entropy for each time period. The first two indicators measure the labour force participation, while the latter figure can be used as an indicator of within-group diversity.

Figure 5.5 displays the proportion of parents in Luxembourg who had a child in 2003 according to their labour force participation and use of parental leave. The graph shows what fraction of parents are participating in the labour force at each month from the observation period. Both men and women who used parental leave part time seem to be most likely to remain in the labour force after the birth of the child. Women who used leave full time or did not use leave at all have only about 80 per cent probability to remain in the Luxembourg labour force at the end of the observation period. Women who use full-time leave seem to leave the labour force immediately if they do so, while women who do not use leave tend to leave the labour force more gradually in subsequent time periods.

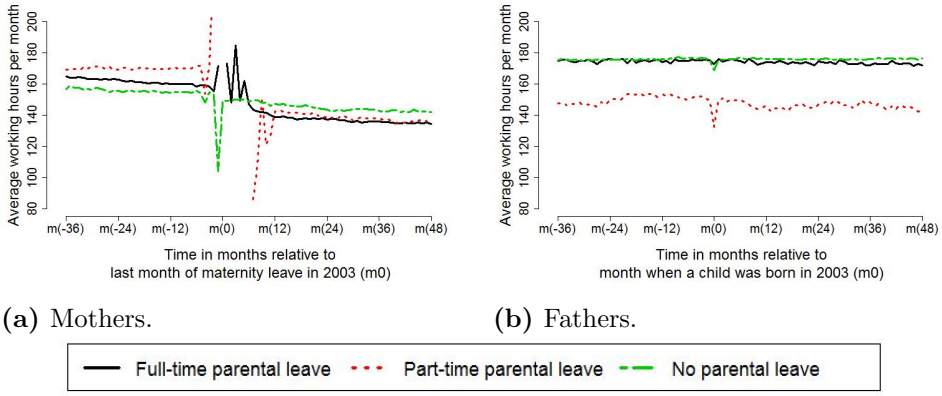
Figure 5.6 displays the average working hours supplied by parents in the labour force for each time period. For this calculation the hours were averaged for each period only for persons who were working in Luxembourg (as indicated by the presence of a social security record) and who were at work (persons on maternity leave, parental leave, dispense or unemployed were not included). Self-employed persons could not be included, as their hours of employment are not recorded in social security records. The months when a child was born were not included. However, hours paid out as sick leave or family leave were included.

As a whole, Figure 5.6 provides an indication of the hours of work supplied on the labour market by the different groups of parents. There is a visible drop in the number of supplied hours of work for all three groups of women. However, it must be noted that this graph only accounts for the hours worked by mothers who did not leave the labour force after the birth of a child in 2003. For men, the hours of supplied work decrease only negligibly.



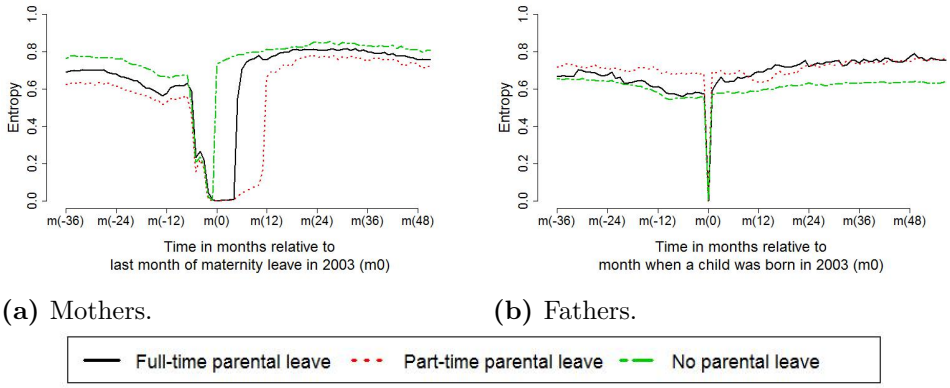
(a) Mothers. **(b)** Fathers.

Figure 5.5: Proportion of parents who had a child in 2003 and who are participating in the Luxembourg labour force.
Notes: Persons who have a social security record are considered to participate in the labour force. This includes also those who are receiving unemployment benefits.



(a) Mothers. **(b)** Fathers.

Figure 5.6: Average working hours per month for parents who are employed and at work.
Notes: Parents who are on parental leave, maternity leave, dispense, or unemployed are not included. Self-employed individuals are not included. Hours paid as sick leave or family leave are included in the calculation of the average for each month.



(a) Mothers. **(b)** Fathers.

Figure 5.7: Transversal entropy of the trajectories of parents according to taking parental leave.

However, there is a visible difference in the average number of working hours supplied by the fathers who take part-time parental leave.

The transversal entropies for the groups of parents displayed in Figure 5.7 can give some indications about the diversity of states at each time point. The idea behind the entropy index is that the proportions of observations in each state at the same time point can be used as probabilities, based on which we could try to make predictions about which states are more or less likely. If everyone is in the same state, the entropy index is equal to 0 and as the diversity increases, the value of the index can range up to 1. The transversal entropy has been calculated with the *seqstatd* function from the TraMineR package (Gabadinho et al., 2011). The formula is presented in equation 5.1. In this formula p_i stands for the proportion of cases in state i and a stands for the number of states in the alphabet.

$$h(p_1, \ldots, p_a) = -\Sigma_{i=1}^{a} p_i \log(p_i) \tag{5.1}$$

For both mothers and fathers there is a dip in the entropy around the time of the birth in 2003 because then all of them experience the same event. Examining the trajectories before and after the birth suggest that the entropies remain about the same before and after birth for men, while for women they tend to increase. This could be due to the fact that women's trajectories become more diverse after the birth of the child, as they adopt different strategies to deal with the increased demand on their time.

5.5 Representative sequences

5.5.1 Overview

The previous section presented the cross-sectional distribution of work-family states for each period for working mothers and fathers in Luxembourg. In this section, the perspective of the analysis is longitudinal and not cross-sectional. In other words, the focus is on analyzing the trajectories of individuals rather than the state distributions. This is achieved through extracting representative sequences (Gabadinho and Ritschard, 2013).

The representative sequence is a sequence that provides an idea of the tendency for the whole group of sequences being examined, in the same way that the mean summarizes the distribution of a group of data points. Similarly to how the mean of a distribution is not necessarily a value, which occurs in the distribution, we could think of a "mean" sequence, which would consist of the states in the alphabet in such order that this theoretical sequence is as close as possible to all other sequences in the data set.

Gabadinho and Ritschard (2013) explain that while this approach may be useful in the biological sciences for summarizing, for example, DNA sequence data, in the social sciences it is not so appropriate, as a synthetic theoretical sequence derived in this way may not necessarily have a meaningful interpretation in reality. This is due to the fact that states in social-science-conceptualized sequences often occur in a logical order and are not necessarily independent of each other. This argument certainly holds true for the present analysis. In the trajectories of parents, both maternity leave and parental leave are policies with a fixed duration, and both occur conditional on a birth preceding them. A synthetic sequence distorting these constraints would not be very useful for summarizing the data.

The goal of the analysis in this section is to search for representatives among the observed sequences. Furthermore, using the approach proposed by Gabadinho and Ritschard (2013), the analysis not only looks for a single representative but for a set of representatives to summarize the data set. These sequences must be actually occurring in the data and they must together provide information on the main aspects of the data set.

Representative sequence sets can be extracted after a distance matrix has been computed (see chapter 4, section 4.6). Using the distances from the

distance matrix, it is possible to define the *neighbourhood* of each sequence. The neighbourhood consists of all sequences that lie within a given radius. The number of sequences, which lie in the neighbourhood of a specific sequence are the *coverage* of that sequence. Respectively, when referring to a set of sequences the coverage would refer to the sequences that lie in the neighbourhoods of the set. The general idea underlying the approach of Gabadinho and Ritschard (2013) for extracting representative sequences is to find the smallest set of sequences that together cover at least a requested percentage of all sequences in the data set[3].

The features of the representative set to be extracted must be defined by the researcher[4]. First either the *coverage* or the *size* of the set must be specified. As explained above, the coverage refers to the proportion of sequences from that data, which should have a representative within their neighbourhood. The size of the set is the number of sequences that can be in the representative set.

Next, a representativeness criterion must be set to initially sort the sequences. Gabadinho and Ritschard (2013) propose four possible such criteria: neighbourhood density, centrality, frequency and likelihood. Using the neighbourhood density criterion means searching for representatives by looking at the sequences that are surrounded by a high number of similar sequences (high density) within a given neighbourhood radius. The centrality criterion means starting with the most central sequences and should be used, for example, to obtain the *medoid* sequence, which is the *observed* sequence, which has the smallest sum of distances from all other sequences in the representative set (Kaufman and Rousseeuw 1990 cited in Gabadinho, Ritschard, Studer, and Müller, 2011). The frequency criterion is based on how often a sequence appears in the data set. The sequence likelihood is a criterion based on multiplying the probability for each state to appear at its observed position.

At each step, the algorithm eliminates redundancy. This is achieved by including a sequence in the representative sequence set only if the distance between it and the other sequences that are already in the data set is higher than a pre-specified threshold. This threshold can be set as a fraction of the maximal possible distance that can occur in the data set.

[3]It must be noted that the method is heuristic, which means that computation is relatively quick, but the results are not necessary optimal.

[4]Extracting representative sequences following the above-mentioned approach is implemented in *TraMineR* and can be performed with the *seqrep* function.

(a) Mothers.

(b) Fathers.

Figure 5.8: The medoid sequences. These are the two sequence, which have the smallest sum of distances from all other sequences in their respective data sets.

5.5.2 The medoid sequences for men and women

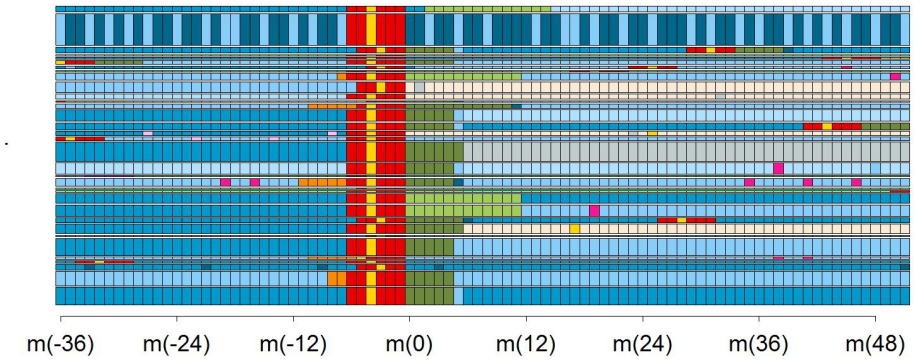
Figures 5.8a and 5.8b show the medoid sequences for men and women in the sample. Following Gabadinho and Ritschard (2013), the medoid sequences have been extracted by using the centrality criterion and setting the size of the set to one. This means that the medoid sequences are the sequences which have the smallest sums of distances from all other distances in their data sets.

Figures 5.1a and 5.1b suggest that the typical pattern for women is to work full time, then take full-time parental leave, then resume work with reduced working hours and experience another subsequent birth and full-time leave. For men, the medoid sequence suggests a pattern of working mostly full time with some overtime throughout the career trajectory. In the period prior to the birth in 2003 there are more months with overtime working hours. Afterwards the hours seem to be more frequently equal to standard full-time employment.

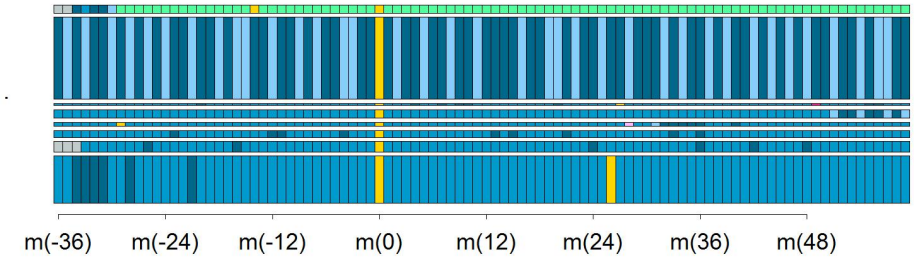
The medoid sequences have in their neighbourhoods (within 10 per cent of the maximum dissimilarity) only 0.045 per cent and 0.017 per cent of the trajectories for women and men respectively. In other words, only a very small fraction of the sequences in the two data sets have these representatives in their neighbourhood. This is not surprising, given the diversity of career paths that can be observed over such a long period of time and the large number of cases in the sample.

Keeping in mind that the medoid sequences may not be enough to represent the main features of the whole data set, I proceed with extracting a set of sequences, as explained in Gabadinho and Ritschard (2013). The set of representative sequences together may provide a better summary of a data set with high levels of diversity. For this step, I use the neighbourhood density criterion with the default values for the parameters, which in TraMineR equal to 10 per cent of the maximum theoretical dissimilarity for the neighbourhood radius and 25 per cent for the coverage.

Figures 5.9a and 5.9b display the sets of sequences needed to represent at least 15 per cent of the trajectories for women and men. The difference is quite striking. For women, we would need 34 sequences to represent 15.06 per cent of the data, while for men only 8 would suffice to represent 26.12 per cent of the set. In part the high number of sequences that are needed to form the representative sequence sets is due to the level of data granularity. With monthly data, it is possible to incorporate also short-term states, which, for example with quarterly data would not be included in the analysis. However, it is likely that even with less detailed data, the trajectories of women would be more diverse than men's: for example, there do not appear to be many men who change their working hours after the event of birth or who transition to labour market inactivity.



(a) The representative sequence set (N = 34) for women with 15 per cent coverage.



(b) The representative sequence set (N = 8) for men with 26 per cent coverage.

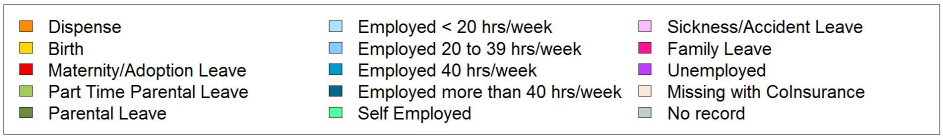


Figure 5.9: Representative sequence sets for the samples of women and men in Luxembourg who had a child in 2003.
Notes: The sets have been extracted using the neighbourhood density criterion described in Gabadinho and Ritschard (2013). The coverage of each set shows the proportion of sequences from the data that lie in the neighbourhood of at least one of the representative sequences.

5.6 Discussion and main directions for further analysis

This chapter serves multiple purposes. To begin with, it aims at illustrating how work-family trajectories can be reconstructed based on administrative records and how sequence analysis can be applied to analyse them. The main idea behind such an attempt is to make a link between the political and academic discourse calling for a life course approach to designing social security systems and an analytical strategy and an empirical application. Such an analysis is possible, provided one has very accurate, longitudinal records and the data are appropriately prepared. The major challenges in the data preparation process are reducing the number of states to a number suitable for analysis, handling the overlapping of states and determining how to align trajectories.

Second, the chapter aims at providing an understanding of parental leave within the longer work-family reconciliation trajectories of parents in Luxembourg. The visual representation of sequences provides a one-glance "snapshot" of the role of parental leave for working parents in Luxembourg. Overall, the findings from the analysis are in line with the expectations that were set in section 5.2 in this chapter. More women than men use parental leave and they tend to take it full time and immediately after maternity leave. After parental leave a small fraction of women leave the labour force, while the majority return to employment. However, there is a visible drop in the level of labour force participation of women as many of them reduce their hours of employment. There appears to be no similar trend in the male trajectories. About 14 per cent of the men who had a child in 2003 had used their right to parental leave by 2008. There does not seem to be a pattern of when men are most likely to use parental leave throughout the observation period.

Third, the chapter is the first step towards generating further research questions related to the use of parental leave and work-family reconciliation. Based on the descriptive analysis in this chapter, three main directions for further research have been identified.

First, it would be interesting to group similar trajectories together. In the trajectories of women, it would be of special interest to identify the trajectories of women who transition to inactivity, women who reduce hours of employment and women for whom the event of birth does not result in a

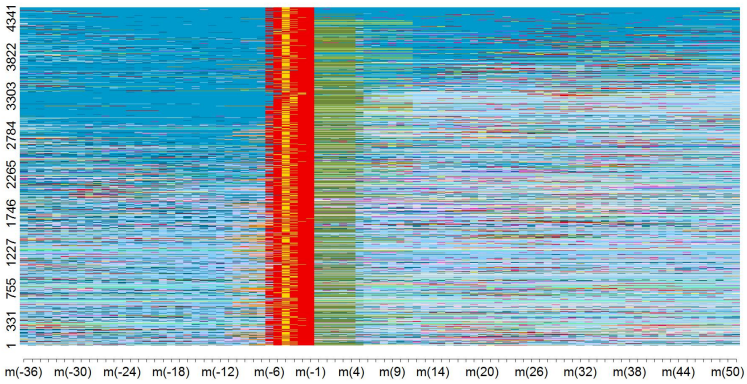
long-term change in the career trajectory. Grouping of similar trajectories could be achieved by a clustering algorithm, which is a common practice in sequence analysis. Group membership can be explained via multiple logistic regression methods. This analysis has been performed in chapter 6.

Second, it would be interesting to explore why some women transition to inactivity after they have a child. This analysis should incorporate the fact that the decision to transition to inactivity can take place in two stages. The first stage is immediately after maternity leave. The second stage is after parental leave. It is quite interesting to explore why women transition to inactivity after parental leave. In view of the political goals to increase female labour participation, it is important to understand the reasons why parental leave is not always followed by a transition back to the labour force afterwards. This analysis has been performed in chapter 7.

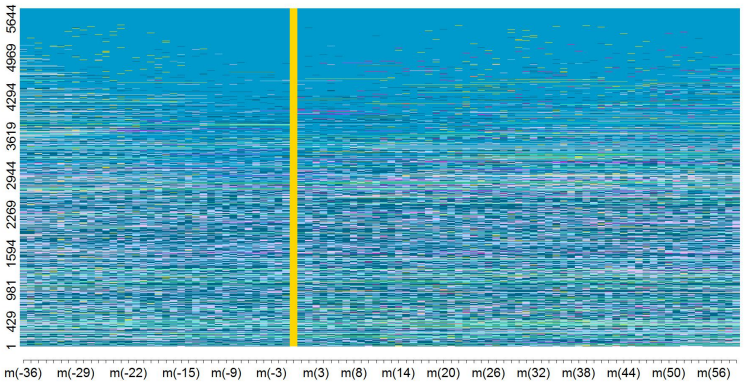
Finally, for men, the visualization of work-family trajectories has revealed that there is not a clear pattern in the timing of parental leave and, in general, the percentage of men using parental leave has remained lower than the percentage of women using parental leave. The visualization of trajectories has revealed that there is a relatively steady pattern of timing the leave throughout the observation period. It would be interesting to explore why some fathers take leave, while others do not, as well as why some time it sooner than others. This analysis has been carried out in chapter 8.

As a whole, the use of sequence analysis methods on administrative records has proven a fruitful approach to the analysis of parental leave in Luxembourg. The visualization of trajectories has made it possible to trace the main patterns of work-family reconciliation and to identify further research questions.

5.A Longitudinal view of trajectories



(a) Mothers



(b) Fathers

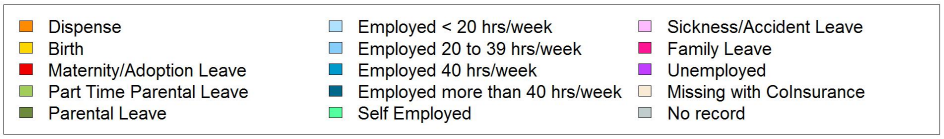


Figure 5.10: Longitudinal state distributions (index-plots) of the trajectories of working parents in Luxembourg who had a child in 2003.
Notes: These trajectories have been sorted according to number of months spent in full-time employment at 40 hours per week.

CHAPTER 6

Cluster analysis

6.1 Introduction and overview

In this chapter a clustering technique is applied to the reconstructed trajectories of parents presented in chapter 5. The main goal of the analysis is to group similar trajectories together and to explore the typology that emerges. Trajectories are grouped on the basis of the distance matrix presented in chapter 4. As pointed out by Studer (2013), identifying common patterns of behaviour can provide a useful summary of the sequence data. In addition, such patterns can provide an account for models of behaviour which are present in society. Unsupervised clustering was considered an appropriate technique for the analysis because of its explorative nature. With this method there is no need to set *a priori* hypotheses about types of work-family trajectories, which would have been difficult given the scarcity of information about work-family reconciliation patterns in Luxembourg.

The sequence analysis literature has made a wide use of clustering algorithms (Abbott and Tsay, 2000). After each sequence has been assigned to a cluster, there are several ways in which the analysis can proceed. Some studies remain at the descriptive level and focus on qualitatively comparing the obtained clusters, as well as on discussing the number of clusters and the proportion of sequences in each cluster. These studies are valuable sources of information and can reveal interesting patterns that would be difficult to expect *a priori*.

Beyond the descriptive level, it is also possible to compare the types and

distributions of trajectories across time (Halpin and Chan, 1998) or across countries (Scherer, 2001), with the latter case offering a possibility to make inferences about the structure of the welfare state and broader institutional factors, such as culture or employment markets on the development of individual trajectories.

Another possibility is to explore who is in each cluster by relating cluster membership to predictor variables, for example by tabular analysis (Han and Moen, 1999), analysis of variance (Huang and Sverke, 2007) or by logistic regression where cluster membership is the dependent variable (Kogan, 2007). Alternatively, cluster membership can be used as an explanatory variable and be linked to outcomes that become relevant at the end of the trajectory or path, such as subjective measures of well-being or socioeconomic status (Huang et al., 2007).

Besides their widespread use in sequence analysis, clustering algorithms have received a number of criticisms. One of the main problems is that cluster analysis is based on the assumption that there is a typology underlying the data structure (Hollister, 2009). This assumption is especially problematic given that cluster analysis will always produce results, whether or not they are truly relevant (Levine, 2000; Studer, 2013).

As already explained in chapter 4, in this study the Longest Common Subsequence (LCS) has been used for computing the distance matrix[1]. The choice of the LCS measure for computing the distance matrix and the states included in the analysis in this study have been described and motivated in chapter 4. For the clustering of trajectories Ward's method for agglomerative hierarchical clustering has been used[2]. The cluster diagnostic tools suggested by Studer (2013)[3] were used to determine the optimal number of clusters. Ward's method and the cluster diagnostic tools are described further in the chapter.

In general, when cluster analysis is performed on a set of sequences, each step in the process can have an influence on the results. The results can change depending on how the states are selected and coded, which measure is chosen to compare the sequences and which clustering algorithm is

[1]Computations were performed using the *TraMineR* package (Gabadinho et al., 2011), which runs under the free environment for statistical programming *R* (R Core Team, 2014).

[2]Computations were performed using the *cluster* Package (Maechler, Rousseeuw, Struyf, Hubert, and Hornik, 2014).

[3]Computations were performed with the *WeightedCluster* (Studer, 2013) package.

applied. To examine the extent to which the results are sensitive to these components, a sensitive analysis has been carried out. It is presented in Appendix 6.F.

The initial approach for the study was to treat men and women as different populations and perform the cluster analysis separately. This has been motivated by the descriptive findings presented in chapter 5. In particular, men and women were shown to have different trajectories with regard to their probability to remain employed after having a child, the number of hours they supply on the labour market and the way they use parental leave. Interestingly, however, the results from the separate clustering revealed more similarities than expected. For this reason, the focus of the analysis shifted towards making direct comparisons of the distribution of the clustering results. To this purpose, the analysis was performed on the pooled sample of trajectories. In this way clustering results are directly comparable.

In the final section of the chapter the associations between cluster membership and the available covariates from the administrative records have been explored. The findings suggest that for both men and women higher monthly earnings and positive salary growth tend to be associated with a trajectory dominated by full-time employment, continuing before and after the birth of the child. For both men and women, being married tended to be associated with higher odds of a trajectory classified as reduced labour force participation. However, number of other children in the household seemed to be associated with cluster type to a greater extent in the female trajectories than in the male trajectories.

6.2 Methodological notes

6.2.1 Overview of clustering methods

This section provides an overview of clustering based on Tan, Steinbach, and Kumar (2006). In short, clustering procedures divide the data into groups (clusters), which could serve the purpose of capturing the underlying data structure or they can serve utility purposes, such as summarization or compression. The goal of clustering is to identify groups of objects (in this case sequences), which consist of items that are as similar as possible

to each other and at the same time as different as possible from the objects in the other groups.

Cluster analysis is sometimes called *unsupervised classification* (Tan et al., 2006, p. 491) because it assigns objects to clusters only on the basis of information available in the set of data points to be clustered. In contrast, *supervised classification* tasks involve assigning objects to clusters based on externally available values of covariates. Tan et al. (2006) point out that there are various types of clustering methods. For example, clustering can be exhaustive or overlapping depending on whether each object can be assigned to only one cluster or to multiple clusters. It is also possible to distinguish between complete and partial clustering, which implies a distinction between clustering all objects or only some of them. One of the most often discussed distinctions is the distinction between hierarchical and partitional clustering approaches (Tan et al., 2006). This distinction refers to whether the obtained clusters have subclusters (the former cases) or not (the latter case).

Using the analogy to a tree, Tan et al. (2006) explain the results obtained through hierarchical clustering as follows. The cluster containing all the objects in the data is the root cluster. Each node in the tree contains the subclusters into which it is subsequently divided, except the so called leaf nodes, which do not have subclusters. Hierarchical clustering methods can be split into two major categories: agglomerative and divisive. In the starting point for agglomerative clustering all data points are seen as individual clusters. In subsequent steps, clusters that are similar to each other are merged together. The end point is one final cluster containing all data points. Divisive clustering works exactly in the opposite way. The starting point is the entire data set and then at each step clusters are split until each data point is a separate cluster by itself.

In partitional clustering the data points are split into a number of groups, which have been pre-specified by the researcher. For each group a centroid point is identified and the algorithm aims to partition the data in such a way that the distances between each point and the centroid of its cluster are minimized. In partitional clustering with sequences the centres used are the medoid sequences of the clusters (see chapter 5). In a continuous n-dimensional space the centroid can be defined as the mean of a group of points (Tan et al., 2006, p. 496).

6.2.2 Choice of clustering algorithm for this study

For this study it was considered appropriate to use a hierarchical clustering procedure and not a partitional one because there was not enough prior knowledge or guidelines, which could have been used to pre-suppose the number of clusters. Another reason to choose a hierarchical procedure was that it has become somewhat of a standard in the sequence analysis literature. More specifically, agglomerative hierarchical clustering with Ward's method has been very frequently applied in previous literature, although it is acknowledged that this choice is mostly a result of convention. For example, in Martin, Schoon, and Ross (2008, p. 186) one reads:

> While most OMA studies in the social sciences have used Ward, no stringent test has ever been applied to test whether this preference is justified.

In agglomerative hierarchical clustering, Ward's method is one among a number of methods for determining the proximity between two clusters. The method for determining the proximity between clusters is important because agglomerative clustering works by merging clusters, which are determined to be most similar to each other at each step. The criterion for similarity can be, for example, the distance between the two closest data points (minimum linkage), the distance between the two furthest data points (complete linkage) or the average distances between all pairs of points in the clusters (group average). Ward's method measures proximity between clusters based on the increase in the sum of the squared distances between each data point and the cluster centroid, which would result from merging the two clusters (Tan et al., 2006).

6.2.3 Criticisms of hierarchical clustering

Like most methods of analysis, hierarchical clustering methods have advantages and disadvantages. Tan et al. (2006) list three major criticisms that such methods have received. First, decisions are made locally at each step. Such local decisions, however, may not necessarily be as good globally (Studer, 2013). The second point raised by Tan et al. (2006) refers to the treatment of clusters of different sizes. If such clusters are treated equally, it is equivalent to giving different weights to the data points of which these

clusters consist. Weighting the points differently is undesirable unless there is a reason to do so. Third, Tan et al. (2006) point out that in hierarchical clustering merging decisions are final. Once a point or a cluster is merged with another one, this action cannot be undone even if later a different decision would be more appropriate.

Another issue is discussed in Studer (2013) who explains that several versions of the same algorithm can lead to divergent results, especially when there is a large number of ties in the data. The problem of ties with hierarchical clustering has also been discussed in Martin et al. (2008) and again mentioned by Aisenbrey and Fasang (2010). It has also been noted that Ward's method is sensitive to the presence of outliers or data noise (Lesnard, 2008; Studer, 2013).

6.2.4 Examples of alternative clustering approaches in sequence analysis research

Although a large number of sequence analysis studies have used agglomerative clustering with Ward's method (Aisenbrey and Fasang, 2010), it must be noted that other approaches have also been used in the literature. Piccarreta and Billari (2007), for example, have proposed a tree-based divisive algorithm, which uses auxiliary variables to define the splits. Piccarreta and Billari (2007) propose that the information on the states experienced by each individual can be used to construct this set of variables. For example, the variable can take the value 1 if a certain state has been experienced before a given time point and 0 if not.

More recently, Studer (2013) has made available the *wcKMedoids* function in the *WeightedCluster* package which combines hierarchical and partitional methods. With this approach the results obtained through hierarchical clustering are used as the basis for partitional clustering. This makes it possible to overcome one of the main limitations of partitional clustering, which is that the choice of initial medoids around which to partition the data may not always be optimal (Studer, 2013).

Another approach is to group trajectories according to their proximity to "ideal types", which have been constructed in advance. An example of this approach is found in Elzinga and Liefbroer (2007) who construct seven types of family-life trajectories of women from 67 cohorts and compare the proportions of clustering that are grouped to each ideal type across

cohorts and across countries. This approach differs from the more often used clustering approach in that the obtained clusters are derived on the basis of prior knowledge and theory.

6.2.5 Determining the appropriate number of clusters

When using a hierarchical clustering procedure the researcher must choose the appropriate point to stop the clustering process. Using the tree analogy mentioned by Tan et al. (2006), the researcher must have some way to know how many branches should be cut from the tree, so what is left is a meaningful representation of the main sub-groups of patterns occurring in the data, assuming there are such patterns in the first place (see Hollister, 2009). Determining the appropriate number of clusters is a critical point in the analysis and it is not surprising that Fonseca (2013) refers to it as the "Achilles heel" (p. 403) of cluster analysis.

In this chapter, the cluster diagnostic tools proposed by Studer (2013) have been applied. He suggests using a number of measures of cluster quality available in the literature, which together can provide some indications as to where to stop the clustering. These measures could also be used to compare the results obtained through different clustering algorithms[4].

The measurements proposed by Studer (2013) are as follows:

- *Point Biserial Correlation (PBC).* This measure has been described in Mulligan and Cooper (1985). It represents the correlation between the distances in the original distance matrix used for the clustering and a dichotomous variable representing whether two points are in the same cluster. The highest value of this index was considered to indicate the optimal number of clusters in the data. In the study of Mulligan and Cooper (1985) the point-biserial index was placed as one of the top ten out of thirty measures for determining the number of clustering when using a hierarchical clustering procedure. This method had the lowest probability to determine too many clusters. However, it also had the highest rate of determining too few clusters.

[4]The diagnostic tools are available in the *WeightedCluster* (Studer, 2013) package, which runs under the free statistical and programming environment R (R Core Team, 2014).

- *Hubert's Gamma (HG)* and *Hubert's Somers' D* (HGSD). These two statistics are based on the association between the distances in the data and a matrix consisting of the values 0 and 1, where 0 means that two objects are assigned to the same cluster and 1 means they are assigned to different clusters (Studer, 2013). The values range from -1 to 1 and higher values correspond to better clustering solutions. The statistics are presented in Hubert and Arabie (1985).

- *Hubert's C Index (HC).* The C-index has been presented in Hubert and Levin (1976) who refer to an earlier publication of it in Dalrymple-Alford (1970). The C-index can range from 0 to 1 and smaller values correspond to better clustering solutions. Charrad, Lechevallier, Ahmed, and Saporta (2010) and Studer (2013) present the formula for the C-index as follows:

$$C = \frac{S - S_{min}}{S_{max} - S_{min}} \tag{6.1}$$

  In Equation 6.1 S is the sum of distances between all pairs in the same cluster for a given cluster. If l is the number of pairs in the cluster, then S_{min} and S_{max} are the sums of the l smallest and largest distances from the whole data (Charrad et al., 2010).

- *Calinski-Harabasz (CH) index.* This index is presented in Calinski and Harabasz (1974). It is also called pseudo-F. It represents the ratio of the between-cluster sum of squares and the within-cluster sum of squares, which have both been normalized (Goerke and Sherbart, 2006). The sum of squares is different for sequences. As noted by Studer, Ritschard, Gabadinho, and Müller (2011), when analyzing sequences, it is more appropriate to use the term discrepancy instead of variance, as comparisons are carried on complex objects and not data points. The discrepancy is obtained similarly to the variance by dividing the sum of squares by the total number of observations. When dealing with sequences, the sum of distances from the centre is not defined as the squared deviations from the mean, but as the average sum of pairwise dissimilarity between all sequences. The formula for the CH index can be presented as follows:

$$CH_{(k)} = \frac{SS_B}{SS_W} \tag{6.2}$$

  In Equation 6.2 SS_B is the between-cluster sum of squares and SS_W is the within-cluster sum of squares. The index can range from 0 to infinity and larger values indicate better solutions. In the study of

Mulligan and Cooper (1985) where thirty stopping rules were compared, the CH index was rated as one of the best (Studer, 2013; StataCorp, 2013). The index can be applied to both hierarchical and non-hierarchical clustering methods (StataCorp, 2013). However, Studer (2013) points out that it is questionable whether the measure can be applied to non-Euclidian distances as the ones produced by OM in sequence analysis.

- *R-squared.* The pseudo-R squared is presented in Studer et al. (2011). Once the sum of squares and the discrepancy are defined, the ANOVA principles can be applied to the analysis of sequences, whereby the total sum of squares can be decomposed into between- and within-sum of squares. The formula for the pseudo-R squared as presented in Studer et al. (2011) is as follows:

$$R^2 = \frac{SS_B}{SS_T} \tag{6.3}$$

In Equation 6.3 SS_B stands for the between-sum of squares and SS_T stands for the total sum of squares. The pseudo-R^2 can range from 0 to 1 and larger values indicate better clustering solutions. When used for cluster analysis, the pseudo-R^2 shows what fraction of the total variance is explained by a given partition. Studer (2013) notes that the pseudo-R^2 can be used only to compare clustering solutions with equal number of groups, because it does not account for complexity.

