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Essays on Parental Leave and Family Labour Supply

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Abstract

This thesis studies married couples' decisions regarding labour supply, fertility, and take-up of parental leave. Importantly, it emphasizes household interactions in a family labour supply framework where husbands and wives jointly make decisions.

In Chapter 2, I describe how differences in married individuals' time allocations between Canada and the U.S. may be related to different parental leave policies in the two countries. First, I document background information on parental leave policies and take-up behaviour in the two countries. Second, I analyze married individuals' time allocations using data from the General Social Survey (GSS) for Canada and American Time Use Survey (ATUS) for the U.S. I examine the role of having children on their parents' time allocations across market work, child care, household chores, and leisure and make cross-country comparisons.

In Chapter 3, I investigate the effects of maternity leave policies on married couples' fertility and employment decisions. I develop and characterize a unique household search model that features home production and endogenous fertility choice. I characterize reservation rules in the household search model and find that this model can generate patterns that cannot be generated by an individual search model. In particular, I parameterize a benchmark model that provides 12 weeks of unpaid leave as in the U.S. I use a parameterized model to examine the impact of an extended paid maternity leave policy on fertility rates and household employment. I find that a longer paid maternity leave increases fertility rates, lowers fraction of dual-earner couples, and increases the fraction of single-earner couples.

In Chapter 4, I examine what prevents married fathers from taking parental leave despite its availability in Canada. As possible explanations, I consider gender differences in rental rates of human capital, wage growth processes, wage penalties for time off from work, preferences for leisure, and productivity in home production. I document supporting empirical evidence for the possible explanations. Next, I develop a life-cycle model of family labour supply that features learning-by-doing human capital accumulation and time allocations across market work, leisure, and home production. Then, I quantify the relative importance of these explanations within the model. I find that lower home productivity in the presence of an infant, higher rental rates of human capital, and higher wage penalties for not working for fathers are the main contributors to the low take-up of fathers. Finally, I conduct policy experiments to highlight the role of cash benefits and paternity leave on fathers' take-up of leave. The results show that fathers' take-up rates are responsive to an increase in an income replacement rate combined with the introduction of paternity leave.

Keywords: Family labour supply, parental leave, time allocation, fertility, household search model, human capital, home production

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Chapter 1

Introduction

As more married women participate in labour markets, the balance between work and family has become increasingly important. Many countries have introduced various family-friendly policies to help parents balance their work and family lives. In this dissertation, I focus on parental leave policies. Parental leave is often called maternity leave or paternity leave when it is specific to mothers or fathers, respectively. Parental leave aims to help working parents after the birth of a child by providing them time off work to bond with their child while guaranteeing their return to the pre-birth job. When parental leave is paid leave, it provides financial support as well as job protection.

Parental leave is an interesting topic for economic research. First, take-up of parental leave can be formalized as economic decisions based on a cost-benefit analysis. Whether to take parental leave or not can be considered as a decision of whether to spend time at work or at home during a period of time after birth of a child. As Becker (1965) formalized the allocations of time as economic decisions, take-up decisions can be formalized as an economic decisions.

Second, parental leave is closely related to parents' labour market behaviour. For example, parental leave influences parents' attachment to the labour market. A longer parental leave has been found to increase mothers' job continuity with their pre-birth employer (Baker and Milligan, 2008). Parental leave also influences working parents' subsequent wages after the birth of a child. Compared to the case where no parental leave is available and many mothers quit a job after childbirth, increased job continuity due to parental leave may help mothers keep firm-specific human capital and maintain wage levels. Compared to the case where parents do not stop working after childbirth, taking parental leave incurs career interruptions. In this case, taking parental leave may have a negative impact on subsequent wages. In particular, fathers who take parental leave has been found to have a larger negative effect on subsequent wages than mothers (Albrecht, Edin, Sundstrom, and Vroman, 1999).

This thesis studies married couples' decisions regarding labour supply, fertility, and take-up of parental leave. Importantly, it emphasizes household interactions in a family labour supply framework where husbands and wives jointly make decisions.

As parental leave aims to help working parents take time off work to care for their newborn child at home, take-up of parental leave is possibly related to parents' time allocations. In Chapter 2, I describe how differences in married individuals' time allocations between Canada and the U.S are related to different parental leave policies. First, I document background information on parental leave policies and take-up behaviour in the two countries. Second, I analyze married individuals' time allocations across market work, child care, household chores, and leisure using data from the General Social Survey (GSS) for Canada and American Time Use Survey (ATUS) for the U.S. I examine the role of the youngest child's age on parents' time allocations for each country and make comparisons between the two countries. Also, I explore the role of the extensive and the intensive margins in shaping the unconditional average time allocations by analyzing participation and the conditional averages separately.

In Chapter 3, I investigate the effects of maternity leave policies on married couples' fertility and employment decisions within a household search framework. I consider decisions regarding job search, fertility, and take-up of maternity leave as joint decisions within a married couple. To emphasize household interactions in these decisions, I develop a unique household search model that features home production and endogenous fertility choice. I characterize reservation rules in my household search model and find the model can generate patterns that cannot be generated by an individual search model. My model generates a case in which a breadwinner in a household shifts from one spouse to the other spouse when an unemployed spouse accepts an offer. In particular, I parameterize a benchmark model that provides 12 weeks of unpaid leave as in the U.S. I use the parameterized model to examine the impact of an extended paid maternity leave on fertility rates and household employment. I find that a longer paid maternity leave increases fertility rates, lowers the fraction of dual-earner couples, and increases the fraction of single-earner couples.

In Chapter 3, only mothers have access to maternity leave while fathers do not have access to parental leave. However, in Chapter 2, I document that a few married men take paid parental leave in Canada. In Chapter 4, I extend the scope of my research and examine why only a few married men take paid parental leave in Canada despite its availability. First, I document supporting empirical evidence for the possible explanations using Canadian micro-data sets. Next, I develop a life-cycle model of family labour supply that features learning-by-doing human capital accumulation and time allocations across market work, leisure, and home production. Then, I quantify the relative importance of the possible explanations within the model. I find that lower home productivity in the presence of an infant, higher rental rates of human capital, and higher wage penalties for not working for fathers are the main contributors to the low take-up of fathers. Finally, I conduct policy experiments to highlight the role of cash benefits and paternity leave on fathers' take-up of leave. The results show that fathers' take-up rates are responsive to an increase in an income replacement rate combined with the introduction of paternity leave.

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Chapter 2

Parental Leave and Married Individuals' Time Allocations in Canada and the U.S.

2.1 Introduction

Paid parental leave, including maternity and paternity leave, is a family policy that helps working parents care for a newborn or newly adopted child by guaranteeing their return to the pre-birth job and providing financial support. Canada and the U.S. have very different parental leave policies. While the U.S. provides 12 weeks of unpaid parental leave after the birth of a child, its northern neighbor provides a much longer paid parental leave. This difference in parental leave policy may play a role in how married couples allocate their time after a child is born and how married parents maintain work-life balance across countries.

The goal of this chapter is to describe how differences in married individuals' time allocations between Canada and the U.S. may be related to different parental leave policies in the two countries. To do so, this chapter is divided into two parts. First, I document background information on parental leave policies and take-up behaviour in the two countries. This includes a brief history, the details of the policies during the period of interest, and current discussions on policy reforms. I mainly focus on policies at the federal level. Then, I document the take-up behaviour in the two countries. For Canada, I focus on take-up behaviour of married individuals using data from the Employment Insurance Coverage Survey (EICS) as in Marshall (2008) and McKay, Mathieu, and Doucet (2016).[1] While McKay et al. (2016) address income inequality in take-up of parental leave, I discuss differences in take-up by gender and education in the two countries. For the U.S., due to lack of a comprehensive survey, I review recent studies on take-up behaviour of leave after the birth of a child. Using these studies, I am able to document that

[1] Hou, Magolis, and Haan (2017) use linked administrative data to examine take-up rates in Canada.

the fraction of married individuals eligible for a statutory parental leave is smaller in the U.S. than in Canada and that most mothers in Canada take up 12 months of parental leave. Given the finding in the literature that most mothers in the U.S. return to work within 6 months, I conclude that differences in statutory parental leave policies influence parents' labour supply after the birth of a child.

In the second part, I analyze married individuals' time allocations using data from the General Social Survey (GSS) for Canada and the American Time Use Survey (ATUS) for the U.S. I examine the role of having children on their parents' time allocations across market work, child care, household chores, and leisure for each country and compare the time allocations between the two countries. In time allocation literature, Kimmel and Connelly (2007) distinguish care-giving time from household chores and leisure. They study the role of economic and demographic factors such as the number of children and age of children on mothers' time choices in the U.S. My study explores the role of children characteristics on time allocations of fathers as well as mothers. Aguiar and Hurst (2007) document trends in time allocations across the four time use categories within the U.S. My classification of four time use categories is based on the measures defined in their study. Guryan, Hurst, and Kearney (2008) document educational differences in care-giving time using data from the ATUS and corroborate their finding by showing that the same finding is observed in other countries including Canada. Cardia and Gomme (2018) develop a life-cycle model that distinguishes childcare from household chores and emphasize the role of childcare in matching the life-cycle patterns of women's market work in the U.S.

For Canada, data from the GSS have been used to document time use patterns (McFarlane and Tedds, 2008, Hilbrecht, 2009, Patnaik, 2016). McFarlane and Tedds (2008) document trends in time allocations within Canada and compare the Canadian trends to the U.S. trends in Aguiar and Hurst (2007). Patnaik (2016) studies the long run consequences of a paternity leave policy in Quebec on fathers' time use. My study is similar to Patnaik (2016) in that I relate parental leave policies with time allocations of parents with a young child. However, my work differs in that I focus on the role of the youngest child's age on parents' time choices and makes comparisons between Canada and the U.S. I also consider both the extensive and intensive margins and examine which margin drives patterns in parents' time allocations by age of the youngest child.

From the time use analyses, I find several interesting results. First, Canadian mothers with an infant spend fewer hours on market work and more hours on other categories than U.S. mothers with an infant. It may be due to differences in parental leave policies in Canada and the U.S. Second, while high-educated mothers in Canada and the U.S. display very similar patterns in time allocations when the youngest child is two years old or older, low-educated mothers show distinct differences in time allocations between the two countries until the youngest child is aged 6 or older. In particular, low-educated mothers of the youngest child aged 2–5 in the U.S. spend fewer hours on market work and child care and more hours on leisure than the Canadian counterparts. I also document that the average child care hours of mothers with an infant are lower in the U.S. than in Canada.

Third, I find that both the intensive and extensive margins play a role in shaping the patterns in parents' time allocations by age of the youngest child. For wives' market work, cross-country differences are explained mostly by participation. For child care time of mothers with an infant, a cross-country difference among the high-educated are accounted for entirely by the intensive margin, whereas a substantial cross-country difference among the low-educated is explained not only by the intensive margin but also by the extensive margins. I also show that both extensive and intensive margins contribute to gender differences in market work and child care time.

This chapter is organized as follows. In Section 2.2, I document background about parental leave policies and patterns of take-up behaviour in Canada and the U.S. In Section 2.3, I examine the role of children on married individuals' time allocations in each country and make comparisons between the two countries. I relate cross-country differences in the take-up of parental leave to cross-country differences in time allocations among married individuals with an infant. I conclude in Section 2.4.

2.2 Parental Leave Policy in Canada and the U.S.

This section briefly documents the background information for the parental leave policy and patterns of married couples' take-up behaviour in Canada and the U.S. Currently, parental leave benefits in most of Canada are paid under Employment Insurance (EI), a public insurance system at the federal level. The exception is Québec. In 2006, Québec developed its own public insurance system for parental leave, called Québec Parental Insurance Plan (QPIP). The rules under QPIP are different from the rest of Canada under EI.[2] As of today, in the U.S., the federal parental leave policy is based on the Family and Medical Leave Act (FMLA) of 1993, while a small number of states have state paid family leave programs and some firms voluntarily provide family leave. This study focuses mainly on the federal parental leave policies, especially under EI from 2001 until 2016 in Canada and under the FMLA in the U.S.