- *Average Silhouette Width (ASW).* The concept of silhouette in cluster analysis has been presented in Rousseeuw (1987). The formula for the silhouette width of an object i is as follows:

$$s(i) = \frac{b(i) - a(i)}{max\{a(i), b(i)\}} \tag{6.4}$$

In Equation 6.4 $a(i)$ is the average distance between object i and all objects in the cluster to which it has been assigned (A), while $b(i)$ is the average distance between the same object and all objects in the cluster, which lies closest to A. The values of $s(i)$ lie between -1 and $+1$. Values close to $+1$ indicate that the object i is appropriately assigned to its cluster. Values close to 0 suggest that the object could also be placed in the other cluster and it lies somewhere in between. Values close to -1 suggest that the object is not well placed in its cluster, because it is actually closer to objects in the neighbouring cluster (B).

Rousseeuw (1987) proposes that the silhouette value can be used to assess clustering solutions in the following ways. The average silhouette width could be computed for each cluster by taking the average of $s(i)$ for all objects per cluster. This would make it possible to distinguish well-defined clusters from not-so-well-defined ones, as the first will have higher values of average silhouette widths. The overall average silhouette width can also be computed for all points in the data. The number will vary depending on the number of partitions. Higher values of the overall average silhouette width would indicate better partitions.

In Studer (2013) one finds a reference to the guidelines proposed by Kaufman and Rousseeuw (2009) for using the values of the average silhouette width to assess the quality of the clustering solution. Values over 0.5 can be seen to suggest a good structure in the data, while values between 0.25 and 0.50 are already questionable. Values below 0.25 are considered to indicate an absence of structure in the data.

6.3 Clustering the trajectories of men and women

6.3.1 Separate clustering

The initial assumption in the analysis was that the trajectories of working fathers and mothers in Luxembourg are very different from each other. The descriptive analysis in chapter 5 shows that the trajectories unfold in a different way for mothers and fathers after a child is born. The general tendency is that the trajectories of fathers remain stable in terms of working participation and working hours, while for many women it is likely that they reduce working hours or transition to labour market inactivity. In addition, a much larger proportion of women use their right to parental leave immediately after their maternity leave following the birth in 2003. The extraction of representative sequence sets in the same chapter also suggested that women's trajectories are much more diverse than the trajectories of men.

Having in mind the above observations, it was initially considered appropriate to treat the two samples separately and to perform qualitative comparisons only. The results based on clustering the male and female trajectories separately are presented as chronograms in Figures 6.1 and 6.2. In Ap-

	Women (k=8)	Men (k=7)
Method	ASW value	
Agglomerative hierarchical clustering (AGNES)	0.23	0.40
Divisive hierarchical clustering (DIANA)	0.23	0.40
Partitioning around medoids (PAM)	0.25	0.34
Combining PAM and AGNES	0.25	0.34
Sample size	1000	1000

Table 6.1: Values of the average silhouette width obtained on two random samples from the data for women and men with different clustering methods.
Notes: Random samples were drawn because computation times were very long for the entire data sets. For each clustering procedure the same two random samples have been used.

pendix 6.A, Figures 6.7 and 6.8 present a longitudinal view (index plots) of the same clustering results.

The clustering was stopped at eight clusters for the sample of women and at seven clusters for the sample of men. The decision to stop at these numbers was made based on the cluster diagnostic statistics explained in section 6.2.5. The values of the obtained statistics are displayed in Appendix 6.B. Figure 6.3 presents graphically the normalized values of these statistics.

What appears to be somewhat problematic, especially for the sample of women, is the value of the Average Silhouette Width (ASW). Tables 6.5 and 6.6 in Appendix 6.B show that the value is below 0.5 for all solutions in the male sample and below 0.25 in the female sample. According to the subjective interpretation of the maximal average value of the silhouette width for the entire data set presented by Kaufman and Rousseeuw (2009), values below 0.50 suggest that the structure could be weak or artificial. Values below 0.25 suggest that there is no structure in the data set. Alternative clustering methods were tried and are presented in Table 6.1. The results suggested that other methods will not necessarily improve the ASW value.

A qualitative comparison of the results for women and men suggests that the obtained cluster types are not as different from each other as expected. In both samples, there is a group where most trajectories are predominantly defined by self-employment (Type 2 in Figure 6.1 and Type 6 in Figure

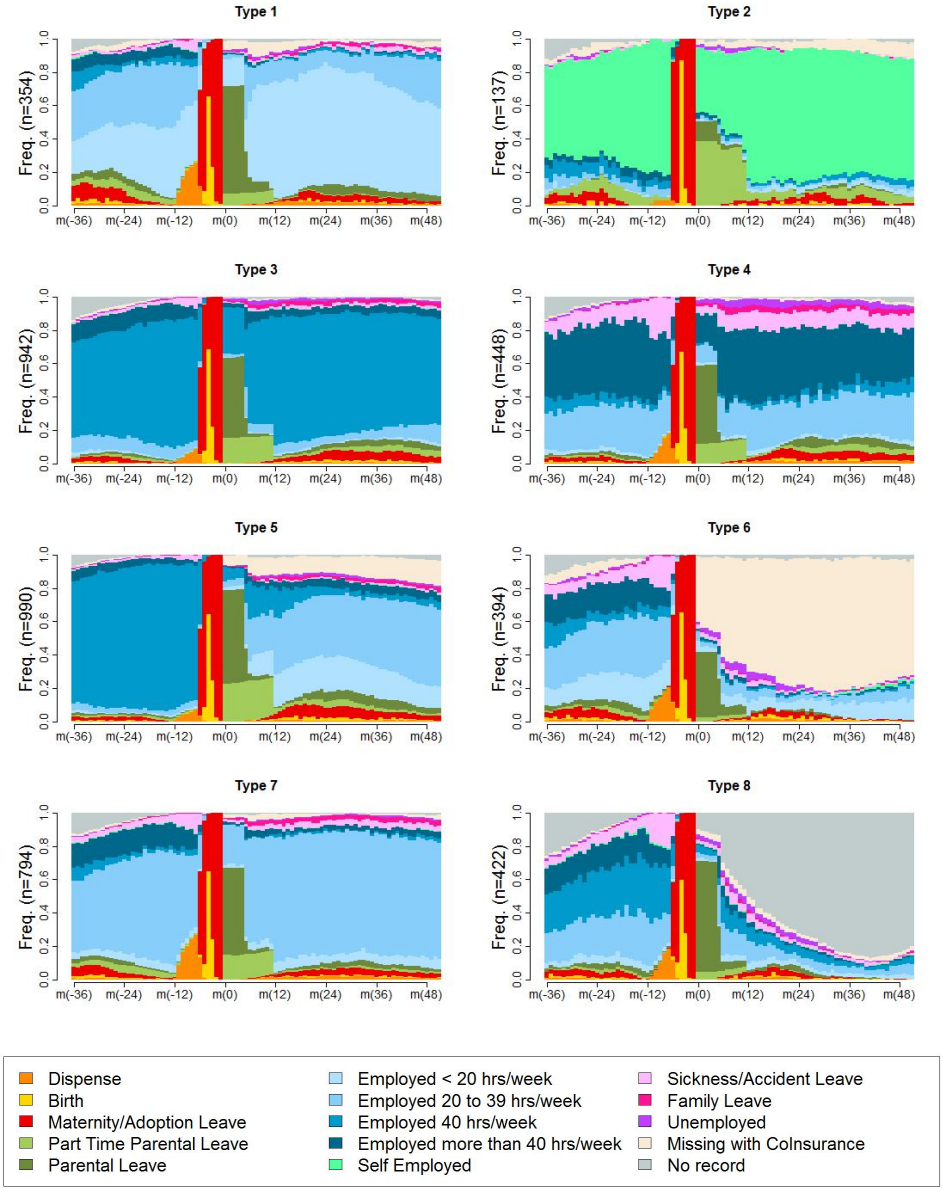


Figure 6.1: Cross-sectional state distribution (chronograms) of trajectories of working mothers in Luxembourg who had a child in 2003 grouped in eight clusters. Notes: The clusters have been obtained based on the sample of women only. The horizontal axis represents time in months. The vertical axis represents proportion of persons that are in each state during the same month. The total number of trajectories in each cluster is presented in brackets on the vertical axis.

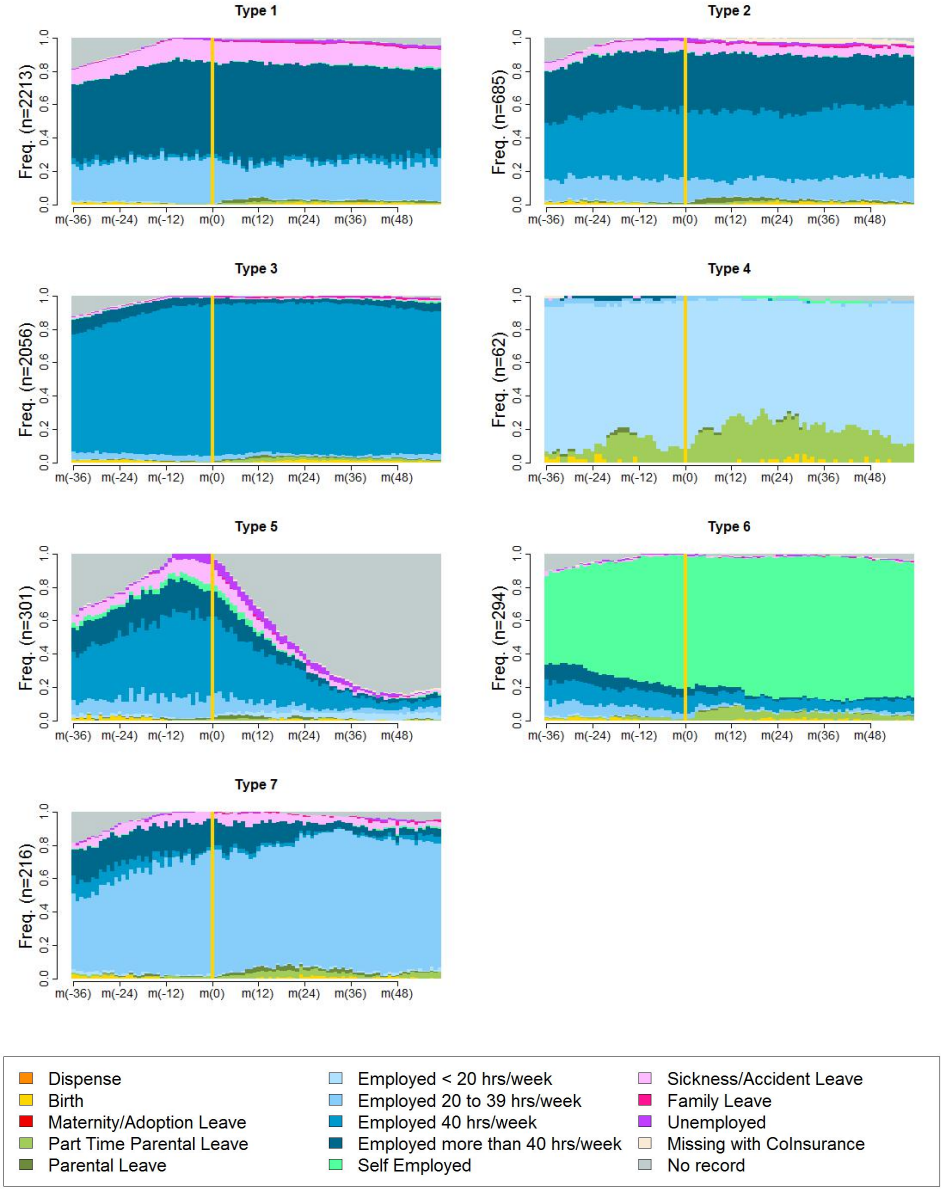
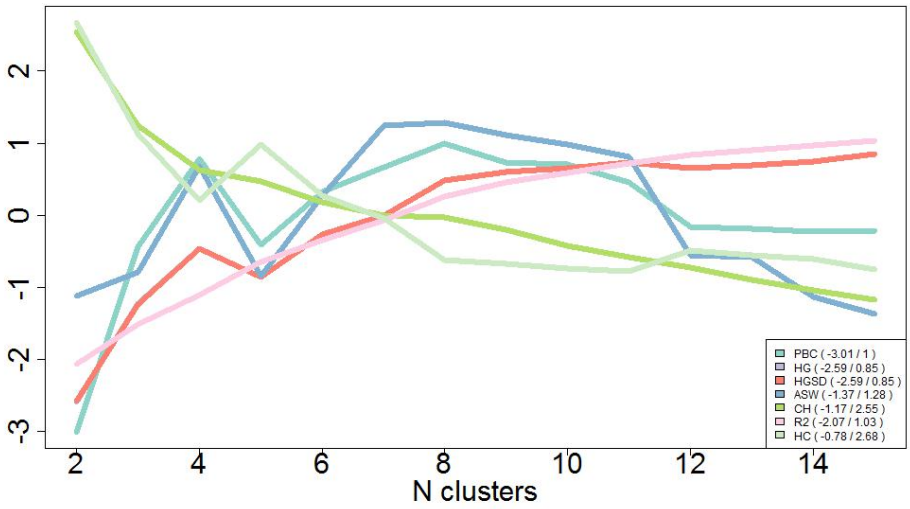
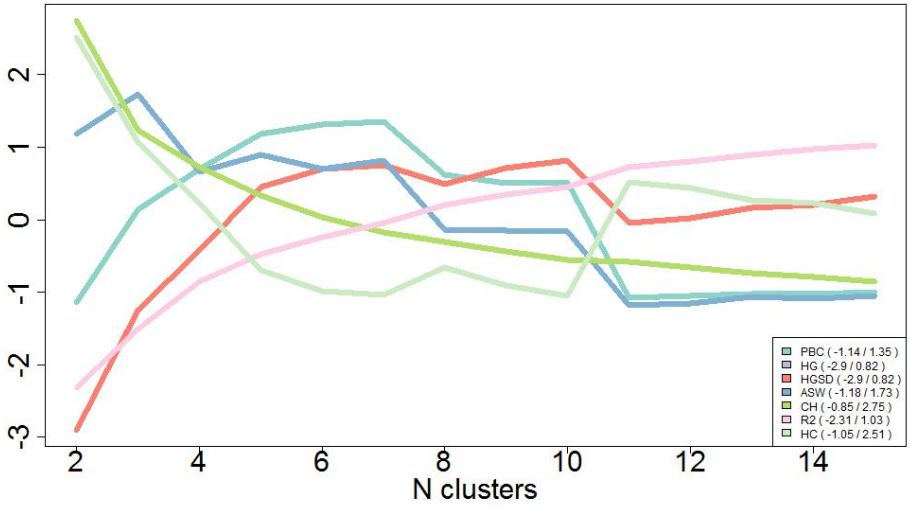


Figure 6.2: Cross-sectional state distribution (chronograms) of trajectories of working fathers in Luxembourg who had a child in 2003 grouped in seven clusters. Notes: The clusters have been obtained based on the sample of men only. The horizontal axis represents time in months. The vertical axis represents proportion of persons that are in each state during the same month. The total number of trajectories in each cluster is presented in brackets on the vertical axis.



(a) Mothers.



(b) Fathers.

Figure 6.3: Values of the cluster diagnostic statistics (y-axis) by number of clusters (x-axis) for the samples of women and men when clustering is performed separately.
Notes: The values of all statistics have been normalized for easier comparison. Higher values of all statistics suggest better clustering solutions, except Hubert's C Index (HC), for which lower values suggest better solutions.

6.2). Both samples contain a cluster of trajectories consisting of continuous full-time employment both before and after the birth of the child (Type 3 in Figure 6.1 and Type 3 in Figure 6.2). Similarly in both samples, we observe a cluster where the majority of trajectories contain multiple hours of overtime employment intermittent with less-than-full-time employment (Type 4 in Figure 6.1 and Type 1 in Figure 6.2). Another similarity is the presence of a cluster where there is an absence of an administrative record in the period after the birth (Type 8 in Figure 6.1 and Type 5 in Figure 6.2). Interestingly, there were two relatively small clusters in the male sample (Types 2 and 7 in Figure 6.2), where the trajectories were dominated by part-time employment, which could be considered to correspond to Types 1 and 7 from the female results.

In terms of qualitative differences, there were two clusters that were present in the results for women, but not for men. One was the group with transitions to what can be assumed labour market inactivity (Type 6 in Figure 6.1) and the other is a group with changes from full-time to part-time employment hours (Type 5 in 6.1). Reversely, the female clustering results contained only one group of overtime employment, whereby the male trajectories with overtime employment appeared to be separated in two clusters based on whether overtime hours interchange with half-time hours or less-than-half-time hours (Types 1 and 2 and Figure 6.2).

Although the types of clusters obtained from both samples appear less different than it was initially expected, there are some very clear differences in the size of each cluster. The most prominent example is the cluster of only 22 male trajectories dominated by part-time employment. Hence it is interesting to discuss the differences in the percentage of men and women in each cluster. With the clustering performed separately, however, such comparisons would not be appropriate because cluster membership would be represented by two different variables for the two samples. Therefore, in the next section the clustering has been performed on the pooled sample of trajectories. In this way it is possible to compare the distribution of men and women in each cluster and to highlight differences in the trajectory types around the time of birth of a child in the family.

6.3.2 Pooled clustering

The pooled sample included 10308 trajectories. The clustering process was stopped at nine clusters based on the clustering diagnostics explained in

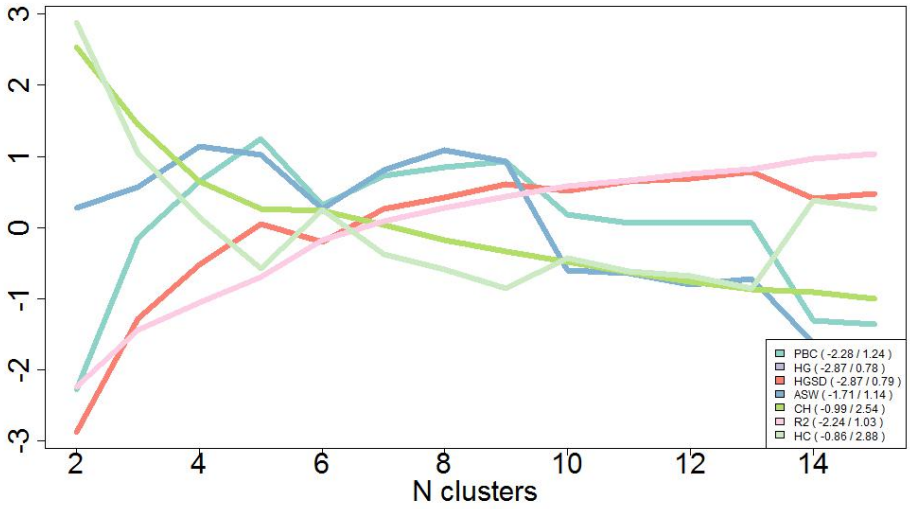


Figure 6.4: Values of the cluster diagnostic statistics (y-axis) by number of clusters (x-axis) for the pooled sample of women and men.
Notes: The values of all statistics have been normalized for easier comparison. Higher values of all statistics suggest better clustering solutions, except Hubert's C Index (HC) for which lower values suggest better solutions.

section 6.2.5. The values of the statistics are presented in Table 6.7 in Appendix 6.D and normalized values are presented in Figure 6.4.

The clustering results are graphically presented in Figures 6.5 and 6.6. Even though the clustering was performed on the pooled sample, the results have been rendered separately for men and women for an easier interpretation of the graphs. In addition, Appendix 6.C presents the same results as index plots. To make the different distribution of male and female trajectories in the clusters apparent, counts and percentages for each gender per cluster have been presented in Table 6.2.

The obtained clusters are described in detail below. Overall, a major division was made between two general categories of cluster types: those representing continuous careers, without marked differences between the periods before and after the birth of the child in 2003 and those where the birth of the child seems to represent a pivotal point, after which the career takes a different turn.

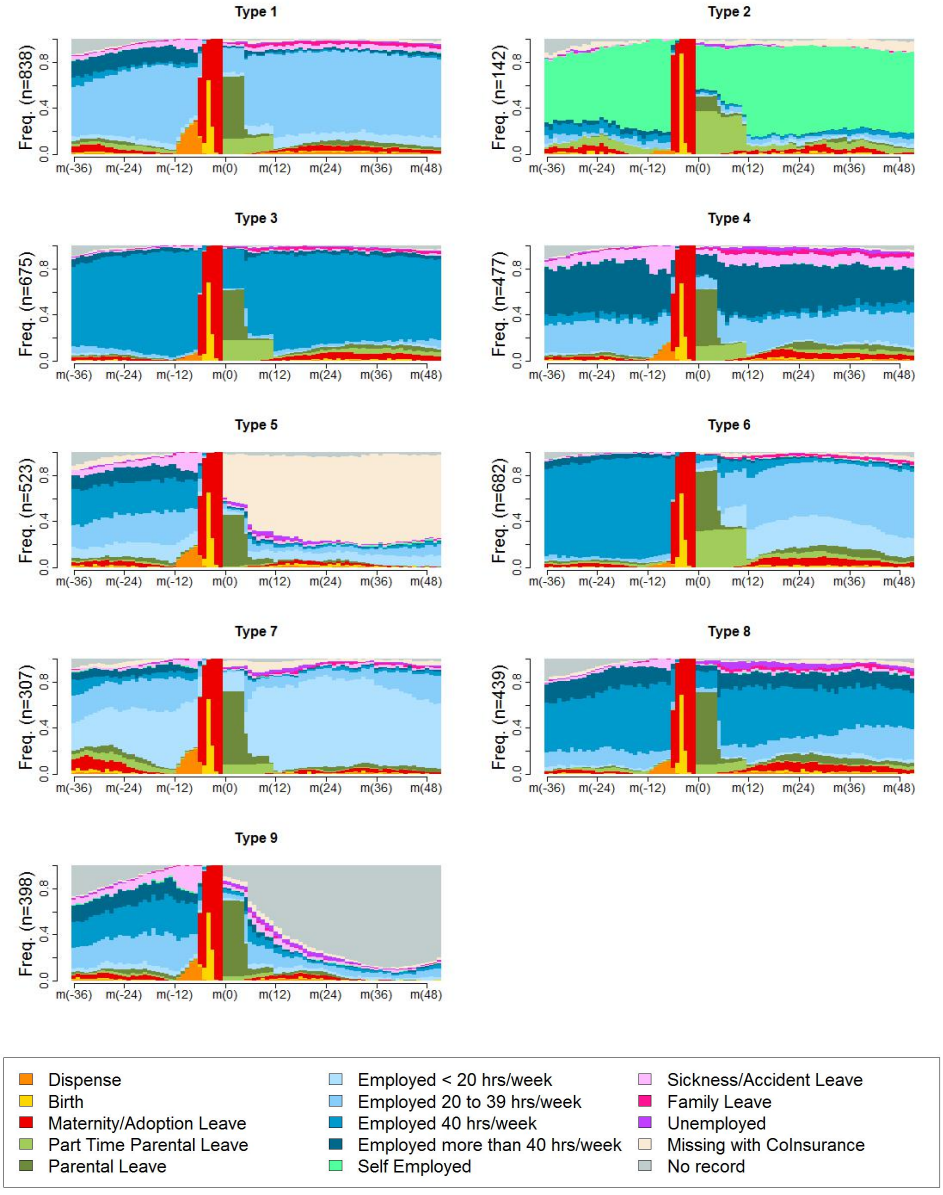


Figure 6.5: Cross-sectional state distribution (chronograms) of trajectories of working mothers in Luxembourg who had a child in 2003 grouped in eight clusters. Notes: The clusters have been obtained based on the pooled sample of mothers and fathers. The horizontal axis represents time in months. The vertical axis represents the proportion of persons that are in each state during the same month. The trajectories are aligned according to the last month of maternity leave following the birth in 2003. The total number of trajectories in each cluster is presented in brackets on the vertical axis.

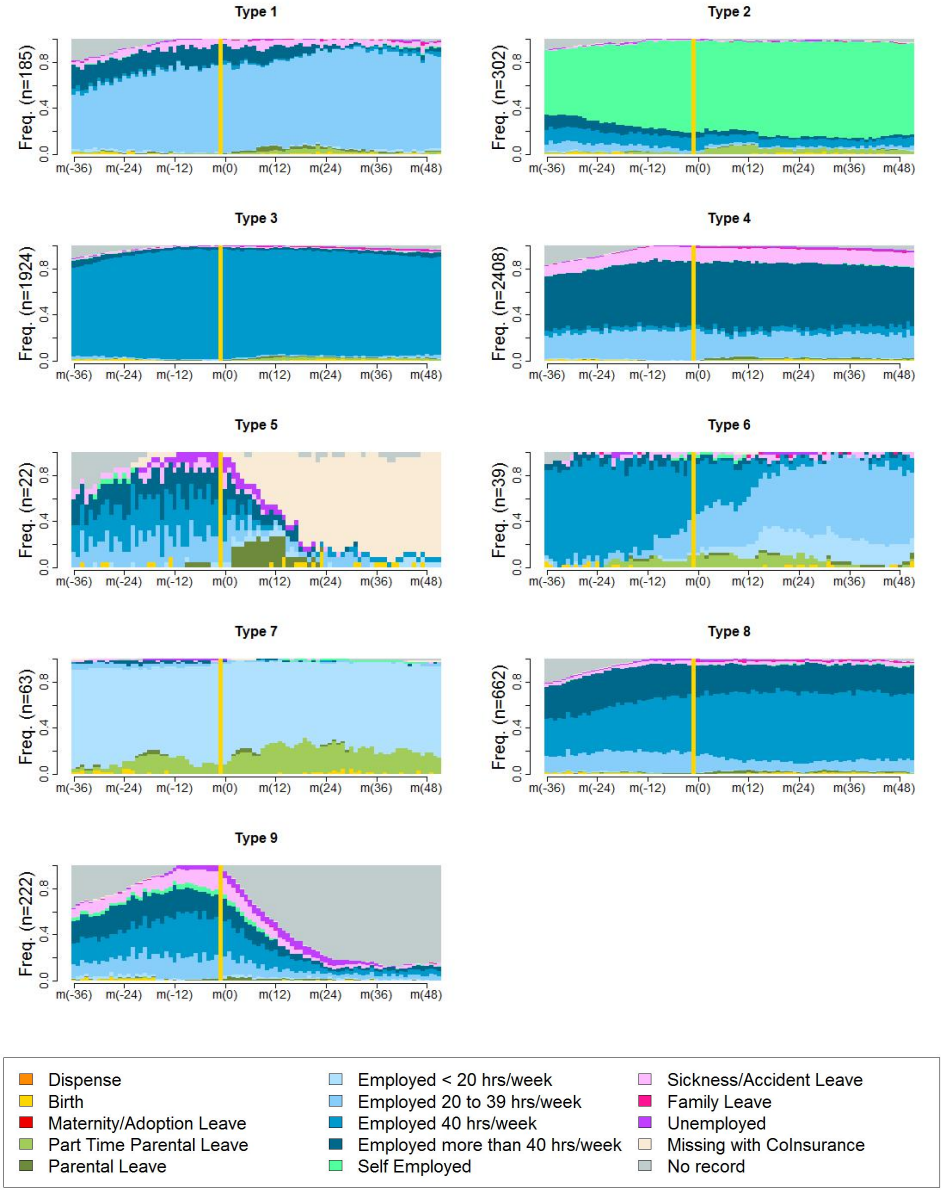


Figure 6.6: Cross-sectional state distribution (chronograms) of trajectories of working fathers in Luxembourg who had a child in 2003 grouped in eight clusters. Notes: The clusters have been obtained based on the pooled sample of mothers and fathers. The horizontal axis represents time in months. The vertical axis represents the proportion of persons that are in each state during the same month. The trajectories are aligned according to month in which the birth occurred in the household in 2003. The total number of trajectories in each cluster is presented in brackets on the vertical axis.

Women		Men	
Count	Per Cent	Count	Per Cent
(1) Continuous part-time careers (20 - 39 hrs/week)			
838	19 %	185	3 %
(2) Continuous self-employment			
142	3 %	302	5 %
(3) Continuous full-time careers			
675	15 %	1924	33 %
(4) Continuous overtime hours intermittent with part-time hours			
477	11 %	2408	41 %
(5)Transition to labour market inactivity after birth in 2003			
523	12 %	22	< 1 %
(6)Reduction of working hours after birth in 2003			
682	15 %	39	1 %
(7) Continuous part-time careers (<=20 hrs/week)			
307	7 %	63	1 %
(8) Continuous full-time careers with some irregular hours			
439	10 %	662	11 %
(9) (Possibly) leaving Luxembourg after birth in 2003			
398	9 %	222	4 %
Total			
4481	100 %	5827	100 %

Table 6.2: Cluster sizes for men and women.
Notes: Counts and percentage correspond to the results obtained through clustering of the pooled data set.

6.3.3 Discussion of clustering results

Clusters representing continuous careers (in the sense that the careers appeared to remain the same before and after the event of birth), include Types 1, 2, 3, 4, 7 and 8. The "typical" careers consisting of full-time work with few job-protected interruptions tend to be assigned to Type 3. Careers consisting of continuous part-time hours of employment are assigned to Types 1 and 7. Type 1 is dominated by employment in the range of 20 to 39 hours per week, which could be seen as part-time, but still more than half-time employment. Type 7, on the other hand, is characterized by employment in the range of 20 hours per week or less. Type 2 contains trajectories that can be characterized by predominant periods of self-employment (or part-time self-employment). Finally, Types 4 and 8 appear to be characterized by somewhat irregular hours of employment, where the parents work overtime in some months and part time in other months. This appears to be especially the case in Type 4. The careers in Type 8 seem to also have some irregularities, but they are dominated by standard full-time hours of work.

Clusters 5, 6 and 9 appear to contain trajectories characterized by a disruption of the employment trajectory. Type 6 represents the least substantial kind of disruption, where the careers are characterized by a switch from full-time to part-time employment in the post-birth period. This switch appears to be permanent at least throughout the observation period. The sand colour dominating the after-birth period in trajectories assigned to Type 5 and the grey colour dominating the after-birth period in trajectories in Type 9 represent months without administrative records. In the first case (Type 5) labour market inactivity can be quite certainly assumed because insurance records for the corresponding periods showed that the person is insured as someone else's dependent for the corresponding period.

It is somewhat more problematic to interpret the trajectories assigned to Type 9, where co-insurance records have not been not found. It is therefore possible that these persons are working in another country or in the European Union institutions in Luxembourg, which are outside the national social security system. The fact that a significant percentage of men (about 4 per cent) is in this cluster makes it possible to think that these careers represent part of general job-related mobility, which could be expected in a highly international, cross-border labour market situation as in Luxembourg. On the other hand, however, the proportion of female trajectories assigned to this cluster is higher (9 per cent), which could also suggest that

for a part of women from this cluster the career interruption is related to the event of birth.

There are some very clear differences in the gender distribution by cluster types. Women are over-represented in clusters characterized by continuous part-time employment (Type 7 and Type 1). In total, about 26 per cent of the female trajectories are assigned to these clusters, compared to only 4 per cent of the male trajectories. Women are also more likely to be assigned to one of the cluster types 5, 6 or 9 characterized by a change of the trajectory after the birth of a child in 2003. About 36 per cent of women are be assigned to one of these three clusters. The change in the trajectory consists either in an absence of administrative record (which could imply inactivity or moving to another country) or a reduction of working hours. In comparison, less than 5 per cent of the male trajectories were assigned to one of these three clusters.

The reconstructed careers of of men appear to be concentrated in two very dominant groups: continuous full-time careers (Type 3) and continuous full-time intermittent with part-time careers (Type 4). Almost three quarters (73 per cent) of the male careers are assigned to one of these two types of employment. The third most represented cluster (Type 8) contains about 11 per cent of the male trajectories. However, it should not be concluded that there are only three clusters in the male trajectories. When clustering was performed on the separate sample of male trajectories, the relatively small sub-groups of trajectories dominated by part-time employment also emerged. It is noteworthy that these somewhat atypical male trajectories appear to be stable across time. This means that the reduced levels of labour market participation are not a reaction to the life event of birth of a child in 2003, but they seem to represent a long-term choice, perhaps related to life-style preferences of the parent.

The sequences representing women's careers of women seem to be spread across all cluster types. This is consistent with the results of other studies based on sequence analysis, which typically tend to find a greater diversity in female's career trajectories. Grouping the percentages of "continuous" career types, it appears that more than half of the working mothers in Luxembourg do not experience a disruption in their career path after having a child. However, a significant part of these careers represent continuous part-time careers.

Overall, the most interesting finding from the cluster analysis is that the trajectory types of men and women are not as different from each other

qualitatively as it was initially assumed. However, the distribution of gender across cluster types is very different. In general, it seems like men are more likely to have continuous careers, while women are more likely to experience career discontinuities. Overall, the group of women who leave their employment in Luxembourg after having a child is rather small. However, the majority of women who remain employed continue their labour participation with less than full-time employment.

6.4 Who is in each cluster? Multinomial logit analysis

6.4.1 Introduction

This section presents a multinomial logit model aiming to provide an idea of how covariates are related to the probability of being in each cluster. The empirical model used in this section does not allow establishing causality or disentangling problems of endogeneity, which are abundantly present given that the construction of the dependent variable incorporates information of the career trajectory over time and the predictor variables include information from a specific time period in the construction of the trajectory. The idea of performing a multi-variate analysis in this case is simply to examine the effects of the variables *controlling* for other variables, which is the maximum that could be achieved with the information which is available. As the distribution of trajectories across clusters for men and women came out so different from each other, separate multinomial logit models were fitted for the female and the male samples.

The covariates included in the analysis as predictors are described in chapter 3, section 3.4. Covariates were chosen based on availability in the administrative records and their relevance to the research question. Generally, there are three types of covariates in the analysis: work-related (including earning information and workplace characteristics), family-related (including the presence of a spouse or other children) and control variables including age and nationality. All variables in the analysis have been constructed to refer to the twelve months prior to the event of the birth of a child in 2003. For some variables there were missing values in the data set. Appendix 6.E explains how missing values have been handled for the analysis.

6.4.2 Hypotheses based on economic reasoning

The covariates available for the analysis allow that these differences are examined within an economic framework. An overview of how economic reasoning could be conceptually applied to the decisions of women to work after childbirth is provided in Joesch (1994). In this framework, women compare the benefits of working with the opportunity cost of working to make a decision about their labour market participation. The benefits of working reflect present and future earnings, while the opportunity costs refer to the value of the time of the woman spent at home. In Joesch (1994) the first part of the equation is termed the *Full Wage* and the latter part is termed the *Reservation Wage*.

Factors that are expected to increase the *Full Wage* include work experience and wages prior to the birth of the child. Work status during pregnancy is seen as an important factor as well, as it increases the *Full Wage* through the accumulation of additional human capital. It can also be seen as an indicator of women's preferences for paid work (Joesch, 1994). In this analysis, all women are pre-selected based on working throughout pregnancy up to the start of their maternity leave.

Factors that increase the *Reservation Wage* include the presence of a husband (thus a higher family income) and more children in the household, as well as the number, ages and spacing of the children (Joesch, 1994). In this study, the marital status is included as a proxy for the presence of partner. However, it must be noted that in the social security records made available for the analysis, persons who are co-habiting without a formal marriage are considered single. In addition, the number of children is made available based on artificially reconstructed fiscal households, which may not necessarily reflect the actual living situation.

Based on economic reasoning, it is expected that women are more likely to belong to a cluster type marked by reduction in the labour participation if:

- The woman has lower earnings prior to the birth;
- The woman is married;
- There are other children in the household.

The male trajectories are analysed in the same way. However, explicit hypotheses have not been formulated for them, as the main clusters did not seem to be affected by the event of birth of a child in the household. However, performing the analysis on the male sample can serve as a robustness check of the analysis and it can provide some more information on the gendered nature of the relationships between work and family.

6.4.3 Results

The results are presented in Tables 6.3 and 6.4. In the sample of fathers, clusters 5, 6, and 7 were grouped together, as there were very few cases in each of these clusters and this resulted in numerical problems for the estimation. For both models the reference category for the dependent variable was Type 3, which included trajectories dominated by standard full-time employment. The choice of reference category means that the effects of all variables can be interpreted with reference to the probability that a parent is in the cluster of continuous full-time employment compared to being in one of the other clusters in the analysis.

The model for women converged after seven iterations, while the model for men converged after eight iterations. The results of the Likelihood Ratio Chi-Square test for both models suggest that the hypothesis that all predictors' coefficients in the model are equal to zero can be rejected ($\chi^2_{women} = 2558.1, p < 0.001$, $\chi^2_{men} = 3973.1, p < 0.001$). However, the results of the Hausman-McFadden test on the *Independence of Irrelevant Alternatives* assumption suggest that the results should be interpreted with caution in the case of the male sample, as the hypothesis that the assumption holds is rejected ($\chi^2_{men} = 546.5, df = 100, p < 0.001$). Some researchers have raised some concerns about the accuracy of this test (see Vijverberg, 2011). However, the test was still applied in this case, as it remains one of the most commonly used tests in the literature and other alternatives have not yet clearly been established [5].

The results on the sample of women are displayed in Table 6.3. For an easier interpretation of the results coefficients have been exponentiated, which means that values can be interpreted as odds ratios. Odds ratios

[5] In the course of the analysis, a number of models were estimated for the male sample and this assumption did not hold for any other specifications. It did not hold also when the dependent variable was estimated based on the clustering performed separately for the male sample.

higher than one indicate a positive relationship, while odds ratios lower than one indicate a negative relationship.

It is particularly interesting to use the results of the model to understand which characteristics are associated to the probability that a women reduces her work participation after having a child. Perhaps the most interesting comparison in this analysis of the female sample is the comparison between Type 3 (Continuous full-time careers) and Type 6 (Reduction of working hours after birth in 2003). The trajectories of the two clusters of women look almost identical in the pre-maternity leave period. However, after the birth of their child, women in Type 3 (Continuous full-time careers) resume their previous full-time employment hours, while most of the women classified as Type 6 (Reduction of working hours after birth in 2003) switch to working part time after they have a child. It is also interesting to examine the differences between women with continuous full-time careers (Type 3) and the other two groups of women whose trajectories change after the birth of a child: Those in Type 5 who seem to transition to long-term labour market inactivity and those in Type 9 who seem to leave the country.

To compare the odds associated with being in Type 3 (Continuous full time careers) relative to Type 6 (Reduction of working hours after birth in 2003) for women according to the covariates used for the analysis, one needs to look at the column titled *Type 6: Trans. FT to PT* in Table 6.3. Work-related variables are surprisingly weakly associated with the odds of reducing working hours from full time to part time. Based on economic reasoning, it would be expected that women with higher opportunity cost (i.e. higher earners) and women with more job-specific human capital (i.e. more experience) will be less likely to reduce their work participation as they have a higher opportunity cost of doing so. However, the results lead to different conclusions. Earners in the category 3000 - 3500 € per month (higher than the reference group) are in fact more likely to be in Type 6 (Reduction of working hours after birth in 2003) than in Type 3 (Continuous full-time careers), as are women who started working in Luxembourg earlier (and have presumably more experience).

Turning to family-related variables, one finds only mixed-level support for a traditional economic explanation. Economic reasoning would suggest that women would be likely to reduce work participation as the value of their time at home increases - i.e. if they have more children. Interestingly, however, it appears that the choice of reducing working hours from full time to part time is made when the first child is born, as women who have no other children are more likely than women with one other child to be

in Type 6 (Reduction of working hours after birth in 2003). Women who are married are almost twice more likely than women who are not married to reduce their working hours. This is in line with the expectations, as women with partners can reduce working hours and the income of their spouse would still contribute to the family's income. While there is no information on the working status of the spouse, it can be assumed that male spouses are working. For example, figures presented in Margherita et al. (2009) suggest that about 95 per cent of fathers of children aged 0 to 11 were employed in Luxembourg, regardless of the age of their child. In the countries where the majority of cross-border workers come from (France, Belgium and Germany), the same report presents employment rates for fathers above 90 per cent (see Margherita et al., 2009, p. 34).

Comparisons between the reference group: Type 3 (Continuous full time careers) and Type 5 (Transition to labour market inactivity) and 9 ((Possibly) leaving Luxembourg) also indicate interesting results. Women in these clusters tend to have a prolonged period without an administrative record after the birth of a child. For women in Type 5 it can be almost certainly assumed that they transition to labour market inactivity as their records are matched with a record of co-insurance. Women in Type 9 are a more "mysterious" group as the absence of administrative record could indicate that they work in another country. Either way both of these trajectories are marked by an interruption in the pre-birth employment, which is what work-family reconciliation policy aims to reduce. Therefore these two types deserve special attention. Workplace related variables seem to play a larger role here, as almost all coefficients are significant. The pre-birth salary-related income dummies suggest a non-linear relationship between salary level and the odds of being into one of these two types relative to the reference group (Type 3 - Continuous full-time careers)). Women earning lower than the reference group or higher both have higher chances of being assigned to Clusters 5 (Transition to labour market inactivity) or 9 ((Possibly) leaving Luxembourg) relative to 3 (Continuous full-time careers).

Family-related variables add more to the story. Women who have a partner have about seven times higher odds of being in Cluster 5 (Transition to labour market inactivity) than in Cluster 3 (the reference group). Women who already have at least two other children also have more than double the odds of transitioning to labour market inactivity. However, the presence of partner and children does not seem to be related to the probability of being in Type 9 ((Possibly) leaving Luxembourg). Interestingly, the birth of twins or triplets in 2003 does seem to increase the odds of interrupting one's career, although the variable is significant only at the 10 per cent level

for Type 5 (Transition to labour market inactivity).

Overall, women with one or two children are more likely than women with no other children prior to 2003 to have continuous part-time careers (Types 1 or 7). The presence of a husband was positively associated to higher odds of being in Types 1, 5, 6, 7, relative to Type 3. What is common in the first four trajectory types is that they are either marked by a reduction in the labour force participation after birth or contain primarily trajectories of part-time employment. The findings on the presence of a husband are consistent with the idea that the potential earnings of the husband reduce the negative economic impact on the family resulting from the reduced earnings of the mother.

It is also interesting that the beginning of the trajectories of women with continuous part-time careers (Types 1 and 7) seems similar to the end of the trajectories of women in Cluster 6 (mothers who have remained in the labour force but who have reduced their working hours after having a child). This suggests that women who belong to Types 1 and 7 during the observation period, perhaps could belong to Type 6 if trajectories were aligned when their first child was born. The odds ratios for the variables indicating the number of other children in the household point in this direction. For types 1 and 7 (dominated by part-time work), there appears to be a positive relationship between the number of children in the household and the odds to be in this type and not in the reference category (Continuous full-time work). This finding is consistent with economic reasoning where it has been suggested that more children in the household increase the values of mothers' time at home and thus increase the cost of labour participation of women. However, the relationship is reversed for women in Type 6 (Transition from full-time to part-time work). This finding appears counter-intuitive because one would expect that women should be more likely to reduce their labour participation if they have more children. A possible explanation in this reversed relationship is that women who are still working full time after having their first child are a selected group with stronger labour market attachment. Since these women have not reduced their working hours after their first child was born, they are likely to either be highly motivated workers, or to have found an effective way to combine work with child care or both.

The results of the same analysis on the male sample are displayed in Table 6.4. These results are interesting to consider next to the results for women, as they provide further insight into the gendered nature of the relationship between employment and family. The relationship between monthly salary

income and salary growth seems and the odds of being in Type 3 (Continuous full-time career) seem to be the same in both samples. For both men and women the odds for earners above the reference category (2500 - 3000 €) are higher to be in Type 3 than in any other types, with a few exceptions in Type 1 (Continuous part-time careers (20 - 39 hrs/week)). For both men and women, positive salary growth is also associated with higher odds of being on Type 3 (Continuous full-time careers).

Family-related variables, such as other children in the household and marital status, are significant in fewer models than for women. Married men are more likely to be in types 4, 5 or 6 (grouped together due to a small number of cases) or in type 2 relative to type 3 (the reference category for the dependent variable). However, the presence of other children in the household does not seem to be associated with higher odds of being classified into one of the career types with reduced labour market participation (Type 1, 5,6 or 7).

	Type 1 Cont. PT I		Type 2 Cont. SE		Type 4 Cont. OT/PT		Type 5 Trans. to COA		Type 6 Trans. FT to PT		Type 7 Cont. PT II		Type 8 Cont. FT/PT		Type 9 Possibly abroad	
Intercept	0.11	***	0	***	0.07	***	0.12	***	0.53		0.01	***	0.65		0.06	***
Salary: <2000	2.91	***	3.75	***	2.16	***	6.65	***	1.01		3.44	***	1.66	*	4.27	***
Salary: 2000-2500	1.56	*	0.53		1.65	.	1.86	*	0.96		1.58	.	1.67	*	1.76	*
Salary: 3000-3500	1.33		0.76		1.48		0.95		1.54	.	0.88		1.11		1.16	
Salary: 3500-4000	1.61	*	0.82		1.43		0.59	.	1.67	*	0.91		1.16		0.49	.
Salary: 4000+	0.54	***	1.06		0.72		0.34	***	1.06		0.13	***	0.66	.	0.28	***
Salary growth: Positive	0.6	***	0.22	***	0.66	***	0.63	***	0.87		0.79		0.81		0.52	***
Years participation in LU	1.02		0.91	***	1.03		1.04	.	1.06	***	1.06	*	0.99		0.92	***
Category: Blue collar	2.62	***	0.12	***	8.01	***	2.18	***	1.08		1.23		2.44	***	3.3	***
Married	1.5	***	0.9		1.23		6.85	***	1.8	***	2.95	***	1.2		0.83	
Other children in HH:(1)	1.9	***	1.36		0.8		1.16		0.65	***	3.55	***	0.77		1.29	
Other children in HH:(2+)	3.21	***	2.36	*	0.91		2.5	***	0.84		6.14	***	1.27		1.75	.
Male child born in 2003	0.94		0.81		0.96		0.97		0.91		0.94		1		1	
Twins or triplets in 2003	1.04		2.89	.	1.08		2.29	.	1.87		1.08		2.51	.	2.86	*
Age in 2003	1.05	***	1.19	***	1.03		1.01		1		1.08	***	0.99		1.08	***
Nationality: France	0.79		0.29	***	1.92	***	0.11	***	0.65	*	0.24	***	1.33		1.73	*
Nationality: Portugal	0.55	*	0.94		1.51	.	0.14	***	0.35	***	0.13	***	0.73		0.27	***
Nationality: Belgium	1.17		0.29	***	2.42	***	0.28	***	0.99		0.5	***	1.37		1.76	*
Nationality: Germany	2.95	***	0.9		2.84	*	2.22	*	3.44	***	4.84	***	2.9	*	10.18	***
Nationality: Other	0.7		0.44	*	1.86	*	0.53	***	0.73		0.35	***	1.73	*	1.45	
Missing: Salary growth	1.06		4.24	*	0.78		3.85	*	1.33		4.28	*	2.24		1.33	
Missing: Record 2003	1.31		0.51		1		0.63		1.15		1.33		1.22		0.63	

Table 6.3: Multinomial logit results (odds ratios) for women.
Reference categories: Salary: 2500-3000, Salary growth: Negative, Employment category: White collar (including self-employed and civil servants), Married: No, Other children in HH:(0), Sex of child born in 2003: Female, Single Birth, Nationality: Luxembourg
Significance codes: *** 0.001, ** 0.01, * 0.05, . 0.1.
Abbreviations: FT: full-time ; PT: part-time ; PT I: 20 to 39 hrs/week ; PT II: <=20 hrs/week ; SE: self-employment ; OT: overtime ; COA assumed labour market inactivity.

	Type 1 Cont. PT I		Type 2 Cont. SE		Type 4 Cont. OT/PT		Types 5 , 6 & 7 Trans. to COA Trans. FT to PT Cont. PT II		Type 8 Cont. FT/PT		Type 9 Possibly abroad	
Intercept	0.02	***	0.02	***	0.42	*	0.01	***	0.3	***	0.02	***
Salary < 2000	8.76	***	11.52	***	0.96		4.6	***	1.2		2.48	*
Salary: 2000-2500	4.73	***	1.01		1.15		1.94		1.09		1.96	*
Salary: 3000-3500	3.79	***	0.71		0.53	***	0.85		0.67	*	0.44	.
Salary: 3500-4000	2.89	*	0.56		0.49	***	0.54		0.61	*	0.95	
Salary: 4000-4500	1.47		0.34	*	0.47	***	0.97		0.48	***	0.89	
Salary: 4500-5000	2.62	*	0.45	*	0.56	***	0.48		0.59	*	0.38	.
Salary: 5000-5500	2.54	.	0.48	.	0.54	***	1.18		0.35	***	0.45	
Salary: 5500+	0.78		0.9		0.39	***	1.78		0.36	***	0.72	
Salary growth: Positive	0.62	***	0.18	***	0.52	***	0.76		0.6	***	0.54	***
Years participation in LU	1.03		1.04	*	1.02		0.99		0.99		0.92	***
Category: Blue collar	3.48	***	0.16	***	19.06	***	22.28	***	2.29	***	4.66	***
Married	1.01		2.01	*	1.08		4.15	*	1.2		1.45	
Other children in HH:(1)	0.86		1.23		1.22	*	1.04		1.12		1.45	*
Other children in HH:(2+)	1.2		1.56	*	1.12		1.02		1.1		1.18	
Sex of child born in 2003: Male	0.92		0.92		0.93		1.15		0.96		0.83	
Twins or triplets	1.82		0.66		0.91		0.88		0.7		0.93	
Age in 2003	1.01		1.06	***	1		1.01		1.01		1.03	*
Nationality: France	1.35		0.44	***	2.09	***	0.1	***	1.98	***	3.7	***
Nationality: Portugal	0.79		2.48	*	5.14	***	0.04	***	2.5	***	8.2	***
Nationality: Belgium	1.55	.	0.95		2.23	***	0.44	*	1.81	***	3.76	***
Nationality: Germany	0.95		0.58		2.21	***	0.7		2.29	***	1.54	
Nationality: Other	1.1		2.19	***	2.9	***	0.5	.	2.53	***	7.1	***
Missing: Salary growth	0.66		1.65		0.55		0.47		0.68		2	
Missing: Record 2003	0.85		1.35		1.32		0.33		0.95		1.47	

Table 6.4: Multinomial logist results (odds ratios) for men.
Reference categories: Salary: 2500-3000, Salary growth: Negative, Category: White collar (including self-employed and civil servants), Married: No, Other children in HH:(0), Sex of child born in 2003: Female, Single Birth, Nationality: Luxembourg
Significance codes: *** 0.001, ** 0.01, * 0.05, . 0.1.
Abbreviations: FT: full-time ; PT: part-time ; PT I: 20 to 39 hrs/week ; PT II: <=20 hrs/week ; SE: self-employment ; OT: overtime ; COA assumed labour market inactivity.

6.5 Discussion

The main goal of this chapter was to identify and describe the main patterns of work-family reconciliation for working mothers and fathers in Luxembourg. The main finding is that the event of a birth of a child in the household is a turning point in about a third of the female trajectories. For some of these trajectories there is a reduction in the number of working hours, while others are marked by withdrawing from the labour force for prolonged periods. About a third of the women employed in Luxembourg maintain a profile of continuous full-time (and even overtime) employment, while the other third have predominantly part-time careers. About 85 per cent of the male trajectories fall in one of three major types: continuous full-time employment, and continuous overtime employment intermittent with either full-time or part-time work.

This chapter has also made an attempt to link the probability of being in any of the major career profiles with certain covariates that have been made available in the administrative data. The results from the analysis of the sample of mothers lend partial evidence to an economic justification of women's career decisions. Lower opportunity cost (in terms of foregone salary earnings) does seem to be associated with higher probability to leave the workforce. More children and the presence of a spouse in the household also make it more likely that a woman will leave her pre-birth employment than maintain a continuous full-time career track. However, these factors do not seem to be associated with a higher probability for women to reduce employment hours from full time to part time after having a child.

The present study has a number of limitations. To begin with, the results are based on the analysis of a specific, restricted sample: parents employed in Luxembourg, who were eligible to take parental leave at the time of birth. By definition, this analysis excludes marginalized workers who work less than twenty hours per week for the same employer, non-parents and parents who do not participate in the labour force. Hence the results are not generalizable to those individuals.

Combining state sequence analysis and clustering means taking two steps: construction of the distance matrix and the clustering algorithm. Critics of the method have pointed out that usually these steps are made in the absence of a clear theoretical foundation (as is the case in this study). In addition, other scholars have pointed out that results based on sequence analysis can be sensitive to *both* the distance metric and the clustering

criteria (Holland, 2006). It is worth mentioning that there already exist methods where links between covariates and trajectories can be established directly, without an intermediate step of clustering. Interested readers are referred to Studer et al. (2011) and Studer, Ritschard, Gabadinho, and Müller (2010), where discrepancy analysis[6] and regression trees are discussed.

One of the most important policy implications of the presented findings are that even though many women in Luxembourg continue working after having a child, the the dual-earner model does not apply to the majority of families with two working parents. The situation seems to be more often the "one-and-a-half" earner model (Lewis et al., 2008, p. 28). This is important to recognize because assuming a dual-earner or a "one-and-a-half" earner model could make a difference in the design, implementation and evaluation of a broad range of social policy programs. For example, it can play a role in the calculation of taxes, setting income brackets of eligibility for social payments and services, determining pension insurance premiums and so forth.

[6]In the course of the analysis discrepancy analysis has also been performed with the present data. The results are available on request. Discrepancy analysis provides a different perspective for the analysis, as it allows one to find out which covariates explain the greatest share of discrepancy - that is, it is possible to find out which factors have the greatest impact on trajectories. However, for this particular study, multinomial logit analysis was considered more informative because it could provide information about the direction of the relationship.

6.A Index-plots based on separate clustering

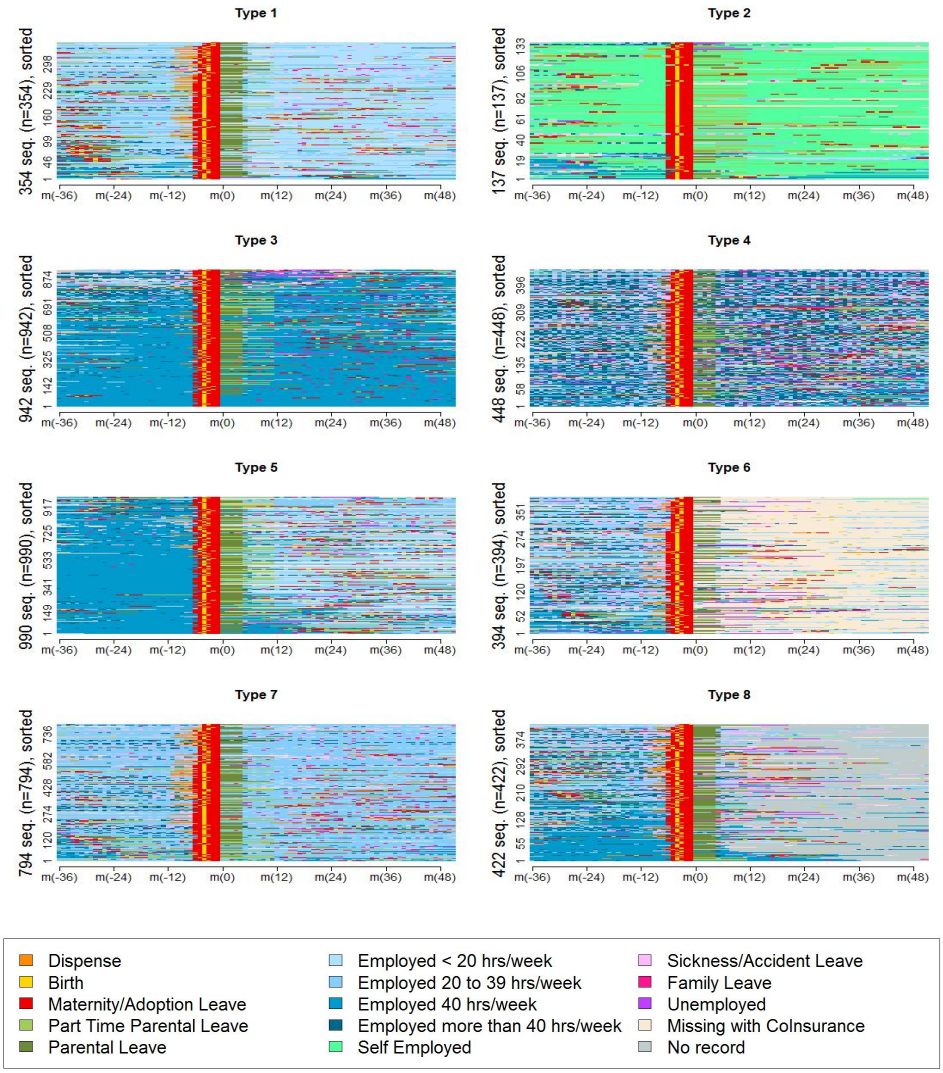


Figure 6.7: Longitudinal view of trajectories (index plots) of working mothers in Luxembourg who had a child in 2003 grouped in eight clusters.
Notes: The clusters have been obtained based on the sample of women only. The horizontal axis represents time in months. The plot represents all trajectories stacked horizontally. For a clearer view, the trajectories have been sorted according to their distance from the most frequent trajectory in the sample.

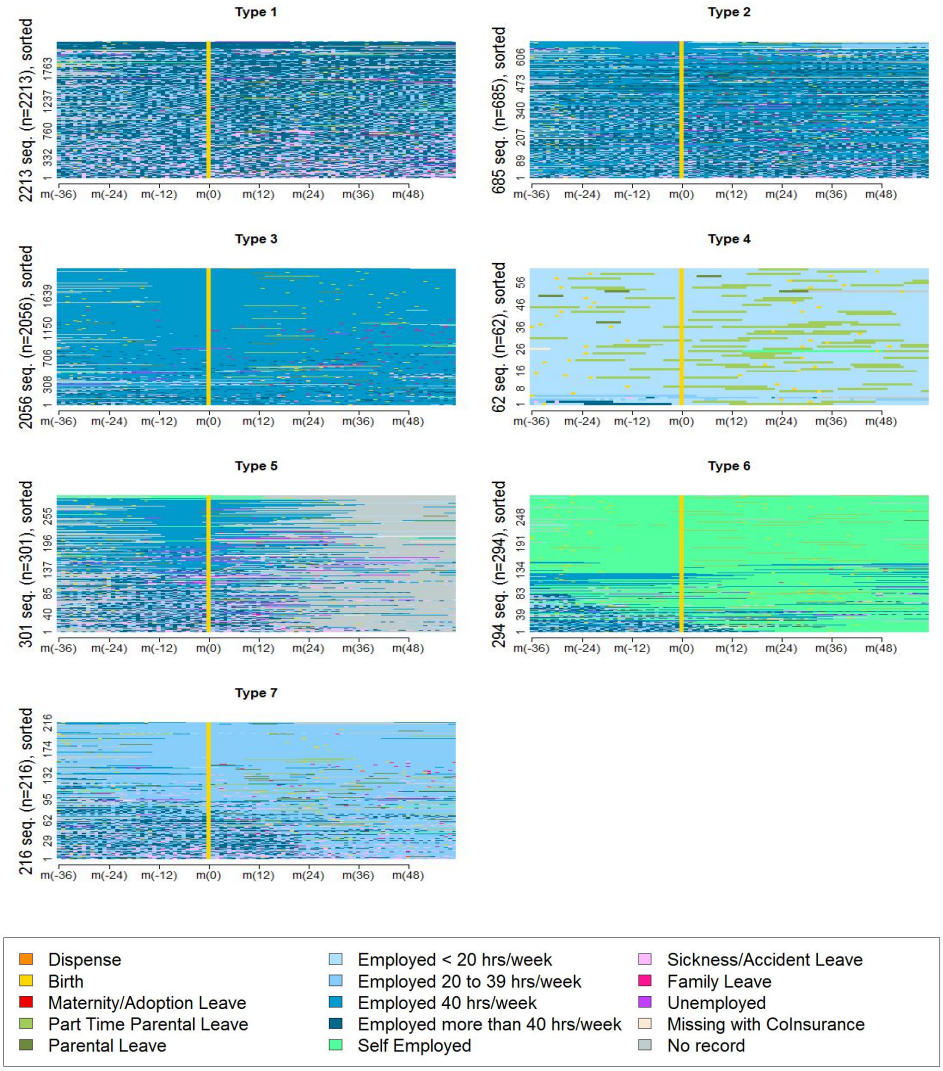


Figure 6.8: Longitudinal view of trajectories (index plots) of working fathers in Luxembourg who had a child in 2003 grouped in seven clusters.
Notes: The clusters have been obtained based on the sample of men only. The horizontal axis represents time in months. The plot represents all trajectories stacked horizontally. The trajectories have been sorted according to their distance (based on LCS) from the most frequent trajectory in the sample.

6.B Diagnostic statistics for separate clustering results

	PBC	HG	HGSD	ASW	CH	R2	HC
2	0.37	0.43	0.43	0.18	556.01	0.11	0.27
3	0.51	0.60	0.60	0.19	439.17	0.16	0.20
4	0.57	0.70	0.70	0.21	383.76	0.20	0.15
5	0.51	0.65	0.65	0.19	370.24	0.25	0.19
6	0.55	0.73	0.72	0.21	344.77	0.28	0.16
7	0.57	0.76	0.76	0.22	327.72	0.31	0.14
8	0.59	0.83	0.82	0.22	325.00	0.34	0.12
9	0.57	0.84	0.84	0.22	310.13	0.36	0.12
10	0.57	0.85	0.84	0.22	290.51	0.37	0.11
11	0.56	0.86	0.85	0.22	276.39	0.38	0.11
12	0.52	0.85	0.84	0.19	262.86	0.39	0.12
13	0.52	0.85	0.85	0.19	248.14	0.40	0.12
14	0.52	0.86	0.86	0.18	235.49	0.41	0.12
15	0.52	0.87	0.87	0.18	223.73	0.41	0.11

Table 6.5: Values of the cluster diagnostic statistics by number of clusters for the sample of women.

	PBC	HG	HGSD	ASW	CH	R2	HC
2	0.54	0.62	0.61	0.41	2424.76	0.29	0.18
3	0.65	0.75	0.75	0.46	1633.74	0.36	0.13
4	0.69	0.82	0.81	0.37	1361.79	0.41	0.10
5	0.73	0.88	0.88	0.39	1158.18	0.44	0.06
6	0.74	0.90	0.90	0.38	1003.22	0.46	0.05
7	0.75	0.91	0.91	0.39	890.93	0.48	0.05
8	0.69	0.89	0.89	0.31	826.91	0.50	0.06
9	0.68	0.90	0.90	0.31	755.67	0.51	0.06
10	0.68	0.91	0.91	0.31	696.06	0.52	0.05
11	0.55	0.85	0.84	0.23	684.72	0.54	0.11
12	0.55	0.85	0.85	0.24	639.83	0.55	0.10
13	0.55	0.86	0.86	0.24	602.74	0.55	0.10
14	0.55	0.86	0.86	0.24	571.37	0.56	0.10
15	0.55	0.87	0.87	0.24	540.49	0.57	0.09

Table 6.6: Values of the cluster diagnostic statistics by number of clusters for the sample of men.

Notes: The diagnostic statistics displayed in this appendix have been computed with the *WeghtedCluster* package (Studer, 2013), which runs under the free statistical and programming environment R (R Core Team, 2014). Descriptions of each statistic are available in section 6.2.5.

6.C Index plots based on pooled clustering

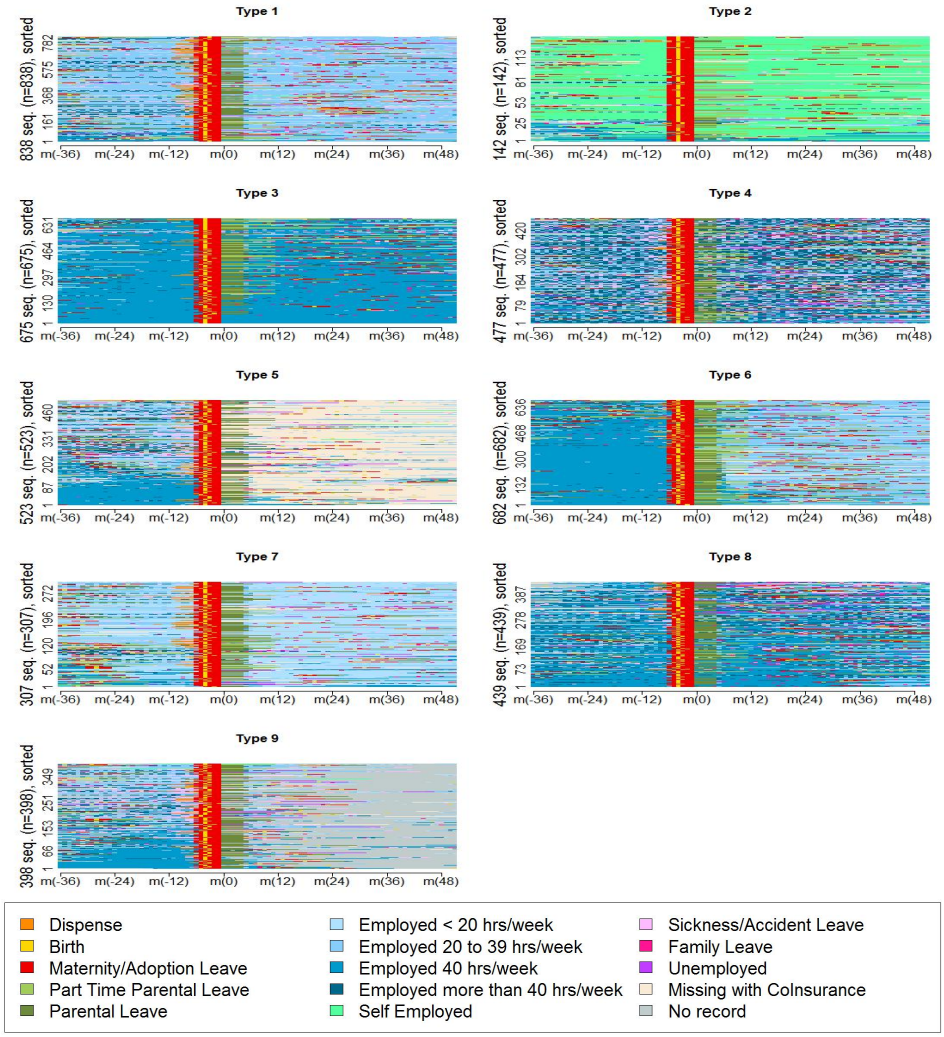


Figure 6.9: Longitudinal view of trajectories (index plots) of working mothers in Luxembourg who had a child in 2003 grouped in nine clusters.
Notes: The clusters have been obtained based on the pooled sample of mothers and fathers. The horizontal axis represents time in months. The plot represents all trajectories stacked horizontally. The trajectories have been sorted according to their distance (based on LCS) from the most frequent trajectory in the pooled sample. The trajectories are aligned according to the last month of maternity leave following the birth in 2003.