[2] A key feature of QPIP is five weeks of paternity leave that is reserved for fathers. Compared to EI, QPIP has higher cash benefits with a higher replacement rate of 70% and a higher maximum insurable income. Also, EI and QPIP have different work requirements for eligibility.

2.2.1 Canadian Parental Leave Policy

In 1971, Canada's policy allowed for fifteen weeks of maternity benefits. Maternity benefits could be used only by birth mothers under Unemployment Insurance, the public insurance system at the federal level preceding EI. In 1990, ten weeks of parental leave that could be shared by parents were added to fifteen-week-long maternity leave. A mother could use maternity and parental leave for at most six months including a two week waiting period.[3] A father could use at most ten weeks of parental leave at the expense of his wife's portion of parental leave.

To help parents spend more time with their newborn children, in 2001, Canada extended statutory parental leave from 10 to 35 weeks. Overall, parents to a newborn child can spend up to a combined total of 52 weeks off work while receiving financial support. Between 2001 and 2017, the maximum lengths of maternity and parental leave remained the same. As of December 2017, a parent has an option of extended parental benefits for 61 weeks with a lower rate of income replacement. The 2018 Canadian federal budget includes a proposal to add 5 weeks of take-it-or-leave-it leave for the second parent who is likely to be a father for many couples.

In Canada, the maximum duration of job protection is the same as the maximum duration of parental benefit payments.[4] The federal Canadian Labour Code guarantees an employee the right to be reinstated in a position the same as or comparable to the pre-birth position when the employee returns to work after parental leave (Section 209.1). The Canadian Labour Code provides employees 17 weeks of maternity leave and 35 weeks of parental leave. While the Canadian Labour Code only applies to employees in federally regulated businesses and industries, most workers in Canada get job-protected unpaid leave under provincial and territorial Employment Standards. Although provincial jurisdictions have slight variations in lengths of job-protected leave, they are fairly similar across jurisdictions because they follow the Canadian Labour Code (Pulkingham and Van Der Gaag, 2004).[5] The federal EI pays at most 15 weeks of maternity benefits and 35 weeks of parental benefits after a two week waiting period.

During parental leave, a worker who is eligible for parental benefits under EI receives cash benefits. To be eligible for parental benefits under EI, a worker must have accumulated at least 600 hours of insurable employment during the 52-week period immediately before the

[3]This two week waiting period before a claimant can start receiving the benefits plays the role of an insurance deductible.

[4]Schönberg and Ludsteck (2014) study reforms in German parental leave policy that changed the duration of job protection and the duration of benefit payments. Their study highlights the relative importance of job protection and benefit payments in mothers' labour market outcomes.

[5]Baker and Milligan (2008) exploited provincial variation in durations of job protection around the introduction and extension of statutory parental leave. The 17 weeks of job-protection for birth mothers is called "pregnancy leave" in Ontario and "maternity leave" in other jurisdictions and at the federal level. In this paper, I use "maternity leave" to indicate the non-transferable leave for birth mothers following the federal EI.

Table 2.1: EI Premiums Rates and Maximum Insurance Earnings and Benefits

Year	EI premium rates (%)	Maximum annual insurable earnings ($)	Maximum weekly benefits ($)	Maximum annual insurable earnings (2002$)	Maximum weekly benefits (2002$)
2001	2.25	39,000	413	39,877	422
2002	2.20	39,000	413	39,000	413
2003	2.10	39,000	413	37,938	401
2004	1.98	39,000	413	37,249	394
2005	1.95	39,000	413	36,449	386
2006	1.87	39,000	413	35,747	378
2007	1.80	40,000	423	35,874	379
2008	1.73	41,100	435	36,021	381
2009	1.73	42,300	447	36,976	391
2010	1.73	43,200	457	37,082	392
2011	1.78	44,200	468	36,864	390
2012	1.83	45,900	485	37,716	399
2013	1.88	47,400	501	38,599	408
2014	1.88	48,600	514	38,818	411
2015	1.88	49,500	524	39,100	414
2016	1.88	50,800	537	39,564	418
2017	1.63	51,300	543	39,340	416
Average	1.89	43,429	460	37,777	400

Data source: EI premium rates and maximum annual insurable earnings are from Government of Canada (https://www.canada.ca/en/revenue-agency/services/tax/businesses/topics/payroll/payroll-deductions-contributions/employment-insurance-ei/ei-premium-rates-maximums.html) and CPI index is from Statistics Canada (CANSIM Table 326-0021).

start date of parental leave. Also, a worker must have paid employment insurance premiums.[6] Before 2011, only paid employees were covered by EI. From 2011, self-employed people can access EI special benefits, which include maternity and parental benefits, by opting in the EI program and paying the EI premium voluntarily.

Parental benefits under EI are funded by employer's and employee's EI premiums as with regular unemployment benefits. The average EI premium rate between 2001 and 2017 was 1.89% per $100 of earnings (Table 2.1). Employer's premiums are 1.4 times the amount of the employee's premiums.

There is a maximum for annual insurable earnings. The maximum insurable earnings amount remained at $39,000 a year between 2001 and 2006. In 2005, the maximum insurable earnings were slightly below the median earnings of Canadians employed on a full-time basis for a full year, $41,401 in 2005 constant dollars. The maximum amount was adjusted up in 2017 to $51,300 in nominal values, while it went down from $39,877 in 2011 to $36,865 in

[6]For more details, see Service Canada: http://www.esdc.gc.ca/en/reports/ei/maternity_parental.page

2002 dollars.

Parental benefits are calculated as a weekly amount. The basic income replacement is 55% of a recipient's average weekly insurable earnings, up to a maximum amount. Between 2001 and 2006, the maximum amount of benefits was set at $413 Canadian dollars. In 2002 dollars, the average maximum amount of benefits between 2001 and 2017 was $400 per week.

2.2.2 U.S. Parental Leave Policy

Currently, the U.S. federal parental leave policy is based on the Family and Medical Leave Act (FMLA) enacted in 1993. Before this federal law was introduced, some workers had access to job-protected leaves through collective bargaining or under state laws (Han and Waldfogel, 2003).[7] Under the FMLA, eligible employees have access to up to 12 weeks of unpaid, job-protected leave after the birth of a newborn child as well as to care for a family member experiencing a serious health condition or for their own serious health condition (U.S. Department of Labor, Wage and Hour Division, 2012a). Mothers can take a FMLA leave for incapacity related to pregnancy or for her own serious health condition following the birth of a child. Fathers can use a FMLA leave to care for his spouse who is unable to work normally due to pregnancy or child birth. Family leaves to bond with a newborn child must conclude within 12 months after the birth. Unlike in Canada, both mothers and fathers in the U.S. have the same right to take a FMLA leave. So a mother and a father each can use up to 12 weeks.

When 12 weeks of unpaid family leave became statutory at the federal level in the U.S., Canada's then federal policy provided 17 weeks of paid maternity leave and 10 weeks of paid parental leave. While Canada has extended its parental leave policy two times in 2001 and 2017, since then the U.S. federal policy has not changed.

The FMLA applies to private-sector employers with 50 or more employees, public agencies, including government agencies at all levels, and all public and private elementary and secondary schools (U.S. Department of Labor, Wage and Hour Division, 2012a). These employers must provide an eligible employee with an unpaid leave and guarantee his or her original job or a comparable job with equivalent compensation when the employee returns to work after a FMLA leave. The FMLA also requires employers to continue health insurance coverage for an employer on leave (U.S. Department of Labor, Wage and Hour Division, 2012b). To be eligible for parental leave under the FMLA, an employee must have worked for their employer at least 12 months and at least 1,250 hours within the past 12 months immediately before the start date of the leave (U.S. Department of Labor, Wage and Hour Division, 2012a).[8]

[7] See the Appendix in Han and Waldfogel (2003) for details of state laws. Also, see Gault et al. (2014) for a detailed history of parental leave in the U.S.

[8] Additional eligibility requirement is to work at a location where the employer has at least 50 employees within 75

As of 2018, paid parental or family leave programs has been put in place in California, New Jersey, Rhode Island, and New York. In the 1940s, these four states established a state temporary disability insurance (TDI) system that provides partial wage replacement for wage losses due to temporary sickness or injury unrelated to a worker's job. Because eligibility reasons for TDI entitlement include temporary disability due to pregnancy, paid leave has been available to pregnant women in these states through TDI even before the states introduced a paid parental leave program. In 2002, a paid parental or family leave law was enacted by California, followed by New Jersey in 2008, Rhode Island in 2013, and New York in 2016. The laws became effective in 2004 in California, 2009 in New Jersey, 2014 in Rhode Island, and 2018 in New York. The District of Columbia passed a law for a paid parental leave program in 2017 with the law becoming effective in 2020 (Ruhm, 2017).

Benefits and eligibility requirements in these state laws vary a great deal. The length of paid leave ranges from 4 weeks in Rhode Island, to 6 weeks in California and New Jersey, to 8 weeks in New York. The income replacement rate of average weekly wages ranges from 55% in California to 66% in New Jersey. The maximum weekly benefit amount ranges from $615 in New Jersey to $1,173 in California. These programs are financed by payroll taxes paid by employees. Because eligibility requirements are less strict under state laws than under the FMLA, the coverage of these state leave programs is greater than that of the FMLA. While the paid leave programs in Rhode Island and New York guarantees job protection, those in California and New Jersey do not guarantee job protection. Thus, in California and New Jersey, those who satisfy FMLA requirements are guaranteed to return to the pre-birth job (Ruhm, 2017).[9]

In recent years, there have been discussions of paid parental leave in the U.S. In December 2013, members of Congress introduced a proposal for the Family and Medical Leave Enhancement (FAMILY) Act, which would create a national insurance fund to make FMLA leaves paid. This bill made no progress and was reintroduced in March 2015. As part of his support for the bill, President Obama proposed US$2.2 billion for the federal Department of Labor's Fiscal Year 2016 budget (Gabel, Waldfogel, and Haas, 2015). However, the bill made no progress again and was reintroduced in February 2017 (Gabel and Kaufman, 2017).

President Trump promised to introduce legislation to make paid parental leave available in the U.S. His budget plan for fiscal year 2019 proposed six weeks of fully paid family leave to new mothers and fathers using the Unemployment Insurance system as a base. The budget plan proposed $1 to 2 billion for funding to provide paid parental leave each year and a total of

miles. The minimum 12 months of tenure is not necessarily consecutive. Paid leave and unpaid leave, including FMLA leave, are not included.

[9] See Ruhm (2017) for more details.

$7 billion between 2019 and 2023 (United States. Office of Management and Budget, 2018).

2.2.3 Take-up of Parental Leave in Canada

I now document patterns of take-up behaviour among married parents in Canada, using the Employment Insurance Coverage Survey (EICS), which is an annual cross-sectional survey that studies the coverage of the EI program in Canada.[10] To examine the coverage of maternity and parental benefits, the survey includes a subsample of mothers of infants less than one year old as a part of its target population. These mothers are either working, unemployed, not in the labour force, or on leave. This survey collects information about whether the mothers were eligible for EI, whether they received maternity and parental benefits, and whether their spouses claimed or intended to claim parental benefits. This survey also collects information about duration of leave. From 2004, the survey started collecting duration of parental benefits claimed by fathers.

I use data from the surveys collected between 2004 and 2011. The sample of interest is restricted to 24- to 42-year-old mothers who have an infant less than one year old and live with their spouse. I exclude mothers living in Québec between 2006 and 2011 because different rules applied to them under QPIP. I also exclude mothers who are students. I do not include male respondents who answer that they were receiving parental benefits under EI because of the small sample size. I apply the weights provided in the survey data. These sample restrictions result in 6,326 mothers. This sample is about 81% of the mother respondents living in Canada outside Quebec under EICS.

Among the mothers in the sample, 67% were eligible for EI. EICS asks eligibility status of the mothers who are not working at the time of the survey. Because the eligibility status of working mothers is not collected, researchers cannot distinguish working mothers who did not use parental leave because of ineligibility from those who choose not to take up or who have returned from leave. I assume all of the working mothers in the data were eligible. Therefore, the universe of "eligible" mothers includes all mothers, except the non-working mothers who did not use parental leave because they were ineligible. Thus, the eligibility rate of mothers may be overstated.

Among the mothers in the sample, 85% had a husband who was eligible for EI. EICS does not directly ask mothers about their spouse's eligibility for EI. The universe of "eligible" fathers includes all fathers, including the fathers who used or planned to use parental leave, except the fathers whose wives answered that their husbands did not use parental leave because they were ineligible.

[10]People living in a common-law relationship are classified as "married" in this survey.

Table 2.2: Take-up Rates by Eligibility and Education (%)

	Fathers	Mothers
All parents	11.1	67.6
Eligible parents	13.1	90.8
Low-educated	11.8	90.6
High-educated	13.6	90.8

Data: Employment Insurance Coverage Survey (2004–2011).

Table 2.3: Take-up Rates by Household Educational Type

Husband's	Low		High	
Wife's	Low	High	Low	High
Fathers	11.2	12.3	10.2	14.2
Mothers	89.6	91.2	91.8	90.7

Data: Employment Insurance Coverage Survey (2004–2011).

Table 2.2 shows a stark difference in take-up rates between married fathers and mothers. Among mothers with an infant, 68% answered that they received maternity and/or parental leave after the child was born. In the survey, most mothers who did not receive parental benefits answered they did not because they have not worked within the past two years, did not pay EI premium, or did not accumulate enough hours to meet the work requirement. Conditional on eligibility, 91% of mothers took paid leave. Meanwhile, only 13% of mothers answered that their eligible husbands had used or planned to use paid parental leave. For the rest of this section for Canada, I report take-up rates conditional on eligibility.

One feature of take-up is that the statistics do not vary much by educational attainment. Throughout this paper, educational attainment is grouped into two levels. The low-educated, denoted by "Low", are some college, high school graduates, and those who have less than twelve years of schooling. High-educated people, denoted by "High", are those who received a certificate, diploma, or degree from a trade school, community college, or university. While there is almost no variation among mothers, there is a small variation among fathers by educational attainment.

The variation in fathers' take-up rates by the wife's education is clearer when I condition on husbands' own education. In particular, among high-educated fathers, their take-up rate increases with their wife's education. Their take-up rate is 10% for those with a low-educated wife and 14% for those with a high-educated wife (Table 2.3).

A similar pattern emerges in durations of parental leave in Table 2.4. The average duration of fathers' parental leave conditional on take-up is 14 weeks, whereas the average duration

Table 2.4: Average Durations of Leave by Individual Educational Level

	Fathers			Mothers		
	All	Low	High	All	Low	High
Number of weeks	14.1	14.9	13.9	46.3	46.6	46.2

Data source: Employment Insurance Coverage Survey (2004–2011).

Table 2.5: Average Durations among Couples Sharing Leave

Household education (Husband's, Wife's)	Husband	Wife	Total
All types	10.2	38.6	48.8
(Low, High)	10.7	35.6	46.3
(High,High)	10.4	39.0	49.4

Data source: Employment Insurance Coverage Survey (2004–2011). Statistics for couples with a low-educated wife are not reported due to a small sample size.

of mothers' parental leave including maternity leave is 46 weeks or 11 months.[11] Among couples where a husband and wife share parental leave, on average, a wife received maternity and parental benefits for 39 weeks, and a husband received parental benefits for 10 weeks. On average, a couple used paid parental leave for 49 weeks in total (Table 2.5).

Some mothers received additional financial support from other sources. While take-up rates and durations of parental leave barely vary by individuals' educational attainment, the statistics for additional payments among mothers show clear variation by mothers' education. Among mothers who took paid parental leave, 30% answered they received additional payments from their employers, insurance or other benefits other than EI maternity/parental benefits. High-educated mothers are more likely to receive additional payments: 13% of low-educated mothers and 35% of high-educated mothers received additional payments. Table 2.6 shows that, among mothers who took paid parental leave and received additional payments, about two-thirds of them received additional payments during a period shorter than or equal to the maximum length of maternity leave. Similarly, two-thirds of low-educated mothers receive additional payments for a period shorter than maternity leave. However, compared to high-educated mothers, more are likely to have less than 8 weeks of additional payments.

[11] I use variable ALLEAVE recording the length of all leave before they returned or expect to return. This variable includes not only maternity and parental leave but also other types of leave such as sick leave. Thus, some recorded responses are longer than the maximum length of 52 weeks. When calculating average duration, I replace the values greater than 12 months with 12 months. I also apply 12 months to those who answered that they do not plan to return.

Table 2.6: Mothers' Duration of Additional Payment (%)

Duration	All	Low	High
0–8 weeks	34.5	41.5	33.8
9–17 weeks	34.5	24.8	35.4
18+ weeks	31.0	33.7	30.8
Total	100.0	100.0	100.0

Data source: Employment Insurance Coverage Survey (2004–2011).

2.2.4 Take-up of Parental Leave in the U.S.

In the U.S., there is no comprehensive annual survey on FMLA leave coverage and usage unlike EICS in Canada. Researchers have used data from various surveys such as the National Compensation Survey, a leave module in the 2011 American Time Use Survey (ATUS), a fertility topical module in the Survey of Income and Program Participation (SIPP), and the Current Population Survey (CPS).[12]

The 2011 ATUS includes leave module supplements that provide detailed information on access to paid and unpaid leaves and usage of unpaid leave after the birth of a child. Although the survey does not limit the type of leaves to FMLA leaves, data from this survey are informative in understanding how many people in the U.S. have access to some kind of leave when their child is born. Using the data, I calculate the fraction of married workers who answered they could take up a leave after the birth of a child. I focus on the sample of 23- to 42-year-old, working married individuals with spouse present.[13] Table 2.7 shows that the fractions for husbands and wives are very similar. Among the sample, 69% of husbands and 73% of wives reported they had access to unpaid leave, and about 50% of each gender reported access to paid leave. By education, a high-educated subsample is more likely to have access to unpaid and paid leave than a low-educated subsample. About three-fourths of the high-educated and two-thirds of the low-educated respondents reported that they could take unpaid leave. Educational differences in access to paid leave are greater that educational differences in access to unpaid leave, especially among husbands.

Leaves in the ATUS leave module may include vacation, sick leave, or disability leave. To describe the eligibility rates for a FMLA leave, I take a similar approach to Waldfogel (1999) using data from the March Current Population Survey (CPS) collected between 2011 and 2016. Because this survey does not directly collect information on respondents' eligibility for a FMLA leave, I impute respondents' FMLA eligibility using available information in the data. I count respondents as working for a covered employer if, in the past year, they were

[12] Gault et al. (2014) summarize features of the commonly used data sets.

[13] The sample includes private and public sector employees plus incorporated self-employed and excludes unpaid workers and unincorporated self-employees.

Table 2.7: Fraction of Married Workers with Access to a Leave after Birth of a Child (%)

	Husbands			Wives		
	Total	Low-edu	High-edu	Total	Low-edu	High-edu
Unpaid leave	69.3	65.1	73.9	73.1	66.1	77.3
Paid leave	47.6	35.9	60.6	49.1	40.5	54.1

Data: 2011 American Time Use Survey - Leave Module.

Table 2.8: Fraction of Married Individuals Eligible for a FMLA Leave by Education (%)

	Husbands			Wives		
	Total	Low-edu	High-edu	Total	Low-edu	High-edu
All	53.6	44.2	64.4	36.0	26.2	44.4

Data: March Current Population Survey (2011–2016).

1) paid employees in the public sector, 2) elementary and secondary school teachers, or 3) paid employees for an employer with 50 or more employees.[14] Also, the minimum work requirement is viewed as satisfied if the product of weeks worked last year and usual hours worked per week is at least 1,250 hours and the number of weeks employed last year is at least 50 weeks.[15] The sample of interest is restricted to 23- to 42-year-old married individuals living with their spouse. Table 2.8 shows that, among this sample, 54% of husbands and 36% of wives are eligible for a FMLA leave. The remainder is not eligible because they were not employed last year, they were self-employed last year, or they are paid employees who do not meet the FMLA requirements. The eligibility rates show large differences by sex and by education. Overall, husbands' eligibility rates are 20 percentage points higher than wives' eligibility rates. By education, for both husbands and wives, the eligibility rates of the high-educated are about 20 percentage points higher than those of the low-educated.

Compared to Canada, the eligibility rates for FMLA in the U.S. are low. This likely stems from less coverage. For example, unlike in Canada, small employers with fewer than 50 employees are not covered by the FMLA and the minimum work hours for FMLA eligibility are twice the minimum for an EI parental leave. This implies that, compared to parents in Canada, parents in the U.S. have a much shorter, unpaid job-protected leave after the birth of a child and are less likely to have access to a statutory leave.

For U.S. take-up rates of leaves after birth of a child, Han, Ruhm, and Waldfogel (2009) used the panel structure of the CPS and its fertility supplements collected in June. Because households are interviewed for four consecutive months and for another four consecutive months after an 8-month-long break, the authors could follow parents for up to three con-

[14]The March CPS before 2011 groups employers with 25 to 99 workers in one category.
[15]Waldfogel(1999) restricted her analysis to full-time workers who work 35 or more hours per week.

secutive months after the birth of a child. In their study, absence from work around the birth of a child for "other reasons", other than vacation, own illness, labor dispute, or layoff is viewed as a proxy for take-up of maternity or paternity leave.[16] According to their results, in 2004, 45% of mothers and 91% of fathers were employed during the month of birth, and the share of parents who are employed and absent for "other reasons" was highest one month after the birth for mothers at 63% and during the birth month for fathers at 6%. The share went down to 17% three months after birth for mothers and below 1% two months after birth for fathers (Han et al., 2009). These patterns imply that employed parents in the U.S. return to work in a relatively short period of time after the birth of a child.

The figures from Han et al. (2009) need to be treated with caution for two reasons. First, maternity or paternity leave in the survey is not limited to a FMLA leave but can come from collective bargaining. Second, the absence rates are conditional on employment during the reference period for the survey, rather than employment at the moment of the birth. A decrease in the rates may be due to a decrease in employment.

Although the SIPP also does not limit the type of leaves to FMLA leaves and does not include fathers' take-up behaviour, data from the survey are informative in understanding educational differences in mothers' take-up behaviour. Using data from the SIPP, Laughlin (2011) reported take-up behaviour of mothers who worked during pregnancy for their first child. She reported that, among those who worked during pregnancy before the first birth between 2006 and 2008, 51% and 42% used paid and unpaid leaves around the birth, respectively, and 22% quit their job.[17] By education, a larger fraction of higher educated mothers used paid leave compared to lower educated mothers (32% of high school graduate vs. 66% of a bachelor's or degree), and a larger fraction of lower educated mothers quit their jobs compared to higher educated mothers (33% of high school graduate vs. 13% of a bachelor's or degree). For unpaid leave, lower educated mothers were more likely to use unpaid leave than high-educated mothers, but the educational gradient was quite flat. For the duration of leave, this report also finds evidence that most mothers in the U.S. return to work within a short period of time. Among the sample, 59% started working within 3 months after the birth. By 6 months after the birth, 73% had returned to work. Only 6 % started working between 6 and 12 months after the birth. By education, high school graduates were more likely to start working within 3 months after the birth than college graduates, and college graduates were more likely to start working within 3

[16] Since 1994, the CPS has collected maternity or paternity leave as a separate reason. However, as Han et al. (2009) include a period before 1994 in their study, "other reasons" was used as a proxy for maternity or paternity leave.