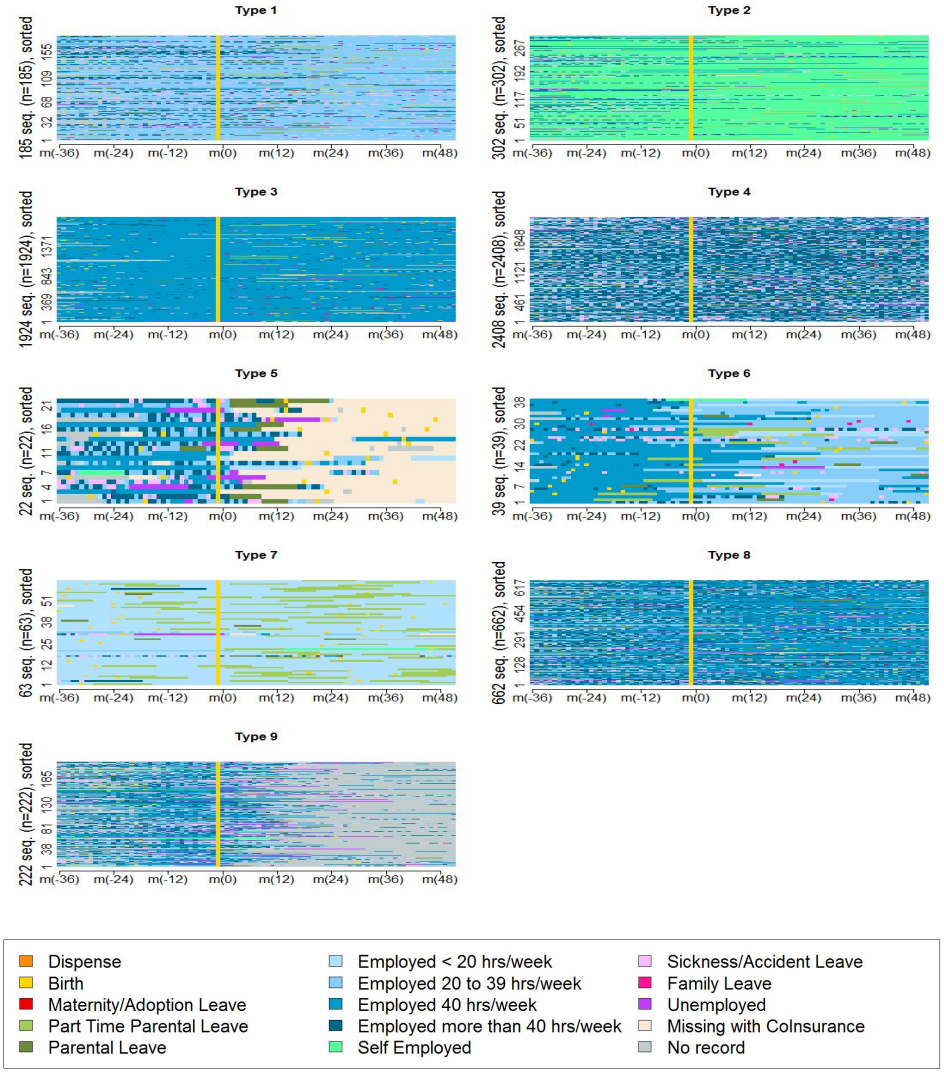


Figure 6.10: Longitudinal view of trajectories (index-plots) of working fathers in Luxembourg who had a child in 2003 grouped in nine clusters.
Notes: The clusters have been obtained based on the pooled sample of mothers and fathers. The horizontal axis represents time in months. The plot represents all trajectories stacked horizontally. The trajectories have been sorted according to their distance (based on LCS) from the most frequent trajectory in the pooled sample. The trajectories are aligned according to the month in which the birth occurred in the household in 2003.

6.D Diagnostic statistics for pooled clustering results

	PBC	HG	HGSD	ASW	CH	R2	HC
2	0.48	0.55	0.54	0.28	2243.10	0.18	0.20
3	0.61	0.71	0.70	0.29	1772.56	0.26	0.14
4	0.66	0.78	0.78	0.32	1428.26	0.29	0.11
5	0.70	0.84	0.84	0.31	1261.62	0.33	0.09
6	0.64	0.81	0.81	0.28	1255.22	0.38	0.11
7	0.66	0.86	0.86	0.30	1165.16	0.40	0.09
8	0.67	0.88	0.87	0.31	1074.77	0.42	0.08
9	0.68	0.90	0.89	0.31	1004.37	0.44	0.08
10	0.63	0.89	0.88	0.25	942.92	0.45	0.09
11	0.62	0.90	0.90	0.25	878.13	0.46	0.08
12	0.62	0.90	0.90	0.24	825.10	0.47	0.08
13	0.62	0.91	0.91	0.24	779.02	0.48	0.08
14	0.54	0.87	0.87	0.21	758.26	0.49	0.12
15	0.53	0.88	0.88	0.21	722.80	0.50	0.11

Table 6.7: Values of the cluster diagnostic statistics by number of clusters. Notes: The values are computed for the pooled clustering results. Each diagnostic is explained in section 6.2.5.

6.E Missing values

Several variables contained a number of missing values. For both men and women, the largest number of missing values was found in the variables measuring the number of children in the household as of 2003, the presence of a spouse and the size of the organization in 2003. These values were missing due to a lack of administrative record for 200 women and 380 men for 2003. To deal with this problem, missing values were substituted with the values for the first available record after 2003. For about half of the observations this was as soon as 2004. In other cases records were used from as late as 2007. With this procedure, the missing values of the records of 196/200 women and 378/380 men were imputed.

Using these values means making the assumption that the situation of the person the first time a record appeared was the same as in 2003. To control for the bias introduced by these imputed records, a dummy variable was included in the analysis, which took the value of 1 if information on these three variables was based on a record later than 2003. In Tables 6.3 and 6.4 this variable is displayed with the name "Missing: Record 2003". This variable is not significant in any of the multinomial logit models, suggesting that parents who did not have a record for 2002 are not structurally different from others in terms of their work-family reconciliation trajectory.

Another variable, which contained a large number of missing values, was the variable indicating the growth of the salary in a six-month period prior to the maternity leave for women and the birth for men. The variable was calculated with a lag of six months to avoid capturing fluctuations in the level for salary growth due to the expectation of a child in a the near future. This means that information on the salary should be available for a record for as far back as 12 months before the start of the maternity leave or the birth so that the average growth rate could be computed. For some individuals there were no records, if they had started working in Luxembourg later than this period. Other reasons why some values could be missing were gaps in the salary information. Overall, these were very few records. To deal with the problem, a dummy variable indicating a missing value was introduced in the model. In tables 6.3 and 6.4 this variable is displayed with the name "Missing: Salary growth". This variable is never significant for men, but it is a significant predictor of the probability of women to be in clusters 2, 5 or 7. This indicates that the missing values are not randomly distributed, as women with missing values on salary growth are more likely to be self-employed, working part time or to leave the labour force after having a child.

6.F Sensitivity Analysis

6.F.1 Overview

This section presents a sensitivity analysis of the results. The results obtained in this chapter are sensitive to the coding of the states, the choice of distance measure and the clustering technique. To illustrate the extent to which the obtained results are sensitive to varying any of these components, a sensitivity analysis is presented, which shows the extent to which sequences would be assigned to the same clusters if any of these components are changed.

The alternatives explored in this sensitivity analysis do not form an exhaustive list of all possible alternative state codings, distance measures or clustering techniques. Rather, techniques have been selected based on being relatively wide-spread and well-known, which is reflected in their availability in the *cluster* package (Maechler et al., 2014) and the *TraMineR* package (Gabadinho et al., 2011) for the free statistical and programming environment R (R Core Team, 2014). The purpose of this sensitivity analysis is to show to what extent the results will change if any of these components are changed and to present an idea of the magnitude of the change.

The general approach in the sensitivity analysis was to compare the clustering result obtained through the presented analysis to clustering results that would be obtained if some of these components are varied. Such an approach is presented in the sensitivity analysis in the paper of McVicar and Anyadike-Danes (2002). In this section, the same approach has been followed. The section reports the proportion of overlap between solutions as well as the Rand's index (RI) (Rand, 1971) and Hubert and Arabie's adjusted Rand index (ARI) (Hubert and Arabie, 1985) as measures of agreement between cluster solutions.

The proportion of overlap between cluster solutions is calculated as the fraction of cases that would be assigned to the same cluster by both solutions (N_{match}) out of the number of sequences in the data set (N).

Rand's index is a measure of cluster agreement, which is presented in Rand (1971). The formula takes into account both the data points that are assigned to the same cluster by two methods and the data points that are assigned to different clusters. The measure can take on values between 0

and 1. Values equal to 1 indicate perfect agreement between two solutions and values closer to 0 would indicate lower levels of agreement.

Milligan and Martha (1987) note that, although Rand's index has been widely used after its publication, it is recommended that one of its adjusted variations is used. In this analysis the adjusted formula presented by Hubert and Arabie (1985) was used. The adjusted index can also take negative values, in cases where the cluster agreement is lower than what would be expected to be due to chance alone. Other adjusted are also available (see Steinley, 2004).

Due to being computationally demanding, calculations were performed on a random sample consisting of 30 per cent women and 30 per cent men drawn from the entire data. However, this led to the problem that the results obtained through the random sub-sample were not identical to the results obtained from using the whole data set. Most importantly, the cluster of careers marked by transition from full-time to part-time working hours was not clearly defined and these careers were grouped with careers dominated by continuous part-time employment. Another difference with the results obtained through the full sample is that the two clusters dominated by part-time employment were not clearly defined but mixed with some full-time employment trajectories. However, as the same sample was used for all comparisons, it was assumed that variations resulting from changing the distance measure or the clustering algorithm can still be explored. The clustering results based on the sample used as a baseline for the sensitivity check are displayed in Figure 6.11.

A related problem is the issue of robustness across samples. The problem of robustness of the results across samples is also discussed in the sensitivity check of McVicar and Anyadike-Danes (2002), although their sample size was much smaller than the sample size used for this analysis. McVicar and Anyadike-Danes (2002) compared the results obtained through performing the same analysis on two random sub-samples of the full data, finding that the cluster structure obtained in the two cases was similar.

The issue of robustness across samples is particularly important for the presented sensitivity check, as the sensitivity check is also performed on a random sample from the data. To check if the results can change with changing the sample, three additional samples were drawn of size equal to the first sample selected for analysis. In all four cases, a distance matrix was computed using LCS and the clustering was performed using Ward's agglomerative hierarchical clustering. Although the cluster structure ob-

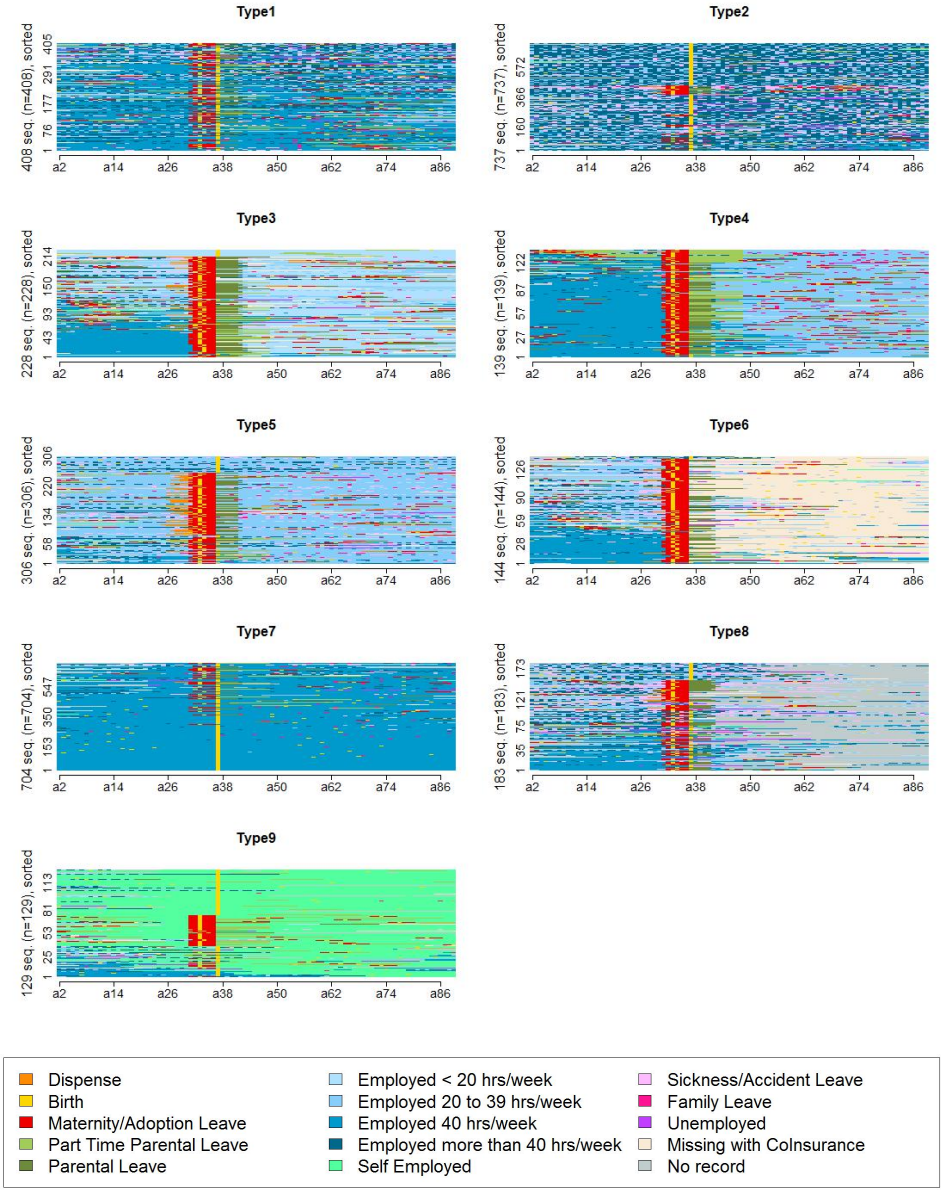


Figure 6.11: Longitudinal view of trajectories (index plots) of working parents in Luxembourg who had a child in 2003 grouped in nine clusters using agglomerative hierarchical clustering.
Notes: The clusters have been obtained based on a pooled sub-sample of mothers and fathers equal to 30 per cent of the data set. The horizontal axis represents time in months. The plot represents all trajectories stacked horizontally. The trajectories have been sorted according to their distance (based on LCS) from the most frequent trajectory in the pooled sample.

	Sample 1		Sample 2		Sample 3		Sample 4	
Cluster	N	%	N	%	N	%	N	%
1	408	13.7	304	10.2	293	9.8	395	13.3
2	737	24.7	750	25.2	784	26.3	548	18.4
3	228	7.7	146	4.9	173	5.8	189	6.3
4	139	4.7	176	5.9	172	5.8	242	8.1
5	306	10.3	326	10.9	328	11.0	250	8.4
6	144	4.8	150	5.0	172	5.8	200	6.7
7	704	23.6	704	23.6	759	25.5	876	29.4
8	183	6.1	178	6.0	161	5.4	200	6.7
9	129	4.3	104	3.5	136	4.6	125	4.2
N	2978	100 %	2978	100 %	2978	100 %	2978	100 %

Table 6.8: Counts and percentages of sequences assigned to each cluster by different random sub-samples of the data.
Notes: In all cases samples were drawn without replacement. The distance matrix is computed by LCS and Ward's agglomerative hierarchical clustering is performed.

tained through all samples is very similar, the exact numbers of sequences assigned to each cluster differed in each case. Table 6.8 illustrates the differences in terms of percentages of sequences assigned to each cluster.

6.F.2 Sensitivity to coding of states

The sensitivity of the results to the coding of states is explored in the following way. First, the baseline clustering results are computed using the sample described in section . Next, some of the states in the same sample are replaced by the working-hours category for their respective months. Finally the distribution of clustering results is compared to the baseline.

The states chosen to be replaced for the comparison represent health-related states. The most obvious example is the leave due to sickness or accident. Dispense and maternity leave are also health-related leaves, because their main objective is to protect the health of the pregnant woman and the unborn baby. Apart from their health-protection goal, all of these leaves are similar in that they are job-protected - it is not possible to terminate the employment contracts of persons during these leaves. Loss of income during these leaves is also provided on an income-related basis (i.e. as a

percentage of prior earnings). That is why it was considered appropriate to replace the states with working hours for the comparison - the person is still considered working during these leaves.

In all cases the distance matrix was computed by LCS and Ward's agglomerative hierarchical clustering was performed and men's and women's trajectories were pooled together. The results are reported in Table 6.9. The results suggest that more than 75 per cent of the cases would be clustered in the same group when using the baseline or the any of the alternative coding schemes. Interestingly, the comparison where the largest number of codes was replaced (third row) did not yield the largest level of difference (second row). Rather, it was replacing the pregnancy-related leaves (dispense and maternity leaves), which appeared to lead to a slightly larger difference.

Visually exploring the clustering results did not reveal a different overall structure of the grouping. However, when maternity leave and dispense leave were excluded from the analysis, the clustering results looked much closer to the clustering results obtained by clustering the full data in the sense that the groups of working part time were more clearly separated from the group of transitioning from full-time to part-time hours of work.

It is important to note that while overall there was a good match between the results obtained with the baseline and the alternative codings, the percentage of matched cases varied considerably for some of the clusters for the women's trajectories. The clusters marked by transition to inactivity or leaving the country were reasonably well-defined with an overall match around 80 per cent. The match in the clusters with continuous full-time employment and transition from full-time to part-time working hours was considerably lower - sometimes even lower than 40 per cent. This is probably due to the fact that with the smaller sample on which the sensitivity check was performed these clusters were not clearly defined in the first place - they contained trajectories from different groups, so it is not so surprising that the match was less good.

Alternative coding	Overall	Women	Men	RI	ARI
Replace sick/accident leave	0.90	0.87	0.94	0.94	0.80
Replace dispense and maternity leave	0.79	0.76	0.85	0.90	0.64
Replace dispense, maternity and sick/accident leave	0.82	0.75	0.90	0.92	0.72
Sample size	2978	1344	1634	2978	2978

Table 6.9: Illustration of sensitivity to coding of states.
Notes: The table shows the agreement of cluster assignments between the baseline coding and alternative coding schemes where some of the states are replaced with states representing working hours for the same month.

6.F.3 Sensitivity to choice of distance measure

To examine the sensitivity of the results to the choice of distance measure, the results obtained through using the LCS measure have been compared to three other measures, which are described below.

- *Transition rates.* With this method of computing the distances, the substitution costs are not constant but are set based on the transition rates estimated from the data (Gabadinho et al., 2011). The formula for computing the transition rates is presented in Gabadinho et al. (2011), (p. 26) as shown in Equation 6.5. In this equation $p(s_i|s_j)$ stands for the probability of observing state s_j at time $t+1$, given that at time t the state s_i has been observed. When using transition rates for setting the substitution costs, higher costs will be assigned to states between which transitions are not frequently observed and lower costs for states between which transitions are observed more frequently.

$$2 - p(s_i|s_j) - p(s_j|s_i) \tag{6.5}$$

- *OM with indel = 2, subst = 1.* This distance measure has been chosen because it has the inverse ratio of the indel and substitution costs in the LCS measure. The LCS measure is OM with the indel cost equal to 1 and substitution cost equal to 2. This means that with the LCS method, indels will be used less frequently than substitutions because they are more expensive. With reversing the values, indels

Alternative measure	r	Proportion match			RI	ARI
		Overall	Women	Men		
Transition rates	0.99	0.83	0.81	0.86	0.91	0.68
Indel = 2, Subst = 1	0.94	0.77	0.71	0.84	0.90	0.64
Hamming	0.92	0.79	0.72	0.86	0.90	0.66
Sample size	$\frac{2978*2977}{2}$	2978	1344	1634	2978	2978

Table 6.10: Comparisons of the results of cluster assignment between a sample using the distance measure used for the analysis (LCS) and an alternative distance measure.
Notes: In all cases agglomerative hierarchical clustering with Ward's method was used and it was stopped at nine clusters.

will be used more frequently. This means that the measure will be more sensitive to differences in timing (Gabadinho et al., 2011).

- *Hamming Distance*. With this distance measure only substitutions are used and no indels (Lesnard, 2010). It is equivalent to OM with substitution costs equal to 1 and the cost of the indel set to an arbitrary very high value. The measure is very sensitive to timing. With this distance only sequences of equal length can be compared (Gabadinho et al., 2011).

The comparisons suggest that the distance matrices are highly correlated in all cases. The Pearson correlation coefficient (r) between the distances was above 90 per cent in all cases. However, even though the distance matrices were highly correlated, there were differences in the cluster assignment. This is especially true for the sample of women, where only about 70 per cent of cases would be assigned to the same cluster by both procedures on average when comparing to a distance measure with higher costs of the indel.

6.F.4 Sensitivity to choice of clustering procedures

To explore this sensitivity, the cluster assignment was compared to the assignment generated by two alternative clustering procedures implemented in the *cluster* package (Maechler et al., 2014). The function *diana* performs divisive hierarchical clustering. This type of clustering is different from agglomerative clustering in that it starts from the whole data and splits it

Alternative measure	Proportion match			RI	ARI
	Overall	Women	Men	RI	ARI
diana	0.70	0.61	0.83	0.86	0.56
pam	0.82	0.76	0.89	0.92	0.71
Sample size	2978	1344	1634	2978	2978

Table 6.11: Comparisons of the results of cluster assignment between the clustering used for the analysis (agglomerative hierarchical clustering with Ward's method) and an alternative procedure.
Notes: In all cases clustering was stopped at nine groups.

into sub-clusters in a top-down direction. Agglomerative clustering works in the opposite direction - bottom up. The function *pam* partitions the data round medoids. It is necessary to pre-specify how many partitions are wanted in advance - in this case those are nine partitions.

The results from the comparison are presented in Table 6.11. Overall, the results from the partitional clustering are similar to the results obtained with the agglomerative hierarchical clustering. The results from the divisive clustering, however, are quite different. There is a small cluster where the trajectories share multiple episodes of use of sick leave throughout the observation period. There is also another small cluster where alternations between different levels of part-time leave seemed to dominate the trajectories. At the same time the trajectories marked by continuous self-employment and transition to assumed labour inactivity are all grouped together. These results are shown in Figure 6.12.

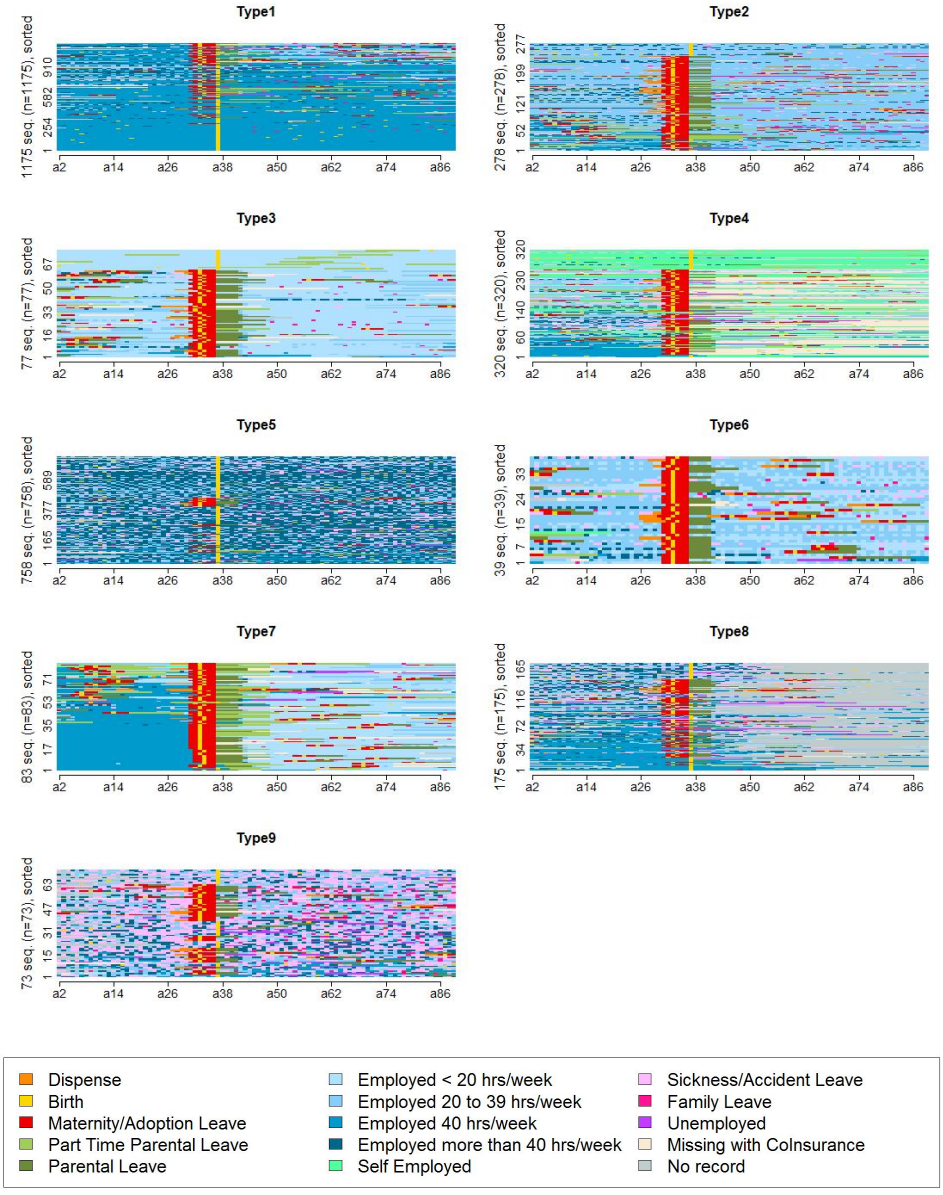


Figure 6.12: Longitudinal view of trajectories (index-plots) of working parents in Luxembourg who had a child in 2003 grouped in nine clusters using divisive clustering.
Notes: The clusters have been obtained based on a pooled sub-sample of mothers and fathers equal to 30 per cent of the data set. The horizontal axis represents time in months. The plot represents all trajectories stacked horizontally. The trajectories have been sorted according to their distance (based on LCS) from the most frequent trajectory in the pooled sample.

Part III

Determinants of Use of Parental Leave

CHAPTER 7

Parental leave take-up and return to work of mothers in Luxembourg: A study based on nested dichotomies

7.1 Introduction and literature review

This chapter analyses the use of parental leave after birth of a child for working mothers. The behaviour of mothers is represented as a series of three decisions taking place after the compulsory period of maternity leave. The first decision is to retain a relationship with the pre-birth employment or to leave the labour force. Women who do not quit their employment, make a second choice: to return to work immediately or to take parental leave for a fixed period of time, which guarantees them the right to return to work. Finally at the end of parental leave, women decide whether to return to work or to quit their job.

These three decision points have been conceptualized based on the empirical analysis presented in chapter 5, which shows that not all women use parental leave, and, women may exit the labour force both after maternity and after parental leave. This finding is in line with the findings of Valentova (2011) who shows that women who do not plan[1] to use parental leave are a very heterogenous group. On the one hand, there are women who do not want to take parental leave because they want to remain outside the labour force for a longer period of time. On the other hand, there is a

[1]The study of Valentova (2011) is not based on actual behaviour but on anticipated behaviour.

group of women who do not take leave because they want to resume working immediately after maternity leave. It is interesting to find out in what respects these two groups differ and to better understand women's labour market participation decisions around birth.

Policy evaluation studies in previous literature have shown that parents' behaviour responds to variations in parental leave policy design. Using changes in policy provisions to create a quasi-experimental framework for analysis, previous studies have shown that the duration of time mothers spend taking care of their infant at home follows the duration of provided parental leave, especially for the duration that it is also accompanied by a financial benefit (Lalive and Zweimüller, 2009; Bergemann and Riphahn, 2011; Kluve and Tamm, 2012; Baum and Ruhm, 2013). In addition, evaluations of recent policy reforms earmarking parts of the paid parental leave for fathers have demonstrated that men are also likely to be involved in stay-at-home caring activities given the respective policy incentives (Duvander and Johansson, 2012; Kluve and Tamm, 2012; Ekberg et al., 2013).

It has also been shown that not all parents respond to changes in parental leave policy in the same way. Parents differ in the extent to which they can actually afford to take leave (if they are at all eligible), especially in cases where the leave is unpaid or paid on a flat-rate basis[2]. For example, in the USA, where only unpaid leave is available Han et al. (2009) find that married women are more likely to use leave, which is possibly due to the additional income support they can receive from their partners. In European countries with generous paid parental leave schemes where take-up is generally high, return to work has been shown to differ between mothers. For example, higher educated mothers are more likely to return to work than their lower-educated counterparts (Ondrich, Spiess, and Yang, 1996; Bergemann and Riphahn, 2011).

Although the analysis in this chapter cannot explain to what extent the presence of a parental leave statute is altering women's behaviour[3], the study can contribute to understanding women's decisions to use parental leave and to participate in the labour force after giving birth. The main contribution of the study is in that it breaks down the decision of women to participate in the labour force into a set of decisions. This has been

[2]Flat-rate basis means that all parents on parental leave receive the same monthly benefit. An alternative compensation scheme is income replacement where the benefit for each parent is calculated as a percentage of previous earnings.

[3]There is no available data for the period prior to the introduction of the parental leave policy in Luxembourg.

made possible due to the available administrative data. The data allow for a distinction between maternity leave, parental leave and time outside the labour force, which are often grouped together in previous literature. In addition, the longitudinal nature of the data makes it possible to trace women's behaviour for sufficient time periods both before and after the event of giving birth.

7.2 Theoretical framework

The present study is based on the theoretical model developed by Klerman and Leibowitz (1997). The model of Klerman and Leibowitz (1997) allows one to investigate how the labour-force participation decisions of mothers would be affected by the introduction of a fixed-term parental leave mandate. In parallel with parental leave in the European Union, the mandate investigated by Klerman and Leibowitz (1997) guarantees women the right to return to work and to receive the same wage as they received prior to giving birth. However, in contrast to most European Union leaves, there is no compensation during the leave in the theoretical model.

The model is developed for a simplified situation where women only make a decision to work or not (without distinguishing the number of hours) and women have only one child. As the child grows older, the value of women's time at home decreases. For each woman, the salary she was receiving before birth (w_0), is higher than the potential salary she could receive if she quits work and searches for another position after the birth (w_a). The latter salary is lower due to the loss of human capital during the leave. In the presented theoretical model each woman returns to work when her reservation wage (the value of her time at home) is equal to the pre-birth wage offered by her employer. Essentially each woman has an optimal amount of time she would like to remain at home, which differs according to how quickly the value of her time at home is decreasing with time and how high was her pre-birth wage.

The introduction of a fixed-term parental leave changes the decision situation of the woman depending on whether the available leave duration is longer or shorter than the optimal amount of time she would like to stay at home. Women who, in the absence of a leave provision, would like to take a leave shorter than the leave made available through the mandate, are likely to extend the duration of the time they spend at home to the full dura-

tion of the provided leave especially if they can afford to fund the period themselves. On the other hand, women who would like to take more leave than the leave period offered will have to compare the difference between the initial wage (w_0), which they can maintain if they shorten the duration of their leave and the potential wage (w_a) they could earn if they change jobs combined with the utility of remaining at home for a longer period of time.

The theoretical model of Klerman and Leibowitz (1997) has been developed with the US context in mind, therefore it needs to be applied to the Luxembourg context with a few explanations. Table 7.1 provides an overview of the main differences between the theoretical model developed by Klerman and Leibowitz (1997) and the situation in Luxembourg as of 2003.

The maternity leave available in Luxembourg has been positioned at the same level as the situation prior to the existence of the leave mandate in the model of Klerman and Leibowitz (1997) because its use is compulsory[4] and it can be assumed that everyone uses this leave. This leave is of (relatively) short duration and can be seen as equivalent to the minimum short-term leave an employer is likely to be providing in the absence of government-required parental leave.

The decision which is interesting to analyse is the one related to use of parental leave. As the duration of parental leave in Luxembourg is fixed and the leave cannot be shortened or extended, the model of Klerman and Leibowitz (1997) is suitable to be applied in the analysis. Based on this model, it is expected that women with very high pre-birth wages would return to work immediately after maternity leave, whereas women with lower pre-birth wages, which are not substantially higher than an alternative job after a job search, would quit their jobs and not use parental leave.

As the theoretical framework by Klerman and Leibowitz (1997) has been developed in view of only unpaid leave being available, the question whether parents can actually afford to take leave must also be considered (Han et al., 2009). In Luxembourg the leave is paid, but only on a flat-rate basis. This means that all parents receive the same monthly benefit regardless of the level of their previous earnings. This arrangement has some similarities and differences with the situation when the leave is unpaid. The similarity

[4]In Luxembourg, as in all European Union countries, maternity leave is considered a health-related benefit. This is in line with the legal requirements of Council Directive 92/85/EEC of 19 October 1992, which guarantees all pregnant workers the right of at least 14 continuous weeks of maternity leave.

Klerman and Leibowitz (1997)	Situation in Luxembourg as of 2003
Initial state	
• No legal provision concerning leave • Employers likely to provide leave • Duration: likely to be short-term • Compensation: not specified	• Maternity leave provision • All workers eligible if under social security scheme for 6 months • Duration: four to five months • Compensation: paid at 100 per cent wages
Fixed-term leave mandate of interest	
• Maternity leave statute • Duration: 12 weeks • Compensation: unpaid	• Parental leave • Duration: 6 months • Compensation: paid at 1651.38 € per month
Employment after birth/leave	
• Assumed that women want to return to work after birth/leave • The question is when and what wage they will be offered	• Data suggest that leaving the labour force upon birth may be long-term • Less than half of women who leave labour force after maternity leave were employed after five years.

Table 7.1: A summary of the elements in the theoretical model developed by Klerman and Leibowitz (1997) and their counterparts in the leave system in Luxembourg.

is that workers differ in the levels of the opportunity costs they face when taking leave - higher-earning women have higher costs of being on parental leave. However, in the Luxembourgish system, unlike in the US system, the workers in the lowest earning bracket do not face a risk of negative or below-subsistence income for the duration of the parental leave. In fact they may even be in a situation where the monthly benefit is higher than their previous earnings. More details about the parental leave system in Luxembourg are provided in chapter 2.