[17] Multiple answers were allowed. Paid and unpaid leaves include a maternity, sick, and vacation leaves. Among the sample, 41% and 36% used paid maternity leave and unpaid maternity leave, respectively. The type of a leave is not limited to a FMLA leave. Also, their sample is not limited to married individuals.

to 5 months after the birth compared to high school graduates.[18]

2.3 Understanding Married Individuals' Time Allocations

The purpose of parental leave is to help parents take time off work and to spend their time at home with their newborn child. I conjecture that take-up of parental leave is closely related to parents' time allocations. Therefore, patterns of married people's time allocations are informative in understanding their decisions regarding parental leave. In this section, I document patterns of married people's time allocations particularly by the characteristics of their children.

This analysis is done with data from the GSS for Canada and data from the ATUS for the U.S. These two time use surveys collect cross-sectional data which measure individuals' time use in various activities. GSS collects this information every five to six years, and ATUS is an annual survey. For these surveys, individuals record a retrospective 24-hour time diary during a day of the week. Recorded activities include detailed items related to paid work, housework, recreation, personal care, and so on. Also, the survey collects respondents' demographic and household characteristics, such as age, marital status, the number of children, and the age of the youngest household member. I use data from GSS collected in 2005 and 2010 and data from ATUS collected between 2003 and 2016.[19]

I characterize four major uses of time: market work, child care, household chores, and leisure. My definition of market work is comparable to the category of core market work in Aguiar and Hurst (2007). This category includes all time spent working in the market sector on main jobs, second jobs, and overtime, but it excludes commuting time. Child care includes child care for young children and reading to and playing with children. Household chores include activities such as housework, shopping, repairs, and maintenance. Leisure is defined as time endowment remaining after subtracting the time spent on market, child care, household chores. In my classification, commuting time is included in leisure. The time endowment is discretionary time that excludes time dedicated to sleeping and other necessary personal care. Because I assume that a person spends 8 hours per day on necessary personal care and sleeping, the time endowment is equivalent to 16 hours per day or 112 hours per week in calendar time. For both surveys, the amount of time spent in an activity is recorded in minutes. By averaging all records on weekdays and a weekend and multiplying the averages by 7/60, following Aguiar and Hurst (2007), I report weekly time allocations for each time-use category.

[18] See Laughlin (2011) for detail statistics.

[19] The most recent time use data from GSS were collected between 2015 and 2016. I do not use this cycle because changes of classifications in the public-use micro data from the previous two cycles cause difficulties in creating consistent measures of time use.

Table 2.9: Summary Statistics – Canada

	High-educated		Low-educated	
	Husbands	Wives	Husbands	Wives
Respondent's Age				
25–34	0.245	0.297	0.220	0.232
35–44	0.398	0.372	0.327	0.327
45–54	0.357	0.331	0.453	0.441
Have children under 18	0.623	0.626	0.599	0.513
Number of children				
One	0.168	0.180	0.178	0.130
Two	0.309	0.323	0.271	0.250
Three+	0.146	0.123	0.150	0.132
Youngest child aged				
0–1	0.108	0.118	0.102	0.069
2–3	0.101	0.085	0.080	0.062
4–5	0.069	0.058	0.045	0.055
6–8	0.088	0.104	0.080	0.081
9–11	0.088	0.093	0.091	0.091
12–14	0.091	0.096	0.104	0.076
15–17	0.077	0.072	0.097	0.078
N. Obs.	2852	3623	1781	1985

Data: General Social Survey (2005, 2010).

The sample of interest is restricted to married individuals aged between 25 and 54. As in the previous section, educational attainment is grouped into two levels. I exclude observations whose records do not sum to 1440 minutes which is a full day. For the Canadian sample, people who live in Québec and whose youngest child is born in 2006 or afterwards are excluded from the sample. Observations missing information about respondent's education, age of the youngest child, and main activity in the last 7 days and observation missing information about their spouse, such as spouse's education and main activity in the last 7 days, are excluded. Also, students and retirees are excluded. This sample restriction results in 6,475 high-educated observations and 3,766 low-educated observations for Canada. For the U.S. sample, observations missing information about spouse's education and employment status in the last 7 days are excluded. Also, retirees are excluded. These restrictions result in 28,270 high-educated respondents and 26,009 low-educated respondents for the U.S.

Tables 2.9 and 2.10 display summary statistics for these two samples by sex and education. Across the sample, about 60% have children under 18 living in their household. The remainder has no children under 18 living in the household either because they have not yet had a child or because their children have grown up. A noteworthy difference between Canada and the U.S. is that the U.S. has a higher fraction of people who are low-educated than Canada, as seen in OECD (2018b). Also, the U.S. sample has a higher fraction of people living with children,

Table 2.10: Summary Statistics – The U.S.

	High-educated		Low-educated	
	Husbands	Wives	Husbands	Wives
Respondent's Age				
25–34	0.276	0.329	0.288	0.279
35–44	0.368	0.361	0.344	0.336
45–54	0.356	0.310	0.368	0.385
Have children under 18	0.658	0.640	0.665	0.623
Number of children				
One	0.225	0.240	0.233	0.226
Two	0.291	0.276	0.258	0.231
Three+	0.142	0.124	0.174	0.166
Youngest child aged				
0–1	0.151	0.138	0.128	0.108
2–3	0.111	0.102	0.107	0.090
4–5	0.076	0.073	0.086	0.077
6–8	0.097	0.100	0.107	0.102
9–11	0.089	0.087	0.092	0.091
12–14	0.074	0.076	0.077	0.085
15–17	0.059	0.064	0.068	0.071
N. Obs.	12,858	15,412	12,735	13,274

Data: American Time Use Survey (2003-2016).

people living with one child, and people with an infant, compared to the Canadian sample. These differences are related to the fact that the mean age of mothers at childbirth is higher in Canada than in the U.S. (OECD, 2018a).

2.3.1 Presence of Children

First, I examine how the presence of children is related to married individuals' time allocations. Tables 2.11 and 2.12 report coefficients from a linear regression of total time spent on each category on sex, presence of children under 18, and their interaction terms for the U.S. and Canada, respectively. Regressions are separately estimated by education group for each country. A constant term shows the average hours per week spent by husbands not living with children. The coefficient on "Wife" represents the gender difference in the amount of time spent on a category. The coefficients on "HaveChildren" and "Wife×HaveChildren" show the impact of living with children on their parents' time allocation and a gender difference in its impact, respectively.

The tables show that specialization between the two categories is stronger among the low-educated than among the high-educated. For example, in Canada, high-educated wives spend 4 fewer hours on market work and 6 more hours on household chores than high-educated husbands. Among the low-educated, wives spend 11 fewer hours on market work and 12

Table 2.11: Average Hours per Week by Sex and Presence of Children – Canada

(a) High-educated

	Market Work	Child Care	Household Chores	Leisure
Constant	36.669**	0.033	16.767**	58.531**
	(1.165)	(0.028)	(0.683)	(1.022)
Wife	-4.454**	0.026	5.880**	-1.452
	(1.508)	(0.044)	(0.922)	(1.296)
HaveChildren	3.688*	7.260**	-1.199	-9.750**
	(1.455)	(0.290)	(0.867)	(1.250)
Wife×HaveChildren	-13.401**	6.804**	4.997**	1.600
	(1.875)	(0.522)	(1.175)	(1.592)

(b) Low-educated

	Market Work	Child Care	Household Chores	Leisure
Constant	37.833**	0.085	15.847**	58.235**
	(1.417)	(0.078)	(0.811)	(1.313)
Wife	-11.291**	0.097	11.171**	0.022
	(1.774)	(0.112)	(1.172)	(1.612)
HaveChildren	1.930	5.546**	-0.553	-6.923**
	(1.861)	(0.409)	(1.062)	(1.701)
Wife×HaveChildren	-8.339**	7.402**	2.509	-1.572
	(2.372)	(0.731)	(1.554)	(2.140)

Data: General Social Survey (2005, 2010). Robust Standard Error in parenthesis. **Significant at the 1% level. *Significant at the 5% level. +Significant at the 10% level.

more hours on household chores. On average, husbands and wives have almost the same amount of leisure time. For the U.S., the time allocations among those with no children show similar patterns to the time allocations in Canada in terms of gender differences. A noticeable difference between the two countries is that, for high-educated husbands without children, those in the U.S. spend more time on market work and less time on leisure than those in Canada.

The presence of children within a household does influence married individuals' time allocations in both countries. In particular, specialization between market work and home production, such as child care and household chores, is stronger among those with children than those with no children. For Canada, although high-educated husbands in Canada increase child care time by 7 hours per week by reducing leisure time, wives spend twice as much time on child care as husbands. Furthermore, while the presence of children barely changes high-educated husbands' time on household chores, it significantly increases high-educated wives' time on household chores. To increase time spent on home production by such a large amount, high-

Table 2.12: Average Hours per Week by Sex and Presence of Children – The U.S.

(a) High-educated

	Market Work	Child Care	Household Chores	Leisure
Constant	40.562**	0.240**	16.302**	54.896**
	(0.734)	(0.058)	(0.411)	(0.633)
Wife	-7.407**	0.397**	5.678**	1.332
	(0.980)	(0.098)	(0.587)	(0.835)
HaveChildren	0.947	8.513**	-1.910**	-7.550**
	(0.816)	(0.149)	(0.453)	(0.695)
Wife×HaveChildren	-9.322**	6.746**	4.627**	-2.051*
	(1.093)	(0.243)	(0.649)	(0.919)

(b) Low-educated

	Market Work	Child Care	Household Chores	Leisure
Constant	37.966**	0.394**	16.554**	57.087**
	(0.769)	(0.060)	(0.451)	(0.664)
Wife	-11.948**	0.904**	9.350**	1.694+
	(1.002)	(0.137)	(0.650)	(0.873)
HaveChildren	0.396	5.812**	-1.484**	-4.724**
	(0.868)	(0.152)	(0.498)	(0.745)
Wife×HaveChildren	-7.094**	5.486**	4.220**	-2.613**
	(1.135)	(0.269)	(0.730)	(0.985)

Data: American Time Use Survey (2003–2016). Robust Standard Error in parenthesis. **Significant at the 1% level. *Significant at the 5% level. +Significant at the 10% level.

educated mothers reduce additional market hours.

Overall patterns for U.S. high-educated parents are similar to those in Canada, but the two countries show differences. High-educated parents in the U.S. spend more time on market work and child care and less time on household chores and leisure than those in Canada. For the impact of living with children on parents' leisure time, a decrease in leisure time is statistically significantly greater for mothers than for fathers in the U.S. while it is smaller for mothers than for fathers in Canada.

Similarly, the low-educated show stronger specialization among those with children than those without children in both countries. A noteworthy difference from the high-educated is that the low-educated increase child care time by a smaller amount as seen in Guryan et al. (2008). Another difference from the high-educated is that changes in market work and household chores due to the presence of children are smaller for low-educated parents. Two countries show different impact of living with children on parents' household chores and leisure. The presence of children does not add a significant amount of time on household chores in Canada.

However, U.S. mothers living with children under 18 spend significantly more time on household chores than those living with no children under 18. For leisure time, a decrease in leisure time is statistically significantly greater for mothers than for fathers in the U.S. while a gender difference in the impact on leisure is not statistically significant in Canada.

2.3.2 Time Allocations by Age of the Youngest Child

I now discuss how the age of the youngest child is related to married parents' time allocations in more detail. Using the subsample of married individuals living with children under age 18, I estimate ordinary least squares regressions with time spent in each category as the dependent variable. I control for age, sex, number of children, and age of the youngest child, as dummy variables. I also include interaction terms between sex and number of children and between sex and age of the youngest child. These regressions are estimated separately by education for each country. Complete results are presented in Tables A.1 – A.4 in Appendix A.

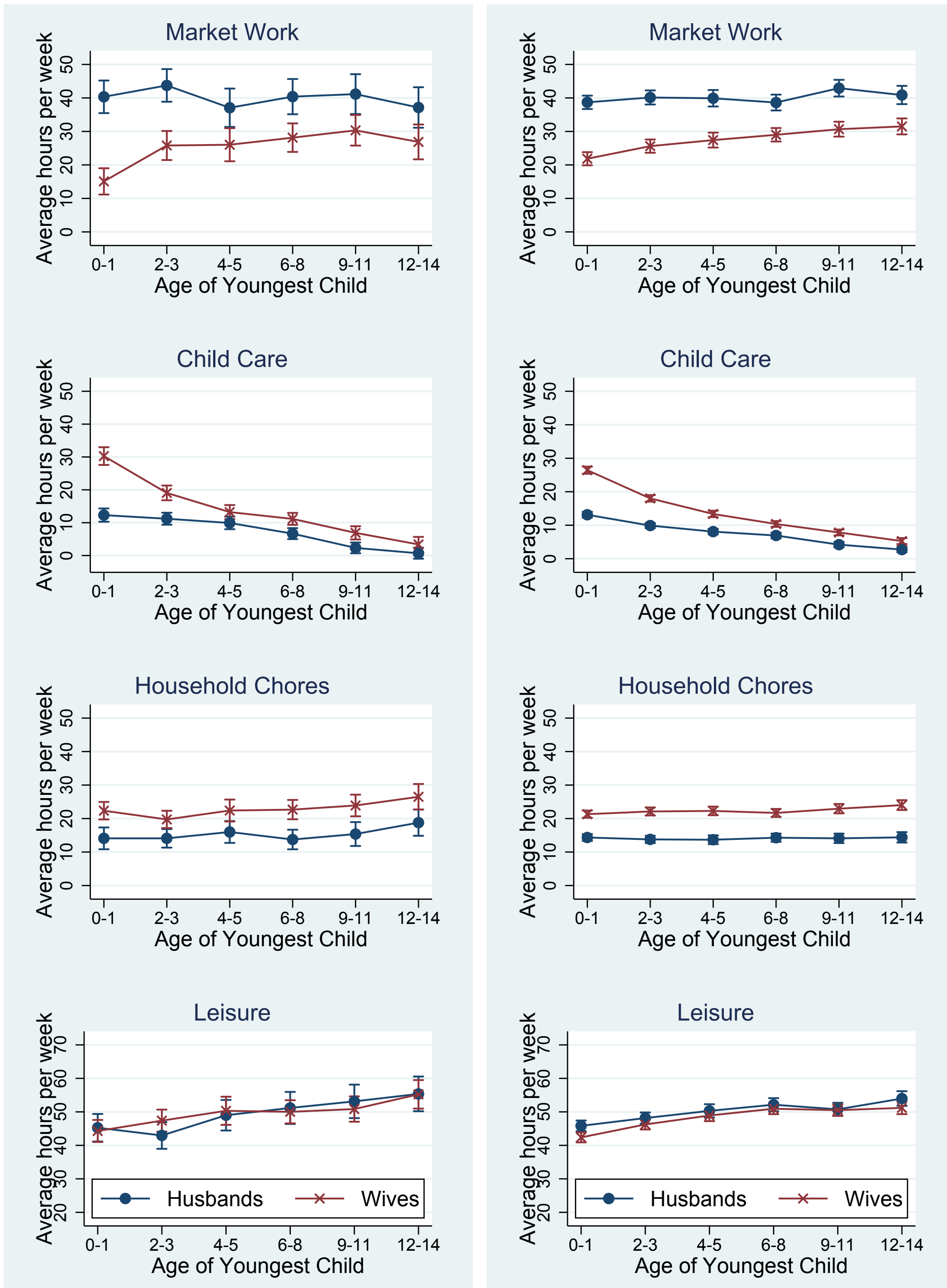
Figure 2.1 displays how high-educated parents' time allocations depend on age of the youngest child for Canada in the left panel and for the U.S. in the right panel. The base group for this figure is 35- to 39-year-old parents living with one child. High-educated husbands' time allocations in Canada and the U.S. are quite similar. Those with an infant spend roughly 40 hours per week on market work and 14 hours per week on household chores, and these categories show little or no changes by age of the youngest child. Those with an infant spend roughly 12 hours per week on child care and 45 hours per week on leisure. As the youngest child gets older, high-educated husbands gradually reduce child care time and increase leisure time. Thus, the results Kimmel and Connelly (2007) found for mothers hold for fathers as well.

High-educated wives in Canada and the U.S. also have similar patterns, except for those with an infant. Those with no children work almost the same hours in the two countries (Tables 2.11 and 2.12). In contrast, among those with an infant under age two, the average market hours in the two countries display a large difference. On average, those in Canada work 7 fewer hours than their U.S. counterparts. They allocate the 7 hours across all the other time-use categories. Compared to U.S. mothers, Canadian mothers spend 3.5, 2, and 1.5 more hours on child care, household chores, and leisure, respectively. This result confirms that parents who have access to a longer parental leave allocate time taken away from market work between home production and leisure. When the youngest child is two years old or older, the average market hours of high-educated mothers look similar in the two countries.

As a result, specialization between market work and home production, such as child care and household chores, is stronger among parents with an infant than among parents with only older children. In addition, specialization among high-educated parents with an infant

Figure 2.1: Time Allocations by Age of the Youngest Child – High-educated Parents

(a) Canada (b) US



Source: General Social Survey (2005, 2010) and American Time Use Survey (2003–2016). These figures plot adjusted predictions from OLS regressions of each time-use category. The representative group is parents aged 35–39 with one child.

is stronger in Canada than in the U.S., while time allocations of high-educated parents with only older children look alike in the two countries. It is plausible that the large Canada-U.S. differences among parents with an infant are related to major differences in parental leave policies and take-up behaviour between the two countries. For Canada, a relatively more generous, extended parental leave policy allows mothers to take more time off from work and spend more time at home to care for their babies. This may imply that while the Canadian mothers benefit from a longer job-protected leave, many high-educated mothers in the U.S. maintain their job by taking a leave under the FMLA or collective bargaining and returning to work within a short time after the birth of a child.

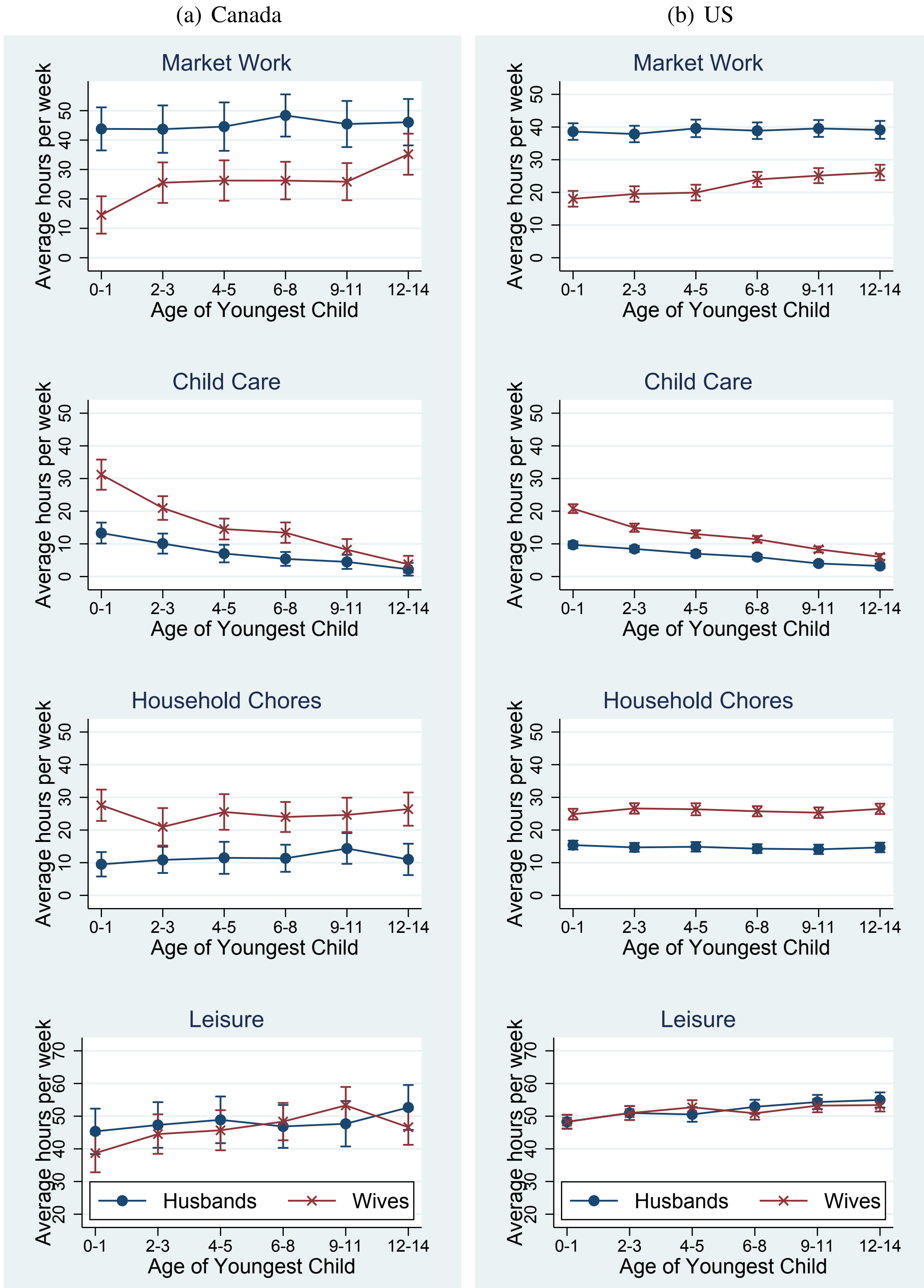
Figure 2.2 reports low-educated parents' average weekly hours as a function of the youngest child's age for Canada in the left panel and the U.S. in the right panel. For low-educated husbands, overall patterns by the age of the youngest child are very reminiscent of time allocations in Figure 2.1. However, while the average weekly hours of high-educated fathers are more or less the same in the two countries, low-educated husbands in the two countries show differences in levels of the means. Canadian low-educated fathers spend 5 more hours on market work and 5 fewer hours on household chores than their U.S. counterparts. Another interesting Canada-U.S. difference is that, in Canada low-educated fathers to an infant spend time on child care as much as high-educated fathers, whereas those in the U.S. spend 3 fewer hours on child care and have more leisure time than high-educated fathers in the U.S. and low-educated fathers in Canada.

For low-educated wives, there are greater differences in time allocations between the two countries. Those with an infant allocate their time remarkably differently in the two countries. Those in Canada spend 5 fewer hours on market work than those in the U.S. A more dramatic difference is observed in child care time. For Canada, low-educated mothers spend as much time on child care as high-educated mothers in Canada do. Meanwhile, in the U.S. low-educated mothers spend 11.5 fewer hours on child care than their Canadian counterparts. The Canada-U.S. difference in child care time is more than twice the difference in market hours. In addition, Canadian mothers spend more time on household chores than U.S. mothers. As a result, Canadian mothers have significantly less leisure time than U.S. mothers.

Interestingly, Canada and the U.S. show opposite relationships between education and leisure time. For Canada, the low-educated have less leisure time than the high-educated mainly because the low-educated do more household chores than the high-educated. In contrast, for the U.S. the low-educated have more leisure time than the high-educated mainly because they spend less time on market work and child care than the high-educated.

Next, unlike high-educated wives, low-educated wives with children aged 2 to 5 also display interesting differences in time allocations between the two countries. The low-educated

Figure 2.2: Time Allocations by Age of the Youngest Child – Low-educated Parents



Source: General Social Survey (2005, 2010) and American Time Use Survey (2003–2016). These figures plot adjusted predictions from OLS regressions of each time-use category. The representative group is parents aged 35–39 with one child.

wives show a lasting impact of leave on time allocations. When the youngest child's age increases from 0–1 to 2–3, the average market hours of low-educated wives increases by 12 hours per week in Canada and only by 2 hours per week in the U.S. The statistics barely change when the youngest child is aged 4–5. I conjecture that the difference between the two countries may be related to greater coverage of paid, job-protected leaves in Canada. As seen in the previous section, only 26% of low-educated wives meet the eligibility requirements for FMLA leaves. Also, low-educated wives are more likely to quit their job and stop working after birth of a child, compared to high-educated wives. Therefore, low-educated mothers in the U.S. may be less likely to return to the pre-birth job. They may face difficulties in returning to the labour market.[20]

Extensive Margin vs. Intensive Margin

The average time allocations I reported in the previous analysis include zeros in the calculation because not all respondents report positive minutes in all four categories. Therefore, a difference in the statistics between two groups can be due to a difference at the extensive margin or one at the intensive margin. I now consider the extensive and intensive margins and examine which margin drives the patterns in Figures 2.1 and 2.2.