Although the theoretical framework presented by Klerman and Leibowitz (1997) is very useful in making predictions about how women would make decisions regarding taking a fixed-term leave, the framework makes the important assumption that all women who take parental leave return to their previous employment, which is not necessarily in line with the situation in most European countries. For example Plantenga and Remery (2005) report that in 2001 return rates of around 80 per cent (such as in Austria or the UK) could already be considered high. However, other countries had much lower return rates, such as 50 per cent in Germany and 45 per cent in Hungary. Some recent policy evaluation studies have demonstrated that changes in the design of parental leave regulations can have a significant and noticeable impact on return rates of leave takers (Lalive and Zweimüller, 2009; Kluve and Tamm, 2012). However, systematic information on why some women return to work after parental leave whereas others do not is relatively scarce in the literature.

The present study extends the analysis from parental leave take-up to return to work (conditional on parental leave take-up) in order to bring the analysis closer to the actual situation in most European countries. At the same time, the analysis extends the conceptual understanding of decisions related to parental leave by taking into consideration the sequential nature of the decisions made by women: to remain employed, take leave and return to work. This is achieved by first breaking down the decisions into sets of binary choices and then applying a sequential logit model, which can account for the fact that each subsequent choice is conditional on a previous one.

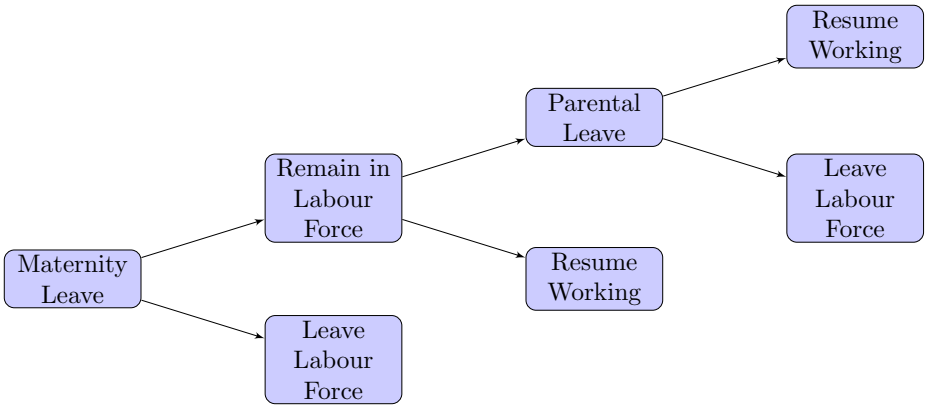


Figure 7.1: Diagram of women's decisions regarding labour-force participation after maternity and parental leave.

7.3 Conceptual model

The present analysis assumes that women make decisions about taking parental leave and subsequently returning to work in stages rather than at a single point in time. Figure 7.1 displays a simplified model of how the decision stages can be represented as a three-step decision process, where each decision consists of a set of binary choices.

The analysis focuses on women who are working prior to the birth of a child and who qualify for parental leave. In the first stage of the decision process all women are on maternity leave[5]. At the end of maternity leave, women make a choice between leaving the labour force (at least for a period longer than the duration of parental leave) or remaining in the labour force. Given that they have decided to remain in the labour force, women decide whether to resume working immediately after the maternity leave period or to take a fixed-term period of parental leave. Finally, at the end of the parental leave women make a choice whether to return to work or to remain outside the labour force for an additional period of time.

The presented conceptual framework makes several simplifications of reality. To begin with, parental leave is reduced to a single choice of parental leave, ignoring the fact that, in Luxembourg, it can be taken full-time or

[5]This is in line with the legal regulations in all EU-countries where maternity leave is a health-related benefit and considered compulsory.

part-time. Second, this conceptual model, as in the theoretical framework proposed by Klerman and Leibowitz (1997), does not make a distinction between the amount of hours worked upon re-entering the labour force. Finally, the model ignores the possibility that the father is on parental leave as well as the potential effect of additional children being born during the parental leave period. These simplifications allow that the parents' decision process is modelled parsimoniously. Several of the features ignored in the theoretical model, such as the number of children and the presence of a spouse, are taken into account in the empirical model.

7.4 Variables in the decision process

This section explores the variables that from a theoretical perspective or based on previous literature are important in each of the three decision phases. The literature review in this section tries to integrate the findings from studies addressing different phases in the decision process as presented in Figure 7.1. This has not been an easy task, as an integrated approach has not been very common in the literature. Furthermore, academic studies differ in the ways they deal with leave provisions: sometimes treating them as periods of employment and sometimes as periods of non-employment.

7.4.1 Decision I: Remaining in the labour force after maternity leave

At the end of the compulsory period of maternity leave mothers make a decision whether to stay in the labour force or to leave it[6]. At this stage staying in the labour force entails either returning to work immediately or taking parental leave, whereas leaving the labour force is conceptualized as leaving one's job for a longer term (at least longer than the duration of the leave). The question is which employees are likely to leave the labour force. In the model of Klerman and Leibowitz (1997) these would be the women from the lower-earning part of the distribution. In the absence of a parental leave provision these women would be expected to leave the labour force.

[6]In Luxembourg, this decision must, in fact, be made earlier, as employees must register an application for parental leave at least six months prior to the projected start of the leave. The end of the maternity leave, however, is the first time when it is possible to observe the results of this decision.

To analyse the first decision, it is reasonable to consider what factors would lower the opportunity cost of not working, the difference between the pre-birth salary and a potential future salary and at the same time what factors would increase the value of women's time at home. In terms of variables represented in the analysis, on one side one could position the level of pre-birth earnings (relative to other women) and the years of experience with the same job (as an indicator of job-specific human capital which will be lost if a new job is to be searched upon return to the labour market). Marital status can also be seen as an important factor as the availability of a husband's income also contributes to making the period of a longer leave financially feasible. On the other side, variables that would contribute to an increase in the value of a mother's time at home would be the presence of more children in the household and especially if they are younger than school age.

This line of reasoning seems to be supported by empirical research. In the study of Joesch (1994) women's labour market exit decisions at birth are analysed as a result of a comparison of the opportunity cost of not working with the opportunity cost of working. The former cost consists of the potential wage a woman could be earning on the labour market and the potential depreciation of human capital during the period of absence from the labour force. The latter cost is related to variables, which increase the reservation wage (for example additional sources of income, such as husband's income or non-wage income) and variables which increase the value of the mother's time at home (number and ages of children, etc.).

In a study analysing mothers' decisions to exit the labour force after birth Hotchkiss, Pitts, and Walker (2011) in Georgia, the US, found that variables increasing the opportunity cost of not working, such as higher wages and education, longer working experience and working for larger employers decreases the possibility of a labour market exit after birth. On the other hand, variables increasing the reservation wage or the value of mothers' time at home, such as being married or the presence of other children increase the probability of exit. The study of Hynes and Clarkberg (2005), comparing the characteristics of women whose trajectory followed the pattern of continuous employment even around birth to women exiting the labour force after birth, also found that women who are younger, with lower levels of education and who have a non-wage source of income are more likely to exit the labour force after birth. In Spain, the study of Gutiérrez-Domènech (2005) analysed the factors contributing to women leaving the labour force permanently after the use of the compulsory job-protected and paid maternity leave period. The findings suggest that more educated women who

also earn higher wages are more likely to remain in the labour force. Furthermore, the analysis highlights the importance of the job characteristics, as women working full-time and with permanent contracts are less likely to exit the labour force.

7.4.2 Decision II: Taking parental leave

At this stage of the conceptual model women who have not left the labour force are making the decision whether to return to work immediately or to take the fixed-term period of parental leave. In the theoretical framework provided by Klerman and Leibowitz (1997) women in the highest earning bracket and whose value of time at home is relatively low should be expected to return to the labour market after the minimum provision of the maternity leave, regardless of whether leave is offered or not. Parental leave should be taken by women whose pre-birth wages are lower than the highest-earning group, but also higher than the wages of the women who choose to leave the labour market for an indefinite duration.

The hypothesis to be tested here is whether, given that women have remained in the labour market after the end of their maternity leave, women with the highest earnings are more likely to return directly to work. It would also be expected that married women are more likely to use parental leave as the potential income of the husband would be helpful in accommodating the period of parental leave with lower income. Finally, the presence of more children in the household is expected to be associated with a higher probability of taking parental leave.

One possible source of empirically-based information in relation to these hypotheses[7] is the study of Han et al. (2009). The study suggests that, indeed, married women are more likely to use parental leave than single women. However, the results of Han et al. (2009) suggest that the relationship between earnings and probability to use parental leave may run in the opposite direction, as higher education was shown to be related to a higher probability of taking parental leave. Assuming a positive relationship between education and earnings, one could expect that higher earners would

[7]Very few studies analyse women's labour force participation around the time of birth in relation to parental leave. Most studies focus on employment rates and assume parental leave was used at times when women were not employed.

be more and not less likely to take parental leave[8].

7.4.3 Decision III: Return to work after parental leave

The third decision analysed in this chapter is made by women who have taken parental leave. The decision they make is whether to return to work after the parental leave period or to leave the labour force[9]. It is difficult to find previous literature on this particular decision, as the majority of studies are concerned with the effect of parental leave legislation on return rates and focus on international comparisons (see Pronzato, 2009) or before-after comparisons'(see Ondrich et al., 1996; Lalive and Zweimüller, 2009; Hofferth and Curtin, 2006), whereby it is difficult to know whether leave is actually used or not. Nevertheless, these studies typically find that women's employment rates seem to be lower during the period of paid, job-protected leave available and to increase afterwards, suggesting that the majority of women use the available paid leave and return to work afterwards. Socio-economic characteristics analysed in such studies consistently find that women with higher levels of education (reflecting higher levels of human capital) return to the labour force sooner (Ondrich et al., 1996; Hofferth and Curtin, 2006; Pronzato, 2009). Other variables that might play a role here are the number of children in the household and the general availability of income in the household, as they increase the value of time spent at home and decrease the opportunity cost of not working, respectively.

7.5 Method

7.5.1 Estimation strategy

The model used for the empirical estimation in this chapter is the model for nested dichotomies presented in Fox (1997). This approach belongs to the general family of models dealing with polytomous data and to the

[8]Education could not be included in the presented analysis because data are not available in the administrative records.

[9]In the present analysis, the assumption is made that women are making this decision. However, it is difficult to say whether this is the case. The data show only that women do not return to work. The reasons for this may also be that employers are not respecting the right to return after parental leave. With the data available, however, it is not possible to distinguish between the two reasons.

specific case where the categories of the dependent variable represent a set of hierarchical binary partitions. Nested dichotomies were chosen for the analysis in this chapter, because the conceptual model of decision-making presented in Figure 7.1 represents a movement through successive stages.

Fox (1997) provides an example of a situation where this model is applicable by considering employment of women as an outcome variable with three levels: not working, working part-time or working full-time. In this example the latter two categories are in fact divisions of a larger category: "working". Therefore, we can see the decision represented by the outcome variable as two-step process. In the first step the woman decides to work and in the second step, only after on deciding to work, she can choose whether to work full time or part time. Therefore the dichotomy of working full time or part time is nested within the working category.

Another example of a situation which can be modelled in the same way is the movement of individuals through different levels of the educational system (Buis, 2010). Each individual can be conceptualized to be making a binary choice (to continue or to stop) at the beginning of each level of education: primary, high school, university level. However, only these individuals who have chosen to continue at the first two levels are making the choice of whether to continue to university or not; this choice is not relevant for the others[10]. Fox (1997) notes that models for nested dichotomies present results similar to the more general models for polytomous data (multinomial logistic regression). Still, the results are not equivalent, as the fitted probabilities based on models for nested dichotomies are computed differently depending on how the binary splits in the dependent variable are conceptualized.

As described in Fox (2002a) and Fox and Weisberg (2011), the estimation consists of re-coding the dependent variable, so as to capture the dichotomies at each level. Next, an independent binary logit is fit to each subset of the observations for whom a dichotomy is relevant. This means that the dependent variable for the first stage consists of two categories: keep work relationship or leave after maternity leave. The dependent variable for the second stage has two categories: take parental leave or return to work after maternity leave. Women who have already left their employment are not included in this model. The third dependent variable also has two levels: return to work after parental leave or not. Only women who

[10]Interested readers are referred to the work of Buis (2010), who applies the same strategy for the analysis of transitions through educational stages in the Netherlands.

have taken parental leave are included in the estimation of the final model. At each "higher" level the estimated predicted probabilities are multiplied with the probability of "passing" the preceding transition in order to obtain the overall probability of being categorized as a "success" at that stage.

The estimation for this chapter has been performed with the Free Statistical and Programming Environment R (R Core Team, 2014). The binary logistic regression models have been estimated using the *glm* functions from the *stats* package, which is included with the installation of R (R Core Team, 2014). Results have been prepared for export to LaTeXusing the *xtable* package (Dahl, 2014)[11].

7.5.2 Data

Data for the analysis are extracted from anonymous social security records by the *Inspection Générale de la Sécurité Sociale (IGSS)* Luxembourg. The data are described in more detail in chapter 3. Section 3.4 in chapter 3 presents an explanation of all covariates available for the analysis. The distribution of the variables used for the analysis (including the values imputed from subsequent records) is displayed in Appendix 7.A.

Three variables presented a problem for the analysis due to a large number of missing cases. Those variables are the same as in chapter 6 and they were handled in the same way. Those were the variables measuring the number of children in the household as of 2003, the presence of a spouse and the size of the organization in 2003. For the most part values were missing due to a lack of administrative record of these individuals for 2003. In order not to exclude observations, values were substituted with values from later available records. In the estimation, a dummy variable called *Record in 2003* was added as a control variable. This variable takes the level 1 if there is a record for 2003 and 0 otherwise.

The variable describing the size of the organization where a person works had a large number of missing values, which were entered as missing values in the IGSS record. Observations with those missing values were dropped from the analysis, because when an attempt was made to include them as a separate category, Models I and III did not converge.

[11] It is also worth mentioning that a STATA package for the estimation of a sequential logit model has also been developed by Buis (2007).

In addition, self-employed persons were dropped from the analysis because for them working hours are not recorded. Another problem with records of self-employed persons is that many of them are only in part-time self-employment, which means that the recorded values for the covariates may reflect characteristics of a second job that they work part time.

7.5.3 Construction of dependent variables

Following the conceptual model presented in Figure 7.1, three binary logistic regressions have been estimated, with three different dependent variables reflecting the outcomes of each decision. The first one models the decision to stay in the labour force or to leave it. Second, conditional on women deciding to not leave the labour force, the decision to go directly back to work or to take a parental leave is analysed. Finally, conditional on women taking parental leave, the decision to return to employment is analysed.

For analysing decisions one and three, it was important to identify women who leave the labour force. For the analysis women were considered to leave the labour force if they had no administrative record for the major amount of time in the six-month period following the end of their maternity leave. For women who took parental leave, leaving the labour market after the leave was computed in the same way. In addition, women who were predominantly in unemployment were also considered to be leaving the labour force. This is somewhat ambiguous, as unemployment benefits could indicate also part-time unemployment: for example if women were unemployed from one out of two or more jobs. However, the decision was made to include these women among the group who leaves the labour force in order to emphasize the employment discontinuity in their career. The main idea of parental leave is that women can return to their pre-birth employment and it is important to analyse all cases where this is not happening.

It must also be noted that a lack of administrative record could indicate that a woman is performing work in another country. For about half of the records labour market inactivity could be assumed with somewhat greater certainty as they could be matched to a record of co-insurance. A record of co-insurance indicates that a person is insured as the dependent of someone else, meaning most likely that he or she is in the country but not working. For about half of the cases such records were not found. This could mean that the woman is in another country. Again, the decision was made to

consider these women as leaving the labour force in order to emphasize the fact that they interrupt their pre-birth employment.

Decision I: Remaining in the labour force after maternity leave

The dependent variable in the first regression equation takes the value 0 if women leave their pre-birth employment in the six-month period following maternity leave. Women were assumed to be returning to the same employment as before, although it is not possible to find out exactly whether this is the case. The distribution of the decisions after maternity leave is displayed in Table 7.2. The table shows that a relatively small fraction (less than ten per cent) of women leave the labour force at this stage, the rest choose to retain their employment relationship.

	Count	Percentage
Remain in labour force	4050	90.4
Leave labour force	431	9.6
Total	4481	100.0

Table 7.2: Distribution of mothers' decisions after maternity leave used in 2003.

Decision II: Taking parental leave

The second decision concerns the use of parental leave, given a decision to not interrupt the pre-birth employment relationship. Subsequently women were assumed to decide whether to resume working immediately or to spend the time allowed by parental leave at home. The dependent variable in this case was computed based on the activity recorded for women in the first month after maternity leave. For simplicity full-time and part-time parental leave were grouped together. Only women who have decided to remain in the labour force make this decision. The distribution of the decisions is displayed in Table 7.3. The table shows that the majority of women who remain in the labour force, take parental leave, however, about one third of them do not.

	Count	Percentage
Resume working	1094	27.0
Parental leave	2956	73.0
Total	4050	100.0

Table 7.3: Distribution of mothers' decisions who remain in the labour force after maternity leave used in 2003.

Decision III: Return to work after parental leave

Women who take parental leave make a third decision. At the end of the parental leave, the majority of them return to work. However, over ten per cent leave the labour force at this point. To determine who leaves the labour force, the same search algorithm was applied as in Decision I. The final distribution is displayed in Table 7.4.

	Count	Percentage
Leave labour force after parental leave	394	13.3
Resume working after parental leave	2562	86.7
Total	2956	100.0

Table 7.4: Distribution of decisions of mothers who take parental leave after maternity leave in used in 2003.

Are these decisions long-term?

Table 7.5 shows the predominant employment status of women at the end of the observation period (around 5 years after the birth of the child in 2003) in the analysis across the outcomes of decisions I, II and III described in this section. For simplicity, the activities recorded in the administrative records of women have been coded as either in or out of the labour force. All records where the predominant status in the last six months of the observation period have been marked by an absence of a social security record (with or without a record of co-insurance) have been counted as out of the labour force, while all other states have been counted as in the labour force, including unemployment. The results displayed in Table 7.5 suggest that the majority of women who leave the labour force, either after maternity or after parental leave, do not return to it in the course of five years. However, a substantial portion of women (over one third) do return

to the labour force at a later period of time. At the same time the results show that a fraction of women who return to their work after these leaves leave the labour force later on.

	Outside labour force (%)	Inside labour force (%)	Total (%)	Total
Leave labour force after maternity leave	54	46	100	431
Resume working after maternity leave	11	89	100	1094
Leave labour force after parental leave	66	34	100	394
Resume working after parental leave	12	88	100	2562

Table 7.5: The predominant status of women according to Decisions I, II and III (in rows) and during the last six months of the five-year observation period (in columns).

7.6 Results

The results of running the three binary logit models are displayed in Table 7.7. The results yield partial support to the proposed hypotheses. The main hypotheses for each decision based on the theoretical framework and on previous literature have been summarized in Table 7.6. Detailed results for each model including z and p values are presented in Appendix 7.B.

7.6.1 Decision I: Remaining in the labour force after maternity leave

Opportunity cost of not working seems to play an important role in the first decision, as higher-earning women are more likely to keep the relationship with their pre-birth employment. These results are in line with the expectation that higher-earning women would be more willing to remain employed after having a child[12]. Women who had more months of uninterrupted employment prior to the start of their maternity leave are also more likely

[12] As education is missing in the data, it is also possible that to the extent that higher earnings reflect a higher educational attainment, these variables reflect the effect of education.

Variable	Decision	Hypothesis	Supported?
Opportunity cost of not working			
Monthly salary before maternity leave	I	Lowest earners are expected most likely to quit, as the difference between their pre-birth wage and potentially lower wage offer at return is the lowest (Klerman and Leibowitz, 1997)	Yes
	II	Highest earners less likely to use leave and more likely to resume working immediately	Yes
	III	Same as decision I	Yes
Job-specific human capital			
Years since labour market entry in Luxembourg	I	Women with less experience are expected more likely to quit, as they have less firm-specific human capital (Klerman and Leibowitz, 1997)	No
	II	No hypothesis	
	III	Same as decision I	Yes
Work during pregnancy			
Months of uninterrupted employment in year before maternity leave	I	Women with more interruptions are expected to be more likely to quit work, as more interruptions could signal a lower preference for paid work or the presence of other impairment factors, such as lack of alternative care arrangements for children, health problems, physically demanding work, etc.	Yes
	II	No hypothesis	
	III	Same as decision I	No
Value of mothers' time at home/Reservation wage			
Other children in the household	I	More children increase the value of mothers' time at home, therefore women with more children should be more likely to quit (Joesch, 1994)	No
	II	Women with more children more likely to need leave	No
	III	Same as decision I	No
Multiple births	I	Same as for other children in household	No
	II	Women with more children more likely to need leave	Yes
	III	Same as decision I	No
Married	I	Presence of spouse makes it more likely that women can afford to stop working (Joesch, 1994)	No
	II	Presence of spouse makes it more likely that women can afford to take leave (Han et al., 2009)	No
	III	Same as decision I	No

Table 7.6: Summary of main hypotheses and results.

to retain their pre-birth employment relationship. Regarding the value of women's time at work, as expected, women who already had two children in 2003 are more likely to leave the labour force than women for whom this is the first birth. Women employed in larger organizations are more likely to retain their employment relationship. This is often the result in previous studies and the explanation is that larger employers have more flexibility to offer leave or alternative working arrangements to working parents.

Some other variables were surprisingly not significant. The dummies for the salary growth levels and the variable measuring the years of participation in the Luxembourg workforce were expected to have a positive effect on retaining the work relationship at this stage, as they reflect the level of work commitment. Another variable, which was expected to be significant, based on previous literature, was the marital status of the women. It was expected that married women would be more likely to leave their employment due to the income support of their husbands. However, as already explained in chapter 3, the variable married refers only to persons who are legally married, while cohabiting persons are classified as single.

Other interesting results are these concerning nationality. It seems that workers with Luxembourgish and German nationality have lower probability of keeping their employment relationship relative to workers with other nationalities. It was not possible to control for the cross-border status of the workers or to include their place of residence as virtually all Luxembourg nationals, and a large part of the Portuguese nationals in the data set were also living in Luxembourg, which created problems with collinearity. However, alternative specifications of the model, including only residence, showed similar results with women living in France and Belgium having a higher probability to remain in the labour force at this stage and no difference between women living in Luxembourg and Germany.

7.6.2 Decision II: Taking parental leave

For the second decision stage, it was expected that women in the highest earning category who have not quit their pre-birth employment, would be less likely to use parental leave, while women with lower earnings would be more likely to use it. In addition, it was expected that married women would be more likely to use leave, as the potential income of a husband could be helpful in buffering the lower monthly income during the period of leave for women whose earnings exceed the leave benefit. The income-

related hypothesis was confirmed, as the odds ratios of the coefficients for the highest earning groups indicate lower odds of taking parental leave compared to the reference category. The relationship appears to be non-linear as there are no significant differences in terms of the odds of taking parental leave between women in the reference category and the lower-earning groups, and the signs of the coefficients are in the opposite direction of what would be expected. It was also expected that married women would be more likely to use parental leave. The variable married is not significant in the model, however, as explained earlier, this variable does not include cohabitation.

Regarding the importance of the value of the time of the mother at home, mixed results were obtained. Contrary to what was expected, women were more likely to use parental leave for the first child. This is contradicting the idea that women would be more likely to want to use leave if they have more children (higher demand for their time at home). One possible explanation for this result is that the women in this stage of the analysis are not a random sample, but women who have remained in the labour force despite already having one or two children. This could mean that they already have access to the necessary resources to deal with caring for another child (for example childcare provided by relatives, stay-at-home partners, etc.). At the same time, however, the effect of the variable multiple births, indicating that either twins or triplets were born, is significant and it shows a higher probability of using parental leave. This result could be seen as supporting the idea that the value of a mother's time at home is important in making the decision to use leave, especially given that multiple births could be assumed to be an exogenous event.

Some interesting results at this stage of the decision process concern the nationalities: German women have almost six times higher odds than Luxembourgish women to use parental leave, while Portuguese women are more likely to return directly to work without using parental leave.

	Decision I stay in LF after ML		Decision II take PL after ML		Decision III stay in LF after PL	
Intercept	0.88		10.35	***	20.23	***
Salary: <1000 €	0.2	***	0.64		0.4	*
Salary: 1000-2000 €	0.46	**	0.9		0.79	
Salary: 3000-4000 €	3.28	**	0.84		2.21	***
Salary: 4000-5000 €	1.82		0.53	***	2.05	**
Salary: 5000+ €	2.56	*	0.37	***	1.55	.
Salary growth: Quintile 2	1.22		1.25		0.8	
Salary growth: Quintile 3	1.12		1.02		0.99	
Salary growth: Quintile 4	1.39		1.16		0.98	
Salary growth: Quintile 5	1.05		0.93		1.06	
Hours: Full time	0.94		1.11		1.32	.
Hours: Overtime	1.62	.	0.96		1.09	
Years participation in LU	1.02		1.02		1.05	**
Uninterrupted employment months	1.19	***	0.94	**	1.05	.
Organization: Medium (50-200)	1.43		0.92		1.5	
Organization: Small (<50) or N/A	0.65	.	0.79	.	1	
Organization: Very large (1000+)	2.05	**	7.38	***	0.81	
Category: Blue collar	1.57	.	0.42	***	1.06	
Category: Civil servant	0.45	*	0.2	***	1.63	.
Married	0.91		1.01		1.15	
Other children in HH: (1)	0.74		0.51	***	0.98	
Other children in HH: (2+)	0.46	**	0.23	***	0.95	
Male child born in 2003	0.75	.	0.98		1.2	
Twins or triplets in 2003	1.04		2.58	*	0.87	
Nationality: France	4.45	***	0.9		1.86	**
Nationality: Portugal	2.37	**	0.33	***	1.21	
Nationality: Belgium	5.9	***	0.79		1.78	*
Nationality: Germany	1.31		6.76	***	0.6	*
Nationality: Other	2.03	*	0.79		0.69	.
Age in 2003	1.01		1.01		0.95	**
Record in 2003	1.65		0.55	**	0.41	*
N	3867		3701		2729	
Chi-Square	231.04		953.29		143.07	
df	30		30		30	
p	0		0		0	

Table 7.7: Results for the estimation in the three decision stages. Coefficients are presented as odds ratios.
Reference categories: Salary: 2000-3000 €, Salary growth: Quintile 1, Hours: Part time, Category: White collar, Married: No, Other children in household (HH): None, Sex of child born in 2003: Female, Single Birth, Nationality: Luxembourg, Record in 2003: No.
Significance codes: *** 0.001, ** 0.01, * 0.5, . 0.1.
LF = Labour force, PL = Parental leave, ML = Maternity leave.

7.6.3 Decision III: Return to work after parental leave

Opportunity cost seems to play an important role in the third decision. The results are in line with the expectation that higher-earning women would be more willing to return to their pre-birth jobs. The odds ratios for all categories have higher values than the reference group (with monthly income between 2000 - 3000 €). The variable measuring the years since first time entry into the Luxembourgish labour market, which was introduced as proxy for work experience and job-specific human capital, is significant at this stage and it indicates that women with more experience are more likely to return to work after parental leave. Relative to Luxembourgish women, French and Belgian nationalities are more likely to return to work after parental leave, while German women were less likely.

7.6.4 Graphical illustration of the results

The sequential nature of the decisions is reflected in the way fitted probabilities and marginal effects are computed at each step. Figure 7.2 shows the succession in which fitted probabilities are computed with each other. In Figure 7.2 $\hat{p_1}$ is the predicted probability for remaining in the labour force after the end of maternity leave. Respectively, $1 - \hat{p_1}$ is the predicted probability of leaving the labour force. In the second stage of the decision process, the predicted probability that someone will take parental leave is $\hat{p_2} * \hat{p_1}$. The multiplication is necessary, because women make decision II only if they have decided to remain in the labour force before that. In the same way, the predicted probability of remaining in the labour force after parental leave is equal to $\hat{p_3} * \hat{p_2} * \hat{p_1}$.

Following the theoretical expectation that women make decisions in the three stages based on the opportunity cost of not working and the value of their time at home, the fitted probabilities are displayed varying according to number of children and monthly income prior to taking maternity leave. Nationality was included because it was significant at all three stages. Each of the other covariates has been fixed at a given level, as explained in the note to Figure 7.3.

Figure 7.3 shows that although women have a relatively high probability to remain in the labour force after Decision I, the number of children in the household does play a role. This is especially visible when comparing the

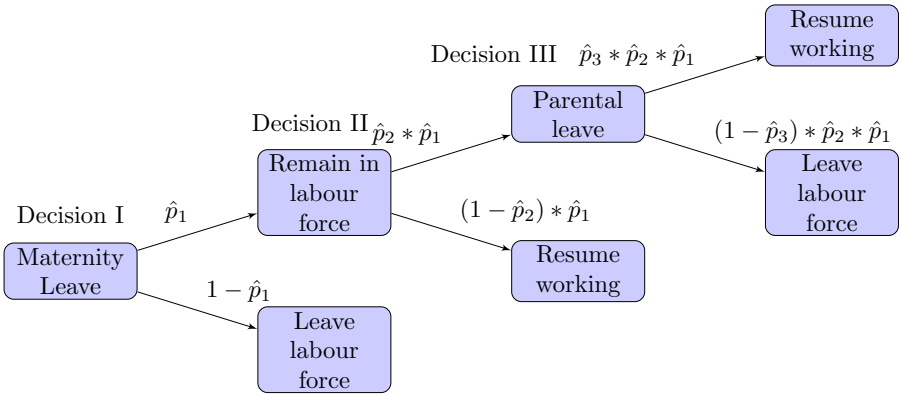


Figure 7.2: Decisions diagram showing how predicted probabilities are computed

probability of remaining in the labour force for women with lower income levels. While the fitted probability for the lowest earners is above 70 per cent if this is their first child, it drops to as low as 50 per cent in the case of two or more other children in the household. For the highest-earning women, however, the probability to remain employed is close to 100 per cent in all cases.

Conditional on remaining in the labour force, women make a second decision: to take parental leave or to return to work immediately. Figure 7.3 shows that the effect of income varies non-linearly related to the outcome of this decision. Starting from the lowest earning levels, we see that the probability of taking parental leave increases as income increases. At income levels higher than 3000 - 4000 € per month, however, the relationship takes the opposite direction. As income increases the probability to take leave decreases. These results are consistent with predictions from previous literature. Women at the highest earning level have a very high opportunity cost to take leave, so they return directly to work. However, it is somewhat perplexing why women who earn less than the parental leave benefit (<1000 € per month) are the least likely to use leave. Eligibility restrictions can be rules out as an explanation because only women eligible to take parental leave are included in the sample for analysis. One possibility is that they are using the child-raising allowance available in Luxembourg, for which parents are eligible if they make a partial reduction of their working hours.

It is also interesting to note that the shape of the relationship remains the same across the three groups, but the starting point tends to shift

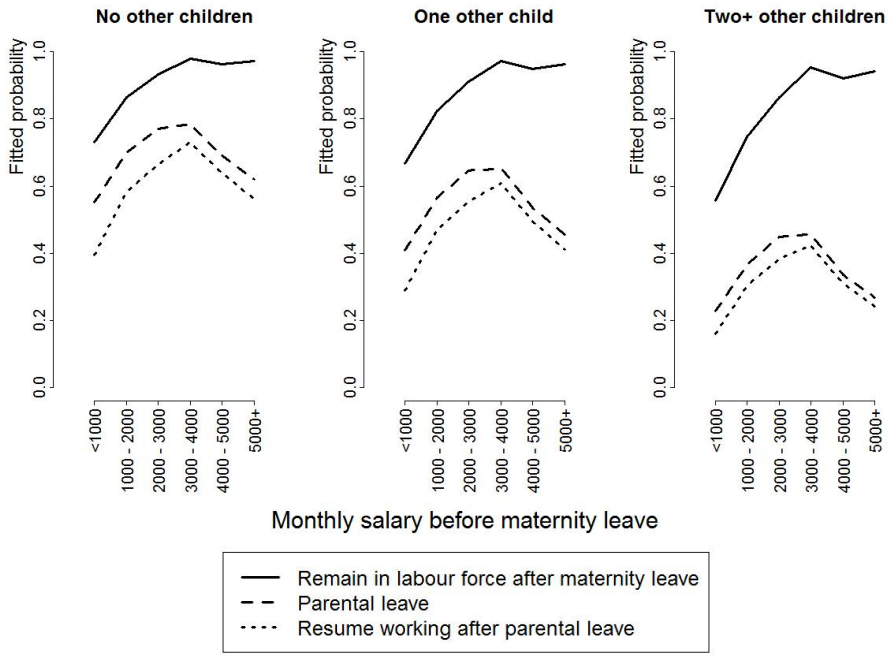


Figure 7.3: The fitted probabilities for women to make decisions 1, 2 and 3, according to number of other children and their average monthly salary income in the period before taking maternity leave.
Values for the other covariates used: Salary Growth: Quintile 3, Hours: Full time (173), Years of participation: mean, Uninterrupted employment months: mean, Organization: Large, Category: White collar, Married: Yes, Female child born in 2003, Single birth in 2003, Nationality: Luxembourg, Age in 2003: mean, Record in 2003: yes.

downwards as the number of children in the household increases. This means that women with more children are actually less likely to use parental leave. A possible explanation for these counter-intuitive results could lie in the selected nature of the group of women who already have one or more children in the household. These are women with very high attachment to the labour market, as they have remained employed after the birth of their previous children and they have not left the labour market now. It would definitely be interesting to learn more about this group in future research.

Finally for users of parental leave, Figure 7.3 shows that the probability to return to work after parental leave closely follows the probability to take parental leave. It is interesting that women in the highest earning categories have lower probability to return to work than women earning at the medium level. One possible explanation for this result is that only a selected group of women is taking parental leave if they are in the highest earning category. The analysis of the decision to use parental leave showed that for women earning more than 3000 € per month, the probability to take parental leave starts to decrease. Thus, one could assume that the highest earners with the strongest labour market attachment have not even taken parental leave. It is also interesting that women in the lowest earning category have the lowest probability to both use parental leave and to return to work afterwards.