For the extensive margin, I estimate the probability of participation in each time-use category using a logit regression with a binary variable indicating a non-zero duration as a dependent variable. For the intensive margin, I estimate ordinary least squares regressions with time spent in each category conditional on participation. The same set of control variables are used as before. A regression is estimated separately for each category by education and country.

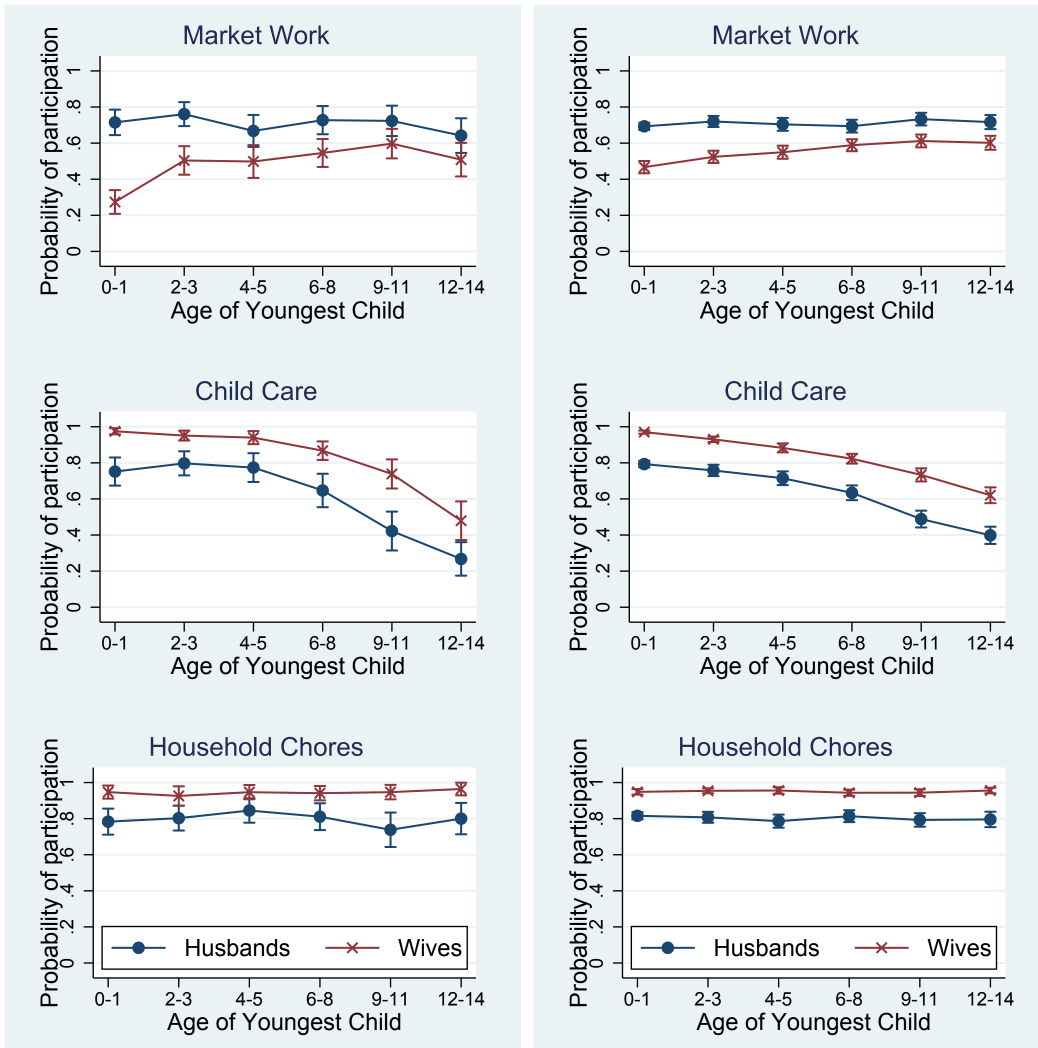
For high-educated parents, Figures 2.3 and 2.4 display predicted probabilities of participation and average time allocations conditional on participation as a function of the age of the youngest child, respectively. Figures 2.5 and 2.6 display the results for low-educated parents for Canada in the left panel and for the U.S. in the right panel.

The patterns by the age of the youngest child and cross-country differences in high-educated mothers' market work are explained mostly by participation. Among high-educated mothers with an infant, a participation rate in market work is 20 percentage points lower in Canada than in the U.S., while the conditional average hours show only a small difference (about 40 minutes per day). When the youngest child is two years old or older, participation rates look alike in the two countries. As seen among high-educated mothers, Canada-U.S. differences in market hours among low-educated mothers are largely due to participation. In particular, the pattern of low-educated mothers' participation in market work is very reminiscent of the average market

[20] Another possible reason is how affordable child care services are in the two countries compared to the average earnings of the low-educated. This discussion is beyond the scope of this study.

Figure 2.3: Participation Rates by Age of the Youngest Child – High-educated Parents

(a) Canada (b) US

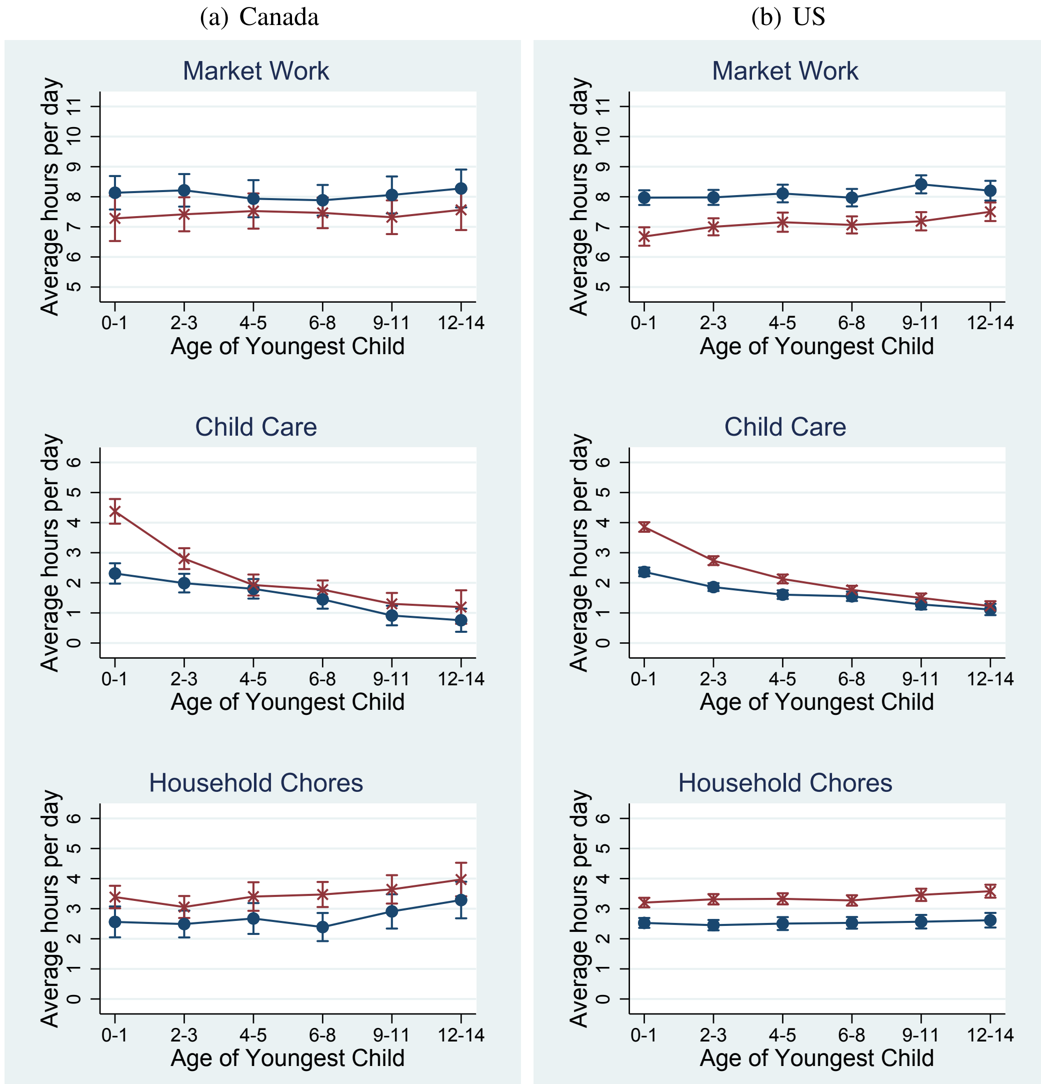


Source: General Social Survey (2005, 2010) and American Time Use Survey (2003–2016). These figures plot margins from logit regressions of each time-use category. The representative group is parents aged 35–39 with one child.

hours in Figure 2.2. Among those with an infant, a larger fraction of the U.S. mothers report market work than the Canadian mothers. Among those with the youngest child aged 2–5, a higher fraction of the Canadian mothers report market work, and they also work roughly 30 more minutes per day than the U.S. mothers. These findings suggest that high-educated mothers in the U.S. maintain similar job continuity rates as those in Canada while low-educated mothers in the U.S. may have difficulties in securing jobs possibly due to lower eligibility rates for a FMLA leave.

In Figures 2.1 and 2.2, Canada and the U.S. show differences in child care time among

Figure 2.4: Conditional Average Hours by Age of the Youngest Child – High-educated parents

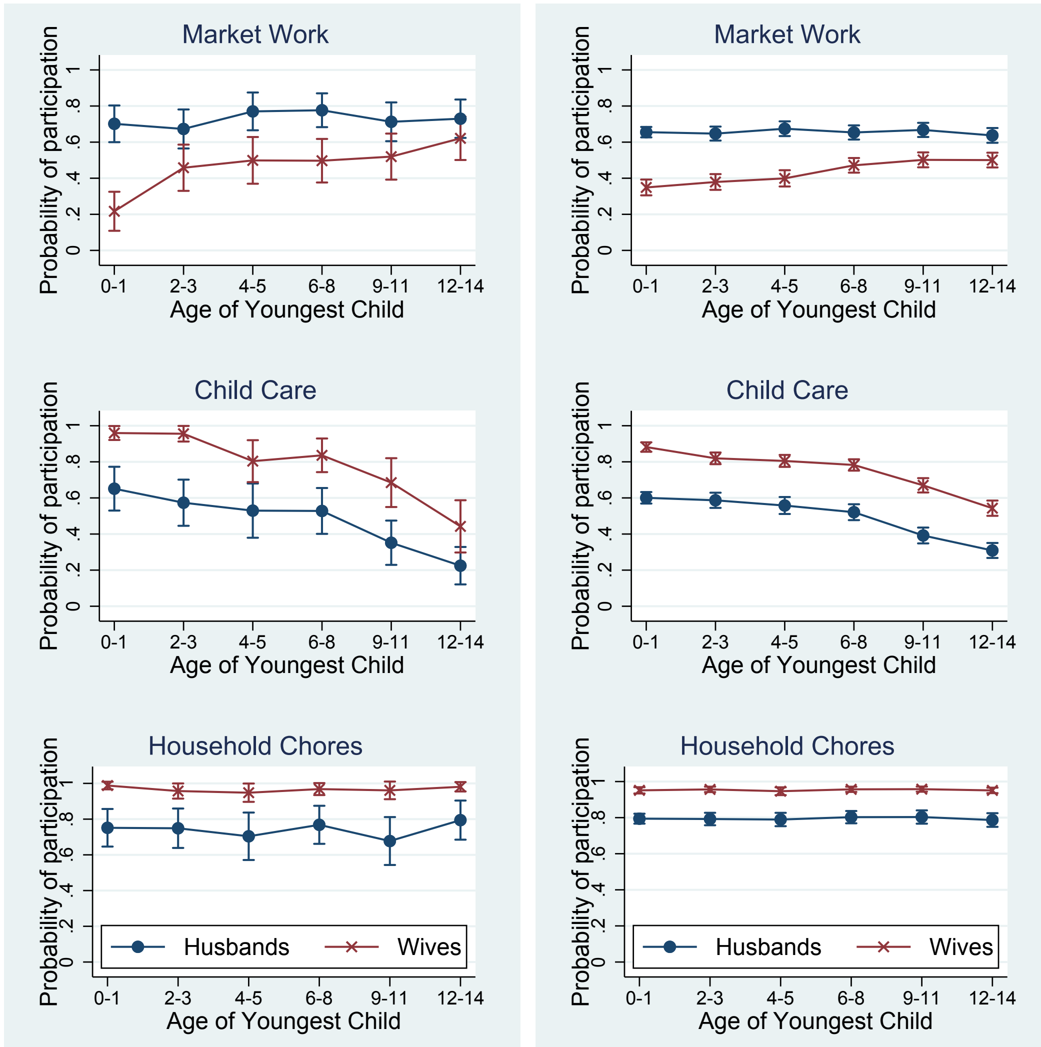


Source: General Social Survey (2005, 2010) and American Time Use Survey (2003–2016). These figures plot adjusted predictions from OLS regressions of each time-use category conditional on reporting non-zero durations. The representative group is parents aged 35–39 with one child.

mothers with a young child. For high-educated mothers with an infant, the entire cross-country difference is accounted for by the intensive margin. In both countries, 97% of the mothers report child care time. Conditional on participation, those in Canada spend 30 more minutes per day, or 3.5 hours per week, on child care than those in the U.S. In contrast, for low-educated mothers, the differences are explained by not only the intensive margin but also the extensive margin. For Canada, almost all low-educated mothers with a young child aged under 4 report child care time. However, for the U.S., only 88% of those with an infant and 82% of those with the youngest child aged 2–3 report child care time. In addition, conditional on participation,

Figure 2.5: Participation Rates by Age of the Youngest Child – Low-educated Parents

(a) Canada (b) US



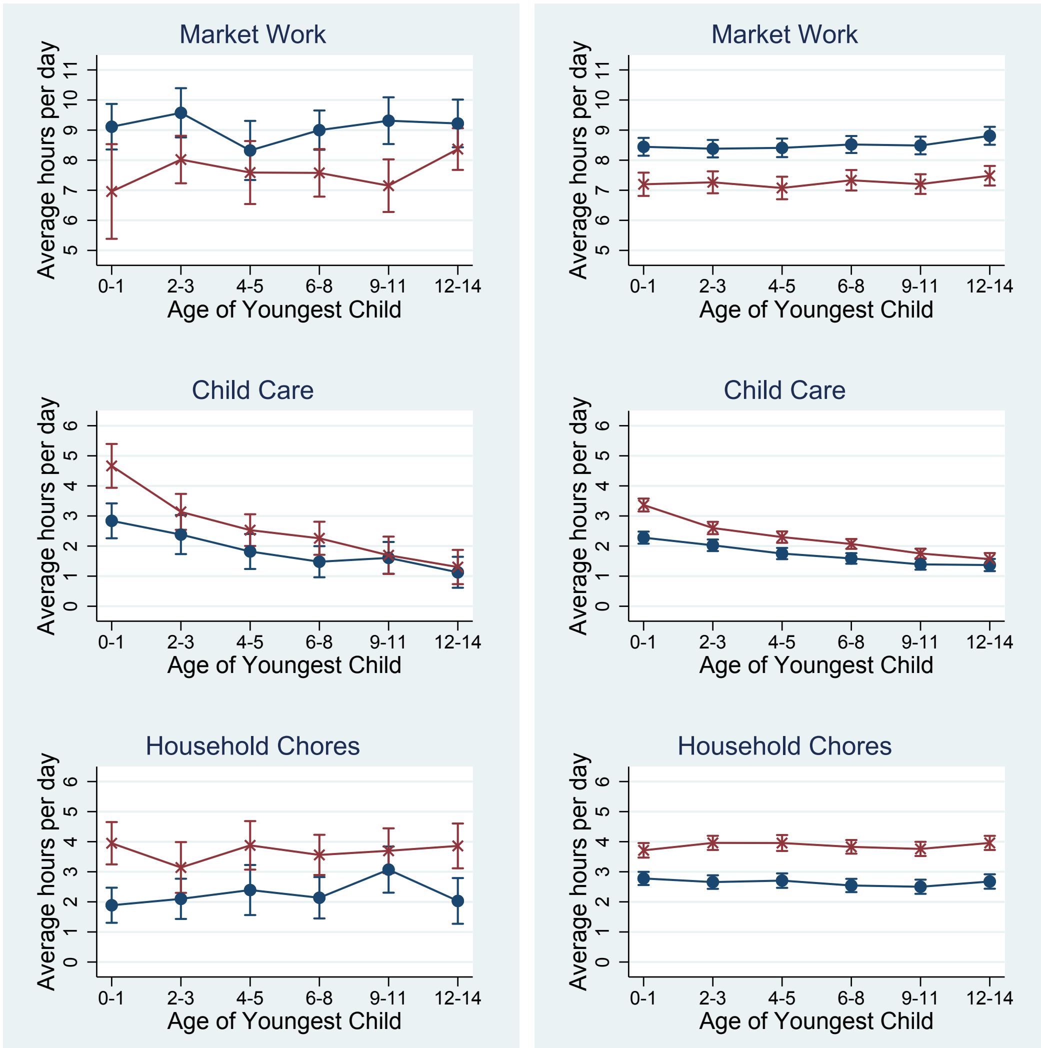
Source: General Social Survey (2005, 2010) and American Time Use Survey (2003–2016). These figures plot margins from logit regressions of each time-use category. The representative group is parents aged 35–39 with one child.

those in the U.S. spend on child care one hour less per day than those in Canada.

In addition, this analysis of the intensive and extensive margins illustrates that in both countries, both extensive and intensive margins play a role in explaining gender differences in time allocations, especially on market work and child care. High-educated husbands' probability of reporting market work is about 0.71, which implies that they work 5 days a week, on average. Compared to high-educated husbands, a smaller fraction of high-educated wives report market work. Also, conditional on participation, the wives work fewer hours than the husbands. Among high-educated parents with a young child in the U.S., conditional on participation,

Figure 2.6: Conditional Average Hours by Age of the Youngest Child – Low-educated Parents

(a) Canada (b) US



Source: General Social Survey (2005, 2010) and American Time Use Survey (2003–2016). These figures plot adjusted predictions from OLS regressions of each time-use category conditional on reporting non-zero durations. The representative group is parents aged 35–39 with one child.

wives work 12–15% fewer hours than husbands. This finding for market work is consistent with Erosa, Fuster, and Restuccia (2016). While participation differences between the husbands and the wives are greater in Canada, gender differences in conditional means are greater in the U.S.

For child care time, a smaller fraction of high-educated fathers report child care than high-educated mothers at all ages of the youngest child, and the conditional average child care time is significantly lower for the fathers than for the mothers. Among those with an infant, while almost all mothers report child care, one in five fathers report no child care time in both countries. Among those who report child care, the fathers spend on average 2 hours per day, which is a half of the time spent by mothers. When the youngest child is under 4, the gender differences in both participation and the conditional averages remain significant in both countries. When the youngest child is 4 years old or older, gender differences in the unconditional average child care time are mainly due to differences in participation between mothers and fathers.

It is also noteworthy that both the extensive and the intensive margin contribute to educational gradients in husbands' child care time. Figure 2.2 showed that for Canada the average child care time spent by low-educated and high-educated fathers are almost the same and that for the U.S. low-educated fathers spend fewer hours than high-educated fathers. Figure 2.5 displays, in both countries, a much smaller fraction of low-educated fathers reporting child care time than high-educated fathers even when they have a young child. Among Canadian fathers with an infant, the educational gradient in child care time is flat because despite the lower participation rate, low-educated fathers spent 30 more minutes than high-educated fathers conditional on participation. Meanwhile, for the U.S. fathers with an infant, differences in participation by educational attainment shape the educational gradient in unconditional average time spent in child care.

2.4 Conclusion

In this chapter, I document differences in statutory parental leave policies and take-up behaviour in Canada and the U.S. and relate the differences to married parents' time allocations across market work, child care, household chores, and leisure. In particular, I examine the role of the age of the youngest child on parents' time allocations in the two countries and make cross-country comparisons. Also, I explore the role of the extensive and the intensive margins in determining the unconditional average time allocations by analyzing participation and the conditional averages separately.

I find several interesting patterns from the analyses. First, I document that the fraction of married individuals eligible for a statutory parental leave is smaller in the U.S. than in Canada and that differences in statutory parental leave policies appear to influence parents' take-up of parental leave and labour supply after the birth of a child. Second, controlling for the presence of children, high-educated parents show different patterns and low-educated parents show similar patterns in the two countries. Meanwhile, high-educated parents show similar patterns and low-educated parents show different patterns in the two countries when controlling for number of children and the age of youngest child. This implies that, in aggregate, the average child care hours of U.S. low-educated parents are comparable to the figure in Canada, but it is due to higher fertility rates in the U.S. Controlling for the number of children, parents in the U.S. spend significantly less time caring for children than those in Canada.

Third, I find that the two countries display a large difference in high-educated mothers' market work only in the presence of an infant, whereas they show significant differences in low-educated mothers' market work until the youngest child is aged 6 or older. From this finding, I conjecture that a great number of high-educated mothers in the U.S. maintain job continuity as successfully as those in Canada possibly though employers' voluntary provision of job-protected maternity leave as well as the FMLA. Another conjecture from the finding is that many low-educated mothers in the U.S. may have difficulties in securing their jobs after the birth of a child due to lower eligibility rates for a FMLA leave. There are, of course, other cross-country differences that can results in the same patterns. A difference in taxation for married couples between the two countries is another possible explanation for the finding. Canada has a system based on individual taxation of spouses, whereas the U.S. features joint taxation. Joint taxation in the U.S. may disincentivize the labour supply of mothers with a young child, especially for low-educated mothers, as net benefits of working are relatively small considering all the cost of working such as daycare costs. Another possible explanation is differences in preferences among the low-educated between the two countries. Identifying reasons for the finding is an interesting area for future research.

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Chapter 3

The Effects of Child-related Leaves on a Married Couple's Fertility and Labour Decisions in a Household Search Framework

3.1 Introduction

Childbirth and childcare have been crucial to women's labour supply decisions, while women's labour supply decisions significantly affect fertility decisions. Some women postpone childbirth to keep their careers, whereas some women give up their careers to raise children. As more women, particularly married women, participate in labour markets, the balance between work and family has become increasingly important. Many countries have introduced child-related leave policies, such as maternity and parental leaves, to help mothers balance their work and family lives. In terms of length and benefits, there is considerable variation in child-related leave policies across countries. Sweden provides 16 months of paid parental leave.[1] Parents are entitled to 80 percent of their usual salary for 13 months and a fixed amount of benefits for three months. In Canada except Quebec, parents are entitled paid maternity and parental leave. Mothers are entitled to 55 percent of their usual salary for 12 months or 33 percent of their usual salary for 18 months. In the United States, parents are entitled to 3 months of unpaid

[1]Among 16 months, two months are eligible only for fathers

Table 3.1: Employment Statistics of Married Couples with Young Children

	Sweden[†] vs. U.S. (children under 3)		Canada vs. U.S. (children under 6)	
	Sweden	U.S.	Canada	U.S.
Dist. by employment pattern (%)				
Both spouses employed (a)	71	53	67	56
Only husband employed (b)	24 (=b+c)	40	21	38
Only wife employed (c)		4	10	4
Neither spouse employed (d)	5	3	2	3
Employment/Population ratio (%)				
Male (a+b)	at most 95	94	88	93
Female (a+c)	at least 71	57	77	59

Source: U.S: Bureau of Labor Statistics (2007); Sweden: OECD Family Database (2008); Canada: Marshall (2009) (Original data from Labour Force Survey). [†]The Swedish statistics are for couples with youngest child under 3.

leaves through the Family and Medical Leave Act (FMLA).[2,3]

This variation in child-related leave policies is seemingly related to married couple's employment patterns and employment rates across countries. Table 3.1 shows employment statistics of married couples with young children in Sweden, Canada, and the United States. In Sweden, which has the most generous child-related leave policy among the three countries, married couples with young children under the age of three are more likely to be dual-earner couples than those in the United States. A higher fraction of married couples with children under the age of six are dual-earners or designate the wife as a primary breadwinner in Canada than in the United States, which has the least generous policy among the three countries and even among all developed countries. This pattern leads to lower employment-to-population ratio of married women in the United States, compared to Sweden and Canada. In this paper, I investigate the effects of child-related leave policies on married couples' fertility and labour supply decisions in a household search framework.