There were also some interesting differences in terms of nationality. These are illustrated in Figure 7.4 in Appendix 7.C. Relative to other nationalities, Luxembourgish women seem to have the highest probability to leave the labour force after having a child. It is possible that this reflects a selection into working, especially for cross-border workers. It is reasonable to expect that women who commute from another country are more attached to the labour market than women who work in their home country, on average. In terms of parental leave use it seems like women of German nationality were most prone to use parental leave, while women of Portuguese nationality were least likely to use it.

7.6.5 Sources of bias in the estimation

Sample selection

The initial sample of women has been selected to consist of women who were working and eligible to use parental leave when they had a child in 2003. The results must be interpreted with caution and they cannot generalize to all women in Luxembourg. The correction of this sample selection bias could have been possible if a variable would be found, which would be correlated with the selection but not with the dependent variable (see Wooldridge, 2012, chap.17). Given that for the study only employment-related records are available and the dependent variables are related to employment participation, such a variable has not been found.

Unobserved heterogeneity

It must be noted that the problem of unobserved heterogeneity is especially pronounced with the sequential logit model. Buis (2011) summarizes the problem by identifying two major mechanisms through which unobserved heterogeneity introduces bias in sequential logit models. He refers to them as "averaging" and "selection" (Buis, 2011, p.248).

The first issue refers to the fact that, unlike in the case of linear models, omitted variables can introduce bias in a logistic model even if they are not correlated with the regressors included in the equation (Neuhaus and Jewell, 1993; Cameron and Heckman, 1998).

The second problem is related to the selection of individuals after each transition. Even if in the first transition the omitted factor is independent of the regressors in the equation, this will not be true for subsequent transitions. Cameron and Heckman (1998) provide an example from the education context. If the omitted variable is motivation or ability, they note that after the first transition, the individuals continuing to further levels of education will be the ones who have high values on this variable. In addition, the relationship between regressors in the equation and the omitted variable changes, because now those who have low levels on the observed regressors are in the sample only if they have high levels on the omitted variable.

As noted in Buis (2011) it is not always possible to correct for unobserved

Scenario	ρ	β_u	β_1		β_2		β_3	
Baseline			1.14	***	-0.41	***	0.76	***
Scenario 1	0.50	0.00	0.75	.	1.10	***	0.80	*
Scenario 2	0.50	0.50	0.79	.	1.17	***	0.88	*
Scenario 3	0.50	1.00	0.92	*	1.33	***	1.07	*
Scenario 4	0.75	0.00	0.75	.	1.10	***	0.80	*
Scenario 5	0.75	0.50	0.77	.	1.14	***	0.84	*
Scenario 6	0.75	1.00	0.85	*	1.24	***	0.97	*
Scenario 7	0.25	0.00	0.74	.	1.10	***	0.80	*
Scenario 8	0.25	0.50	0.80	*	1.18	***	0.89	*
Scenario 9	0.25	1.00	0.96	*	1.38	***	1.14	*

Table 7.8: Results from sensitivity check based on 9 scenarios.
Notes: The sensitivity check explores how the coefficient of the logarithm of Monthly Salary would change in 9 hypothetical scenarios with different levels of amount of unobserved heterogeneity (β_u) and different correlation between the unobserved heterogeneity and the logarithm of Monthly Salary (ρ).
Significance codes: *** 0.001, ** 0.01, * 0.5, . 0.1.

heterogeneity. In such cases it is advisable to perform a sensitivity analysis with the goal of identifying how the results would change if one were to assume varying degrees of heterogeneity. Buis (2011) notes that the purpose of the sensitivity analysis is not to obtain an estimate of the effect of unobserved variables, but rather to gain an idea of possible ranges of the effect under given assumptions. A sensitivity analysis of the results presented in this chapter has been performed with the Stata routine made available by Buis (2013). The results are presented in Table 7.8.

For the sensitivity analysis, the main variable of interest is salary-related opportunity cost of taking parental leave. This variable has been chosen as the focus of the sensitivity analysis because this is the only variable in the model, which policy-makers have at least some level of control over - by increasing the amount paid as parental leave, the opportunity cost can be reduced.

The logarithm of the opportunity cost has been used instead of the five dummy variables representing different levels of opportunity cost in Table 7.7. The reason is that the Stata routine presented by Buis (2011, 2013) only allows that one variable is correlated with the sources of unobserved heterogeneity. The coefficients obtained for the logarithm of opportunity cost are consistent with the patterns suggested by the coefficients of the dummy variables in Table 7.7. Please, note that in in Table 7.8 the coeffi-

cients are not presented as odds ratios - therefore values larger than 0 and not larger than 1 indicate a positive relationship.

Buis (2011) notes that it is useful to think of the unobserved heterogeneity u not in terms of a specific omitted variable, but in terms of a (weighted) sum of all variables omitted from the model. In addition, the unobserved heterogeneity should be conceptualized in terms of its standardized value. The scenarios chosen to be explored represent combinations of two components with different levels: the presence of unobserved heterogeneity and its correlation with the regressor of interest (logarithm of monthly salary).

The first component (β_u) represents the value of the hypothetical coefficient that would be observed for each transition if the variable representing the weighted sum of all variables omitted from the model was included. It was difficult to form expectations on this hypothetical coefficient, but 1 was considered a large effect, based on the coefficients obtained for other variables. The values used for the scenarios were 0, 0.5 and 1.

The second component (ρ) represents the correlation coefficient between the factor representing unobserved heterogeneity and the logarithm of monthly salary. For this component three values were assigned across the different scenarios: 0.25, 0.5, and 0.75. The central value (0.5) was chosen after estimating the correlation between education and salary among working women in Luxembourg[13]. The reason why education was used to form expectations about this correlation coefficient is that it is arguably one of the most important among the variables that are omitted in this chapter.

The results of the sensitivity check, suggest that the signs of the coefficients for salary-related income for Decisions I and III will not change in any of the nine scenarios. Their magnitude, however, would vary somewhat. The greatest change is observed in Decision II, where in all nine scenarios the estimated coefficient would have a reversed sign - that is, if the omitted variables were included in the model, salary-related income would be positively related to the probability of taking parental leave.

Overall, the sensitivity check has confirmed that, as expected, the omission

[13]This correlation coefficient was computed using data from the European Social Survey (2004). By combining the information from the variables measuring total household income and the fraction of income each respondent earns, it was possible to compute a correlation between years of education and the logarithm of (estimated) individual income. The correlation between income and education was estimated to be 0.51 and statistically significant ($N = 86$, $p < 0.01$).

of important variables, such as education, may have a strong influence on some of the coefficients estimated by the sequential logit (particularly for the second transition). However, it must be noted that there is no way to really know how much the unobserved heterogeneity really is and how it is correlated with the regressors. The scenarios tested in the sensitivity check also represent assumptions that may or may not hold in reality. Therefore, the coefficients of all models must be interpreted with caution and future studies should aim at incorporating more variables in their models.

7.7 Discussion

This chapter has provided an integrated analysis of women's labour market participation decisions after the birth of a child. The analysis has been based on a conceptual model of the decision-making process involving three steps: the decision to remain in the labour force after maternity leave, the decision to take parental leave and the decision to return to work after parental leave. The analysis has incorporated the sequential nature of the decisions by using the model of nested dichotomies (Fox, 1997), also known as a sequential logit model (Buis, 2010).

The results of the analysis lend partial evidence to economic reasoning about mothers' decisions. The opportunity cost of not working, measured by the pre-birth salary does seem to play an important role in all three decisions. Higher-earning women are more likely to remain in the labour force and to return to work after parental leave. Higher-earning women were also found to have a lower probability of taking parental leave, however, this result must be interpreted with caution, as the sensitivity check performed as advised by Buis (2011) suggests that the relationship may, in fact, run in the opposite direction if omitted variables are included in the model.

Women who have two or more other children are more likely to leave their employment after maternity leave. Interestingly, however, women seem less likely to use parental leave when they already have other children, provided they have not left their employment. This fact could possibly be explained by selection, as women who already have children and do not leave the labour force possibly have a very strong attachment to the labour force and/or have found ways to combine parenthood and employment. Multiple births make it more likely that a mother would use leave, but it does not seem to play a role in returning to work after parental leave.

The variable capturing previous work experience was also statistically significant and indicated a positive association with return to work after parental leave. This is consistent with the hypothesis derived from the theoretical framework of Klerman and Leibowitz (1997), although the hypothesis that women with less experience are more likely to quit after maternity leave has not been confirmed.

The variable measuring the number of uninterrupted employment months in the twelve-month period prior to the start of the maternity leave was intended as a measure of labour market attachment. The variable was significant in Decisions I and II and approaching significance for Decision III, which is consistent with the expectations. Similar results have been found in other studies, albeit with using slightly different variables. For example Joesch (1994) found that work status during pregnancy is one of the major predictors of women's work after birth. Similarly, in both Norway and Sweden, Ronsen and Sundstrom (1996) have found that the proportion of time that a woman has worked during pregnancy is significantly and positively associated with the probability of return to work after having a child.

The study has also revealed some interesting nationality differences between women. Given the fact that a large proportion of foreigners in Luxembourg are labour migrants or cross-border workers, differences between foreign and Luxembourgish nationals are to be expected. One possibility, as suggested in Brosius and Ray (2012), is that foreign workers may have a lower reservation wage than natives.

Finally, the study can be improved in a number of ways. To begin with, the analysis would greatly benefit from the possibility of including a variable measuring education. It would also be valuable to add some more information about the earnings of the spouse and his use of parental leave. It would also be a possible direction for future research to extend the decision model to include a distinction between full-time and part-time parental leave, as well as to explore the reduction of working hours as a longer-term work-family reconciliation strategy of mothers.

7.A Distribution of covariates

	Decision I Stay in LF after ML			Decision II Take PL after ML			Decision III Stay in LF after PL		
	No	*Yes*	N	*No*	*Yes*	N	*No*	*Yes*	N
Monthly salary prior to the birth in 2003									
(%) <1000	34.70	65.30	167	57.80	42.20	109	37.00	63.00	46
(%) 1000-2000	16.40	83.60	1311	32.80	67.20	1096	19.00	81.00	736
(%) 2000-3000	7.30	92.70	1005	20.20	79.80	932	14.90	85.10	744
(%) 3000-4000	3.40	96.60	783	17.60	82.40	756	7.40	92.60	623
(%) 4000-5000	3.90	96.10	533	25.00	75.00	512	8.30	91.70	384
(%) 5000+	3.10	96.90	451	33.90	66.10	437	9.30	90.70	289
Salary growth prior to the birth in 2003: Quintiles									
(%) 0-20	11.80	88.20	816	29.90	70.10	720	13.70	86.30	505
(%) 20-40	7.90	92.10	796	25.40	74.60	733	13.90	86.10	547
(%) 40-60	8.30	91.70	860	24.60	75.40	789	12.80	87.20	595
(%) 60-80	7.60	92.40	853	24.50	75.50	788	12.10	87.90	595
(%) 80-100	9.30	90.70	818	27.10	72.90	742	12.60	87.40	541
(%) Missing	34.60	65.40	107	44.30	55.70	70	30.80	69.20	39
Monthly hours prior to the birth in 2003									
(%) Part time(<173)	15.10	84.90	1656	29.90	70.10	1406	17.50	82.50	985
(%) Full Time (173)	5.90	94.10	1838	22.90	77.10	1729	9.90	90.10	1333
(%) Overtime (173+)	6.40	93.60	755	28.70	71.30	707	13.70	86.30	504
(%) Missing	100.00	0.00	1			0			0
Years since first entry into Luxembourg labour force									
Mean	7.90	7.50	4237	7.40	7.50	3832	7.30	7.60	2814
SD	4.50	4.10	-	4.10	4.10	-	4.40	4.00	-
Uninterrupted employment in 12 months prior to maternity leave in 2003									
Mean	8.80	10.30	4250	10.00	10.40	3842	9.80	10.50	2822
SD	3.30	2.60	-	2.80	2.60	-	3.10	2.50	-
Organization size									
(%) Large: 200-1000	5.50	94.50	613	39.20	60.80	579	10.50	89.50	352
(%) Medium: 50-200	4.30	95.70	514	38.40	61.60	492	8.30	91.70	303
(%) Micro/Small <50 or Not Appl	9.00	91.00	857	45.30	54.70	780	12.60	87.40	427

continued ...

Table 7.9: Distribution of covariates.

. . . continued

	Decision I Stay in LF after ML			Decision II Take PL after ML			Decision III Stay in LF after PL		
	No	Yes	N	No	Yes	N	No	Yes	N
(%) Very Large: 1000+	2.70	97.30	1977	12.10	87.90	1923	12.80	87.20	1690
(%) Missing	76.50	23.50	289	26.50	73.50	68	80.00	20.00	50
Employment category in 2003									
(%) White collar	6.80	93.20	2778	20.50	79.50	2590	12.20	87.80	2059
(%) Blue collar	16.70	83.30	1019	43.20	56.80	849	21.00	79.00	482
(%) Civil servant	11.00	89.00	453	30.30	69.70	403	7.50	92.50	281
Other children in household in 2003									
(%) None	6.90	93.10	2483	20.70	79.30	2312	12.10	87.90	1834
(%) One	10.60	89.40	1386	31.20	68.80	1239	15.40	84.60	852
(%) Two+	23.10	76.90	377	53.40	46.60	290	15.60	84.40	135
(%) Missing	75.00	25.00	4	0.00	100.00	1	0.00	100.00	1
Sex of the child born in 2003									
(%) Female	9.20	90.80	2060	26.40	73.60	1870	14.20	85.80	1377
(%) Male	10.00	90.00	2190	26.70	73.30	1972	12.30	87.70	1445
Multiple births in 2003									
(%) Single birth	9.50	90.50	4167	26.80	73.20	3770	13.20	86.80	2760
(%) Twins or triplets	13.30	86.70	83	13.90	86.10	72	14.50	85.50	62
Multiple births in 2003									
(%) Luxembourg	13.90	86.10	1349	22.30	77.70	1161	12.00	88.00	902
(%) France	4.20	95.80	1088	22.00	78.00	1042	10.00	90.00	813
(%) Portugal	14.20	85.80	564	50.80	49.20	484	17.60	82.40	238
(%) Belgium	3.70	96.30	602	26.40	73.60	580	9.60	90.40	427
(%) Germany	6.60	93.40	196	3.80	96.20	183	24.40	75.60	176
(%) Other	12.70	87.30	448	32.20	67.80	391	21.90	78.10	265
(%) Missing	66.70	33.30	3	0.00	100.00	1	0.00	100.00	1
Age in 2003									
Mean	31.10	31.70	4247	31.70	31.70	3841	32.00	31.60	2821
SD	4.80	4.40	-	4.60	4.40	-	4.70	4.30	-

7.B Detailed presentation of binary logit models

	Estimate	SE	z	p
Intercept	−0.12	0.82	−0.15	0.88
Salary: <1000 €	−1.62	0.37	−4.41	0
Salary: 1000-2000 €	−0.77	0.24	−3.16	0
Salary: 3000-4000 €	1.19	0.39	3.03	0
Salary: 4000-5000 €	0.6	0.38	1.56	0.12
Salary: 5000+ €	0.94	0.45	2.08	0.04
Salary growth: Quintile 2	0.2	0.27	0.75	0.46
Salary growth: Quintile 3	0.11	0.26	0.44	0.66
Salary growth: Quintile 4	0.33	0.27	1.23	0.22
Salary growth: Quintile 5	0.05	0.25	0.18	0.86
Hours: Full time	−0.07	0.22	−0.31	0.76
Hours: Overtime	0.48	0.27	1.76	0.08
Years participation in LU	0.02	0.03	0.88	0.38
Uninterrupted employment months	0.17	0.03	5.13	0
Organization: Medium (50-200)	0.36	0.33	1.1	0.27
Organization: Small (<50) or N/A	−0.43	0.25	−1.7	0.09
Organization: Very large (1000+)	0.72	0.26	2.71	0.01
Category: Blue collar	0.45	0.25	1.78	0.07
Category: Civil servant	−0.8	0.35	−2.3	0.02
Married	−0.09	0.2	−0.45	0.66
Other children in HH: (1)	−0.3	0.21	−1.45	0.15
Other children in HH: (2+)	−0.77	0.28	−2.75	0.01
Male child born in 2003	−0.28	0.17	−1.69	0.09
Twins or triplets in 2003	0.04	0.57	0.07	0.94
Nationality: France	1.49	0.29	5.13	0
Nationality: Portugal	0.86	0.27	3.16	0
Nationality: Belgium	1.78	0.41	4.37	0
Nationality: Germany	0.27	0.44	0.61	0.54
Nationality: Other	0.71	0.29	2.41	0.02
Age in 2003	0.01	0.02	0.51	0.61
Record in 2003	0.5	0.38	1.3	0.19
N	3867			
Chi-Square	231.04			
df	30			
p	0			

Table 7.10: Detailed results for Model 1. Dependent variable: Remaining in the Luxembourg labour force after maternity leave (0 = No, 1 = Yes).
Reference categories: Salary: 2000-3000 €, Salary growth: Quintile 1, Hours: Part time, Category: White collar, Married: No, Other children in household (HH): None, Sex of child born in 2003: Female, Single Birth, Nationality: Luxembourg, Record in 2003: No.

	Estimate	SE	z	p
Intercept	2.34	0.5	4.67	0
Salary: <1000 €	−0.44	0.3	−1.45	0.15
Salary: 1000-2000 €	−0.11	0.14	−0.77	0.44
Salary: 3000-4000 €	−0.17	0.15	−1.18	0.24
Salary: 4000-5000 €	−0.63	0.15	−4.1	0
Salary: 5000+ €	−1	0.16	−6.13	0
Salary growth: Quintile 2	0.22	0.14	1.63	0.1
Salary growth: Quintile 3	0.02	0.14	0.11	0.91
Salary growth: Quintile 4	0.15	0.14	1.07	0.28
Salary growth: Quintile 5	−0.07	0.14	−0.52	0.6
Hours: Full time	0.1	0.11	0.9	0.37
Hours: Overtime	−0.04	0.13	−0.34	0.73
Years participation in LU	0.02	0.01	1.44	0.15
Uninterrupted employment months	−0.06	0.02	−2.88	0
Organization: Medium (50-200)	−0.08	0.14	−0.56	0.57
Organization: Small (<50) or N/A	−0.24	0.13	−1.8	0.07
Organization: Very large (1000+)	2	0.14	14.59	0
Category: Blue collar	−0.86	0.16	−5.52	0
Category: Civil servant	−1.63	0.18	−9.14	0
Married	0.01	0.1	0.08	0.94
Other children in HH: (1)	−0.67	0.1	−6.52	0
Other children in HH: (2+)	−1.49	0.17	−8.89	0
Male child born in 2003	−0.02	0.09	−0.24	0.81
Twins or triplets in 2003	0.95	0.42	2.24	0.02
Nationality: France	−0.1	0.14	−0.73	0.46
Nationality: Portugal	−1.12	0.17	−6.66	0
Nationality: Belgium	−0.23	0.16	−1.48	0.14
Nationality: Germany	1.91	0.41	4.64	0
Nationality: Other	−0.24	0.17	−1.4	0.16
Age in 2003	0.01	0.01	0.49	0.62
Record in 2003	−0.6	0.23	−2.64	0.01
N	3701			
Chi-Square	953.29			
df	30			
p	0			

Table 7.11: Detailed results for model 2. Dependent variable: Taking parental leave after maternity leave (0 = No, 1 = Yes). Model has been estimated on the part of the sample remaining in the labour force after maternity leave.
Reference categories: Salary: 2000-3000 €, Salary growth: Quintile 1, Hours: Part time, Category: White collar, Married: No, Other children in household (HH): None, Sex of child born in 2003: Female, Single Birth, Nationality: Luxembourg, Record in 2003: No.

	Estimate	SE	z	p
Intercept	3.01	0.74	4.07	0
Salary: <1000 €	−0.91	0.39	−2.32	0.02
Salary: 1000-2000 €	−0.24	0.17	−1.38	0.17
Salary: 3000-4000 €	0.79	0.2	3.89	0
Salary: 4000-5000 €	0.72	0.24	3.01	0
Salary: 5000+ €	0.44	0.25	1.75	0.08
Salary growth: Quintile 2	−0.22	0.2	−1.11	0.27
Salary growth: Quintile 3	−0.01	0.2	−0.03	0.97
Salary growth: Quintile 4	−0.02	0.2	−0.11	0.91
Salary growth: Quintile 5	0.05	0.2	0.26	0.79
Hours: Full time	0.28	0.16	1.76	0.08
Hours: Overtime	0.08	0.18	0.46	0.64
Years participation in LU	0.05	0.02	2.74	0.01
Uninterrupted employment months	0.05	0.03	1.82	0.07
Organization: Medium(50-200)	0.4	0.29	1.41	0.16
Organization: Small(<50) or N/A	0	0.24	0.01	0.99
Organization: Very large (1000+)	−0.21	0.2	−1.04	0.3
Category: Blue collar	0.06	0.21	0.28	0.78
Category: Civil servant	0.49	0.28	1.72	0.09
Married	0.14	0.14	1.02	0.31
Other children in HH:(1)	−0.02	0.15	−0.12	0.9
Other children in HH:(2+)	−0.05	0.29	−0.19	0.85
Male child born in 2003	0.18	0.12	1.46	0.15
Twins or triplets in 2003	−0.14	0.39	−0.35	0.73
Nationality: France	0.62	0.2	3.15	0
Nationality: Portugal	0.19	0.25	0.77	0.44
Nationality: Belgium	0.57	0.23	2.51	0.01
Nationality: Germany	−0.51	0.25	−2.02	0.04
Nationality: Other	−0.37	0.22	−1.67	0.09
Age in 2003	−0.05	0.02	−3	0
Record in 2003	−0.89	0.44	−2.03	0.04
N	2729			
Chi-Square	143.07			
df	30			
p	0			

Table 7.12: Detailed results for Model 3. Dependent variable: Returning to work after parental leave (0 = No, 1 = Yes). Model has been estimated on part of the sample remaining in the labour force after maternity leave and using parental leave.
Reference categories: Salary: 2000-3000 €, Salary growth: Quintile 1, Hours: Part time, Category: White collar, Married: No, Other children in household(HH): None, Sex of child born in 2003: Female, Single Birth, Nationality: Luxembourg, Record in 2003: No.

7.C Graphical illustration of results including nationality differences

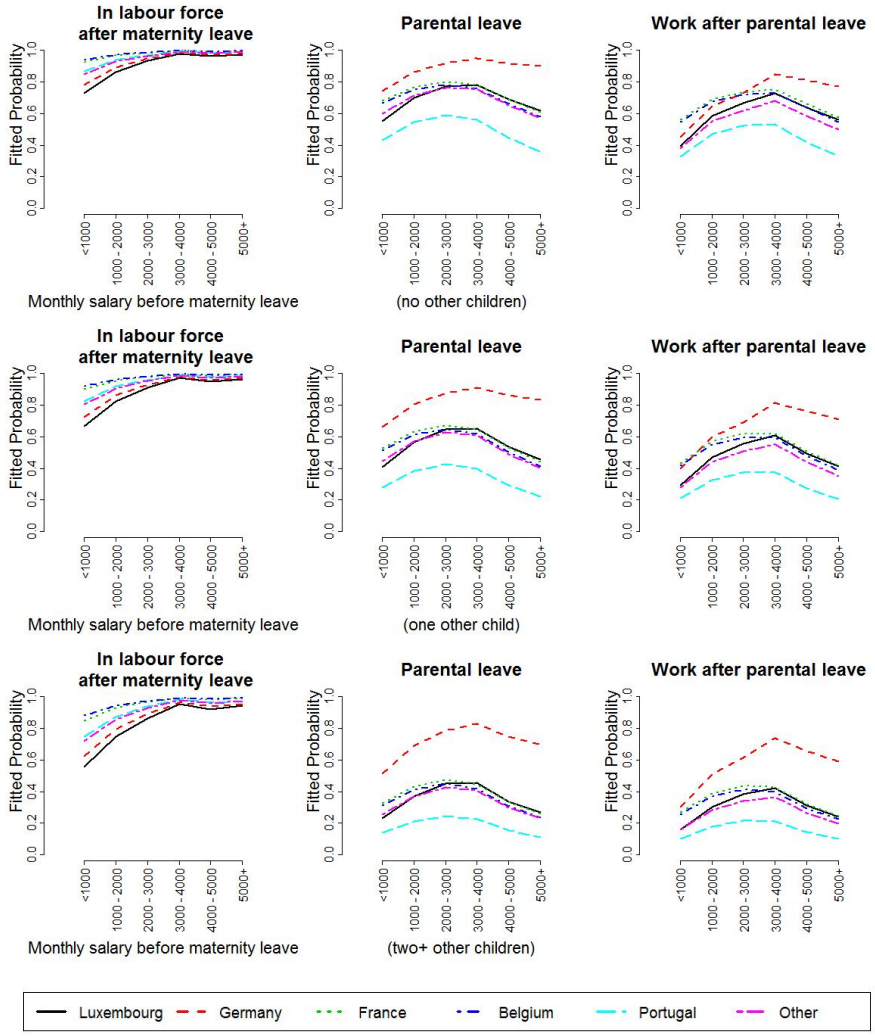


Figure 7.4: The fitted probabilities for women to make decisions 1, 2 and 3, according to nationality, number of other children and their average monthly salary income in the period before taking maternity leave.
Values for the other covariates used: Salary growth: Quintile 3, Hours: Full time(173), Years of participation: mean, Uninterrupted employment months: mean, Organization: Large, Category: White collar, Married: Yes, Female child born in 2003, Single birth in 2003, Age in 2003: mean, Record in 2003: Yes.

CHAPTER 8

Male use of parental leave in Luxembourg: Empirical analysis of administrative records

8.1 Introduction and literature review

This chapter investigates the decision of fathers to use parental leave at the individual level. This question deserves attention because policy makers in industrialized countries are increasingly looking for ways to increase the number of fathers using parental leave. Despite parental leave generally being conceptualized as a gender-neutral work-family reconciliation measure, the majority of leave users in industrialized countries are women (Plantenga and Remery, 2005). Increasingly policy-makers and academics are recognizing the importance of achieving a more equal distribution of paid and unpaid work between men and women. The participation of men in parental leave would mean that women would not be the sole bearers of all negative consequences associated with time spent out of the labour force. Fathers' use of parental leave has been linked to higher probability for couples to have more children in Sweden and Norway (Duvander, Lappegård, and Andersson, 2010). In addition, parental leave provides an important opportunity for fathers to strengthen their emotional connection with their children (O'Brien, Brandth, and Kvande, 2007). There is evidence that fathers' parental involvement is linked to positive outcomes for children (see Pattnaik and Srirarm, 2010) and for their spouses (Lamb, Pleck, and Levine, 1986). Therefore it is important to understand what factors foster or prevent the participation of men in parental leave and to concentrate policy efforts accordingly.

Previous research on male use of parental leave is reviewed in Zhelyazkova (2013). So far, it is well-established that variations in the policy design can significantly affect male take-up rates of parental leave. Earmarking part of the leave for fathers on a use-it-or-lose it basis seems to have particulary pronounced effects, as has been demonstrated by a number of quasi-experiments, comparing take-up rates before and after a reform (Ekberg et al., 2013; Duvander and Johansson, 2012; Geisler and Kreyenfeld, 2012).

Empirical research has also been carried out outside the quasi-experimental framework, linking taking parental leave (or its duration) to several explanatory factors. Typically situated within the context of single countries, this stream of research has provided a deeper understanding of the factors involved in the decision-making of fathers and couples regarding use of parental leave. Some main findings from such studies are that men are more likely to take leave for their first child, if their partner is more educated and if their partner has (relatively) higher earnings (Nielsen, 2009; Geisler and Kreyenfeld, 2011; Lappegård, 2008; Sundstrom and Duvander, 2002). Within the workplace, there is evidence that fathers working in the public sector are more likely to use parental leave (Lappegård, 2012; Nielsen, 2009). Organizational size also matters, as for smaller organizations it is expected to be harder to accommodate prolonged leaves of their employees (Anxo, Fagan, Smith, Letablier, and Perraudin, 2007; Whitehouse, Diamond, and Baird, 2007). In addition, research has pointed out the importance of the employment sector, work scheduling, age and gender-composition of the company, etc. (Anxo et al., 2007). The study of Haas, Allard, and Hwang (2010) further extends the analysis to company-level factors, which are harder to measure, such as organizational culture and the extent to which management was supportive of parenting values.

From an economic point of view, it could be expected that the opportunity cost of fathers when taking parental leave, in terms of their foregone earnings while on leave, would be among the key predictors for use of leave. Previous empirical findings, however, tend to suggest that the association between earnings level and probability of taking parental leave may not always be negative. For example, in the study of Lappegård (2008) in Norway, fathers' income level had a positive effect on the probability of taking leave (controlling for the earnings of the mothers in the couple, which also had a positive effect). In Sweden, Ekberg et al. (2013) found that the Daddy-Month reform had a positive effect on fathers' leave-taking, even in households with above-average income levels (where the opportunity cost of the leave is higher because the fathers' income would be above the income-replacement threshold level), although the strongest differences

were observed in lower-earning households. It seems that the income of the father is important not so much in terms of a measure of opportunity cost, but in terms of a measure of a position of relative career stability, so that the father (and the family) can afford a period of lower earnings.

The present study positions the opportunity cost of every individual father at the centre of the analysis in order to extend previous understanding of the role of income levels for parental leave. Opportunity cost is measured in terms of two main components: direct foregone income and promotion opportunities, conceptualized as the average growth in each previous six-month period.

As discussed in chapter 3, the analysis benefits from the opportunity to use anonymous administrative records from the Grand Duchy of Luxembourg, which provide information about the income and growth of salary at every time point during the whole period when a father is eligible to use parental leave on a monthly basis. The longitudinal nature of the data makes it possible for the effects of covariates to be traced even if they change over time, as information from the entire period of observation can be used, as opposed to relying on values at fixed points of time (typically before the birth). Furthermore, the administrative records provide the rare opportunity to analyse parental leave via knowledge of actual leave-taking as from the records, as opposed to inferring parental leave based on general leave of absence from work or self-reported data. Finally, analysing the Luxembourg data extends the knowledge of male use of parental leave to a new, previously unexplored context. Although Luxembourg is a rather small country, its size and workforce composition make it comparable to the workforce in a number of European regions, especially around large cities (Brosius and Ray, 2012).

8.2 Background: Parental leave in Luxembourg

The present research is situated in Luxembourg where parental leave take-up has not been researched before with the exception of a report for the European Commission prepared by Plasman and Sissoko (2005) and an evaluation performed by KPMG Assurance Advisory Luxembourg (2002). The Luxembourg context is interesting because as early as 2004 (only five years after the introduction of parental leave in Luxembourg) men already constituted 17% of parental leave users, which is amongst the higher figures

for European Union countries. More details are provided in chapter 2.

It is possible that the policy design of the leave in Luxembourg could explain this relatively high rate of male participation. As already mentioned in chapter 2, in a comparative assessment De Henau et al. (2007) classified the parental leave system in Luxembourg as being the best one (amongst the countries in the analysis) in terms of its potential to achieve gender equality. The leave is paid (although on a flat-rate basis) and equally divided between the two parents. That is, each parent in Luxembourg has the individual and non-transferable right to paid parental leave, which can be taken in a block of six months full-time or twelve months part-time. This means that fathers who do take parental leave, take it for a minimum duration of six months. In comparison, data on fathers' take-up of leave in Sweden show that on average fathers took leave of duration equal to the minimum earmarked period of about two months (Plantenga and Remery, 2005).

8.3 Conceptual framework and research hypotheses

According to the parental leave legislation in Luxembourg described in chapter 2, fathers who work in Luxembourg can decide at any point of time between the birth or adoption of their child until his or her fifth birthday whether to use parental leave or not[1]. If the father does not use the leave it is "lost", as it is not possible that the mother uses it instead. The premise underlying the analysis presented in this chapter is that parental leave is an individual entitlement and each father decides whether to use it or not during the five-year period for which it is possible to use it. The decision of fathers is analysed within an economic framework where they are rational agents who act to maximize utility. Fathers decide whether to take leave or not based on comparing their utility of taking the leave and remaining at home with their child to the opportunity cost in terms of salary-related income or career opportunities.

[1] In principle, fathers face several constraints in this decision: that their partner cannot be on parental leave during this time, that the earliest possibility to take the leave is immediately after the end of the maternity (adoption) leave and that they will lose their eligibility rights if they become unemployed or stop to be employed for a minimum of 20 hours. However, for simplicity, I ignore these constraints, as it is very difficult to incorporate them into an estimation model.

Due to the availability of longitudinal employment-related data, the present study can contribute to the current understanding of how men make decisions on taking parental leave by incorporating two measures of opportunity cost. The first measure is the directly measurable cost in terms of foregone earnings, which is equal to the pre-leave wage minus the amount of the benefit. The second measure is conceptualized as a proxy for foregone career development opportunities. It is measured through the average rate of salary growth over the previous six months for each father. The main hypothesis is that, for both measures of opportunity cost, higher opportunity cost would be associated with lower likelihood of using parental leave.

The analysis controls for family-related and workplace-related characteristics of the fathers, which are available in the data and which have been demonstrated to be important in previous studies. Within the family the following variables are included as controls: the order of the birth (if it is first, second, third, etc. in the family), the presence of other children, the marital status of the father, the gender of the child and whether multiple births occurred. In terms of work-related variables, it has been possible to incorporate information on the size of the enterprize and the monthly hours of employment. Nationality and age are also included as controls, as they can reveal differences in fathers' labour-market positions. For example, immigrants' position on the labour market could be less advantageous than that of natives (Li, 2000), while younger fathers are more likely to hold temporary and less-protected job contracts (Baranowska and Gebel, 2010). As discussed in chapter 2, for Luxembourg this is quite important as over a third of the population are non-Luxembourgish with the most represented nationalities being Portuguese, French, Italian, Belgian and German. In addition, about two thirds of the total workforce are cross-border workers who commute on a daily basis to Luxembourg from another country.

The use of administrative records makes it impossible to use education in the analysis. This is an important omission, as higher-educated fathers are considered more likely to hold gender-egalitarian beliefs (Bolzendahl and Myers, 2004) and to participate in household tasks (Nordenmark and Nyman, 2003). At the same time, however, education bears a direct relationship to fathers' work situation, as higher education is associated with higher earnings (Brunello and Comi, 2004), which could suggest a higher opportunity cost of using parental leave.

Finally, it is useful to say a few words on the decision to analyse men individually and not within the family unit. Positioning the analysis at the individual level is somewhat different from the general trend in previ-

ous research, where male use of parental leave is usually analyzed at the family level. Academic research based on the life-course perspective has highlighted the fact that lives of individuals are "linked" (Elder, 1994) and decisions concerning work and family are often made inter-dependently.

Economic frameworks used for analyzing male use of parental leave also tend to analyse the decisions of fathers within the couple (see Zhelyazkova, 2013). Many economic studies base their theoretical analysis on the economic framework derived from Becker's (1981) New Home Economics (Reich, Boll, and Leppin, 2012) and from bargaining theories Amilon (for example, see 2007). In both of these frameworks tasks related to the unpaid production of goods and services for the home would be performed by the spouse who earns less on the labour market. In the New Home Economics reasoning this is due to the fact that this would allow the couple as a unit to be more productive, while in the bargaining theories the partner who has a higher earning power has a more favourable position in the negotiation process of task distribution.

Generally, approaches based on negotiations within the couple have been applied for Germany (Geisler and Kreyenfeld, 2011) and Sweden (Sundstrom and Duvander, 2002), where parental leave is a family-based right. In contrast, in Luxembourg parents are given an individual and non-transferable right to leave, meaning that parents do not need to negotiate on sharing the leave per se. Therefore, an individual approach to the analysis might be more appropriate for the case of Luxembourg.

8.4 Data and method

8.4.1 Analytical approach

The data used for the analysis have been described in chapter 3. The employment histories of 5827 men, who all had a child born in their household in 2003, are included in the analysis. For the analysis, event history modelling methods have been applied[2], as they are designed for questions related to the timing of occurrence of one or more events of interest (for a recent overview see Mills, 2011). In event history analysis models the dependent variable is either the duration until an event occurs or the "hazard"

[2]Those methods can also be called survival or duration modelling methods.

rate (the probability that a particular event occurs at a given time point, conditional on that it has not already occurred)[3].

For event history analysis one needs longitudinal data, a clearly defined event of interest (or multiple events[4]) and a clearly defined starting point at which everyone in the sample starts to be "at risk" of experiencing the event. The longitudinal data available in the monthly social security records of fathers in Luxembourg are used in this chapter to set up an event history model. The event of interest is whether or not a father takes parental leave. Fathers are considered to be "at risk" for taking parental leave from the month when the child is born in 2003.

With event history multivariate modelling, it is possible to investigate what factors contribute to whether a father takes parental leave or not. In addition, if time-varying effects are incorporated, it is also possible to trace how the rate of taking leave varies over time. The possibility of incorporating time-varying covariates makes it possible to incorporate information on how the fathers' circumstances may change during the eligibility period. Five years represents a substantial time span during which a number of important factors in one's family or employment status can change (for example, more children can be born, or salary levels can increase, etc.). Event history analysis methods are common in the literature related to maternity leave, parental leave or, in general, family-related career breaks. A number of studies have examined how soon after birth mothers return to work and the role or parental leave and institutional or individual-level factors in this process (Joesch, 1994; Ondrich et al., 1996; Ondrich, Spiess, Yang, and Wagner, 2003; Smith and Pylkkänen, 2004; Hofferth and Curtin, 2006; Lapuerta, Baizán, and González, 2010).

Event history analysis models make different assumptions about the shape of the hazard function and its relationship with explanatory factors. There are non-parametric, semi-parametric and parametric methods. In this analysis it would be difficult to apply a parametric method, as it is difficult to imagine distribution that would fit the data well. There is very limited information on the timing of parental leaves used by men in Luxembourg. As explained in chapter 2, the report by the Luxembourg Ministry of Family and Integration (2012) shows that, on average, women are more likely to use

[3]All computations were performed using the Free Statistical and Programming Environment R (R Core Team, 2014). For estimating the Cox proportional hazards model, the *survival* library developed by Therneau (2014) was used. Finally results were presented through the use of the *xtable* package, developed by Dahl (2014).

[4]Multiple events of interest can be analyzed via competing risk models.

the "first" leave available for the two parents, while men were much more likely to use the "second" parental leave. For example, in 2012, men represented only 12.3 per cent of the users of the "first" parental leave and 87.7 per cent of the users of the "second" parental. The Luxembourg parental leave scheme also requires that the "first" leave in the family must be taken immediately after the maternity leave, which continues for two or three months (three months if the mother breastfeeds). Thus if the male partner in the couple is less likely to be using the "first" leave, it could be expected that the slope of the hazard rate will be relatively flat in the beginning and will be getting steeper at the point after the period of the "first" parental leave, which, if taken full time would be around the 8th or 9th month after the birth of the child. However, it is difficult to imagine how it will be distributed after this point or to make any assumptions about the relationship of covariates and the shape of the hazard function over time. Therefore, it would be a safe choice to use a non-parametric or a semi-parametric model for the analysis.

The analysis in this study is broken into two parts. The first part is an exploratory analysis, where the survival rate of all fathers in the sample is estimated using the Kaplan-Meier estimation technique (explained in more detail in the next section). In short, the Kaplan-Meier estimation technique can be used to measure the duration until the event of interest (in this case until the father takes parental leave) takes place. It is an especially appealing technique for the explorative part of the analysis, as it makes no assumptions about either the shape of the survival function or a potential relationship with covariates. As a first explanatory step, the survival functions based on the Kaplan-Meier estimator are comparable across the different levels of the main covariates of interest for the analysis: the two measures of opportunity cost. In the second part the analysis is extended to a multivariate level by applying a Cox proportional hazard model (Cox, 1972), a semi-parametric method, which allows the inclusion of multiple covariates (including time-varying covariates and time effects) at the same time.

Equation 8.1 displays one of the generic ways of writing the formula for the Kaplan-Meier estimator. In this formula $\hat{S}(t)$ represent the estimated cumulative probability of survival beyond time point t, n_i denotes the total number of individuals who are "at risk" of experiencing the event (in the first period these are all individuals and in subsequent periods, individuals who already experienced the event in the previous period and censored individuals are subtracted) and d_i stands for the number of individuals experiencing the event at time t_i. Therefore $\hat{S}(t)$ is equal to the product of

the ratios of the number of individuals who have not yet experienced the event at time t_i, $n_i - d_i$, and the total number of individuals at risk n_i, whereby censored cases are subtracted at the time period when they are censored.

$$\hat{S}(t) = \prod_{t_i<t} \frac{n_i - d_i}{n_i} \tag{8.1}$$

The Kaplan-Meier estimator can be used to model the survival probability of the entire sample and to explore the relationship with categorical covariates (one at a time), whereby the survival curves are plotted for groups with different levels of the predictor variable. In this chapter, this technique was used to explore the relationship between the two explanatory variables relating to the opportunity cost of taking parental leave for the fathers.

The statistical significance of the difference between the survival probabilities of the groups has been assessed by using the score test from a semi-parametric model. Under the assumption of proportional hazards this test can be considered equivalent to a log-rank test (see Harrell, 2001; Dalgaard, 2008, p.474, p.255). The log-rank test works by comparing the difference between observed and expected number of events at each event time for the different levels of the predictor variables (see Cleves, 2008, p.123). In this study the log-rank test has not been used because it is difficult to estimate it with time-varying covariates in the *survival* library (Therneau, 2014) in R (R Core Team, 2014).

For the multivariate analysis, the Cox proportional-hazards regression (Cox, 1972) was used. An overview of this model and a step-by-step guide to its application with the free statistical and programming environment R (R Core Team, 2014) is available in Mills (2011, chap. 5). The most important feature of this method is that it does not make any assumption about the shape of the survival function, which makes it suitable for the analysis of events whose distribution cannot be derived theoretically (for an example of the application of this model see Joesch, 1997). Typically in the interpretation of the results one uses the exponentiated values of the estimated coefficients (risk ratios). Values higher than one correspond to a positive relationship, i.e. higher levels of the explanatory variable increase the hazard of the event occurring. Values lower than one indicate the reverse - the hazard, or the conditional probability of the event to occur, is lower. When explanatory variables are interacted with the variable indicating time, the

analysis can also reveal how the effects of the explanatory variables change over time.

Different notations are used in the literature for writing the formula for the Cox proportional hazard model. In Fox (2002b) the following formula is presented, where i is the subscript denoting the different individuals and covariates are denoted as x's:

$$h_i(t) = h_0(t)exp(\beta_1 x_{i1} + \beta_2 x_{ik} + ... + \beta_k x_{ik}) \tag{8.2}$$

To make the model easier to understand Fox (2002b) presents step by step how the hazard ratios of two individuals can be presented. The hazard for individual i is shown in Equation 8.3, while the hazard for individual i' is in Equation 8.4. Equation 8.5 shows how the hazard ratio for these individuals would look like, whereby one can observe that it is independent of time t.

$$\eta_i = \beta_1 x_{i1} + \beta_2 x_{ik} + ... + \beta_k x_{ik} \tag{8.3}$$

$$\eta_{i'} = \beta_1 x_{i'1} + \beta_2 x_{i'k} + ... + \beta_k x_{i'k} \tag{8.4}$$

$$\frac{h_i(t)}{h_{i'}(t)} = \frac{h_0(t)e^{\eta_i}}{h_0(t)e^{\eta_{i'}}} =$$

One potential problem with this estimation technique is that it makes a strong assumption that the hazard functions of groups defined by the explanatory factors (e.g. low and high levels of the same covariate) remain parallel over time. In other words, the ratio of the hazards of any two observations from the data set is assumed to not vary over time. To test this assumption, the Schoenfeld residuals test (Schoenfeld, 1982) was used, as suggested in Mills (2011, chap.7)[5].

[5]Schoenfeld residuals are not residuals for the whole model, but are computed for each individual for each covariate. When residuals are plotted against time, their slope should be equal to zero if the assumption of proportionality holds. The Schoenfeld residuals test is equivalent to testing whether the slope of a regression of the scaled residuals on time would be equal to 0 (UCLA Statistical Consulting Group, 2013). The results of the test are presented in Appendix 8.C.

The results of the model estimated in this study suggest that a number of the covariates in the analysis do not meet the proportional hazards assumption. The solution in this chapter, following Joesch (1997), is to include interactions between the covariates and time in the model[6].

Another potential problem with the analysis is whether the censored observations are random. Censoring means that there are incomplete records in the data where information is missing either in the beginning (left censoring) or at the end of the observation period (right censoring). With right-censored observations, the problem is that it is not possible to know at what time period (and if) they experience the event of interest, as their complete records are not available.

In this analysis, fathers that interrupt their social security record during the five-year period of observation are considered censored. Interrupting the social security record means that these persons "disappear" from the data set. This could mean that they either stop working or they start working in another country or in one of European institutions in Luxembourg. Technically, these persons also lose the right to use parental leave in Luxembourg, as they interrupt their employment relationship. However, they could, obtain the right to parental leave in another country based on employment with another employer. Therefore it cannot be concluded that these fathers will not take parental leave. A potential problem with this analysis is that it is difficult to say whether persons interrupting their employment in Luxembourg do so "at random". Therefore the assumption that censoring is random may be violated.

Further, it must be noted that there are two types of cases: fathers who leave the data set (and presumably their employment in Luxembourg) and do not return and fathers who re-appear after some time. For this analysis the second type of censoring (middle censoring) poses a problem. These cases cannot be fully incorporated into the Cox model. To begin with, there does not really exist an easily implemented solution on middle censoring[7]. Second, for middle-censored cases most of the information on covariates will be missing also for earlier and subsequent time-periods, as the time-varying covariates are recorded on an annul basis as of December the previous year.

[6] In addition to this method, Mills and Begall (2010) suggest that an alternative solution would be stratifying the data. However, interactions with time have the advantage of allowing the researcher to trace how the effect of the covariates changes over time.

[7] There are some solutions already proposed in the literature concerning middle censoring in parametric models. The interested reader is referred to Iyer, Jammalamadaka, and Kundu (2008); Davarzani and Parsian (2011).

Therefore, middle-censored observations are treated as right-censored and their information is used only up to the first time they leave the data set.

It must also be noted that certain simplifications of the actual decision of the father have been made for this modelling. The first one is that the analysis ignores the fact that fathers can take more than one period of parental leave in the observation period (for example, if another child is born). To address this question, it would be possible to use recurrent events modelling (see Mills, 2011, chap. 8). Second, no distinction has been made between full-time or part-time leave. This distinction could be addressed via competing risk modeling (see Mills, 2011, chap. 10). Third, the Luxembourg legislation explicitly states that both parents in a family cannot be on parental leave at the same time. With the available data it would be possible to match only a small fraction of the men to their spouses as long as their spouse also works in Luxembourg. Therefore, although including information on the behaviour of the spouse would have been very interesting, it has not been attempted in this case as it would result in a very selected sample where unmarried men, men whose spouses do not work or work in another country would be excluded. Finally, it must be noted that this model does not make any corrections for non-observed heterogeneity. Therefore, it can be assumed that there is a bias in the estimation of the coefficients, if leave-taking behaviour is correlated with other characteristics, which also are related to the explanatory factors in the model.

8.5 Measuring opportunity cost

8.5.1 Foregone income

Opportunity cost in terms of foregone income was computed by subtracting the benefit rate for each time-period from the total salary-related income of each father in the analysis. Information on the salary-related income was obtained from the IGSS records, while benefit rates were obtained from the online information provided by the Luxembourg Statistical Portal (2013). Both the salary and benefit figures were converted to 2005 € values using the monthly *Harmonized Consumer Price Indices (HCIP)* provided by Eurostat for Luxembourg.

All values of the opportunity cost were lagged six months. Using lagged

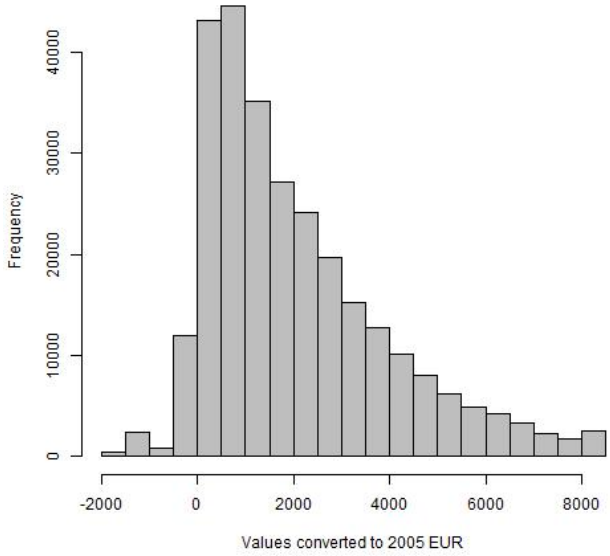


Figure 8.1: Distribution of the opportunity cost of fathers to take parental leave in terms of foregone monthly salary-related income.
Notes: The histogram is based on 281254 person-period months. The highest 5 % of observations have been trimmed off.

variables is commonly advised in event history modelling with time-varying variables. The reason is that without using lagged values causality can be obscured. For example, parents' salary-related income will naturally drop in the month they take parental leave, as they will not receive their salary any more. However, without using a lagged value of the variable, one can incorrectly infer that lower salary levels lead to a higher probability of taking parental leave. In this analysis, six-month lags have been used, because in Luxembourg parental leave must be applied for with the employer a minimum of six months before the desired start date. While there is no way to know exactly when parents apply for the leave, one can assume that both the parent and the employer will be aware of a forthcoming parental leave period six month prior to its start. As a result of the planned parental leave, the labour participation of the parent can be affected. For example, the parent may be less likely to get involved in new projects with a foreseen longer time-frame, etc.

Figure 8.1 displays the distribution of the measure of opportunity cost described above. The distribution is visibly not normal and rather skewed to the left. There were many outliers in the data and in order to make the main body of the distribution more visible and easier to interpret, the top 5 per cent of the values have been trimmed off.

For the multivariate analysis this variable was categorized for two main reasons. First, there were many outliers in the data, representing fathers with very high incomes. For example, in about 0.63 per cent of the person-period months the recorded monthly opportunity cost was higher than as many as three standard deviations above the mean (2812 €). This is not surprising for a high-income context like Luxembourg. However, a large number of extreme values are known to pose significant threats for the validity of results. To avoid the potentially confounding effects of these extreme values, the choice was made to put them together in the highest-earning category. In addition, categorizing the opportunity cost variable allows for detection of non-linear effects. Logarithmic transformation of the variable was also considered as an option to resolve the two issues mentioned before. However dummy variables were chosen due to their more powerful ability to detect different forms of non-linearity. The distribution of the categorized variable is displayed in Appendix 8.A.

8.5.2 Foregone promotion opportunities

The second measure of opportunity cost was constructed using the monthly values of salary-related income converted in 2005 € as described in Section 8.5.1. Average salary growth was computed using the formula displayed in equation 8.6. With this equation, growth equal to 1 corresponds to no changes in the salary. Values higher than 1 reflect positive growth or salary increase and values lower than 1 reflect negative growth or salary decrease.

As salary growth could, similarly to salary levels, be affected by the knowledge of the employer and employee of a forthcoming parental leave, lagged values of six months were used for the analysis. The average monthly salary-related income growth for the previous six months period ranged from 0 to 6 with 920 missing values[8]. It is difficult to say what the extreme

[8]The mean values of the variable showed to vary significantly across years. It is possible that the difference is due to macro-economic factors. To correct for this, the mean growth for all observation periods was subtracted from each observation. When the variable was entered in this format in the multivariate analysis, there were only minimal

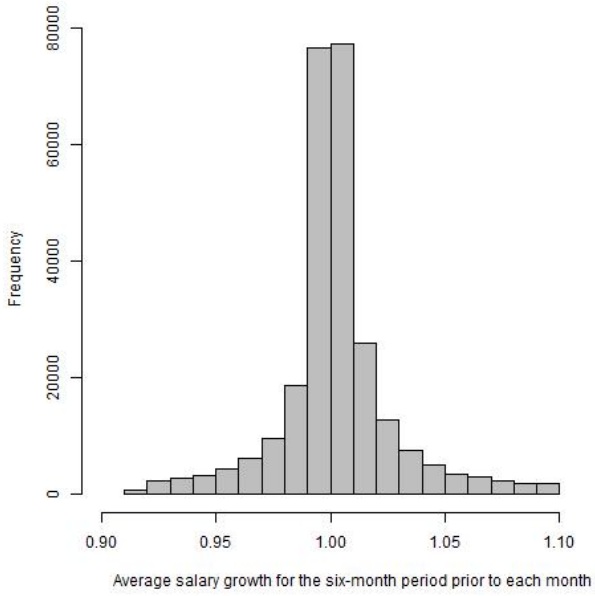


Figure 8.2: Opportunity cost of fathers to take parental leave in terms of salary-related growth.
Notes: The histogram is based on 266084 person-period months. The lowest 5 % and the highest 5 % of observations have been trimmed off.

values represented, but quite possibly they reflected the presence of periods where no income was recorded for a few months. It is possible that these periods represent unpaid leave or unpaid internship employment (in cases when such periods do not alter the social secutiry rights of the person they may continue to be recorded as employment).

The variable was split into eight groups, each of which contains 12.5 per cent of the data points. Categorization has the added advantage of allowing for the tracing of non-linear effects. The distribution of the variable is displayed in Figure 8.2. For creating the histogram, the top and bottom 5 per cent of the values have been trimmed off - otherwise the presence of extreme values made the graph less readable. The distribution of the categorized variable is displayed in Appendix 8.A.

changes in the coefficients, occuring after the second or third decimal sign. There were no changes in the significance levels or in other coefficients. In view of this, the variable has been left in its original form in the analysis.

$$\text{Average monthly growth from period } t \text{ to period } s = \left(\frac{wage_t}{wage_s}\right)^{\frac{1}{t-s}} \quad (8.6)$$

8.6 Descriptive analysis

From the 5827 fathers in the analysis, a total number of 769 fathers took at least one parental leave in the five-year period after a child was born in their household. The number of individuals treated as censored due to missing records was equal to 666. A table with more information on the distribution of explanatory covariates is provided in Appendix 8.A.

8.6.1 Men using parental leave over time

To gain an overall understanding of how the event of interest is distributed over time, it is useful to begin with the Kaplan-Meier curve. Often the starting point in survival analysis, the Kaplan-Meier curve is a plot of the cumulative survival rate throughout the observation period. In this case the event of interest is taking parental leave. This means that fathers who "survive" are those fathers who do not take parental leave.

The *interval survival rate* for time period t indicates what fraction of observations *at risk* to experience the event, survive, i.e. do not experience the event at time t. Observations that already experienced the event in previous time periods are not included in the *at risk* count for period t. Censored observations are included in the count of observations that are *at risk* for all time periods before they leave the data set. The *cumulative survival rate* for time t is obtained by multiplying the interval survival rates for all periods before time t (see Rich, Neely, Paniello, Voelker, Nussenbaum, and Wang, 2010).

The overall Kaplan-Meier curve for the sample fathers in this analysis is shown in Figure 8.3. To read the figure, one must keep in mind that the horizontal axis corresponds to time, while the vertical axis shows the

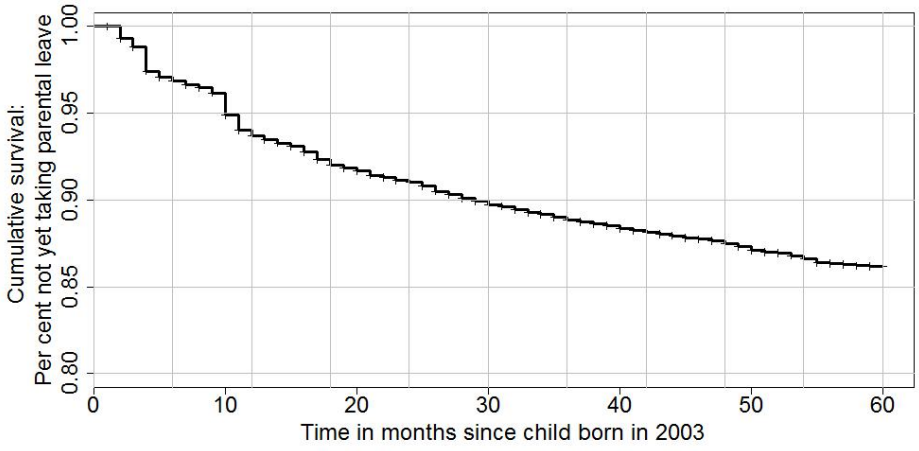


Figure 8.3: The Kaplan-Meier curve for men taking parental leave in Luxembourg.
Notes: All men in the sample had a child born in their household in 2003 and were eligible to take parental leave at that time.

cumulative survival rate, which provides an idea of the fraction of fathers who have not yet taken parental leave until each time point[9].

In Figure 8.3, the curve is flat for the first two months. This corresponds to the two months after the birth of the child when the mother is still on maternity leave and thus fathers are not able to take parental leave. The slope of the curve becomes negative after the second month. At around twelve months after the birth of the child, there also seems to be an increased rate of parental leave taking. In the remaining part of the curve the slope is flattening, which indicates that after the first birthday of the child, few fathers take parental leave in each period.

8.6.2 Opportunity cost and taking parental leave over time

To gain an understanding of how the two measures of opportunity cost may be related to the hazard of taking parental leave over time, the Kaplan-

[9]Please, note that in Figure 8.3 the vertical axis does not start at zero, but at 0.80. The graph presents a "zoomed" view of the survival curve. This presentation makes it easier to trace developments over time, as otherwise the curve appears rather flat and all developments would be concentrated in the top part of the graph.

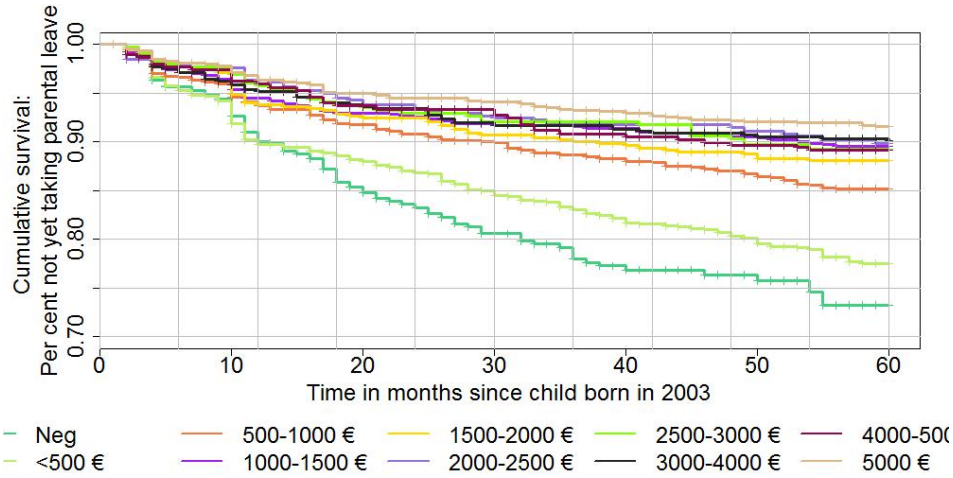


Figure 8.4: The Kaplan-Meier curve for men taking parental leave according to their salary-related opportunity cost.

Meier curves were drawn at their different levels. The Kaplan-Meier curves are displayed in Figures 8.4 and 8.5. It must be noted that the Kaplan-Meier curves can provide only an initial insight into the association, as they do not control for any other characteristics of the fathers.

Figure 8.4 displays the survival rates (the proportions of fathers who have not taken parental leave) along the sixty months of observation for fathers with different levels of salary-related opportunity costs. Note that the values are lagged six months, as explained in section 8.5, as this is the time frame within which parental leave must be formally applied for. Figure 8.4 shows that the group with the lowest survival rate (i.e. with the highest fraction of men taking parental leave) is the group for which the opportunity cost would be negative. For this group the survival rate is equal to 0.73. This group is followed by the group of men with opportunity cost less than 500 €, for whom the survival rate is equal to 0.78 and the group with opportunity cost between 500 and 1000 € per month, with survival rate equal to 0.85 at the end of the observation period. The group with the highest survival rate appears to be the one where the opportunity cost would be over 5000 € per month. For this group the survival rate equals 0.92 at the end of the observation period. The results from the score test from a Cox proportional hazard model with opportunity cost as the only variable in the model[10] indicate that the difference is significant

[10]Under the proportional hazards assumption this is a test equivalent to the log-rank test, see Section 8.4.1.

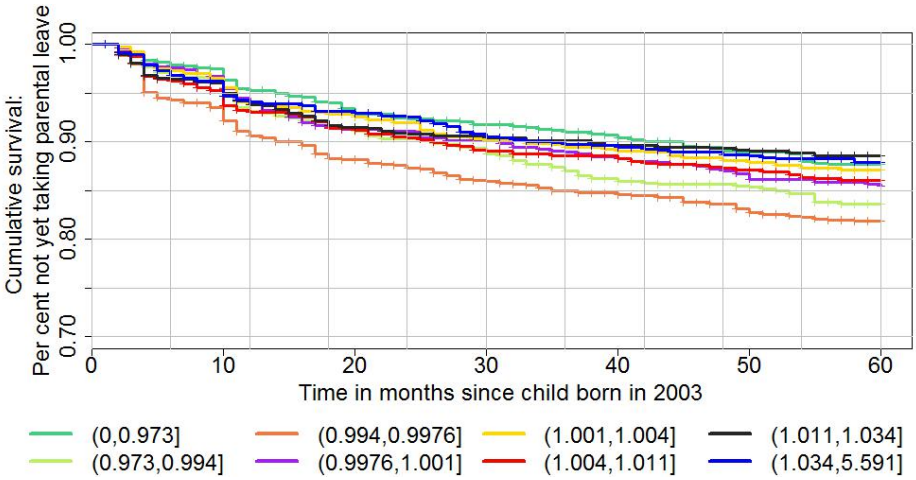


Figure 8.5: The Kaplan-Meier curve for men taking parental leave according to levels of salary growth in past six months.

$(\chi^2 = 138.5, df = 9, p = 0)$.

Figure 8.5 displays the survival rates across time for fathers with different levels of salary growth in the previous six months. The group with lowest survival rate seems to be the group with the third lowest value for salary-growth (0.994 to 0.9976], for which the survival rate at the end of the observation period is 0.82. This level of salary growth is negative and, in fact, indicates a decrease in the salary-related income level. The group with an even greater decrease in salary growth (0.973 to 0.994], has a slightly higher survival rate equal to 0.84. While higher than the rate of the previous group, this rate is still relatively lower than the other groups. The other groups seem to have similar survival rates. Interestingly, the group with the lowest (and negative) rate of income growth (0, 0.973] has the third highest survival rate equal to 0.88. The results from the score test from a Cox proportional hazard model with salary growth as the only variable in the model suggests that the difference is significant ($\chi^2 = 17.36, df = 7, p = 0.015$).

8.7 Multivariate results

To examine the effect of a number of covariates on the probability that a father will take parental leave over time, a Cox proportional hazards

model with time-varying and fixed covariates has been used. The model was estimated on a 253431 number of spells, with a total of 729 events occurring. The method used for resolving ties was the Efron approximation. The log likelihood ratio test is significant (-2LogLikelihood = 1217, df=52, $p<0.001$), meaning that the coefficient of at least one of the covariates is different from 0.

The results are displayed in Table 8.1. The table is organized as follows. The first column displays the names of the variables entered into the analysis. The second column displays hazard ratios, which are the exponentiated values of the coefficients. Hazard ratios greater than one indicate a positive association between the predictor variable and the hazard of the event (in this case, a greater chance of taking parental leave). Negative relationships are indicated by hazard ratios smaller than one. The significance of the hazard ratios is displayed in column three. Column four presents the exponentiated values of the coefficients of the interaction terms between time and these predictors, which were identified to have non-constant effects over time by the Schoenfeld residuals test, displayed in Appendix 8.C. The significance of the interaction terms is shown in the last column.

The hazard ratios of the dummy variables for the first measure of opportunity cost - foregone income - seem to decrease, as the dummy variables indicate a higher income level, although significant differences are only observed between the reference group (where opportunity cost would be estimated at $1500 - 2000$ € per month) and the groups of fathers for whom the opportunity cost would be lower than 1500 € per month who all have a higher probability than the reference to use parental leave. Higher-earning fathers, however, do not have significantly lower probabilities than the reference group to use parental leave, except the group of very high-earners, where the opportunity cost would exceed 5000 € per month. The Schoenfeld residuals test did not suggest a violation of the proportional hazards assumption, so the variable was assumed to have the same effect over time and interactions with time were not included in the model. To sum up, the coefficients suggest some kind of non-linearity in the relationship between foregone income and taking parental leave, whereby the association stronger at the two extreme ends of the distribution of foregone income. These results lend partial support to the hypothesis tested in this study: higher levels of opportunity cost are associated with a lower hazard of taking parental leave.

	Hazard ratio	sig	Time interaction	sig
Salary opportunity cost: Negative	2.82	***	–	-
Salary opportunity cost: <500 €	5.56	***	–	-
Salary opportunity cost: 500-1000 €	2.88	***	–	-
Salary opportunity cost: 1000-1500 €	1.2		–	-
Salary opportunity cost: 2000-2500 €	0.72		–	-
Salary opportunity cost: 2500-3000 €	0.79		–	-
Salary opportunity cost: 3000-4000 €	0.72	.	–	-
Salary opportunity cost: 4000-5000 €	0.77		–	-
Salary opportunity cost: 5000+ €	0.49	***	–	-
Salary growth in past 6 months: (0,0.973]	0.86		1	
Salary growth in past 6 months: (0.973,0.994]	1.44		0.99	
Salary growth in past 6 months: (0.994,0.9976]	1.82	*	0.98	.
Salary growth in past 6 months: (0.9976,1.001]	1.19		1	
Salary growth in past 6 months: (1.004,1.011]	1.6	*	0.98	.
Salary growth in past 6 months: (1.011,1.034]	1.64	*	0.98	*
Salary growth in past 6 months: (1.034,5.591]	2.15	**	0.98	
Monthly working hours: <173	1.63	***	–	-
Monthly working hours: 173+	1.41	**	–	-
Birth order: Second	0.6	***	–	-
Birth order: Third+	0.37	***	–	-
Child sex: Male	0.91		–	-
Multiple births	0.93		–	-
Nationality: France	1.18		0.99	
Nationality: Portugal	0.34	***	1.03	***
Nationality: Belgium	0.97		1	
Nationality: Germany	0.74		1.01	
Nationality: Other	0.5	**	1.03	***
Age	1.16	*	–	-
Age squared	1	*	–	-
Marital status: Married	0.99		1.02	*
Marital status: Re-married	0.42	*	1.05	**
Children under five: 2	1.98	***	0.99	*
Children under five: 3+	3.2	**	0.99	
Size enterprize: Medium (50-200)	0.8		–	-
Size enterprize: Small (<50) or Not Applicable	0.8		–	-
Size enterprize: Very large (1000+)	10.18	***	–	-

Table 8.1: Cox proportional hazard model for taking parental leave with time interactions.
Notes: Reference categories: Salary opportunity cost 1500-2000 €, Salary growth in past six months: (1.001, 1.004], Birth order: First, Child sex: Female, Nationality: Luxembourg, Marital status: Single, Children under five: None or one, Size of the enterprize: Large (500-1000).
Significance codes: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$, . $p < 0.10$.

The second measure of opportunity cost, averaged salary growth in the past six months, also yielded non-linear results. The expectation for this variable was that fathers who have a higher level of salary growth would have a lower hazard of taking parental leave, as this would suggest a potentially higher level of foregone promotion opportunities. Although, the results are somewhat mixed, it seems that the relationship is the opposite of what was expected.

The reference group for this variable was chosen to be fathers with average growth rates between 1.001 and 1.004. With the exception of the coefficient of the third group (0.994 to 0.9976], the coefficients seem to increase - i.e. higher levels of growth, relative to the reference group, are associated with more instances of taking parental leave. The coefficients are significant, however, only for the difference between the reference category and the third group (0.994 to 0.9976] and the groups with higher levels of growth, above 1.004. The relationship was not constant over time according to the Schoenfeld residuals test (see Appendix 8.C). This is also reflected in the significant negative (except for the first group) interactions with time (see columns 4 and 5 in Table 8.1), suggesting that with time, the difference between these groups and the reference group tends to decrease.

The coefficients of monthly hours of work are somewhat surprising, as it appears that *both* fathers working more and less than the standard full-time contract are more likely to take parental leave. The reference group was chosen to represent men working exactly 173 hours per month. In Luxembourg, this is the standard working hours per month figure. Fathers working less than that were grouped together as "part-timers", while these working more than 173 hours were grouped together as "overtimers".

It must be noted that the variable is correlated with the variable indicating the type of job - white or blue collar. Due to a large number of missing cases, the variable could not be directly included in the analysis. In Luxembourg, typically, only blue-collar workers are expected to record their exact hours of work. For white-collars and civil servants hours of work measure the contracted hours and not necessarily the hours actually working.

The distribution of hours worked according to category of employment is displayed in Table 8.2. The percentages are calculated across rows and indicate that blue-collar workers are most likely to have overtime working hours, while civil servants almost always have standard working hours of 173 hours per month. It must also be noted that for many of the fathers in the data set, the working hours represent the combined working hours from

a number of working places. In some cases, these different working places can have different categories. These situations were addressed by using the category of the workplace where the father worked the majority of hours per month.

	<173	173	173+	Missing values	Total
Value	Per cent	Per cent	Per cent	Per cent	Count
Blue collars	22	59	19	0	142353
White collars	27	16	58	0	118962
Civil servants	2	94	4	0	33181
Missing values	27	33	23	17	2074
Total (count)	63571	134430	98069	500	296570

Table 8.2: Distribution of monthly working hours according to category of employment. Percentages sum to 100 across rows.

The other work-related variable in the analysis, size of the enterprize, seems to have an effect consistent with previous findings, whereby persons working in very large enterprizes (over 1000 employees) have the highest hazard of taking leave compared to the reference group working in large enterprizes. The hazard for fathers working in smaller enterprizes is lower than for these in the reference group (large enterprizes with employees between 200 and 1000), although the difference is not significant.

The effect of family-related variables is consistent with expectations based on previous studies. Fathers are more likely to use parental leave when the child born is the first one. The hazard of taking leave for the second child is only 60 per cent of that for the first child and for the third or higher parity only 30 per cent. However, these results can be interpreted directly only for households where there are no other children under five years old. The two variables must be interpreted in conjunction with each other because throughout the observation period the variable recording the number of children in the family can take different values reflecting the births of more children in the family. The presence of other children apart from the child born in 2003 under five years old in the household has a significant positive effect on the hazard of taking leave, whereby the hazard for a father to take leave is more than three times higher if there are three or more small children in the family compared to none or only one. The combined interpretation of the two variables is that fathers are more likely to use the parental leave for the first child. However, if there are two or three birth close to each other, which results in the presence of more

children under five during the observation period, then fathers are more likely to use the leave. Therefore, it seems like not only birth order, but also the spacing of births play a role in the decisions of fathers and the effects are running in somewhat counter-balancing directions.

There do not seem to be any differences associated with multiple births (twins or triplets) or with the gender of the child. Finally, the variable indicating the marital status of the fathers in the sample showed no significant difference between non-married (single, divorced, cohabitant or widowed) fathers and married fathers. However, fathers for whom it was not the first marriage (re-married) were significantly less likely to take leave compared to single fathers.

With regard to the marital status variable, the results are quite interesting, as no difference is found between married and non-married fathers with regards to taking parental leave. Luxembourg provides a legal alternative to marriage, known as a *Partenariat (PACS)*, which provides the same tax, civil and social security rights as marriage. However, in the administrative data cohabiting couples are coded as "not married" and it is not possible to find the difference between single and cohabiting fathers. In addition, Luxembourg does not recognize registered partnerships in other countries. Therefore co-habiting couples from other countries are also considered as single persons. Table 8.3 shows that from the fathers living in Luxembourg only 3 per cent are not married, while for fathers in other countries of residence this number can be over 40 per cent. Due to the almost perfect correlation between nationality and residence (virtually all Luxembourgish and many Portuguese nationals in the sample reside in Luxembourg), it the variable residence has not been included in the regression.

The model also controlled for nationality and age. The effect of age is positive and significant, however, there is a negative and significant quadratic effect. Older fathers tend to have a higher hazard of taking leave compared to younger fathers, however, the difference decreases at higher levels of age. In addition, the positive and significant coefficient of the time interaction suggests that the difference tends to increase over time. The coefficients for nationality in the model reveal that relative to Luxembourgish fathers, Portuguese fathers and fathers with nationalities other than the ones included in the grouping are less likely to use parental leave. For both groups, the differences seem to slightly increase with time, as the time interactions are positive and significant.

	Not married	Married	Re-married	Missing values	Total
Value	Per cent	Per cent	Per cent	Per cent	Count
Belgium	17	79	4	0	29213
France	42	56	2	0	55493
Germany	24	71	5	0	14581
Luxembourg	3	89	8	0	156798
Other	44	51	5	0	1270
Missing values	0	0	0	100	39215
Total (count)	37474	203995	15886	39215	296570

Table 8.3: Distribution of marital status by nationality. Percentages sum to 100 by rows.

8.8 Discussion

The main finding of the chapter is that income-related opportunity costs have a non-linear effect on fathers' use of parental leave. Considering opportunity cost in terms of foregone earnings, the study finds that fathers with lower opportunity cost are more likely to take parental leave than the group for whom the opportunity cost would be between 1500 and 2000 € per month. For the higher income groups there appear to be no significant differences, except in the case of the extreme high-earners (for whom the opportunity cost would be more than 5000 € per month), who are the least likely to use parental leave.

Income-related opportunity cost has been supplemented with the measure of average salary-growth in the previous six months, aimed to study the effects of developments in the income trajectory of the fathers on taking parental leave. The hypothesis was that fathers who are experiencing a period of high salary growth would be less likely to take parental leave, as they will face a higher opportunity cost in terms of foregone salary-growth opportunities during the leave. While the relationship is exactly not linear, the results indicate that this is not necessarily the case. The reference group is the group of fathers experiencing a very slightly positive growth (ranging from 1.001 to 1.004). All groups of fathers experiencing higher levels of growth are more likely to take parental leave, although with time the difference tends to become less pronounced. This result is contrary to what was expected. One possible interpretation is that increases in work-

related income may be associated with increased levels of job security for the fathers. If this is correct, the results would suggest that fathers prefer to take parental leave when their career reaches a relatively stable situation. Future studies on men's use of parental leave could explore this idea by incorporating information on career-stability in their analyses.

Consistent with previous research, fathers working in larger organizations have a higher probability of taking parental leave. On the family level, there are no significant effects for multiple births and the gender of the child. Fathers are more likely to use parental leave if the child born in 2003 was the first child, but when there were more children in the family under the age of five, are also more likely to use the leave. Relative to Luxembourgish men, fathers of Portuguese nationality or one of the less represented nationalities were less likely to use leave. There were no significant differences between Luxembourgish, Belgian, French and German fathers.

8.A Distribution of covariates

Variable	Count	Per cent	Events
Salary Opportunity Cost			
Negative	15693	5.29	96
< 500 €	43103	14.53	199
500-1000 €	44575	15.03	124
1000-1500 €	35145	11.85	69
1500-2000 € (reference)	27185	9.17	60
2000-2500 €	24176	8.15	44
2500-3000 €	19736	6.65	38
3000-4000 €	27941	9.42	48
4000-5000 €	18210	6.14	35
5000+ €	40306	13.59	56
Missing Values	500	0.17	0
Salary Growth in past 6 months			
(0,0.973]	36957	12.46	83
(0.973,0.994]	36956	12.46	114
(0.994,0.9976]	37434	12.62	107
(0.9976,1.001]	36478	12.3	103
(1.001, 1.004] (reference)	36996	12.47	101
(1.004,1.011]	36916	12.45	95
(1.011,1.034]	36956	12.46	82
(1.034,5.591]	36957	12.46	83
Missing Values	920	0.31	1
Monthly Working Hours			
< 173	63571	21.44	279
173 (reference)	134430	45.33	285
173+	98069	33.07	205
Missing Values	500	0.17	0
Birth Order			
First (reference)	114614	38.65	400
Second	91129	30.73	245
Third +	51612	17.4	94
Missing Values	39215	13.22	30
Child Sex			
Female (reference)	139351	46.99	376
Male	157219	53.01	393
Missing Values	0	0	0
Multiple Births			
Single Birth (reference)	290615	97.99	754
Twins or triplets	5955	2.01	15

continued ...

Table 8.4: Distribution of covariates.

. . . continued

Variable	Count	Per cent	Events
Missing Values	0	0	0
Nationality			
Luxembourg (reference)	92465	31.18	303
France	72459	24.43	156
Portugal	38117	12.85	84
Belgium	41575	14.02	95
Germany	19626	6.62	24
Other	32320	10.9	107
Missing Values	8	0	0
Age			
Mean	35.93	–	-
SD	5.4	–	-
Min	19	–	-
Max	65	–	-
Missing Values	8	0	0
Marital Status			
Not Married (reference)	37474	12.64	80
Married	203995	68.78	624
Re-Married	15886	5.36	35
Missing Values	39215	13.22	30
(Other) Children under Five			
None (reference)	174582	58.87	451
One	76709	25.87	262
Two+	6064	2.04	26
Missing Values	39215	13.22	30
Size Enterprize			
Micro/Small <50 or Not Appl	75381	25.42	100
Medium: 50-200	55886	18.84	64
Large: 200-1000 (reference)	59025	19.9	69
Very Large: 1000+	63567	21.43	497
Missing Values	42711	14.4	39

8.B Cox proportional hazards model without time interactions

	Coef	*Haz.rate*	*SE*	*z*	*p*
Salary opportunity cost: Negative	1.00	2.72	0.18	5.50	***
Salary opportunity cost: <500 €	1.70	5.49	0.16	10.55	***
Salary opportunity cost: 500-1000 €	1.05	2.85	0.17	6.30	***
Salary opportunity cost: 1000-1500 €	0.19	1.21	0.18	1.05	
Salary opportunity cost: 2000-2500 €	−0.35	0.71	0.20	−1.69	.
Salary opportunity cost: 2500-3000 €	−0.25	0.77	0.21	−1.19	
Salary opportunity cost: 3000-4000 €	−0.34	0.71	0.20	−1.73	.
Salary opportunity cost: 4000-5000 €	−0.27	0.76	0.22	−1.22	
Salary opportunity cost: 5000+ €	−0.74	0.48	0.20	−3.73	***
Salary growth in past 6 months: (0,0.973]	0.32	1.37	0.15	2.11	*
Salary growth in past 6 months: (0.973,0.994]	0.37	1.45	0.15	2.41	*
Salary growth in past 6 months: (0.994,0.9976]	0.12	1.12	0.15	0.76	
Salary growth in past 6 months: (0.9976,1.001]	0.25	1.28	0.15	1.60	
Salary growth in past 6 months: (1.004,1.011]	0.25	1.29	0.16	1.59	
Salary growth in past 6 months: (1.011,1.034]	0.17	1.18	0.16	1.03	
Salary growth in past 6 months: (1.034,5.591]	0.59	1.80	0.17	3.52	***
Monthly working hours: <173	0.48	1.62	0.10	4.89	***
Monthly working hours: 173+	0.34	1.41	0.11	3.23	***
Birth order: Second	−0.41	0.66	0.09	−4.54	***
Birth order: Third+	−0.89	0.41	0.13	−7.07	***
Child sex: Male	−0.11	0.90	0.07	−1.41	
Multiple births	−0.10	0.90	0.27	−0.38	
Nationality: France	−0.03	0.97	0.12	−0.29	
Nationality: Portugal	−0.44	0.64	0.14	−3.11	***
Nationality: Belgium	0.04	1.04	0.13	0.29	
Nationality: Germany	−0.17	0.85	0.23	−0.73	
Nationality: Other	−0.10	0.90	0.13	−0.83	
Age	0.13	1.14	0.07	1.89	.
Age squared	−0.00	1.00	0.00	−1.88	.
Marital status: Married	0.34	1.41	0.13	2.63	*
Marital status: Re-married	−0.03	0.97	0.22	−0.12	
Children under five: 2	0.38	1.47	0.09	4.44	***
Children under five: 3+	0.80	2.23	0.21	3.81	***
Size enterprize: Medium (50-200)	−0.23	0.79	0.17	−1.34	
Size enterprize: Small (<50) or Not Applicable	−0.23	0.80	0.16	−1.44	
Size enterprize: Very large (1000+)	2.30	9.99	0.13	17.05	***

Table 8.5: Cox proportional hazard model for taking parental leave without time interactions.
Notes: Reference categories: Salary opportunity cost 1500-2000, Salary growth in past six months: (1.001, 1.004], Birth order: First, Child sex: Female, Nationality: Luxembourg, Marital status: Single, Children under five: None or one, Size of the enterprize: Large(500-1000).
Significance codes: $***p < 0.001, **p < 0.01, *p < 0.05, .p < 0.10$.

8.C Testing the proportional hazard assumption

	rho	*chisq*	*sig*
Salary opportunity cost: Negative	0.01	0.02	
Salary opportunity cost: <500 \euro	0.01	0.07	
Salary opportunity cost: 500-1000 \euro	0.03	0.48	
Salary opportunity cost: 1000-1500 \euro	−0.03	0.49	
Salary opportunity cost: 2000-2500 \euro	0.01	0.04	
Salary opportunity cost: 2500-3000 \euro	0.02	0.20	
Salary opportunity cost: 3000-4000 \euro	−0.03	0.75	
Salary opportunity cost: 4000-5000 \euro	0.01	0.06	
Salary opportunity cost: 5000+ \euro	0.01	0.05	
Salary growth in past 6 months: (0,0.973]	−0.02	0.45	
Salary growth in past 6 months: (0.973,0.994]	−0.07	3.20	.
Salary growth in past 6 months: (0.994,0.9976]	−0.00	0.01	
Salary growth in past 6 months: (0.9976,1.001]	−0.01	0.04	
Salary growth in past 6 months: (1.004,1.011]	−0.07	3.62	.
Salary growth in past 6 months: (1.011,1.034]	−0.08	4.75	*
Salary growth in past 6 months: (1.034,5.591]	−0.05	2.18	
Monthly working hours: <173	−0.02	0.29	
Monthly working hours: 173+	−0.02	0.40	
Birth order: Second	0.01	0.08	
Birth order: Third+	−0.00	0.01	
Child sex: Male	0.01	0.05	
Multiple births	0.02	0.43	
Nationality: France	−0.04	1.16	
Nationality: Portugal	0.13	12.08	***
Nationality: Belgium	0.02	0.38	
Nationality: Germany	0.03	0.64	
Nationality: Other	0.14	14.62	***
Age	−0.00	0.01	
Age squared	−0.00	0.00	
Marital status: Married	0.07	3.03	.
Marital status: Re-married	0.10	7.53	*
Children under five: 2	−0.09	6.20	*
Children under five: 3+	−0.05	1.90	
Size enterprize: Medium (50-200)	0.02	0.36	
Size enterprize: Small (<50) or Not Applicable	0.01	0.10	
Size enterprize: Very large (1000+)	0.06	3.18	.
GLOBAL		79.41	***

Table 8.6: Proportional hazards assumption test.
Significance codes:$***p < 0.001, **p < 0.01, *p < 0.05, .p < 0.1$
Notes: Reference categories: Salary opportunity cost 1500-2000, Salary growth in past six months: (1.001, 1.004], Birth order: First, Child sex: Female, Nationality: Luxembourg, Marital status: Single, Children under five: None or one, Size of the enterprize: Large (500-1000).
Significant coefficients suggest that the hazard rates for the groups compared by the different levels of the variable are not constant. To correct for this violation of the proportional hazards assumption, these variables are included in the model together with interactions with time.

Part IV

Conclusion

CHAPTER 9

Conclusion

9.1 Summary of the main findings

The empirical analysis in this thesis has been structured to proceed from the general to the specific. The thesis had two major goals: first, drawing an overall picture of the patterns of work-family reconciliation in Luxembourg and second, analysing these patterns in more detail. To this effect, in part II chapter 5 presents an overview of the work-family reconciliation patterns for both working mothers and fathers in Luxembourg. In addition, the descriptive analysis in chapter 5 has served as foundation on which research questions for the following chapters have been generated.

Gender differences emerged clearly from the descriptive analysis. Perhaps most strikingly, it has been possible to observe the level of working participation of women "fading away" after birth, while men's working hours seem to remain constant. Parental leave has also been positioned quite differently in the trajectories of mothers and fathers: the majority of mothers take it immediately after maternity leave, while fathers seem to be using their right to parental leave at different time-points until the fifth birthday of the child.

The analysis in chapter 6 has been based on the observation from chapter 5 that there is a considerable diversity in the work-family trajectories, especially in the female ones. This chapter adopted an approach commonly applied in the sequence analysis literature whereby a clustering algorithm is applied to the reconstructed trajectories and similar trajectories

are grouped together. As a result, nine clusters with different patterns were identified. The gender composition of the cluster types was markedly different, revealing that the event of a birth of a new child in the family bears a different relationship to the male and female life course.

There were two particularly interesting work-family strategies that were dominated by women: leaving the labour force and switching from full-time to part-time employment. These strategies have already been noted by other researchers, for example in the report of Plasman and Sissoko (2005) and in the articles of Valentova (2006) and Valentova (2011). In the last section of chapter 6, links with possible explanatory factors were tested using a multinomial logit model. The hypotheses were derived from an economic framework, whereby it was expected that mothers would compare the value of their time at home and the wage they are offered at the labour market, similarly to the analyses carried out by Klerman and Leibowitz (1997) and Joesch (1994). Interestingly, the results seemed to support the expectations based on economic reasoning only for the decision to leave the labour market and not for the decision to reduce working hours.

In part III, chapters 7 and 8 were based on a more traditional, econometric-based approach to analysing the use of parental leave within the work-family trajectory. The choice of the conceptual model and the econometric approach for both chapters has been based on the findings in chapter 5. It was observed that the majority of women who take parental leave do so immediately after their maternity leave. Therefore timing was not of particular interest in this analysis. It was, however, more interesting to consider what do women who do not take leave do and whether they return to work afterwards. It has been pointed out by Valentova (2011) that in Luxembourg women who do not use leave tend to belong to either of two extremes: women with very high labour market attachment who do not take leave because they want to return directly to work and women with very low labour market attachment who leave the labour market permanently or at least for a duration of time longer than the parental leave. The graphical analysis of the trajectories of women who take leave full-time in chapter 5 also showed that a small fraction of leave takers do not return to work after parental leave.

The analysis of chapter 7 integrated all these distinct aspects of parental leave via a conceptual model of leave-taking representing the decision-making process as a set of binary steps. The model of nested dichotomies as presented in Fox (1997) could then be applied for the estimation. The analysis revealed that opportunity cost in terms of foregone wages is a sig-

nificant predictor of decisions related to leaving the labour market but not related to taking parental leave. Interestingly, women who remained in the labour force were less likely to use leave if they already had other children. When the variation in the number of children was exogenous, however, as in when there were twins or triplets born, the probability to take leave increased. These results can be seen to demonstrate the selected nature of the sample of working mothers who remain in employment after having children.

Finally, chapter 8 investigated the use of parental leave by men in Luxembourg. In contrast with the majority of previous studies on male use of parental leave, where this decision is analysed at the level of the couple, in chapter 8 the question was approached at the individual level. Since in Luxembourg the right to use leave is individual and non-transferable, it was considered more appropriate to perform the analysis at the individual level.

According the prevalent economic theoretical frameworks, the main factor expected to explain whether fathers use leave is the opportunity cost of doing so. Opportunity cost was measured in two ways: in terms of foregone salary earnings and also in terms of foregone promotion opportunities. The first measure was relatively easy to compute, as it was simply the difference between the salary of the father and the amount paid by the benefit. For measuring promotion opportunities a proxy variable was used, which computed the salary-related growth in the previous six months. The results showed a negative relationship between monthly salary and the probability of using leave. However, opposite to what was expected, salary-related growth seemed to have a positive relationship to the probability of using leave. A possible explanation for this result is that salary-related growth is a proxy not only for foregone promotion opportunities but also for previous upward mobility. Therefore, it is possible that experiencing a salary growth in fact meant that fathers had experienced a promotion to a position in which they felt more secure and thus were more inclined to take parental leave.

9.2 Strengths and limitations of the research

The IGSS Luxembourg provided anonymous administrative records for the empirical analysis. The data and the country context have been described

in chapters 2 and 3. The administrative records contain information on all persons working in Luxembourg. Therefore, certain restrictions had to be made, so that the population of interest, the sample and the time-frame for the analysis could be chosen appropriately. The decision was made to analyse the records of parents with at least one child born in 2003. The year 2003 was chosen as a pivotal point for the analysis, as administrative records in monthly records were available from the start of the year 2000 through the end of year 2008. Choosing year 2003 allowed for observing trajectories for a sufficient time-frame both before and after the even of birth.

The administrative records have a number of advantages for the study of parental leave compared to other available data sources. To begin with, virtually all working parents who had a child in 2003 and were eligible for parental leave could be included in the analysis, including cross-border workers. Few other data sources would have presented a more representative sample. As noted in chapter 3 the detail and accuracy of administrative data definitely have strong advantages over self-reported data when it comes to analysing how people are using multiple social security benefits. In many cases survey respondents may not even be aware which benefits they are receiving exactly and for which time durations.

On the other hand, the empirical work has been constrained due to limited availability of information in the administrative records. By definition, when working with administrative data, persons who never worked are excluded from the analysis. This means that the analysis does not provide any information for parents who never worked or who were inactive on the labour market prior to the birth of the child in 2003. It is unlikely that this selection excludes a large share of fathers in Luxembourg. It is possible, however, that a large number of mothers are excluded. Some evidence for this comes from the press release on the report of Eurostat from 2007 where Luxembourg and Ireland are pointed out as the two countries with the highest rate of labour market inactivity for 2006. Valentova (2006) also discusses the problem of high rates of labour market inactivity for women in Luxembourg.

It must be noted that only parents who were eligible for parental leave in 2003 are included in the analysis. This decision was made in order to be able to establish clear effects on parents' preference to use leave, the underlying idea being that parents who are not eligible for leave will, of course, not be using it. However, this selection has hidden some important information, which will hopefully be investigated in future research: what

share of parents is not eligible for leave. In addition, the selection criteria for leave eligibility leave out parents who are working less than 20 hours week, which essentially translates into a somewhat marginalized position in the labour market.

In terms of variables that are missing from the analysis, the main one is probably education. Education has been linked to use of leave in previous research (Reich et al., 2012; Nielsen, 2009; Han et al., 2009). In addition, it would have been important to know whether some of the parents who appeared inactive on the labour market were actually involved in educational activities. This information, however, is not collected in administrative data and there was no possibility to include it in the study.

Finally, it must be noted that in order to observe trajectories it was necessary to use data on parents with children born in the early 2000s. At the time of writing this conclusion, the year is already 2014, i.e. more than eleven years have passed since the parents in the sample had a child. It is difficult to say whether and to what extent the findings can be generalized to parents having children now. The parental leave policy has not changed, however, other institutional and social factors have not remained constant. The OECD Economic Surely report on Luxembourg of 2012 suggests that although the economy of Luxembourg has come out well of the Global Financial Crisis, the growth of the financial sector is still somewhat undermined. The financial sector represents about a third of the economy, which might mean it could be difficult to sustain the present social model. The OECD report further mentions a continuing trend towards increases in income inequality and long-term unemployment especially for less skilled workers. While these developments are not unique to Luxembourg, they must be taken into account if the results of the thesis are to be extrapolated to parents in Luxembourg who are having children today.

9.3 Directions for future research

The data provided by the IGSS Luxembourg are so rich and detailed that many additional research questions could be addressed. Several directions for future research projects that could be undertaken with the same or similar data are outlined below.

To begin with, it would be possible, and without doubt interesting, to look

at the work-family reconciliation of working couples. This would mean identifying spouses in the data set, matching their trajectories and then examining how their work-family strategies unfold next to each other. We find a similar suggestion in Moss and Deven (2006) who suggest a more holistic approach in analysing the decisions of men and women on using leave. A sequence analysis study of couples' joint work-family trajectories could reveal the main patterns of arranging the time for parental care. It could also highlight information relevant not only for understanding how the trajectory of the parents unfolds over time, but also what is the sequence of care facilities newborn children experience in the earliest stages of their lives. In terms of methodology, there are already some examples in the literature where multiple trajectories are analysed simultaneously: for example Pollock (2007) shows how multiple dimensions of a person's life can be analysed simultaneously.

It would also be interesting to examine the effects of using parental leave on the parents' subsequent earnings. This research question will pose as a main challenge to be addressed the fact that there would be unobserved heterogeneity in parents' decisions to use parental leave. Therefore the parents using leave might be a self-selected group, which cannot directly be compared with the group of parents not using leave. The findings in chapter 7 on women's use of parental leave have suggested the possibility that multiple births - assuming they occur by chance - could be used as an instrument for leave-taking. For men, unfortunately, the analysis did not reveal variables which could be potentially good instruments. Therefore the selection bias needs to be addressed in other ways, for example by using propensity score matching. At any event, it would be important to know more about the costs to parents of using parental leave, as this information could enhance our understanding of why some parents are not using parental leave.

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Valorization

Work-family reconciliation refers to the organisation of paid and unpaid work throughout the life-course. Parents typically have to perform both kinds of work to provide their families with a steady income and their children with the care they need. The challenge in organizing these activities is often the time constraint. Parents, employers and policy makers thus seek ways to address this challenge, each from their own point of view.

From the parents' point of view, issues related to work-family reconciliation arise when work activities need to be interrupted or adjusted so that one can take care for a young child or for a sick, old or disabled family member. In all of these cases, individuals face an increased demand for their time, efforts or both. They ask themselves important questions, such as: How will this interruption affect my career plans? Will the fact that I need to change to part-time hours affect my opportunity for promotion? How will I manage to maintain my standard of living if I need to reduce or interrupt my employment? What policy provisions are available that can assist me in these tasks? What are my rights in this situation? How can I negotiate with my employer?

Another individual perspective is the perspective of the child (or the dependent person being take care of). Is institutionalized care better than care at home? What is better for the child in the early years of his or her development? Do children grow better citizens if they stay at home in their early years or if they go to a child care? What is better for their cognitive development? What about for their emotional relationship with their parents?

Employers, on their side, strive to ensure a smooth work flow and continuous and predictable services and operations. When employees need to

change their working hours or need to arrange absences, this could result in increased costs for employers. Even if governments cover the salary costs related to employees' absences due to reasons related to care for small children and dependents, employers still face extra costs, such as the need to re-organise schedules and train extra staff. Employers thus consider questions related to work-family reconciliation, such as: How do we ensure that our investment in training staff will pay off in the longer term? Will our employees return to employment after taking parental leave? Will they still be willing to work long hours? Will they be able to travel on short notice? What is legally allowed for us to do and not in such cases?

From the point of view of policy-makers, issues related to work-family reconciliation take yet another angle. How much would it cost is to finance a parental leave scheme? What is better: to invest in child-care services or to offer paid parental leave or other allowances? Can we and should we guarantee the right of each individual to freely choose between work and care? How should we design the parental leave scheme? How are we going to disseminate the information, implement the scheme and ensure compliance?

This thesis contributes to the understanding of questions related to work-family reconciliation by presenting a longitudinal analysis of parents' careers. Although work-family reconciliation refers is a broader term, in this thesis, the focus has been on career interruptions due to the arrival of a child in the family. Based on data from anonymous administrative records, the career trajectory of each parent is represented as a linear sequence of states denoting the participation of the parent in the labour force. States include situations such as "employed full time", "employed part time", "parental leave", "out of the labour force", etc.

Listing the states in their temporal sequence makes it possible to visualise the collective pattern of trajectories and to group similar trajectories together. Such an analysis has been performed in part II of the thesis, which deploys sequence methods of analysis. In part III of the thesis, specific time points in the trajectories have been considered. For women, the focus is on the transitions in and out of employment, while for men the focus is on whether and how soon after having a child they take parental leave.

Data for the analysis have been provided by the Grand Duchy of Luxembourg. The situation of Luxembourg is particularly interesting, as parental leave has been introduced relatively late (1999) compared to other European Countries.

The main findings of the thesis and their implications are summarized in chapter 1. Here they are presented once more as follows:

- For working men the event of birth of a child does not seem to cause a discontinuity of the career trajectories. Levels of employment remain the same before and after. For working women, the event of birth of a child is related to a short-term or a long-term disruption in the labour force participation. This disruption can take the form of parental leave, reducing the working hours, withdrawing from the labour force or a combination of these components. These results are important, as they demonstrate that the same event: the arrival of a child in the family can have a dramatically different influence on the life course of men and women.

- While both mothers and fathers in Luxembourg have the right to take parental leave, only 13.3 per cent of fathers use parental leave before the fifth birthday of their child. In contrast more than 72 per cent of mothers use parental leave in the same time period. These results are important for at least two reasons. First, they reveal the persistent gender difference between men and women in assuming care responsibilities. Second, although lower than for women, the take-up rate of men in Luxembourg is still higher relative to other countries. Therefore, the results suggest that other countries could look at Luxembourg as a good-practice example for designing a parental leave policy scheme aimed at increasing male take up.

- There are marked differences in the timing and type of parental leave used. Mothers are more likely to use parental leave full-time and to combine it with maternity leave, while fathers are more likely to use their leave part time and to take it when the child is a bit older. These findings suggest that flexibility may be crucial for fathers to take parental leave. As few men are taking the leave when the child is very small, it might be appropriate for governments to maintain the possibility of taking the leave for at least a number of years (as is currently the case in the European Union).

- Interestingly, analyzing the patterns of work-family trajectories in the long term has not revealed major *qualitative* differences in the types of trajectories for men and women. In both cases, it is possible to see continuous full-time careers, continuous overtime or part-time careers, self-employment and so on. However, there are significant differences in terms of the *proportions* of career trajectories following

each pattern. For example, over one third of the male trajectories but only 15 per cent of the female trajectories can be classified as continuous full-time careers. About 12 per cent of mothers and less than 0.1 per cent of fathers withdraw from the labour market after having a child. Another important finding is that the majority of working mothers do not work full time, but part time. The latter finding is particularly important, as it may have implications about the extend to which these women are ensured for pensions, for example.

- The analysis of women's decisions after birth shows that higher salary levels are positively associated with the probability to remain in the labour force after having a child. This means that lower earning (and presumably lower-qualified) workers are more likely to remain outside the labour force for a prolonged period of time. This situation has implications for increasing earning inequality over time between women and between families.

- The findings from the analysis of the male take up of parental leave reveal that the relationship between earnings and taking parental leave is not entirely straightforward. One the one hand, higher earning men are less likely to take parental leave. On the other hand, men who have experienced salary growth in the previous period are more likely to use parental leave. This result could mean that fathers take parental leave when they reach a higher level of job security within their organization. This claim needs to be investigated further with more accurate data. However, if it is correct, this would mean ensuring job stability would be essential for enabling more parents to take advantage of the possibility to use parental leave.

These results can be considered innovative for the following reasons:

- This is the first systematic analysis of the situation in Luxembourg. Prior to that only data was available about number of people who use the leave, but it was not clear what proportion of eligible parents these are.

- This is one of few investigations based on administrative data, which records actual use of policy provisions. Most previous research is based on self-reported use of leave. This is problematic as individuals are often unaware of the differences between provisions related to child care, such as child care allowances, parental leave, maternity leave, etc.

- This is a study contributing to the understanding of male use of parental leave, a topic gaining popularity on the research agenda only recently as it is a rather recent trend that gender-neutral parental leave is offered and men have the possibility to use it. Luxembourg presents an even more interesting case as the paid parental leave is both gender-neutral and non-transferable.

The results of the thesis could be of interest to the following persons or institutions:

- Governments could benefit from the findings by knowing approximately what per cent of men and women would be likely to take parental leave, given the particular parental leave scheme in Luxembourg and the composition of the work force. It could be of special interest of governments in other countries to learn from the findings about the increased use of parental leave by men, despite its relatively low level of compensation relative to the Luxembourg earnings averages. Although the same policy design may not necessarily perform in the same way in another country context, expectations of how a policy reform could affect take up can still be formulated based on the Luxembourg experience.
- Employers could use the findings as an indication of what proportion of their labour force could be expected to take parental leave and leave the labour force or reduce working hours after having a child. This information could be useful for organizations in sectors where the workforce is of similar composition as the Luxembourg work-force, i.e. service economy sectors.
- Anyone performing analysis (not necessarily for academic purposes) based on administrative records can benefit from the presented methodology sections, which explain how one could restructure the administrative data so that it is suitable for analysis of work-family trajectories. In addition, the thesis offers a review and an example of how sequence analysis methods can be deployed for the analysis of work-family reconciliation over a segment of the life course.

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Biography

Nevena Zhelyazkova was born in 1983 in Sofia, Bulgaria. She holds a Bachelor's degree in Psychology (High Honours) from Smith College, USA, obtained in May 2005 and a Master's degree in Social Policy Analysis (magna cum laude) from KU Leuven, Belgium, obtained in 2007.

Nevena has been a PhD fellow at the Maastricht School of Governance (MGSoG) since 2008. Nevena's PhD research has been financially supported by the National Research Fund of Luxembourg. Apart from training received at Maastricht University, Nevena has benefitted from comments and suggestions by researchers and professionals from the University of Geneva, CEPS/INSTEAD Luxembourg and the Luxembourg Social Security (IGSS).

Prior to joining MGSoG as a PhD fellow, Nevena has worked at the human resources department of Infosys Technologies, Ltd, a multinational software company based in Bangalore, India. She has also been a trainee at the DG Employment, Social Protection and Equal Opportunities at the European Commission in Brussels, Belgium.

Nevena's research interests include labour markets, social protection, gender equality and how these areas interact to produce different outcomes over the life-course. Nevena is particularly interested in life-course research and the reconstruction of individual trajectories using longitudinal data.