Married women's labour supply decisions have been studied in individual labour supply models (Hotz and Miller, 1988, Van der Klaauw, 1996, Hyslop, 1999, Francesconi, 2002), family labour supply models (Blundell and Macurdy, 1999), and collective household models (Chiappori, 1992, 1997). However, these neoclassical labour supply models are problematic in studying parental leaves in that these models categorize work in specific jobs under the one, broad classification "working." One aim of parental leaves is to help a mother keep her job, while she is temporarily away from work raising her newborn child. This is especially the

[2]In the United States, there are large variations in family leave policy at the state level or firm level. Unlike other states, California, New Jersey, and Rhode Island provide mandated paid maternity leaves. Also, some companies voluntarily provide paid leaves. Some mothers take paid sick leave instead of taking unpaid maternity leave.

[3]For cross-country comparison of child-related policies, see Olivetti and Petrongolo (2017).

case if a married woman has a job paying a high wage as she may want to retain that job. These neoclassical labour supply models lacking distinction between two jobs with different wages cannot explain this benefit of parental leave.[4] Thus, a job search model that can make a distinction between the two cases seems appropriate to use in studying parental leaves.

In the search literature, a single-agent search framework has been typically applied in studying the behavior of married individuals (Bowlus, 1997, Erosa, Fuster, and Restuccia, 2002, 2010, Zhang, 2012). Erosa et al. (2010) examine the effects of variations in parental leave policies on fertility rates, labour market outcomes, and social welfare in a general equilibrium model based on an individual search framework. The authors find that introducing statutory paid maternity leave decreases overall social welfare because welfare losses of men dominate welfare gains of low-income mothers. This application of a single-agent search model to a married couple's decisions presumes that a married individual does not interact with his or her spouse in their labour supply decisions. Even an individual search model of a married woman with her husband's employment status and labour income exogenously given does not fully describe interactions between a husband and wife. This model can describe the effect of the husband's employment status and labour income on his wife's decision, but cannot describe the reciprocal effect of the wife's decision on her husband's employment status. If interactions between spouses are considered, the welfare analysis of paid maternity leaves may prompt a different conclusion.

One merit of a household search model is the ability to explain the interdependence between a husband and a wife. However, in the search literature, the joint labour supply decisions of two household members have not attracted researchers' interests until recently.[5] The household search literature suggests there is strong interdependence between married individuals' labour supply decisions and their spouse's wage and employment status (Dey and Flinn, 2008, Gemici, 2011, Guler, Guvenen, and Violante, 2012, Choi and Valladares-Esteban, 2016, Mankart and Oikonomou, 2017, Flabbi and Mabli, 2018). In this literature, interdependence between a husband's and a wife's decisions is derived by a household's risk averse preference over household consumption and sharing of labour incomes.

I develop and characterize a household search model that features home production and endogenous fertility choice. My household search model is unique in the household search literature in that I focus on home production as a driving force for household interactions. In

[4] Bernal and Fruttero (2008) studied the effects of parental leaves in a model with the neoclassical labour supply feature by setting the function of parental leaves as lowering the minimum hours of work required to keep a job. This function allows parents to assign their time in both working and child care. However, this function seems closer to the function of flexible work hours. Yamaguchi (2018) estimates a dynamic discrete choice model of female labour supply and fertility decisions incorporating parental leave policies and finds little effect of parental leave policies on fertility.

[5] The multi-agent search models were first introduced about three decades ago by Burdett and Mortensen (1978).

my model, home production requires both a husband's time and a wife's time, and output from home production is a public good within a household.[6] By eliminating the assumption of a risk averse preference for household consumption, I focus on household interactions which can be explained solely by home production.

My household search model is able to show interactions between a husband and wife in labour supply and fertility decisions. I contribute to the literature in that it is the first to provide a household search model that includes endogenous fertility choices. I find that the model generates a case in which a breadwinner in a household shifts from a spouse to the other spouse when an unemployed spouse accepts an offer. Also, my household search model can generate a pattern that a wife may quit her job to raise her children even if the productivity of her job is higher than that of her husband's job. This intra-household interaction cannot be shown in an individual search model. This model is appropriate for understanding the effects of family-related leaves on a married couple's fertility and labour supply decisions and further evaluating the effects of parental leaves on social welfare.

The model is parameterized to generate similar patterns to the cross-sectional employment patterns of married couples in the United States with twelve weeks of unpaid maternity leave. By varying related parameters, I examine the effects of the generosity of maternity leave policies on married couples' fertility and labour supply decisions. The policy experiments suggest that the introduction of an extended paid parental leave provides married couples an incentive to have more children and raises fertility rates. Also, the model predicts that an extended paid parental leave lowers the fraction of dual-earner couples and increases the fraction of single-earner couples in the economy. This is because as married couples have more children, a husband and a wife are more likely to specialize either in market production or in home production.

This chapter is organized as follows. In Section 3.2, I present my household search model and characterize a married couple's labour supply decisions. I also show household interactions between a husband and wife in the household search model and contrast the household search model with an individual search model. In Section 3.3 and 3.4, I parameterize the model, present quantitative analyses, and carry out policy experiments. In Section 3.5, I present conclusions.

[6] Dey and Flinn (2008) also include a public good for household interactions. However, the public good is in the context of health insurance in their paper.

3.2 Household Search Model

This section describes a household search model. Key features of the model are home production and endogenous fertility choices. The model economy is populated with infinitely-lived married couples in continuous time. A married couple consists of a female spouse, denoted as a superscript f, and a male spouse, denoted as a superscript m.

A couple is either *younger* or *older* depending on their children's ages. A *younger* couple is defined as a couple with children under 18. Also, a *younger* couple is fertile. A *younger* couple stochastically faces an opportunity for a fertility decision (a fertility shock). When having a fertility opportunity, a *younger* couple decides whether or not to have one more child. Let the number of children a *younger* couple has be k. A *younger* couple derives utility from their children and from home production. A couple becoming *older* means that the couple's children are all grown up and, at the same time, a couple becomes non-fertile. An *older* couple, which does not have children to take care of, does not derive utility from their children nor from home production.

A married individual has one of two labour states: either employed or non-employed. Thus, a married couple has one of four labour states: both spouses employed, only a husband employed, only a wife employed, and neither spouse employed. A non-employed individual searches for a job. One job offer stochastically arrives at a time. While receiving a fixed amount of unemployment benefits, z, a non-employed individual participates in home production. An employed individual spends all available time in market work and earns labour income. On-the-job-search is allowed. A worker can be stochastically laid off. An employed mother is eligible for maternity leave after childbirth. If paid leave is available, a mother on leave receives maternity leave benefits partially replacing her usual wage until her paid leave expires.

A married couple has unitary utility from consumption, the number of children, and output from home production:

$$u(w^f, w^m, h^f, h^m, k, \nu) \quad = \quad w^f + w^m - g \cdot k + \gamma \ln(1+k) + Z(g, h^f, h^m, k, \nu).$$

The first part of the household utility is gained from consumption. Let w^f be a wife's wage and w^m be a husband's wage. Household incomes consist of wages, unemployment benefits, and maternity leave benefits. When both spouses are employed, household income is the sum of a husband's and a wife's wages. When only one spouse is employed, household income is the sum of an employed spouse's wage and a non-employed spouse's unemployment benefit, z. When neither spouse is employed, household income is the sum of unemployment benefits, $2z$. When an employed wife is on leave after childbirth, leave benefits replace her wage at the rate of ρ until her leave expires with probability ψ. I assume stochastic expiration of leaves to keep the model stationary. A couple purchases a fixed amount of goods for each child, g, as a sunk cost. A couple with k children spends $g \cdot k$ to purchase market goods for children and consumes the remaining household income.

The second part of the household utility is the utility from having children, which is the happiness parents feel after having their children. Marginal utility from children is positive and decreasing. The third part is the utility from output of home production. This third part is the key feature of this model to generate the interdependence of a husband and wife in their labour supply decisions.

3.2.1 Home Production

Home production in this paper is related to raising children in a household. Output from home production includes domestic child-care services, children's health, and child development. If parents take care of their children themselves, they can save on day-care costs. Home production requires inputs of market goods for children and parents' time spent at home. In this model, parents cannot perfectly substitute market goods for parents' time. Parents purchase fixed amount of goods, g, for each child. To produce output from home production, at least one parent needs to spend his or her time at home. When both parents work in the labour market, the parents do not produce any output from home production. As a couple has more children, the parents produce more output from home production.

Following the literature on home production or child development, a home production function is assumed as a Cobb-Douglas function in market goods and parents' time (Caucutt, Guner, and Knowles, 2002, Jones, Manuelli, and McGrattan, 2015, Albanesi and Olivetti, 2009, Knowles, 2013). Let $Z(g,h^f,h^m,k,\nu)$ be the output from home production. I use the following home production technology:

$$Z(g,h^f,h^m,k,\nu) \quad = \nu \cdot [g \cdot k]^{\alpha} [t(h^f,h^m)]^{1-\alpha} \tag{3.1}$$

where ν is a couple-specific efficiency factor of home production.

The time input from each spouse is aggregated into the time input of a married couple in a CES form (Albanesi and Olivetti, 2009, Knowles, 2013):

$$t(h^f,h^m) \quad = [\theta \cdot (h^f)^{\zeta} + (1-\theta) \cdot (h^m)^{\zeta}]^{1/\zeta}.$$

Let h^f and h^m be a wife's time and a husband's time spent at home, respectively. An employed spouse $i \in \{f,m\}$ contributes no time to home production ($h^i = 0$), whereas a non-employed spouse spends all available time at home with children ($h^i = 1$). Let θ represent a wife's home productivity relative to her husband's home productivity. Albanesi and Olivetti (2009) interpret the parameter as reflecting women's contribution to home production such as the ability to breast feed children. If $\theta = 1/2$, this implies that a wife and a husband are equally productive in home production. When $\theta > 1/2$, a wife is more productive in home production than her husband. In this case, a wife is more likely to stay at home than her husband.

The efficiency factor of home production ν is specific to a married couple. An initial value of ν is randomly drawn from an exogenous distribution, and its value evolves over time following a stochastic process given in Equation (3.2). The efficiency factor is updated with probability η. The productivity tends to be persistent. Those parents who are good at raising children today are likely to be good at childcare in the future as well. To capture this persistence, ν is assumed to follow a Markov chain approximating an AR(1) process:

$$\nu' = (1-\lambda)\bar{\nu} + \lambda\nu + e \quad \text{where } e \sim N(0, \sigma_e^2) \quad \text{and} \quad \bar{\nu} = E(\nu). \tag{3.2}$$

The unconditional distribution of ν is a Normal distribution with mean, $\bar{\nu}$, and variance, $\sigma_e^2/(1-\lambda^2)$. When the efficiency factor becomes higher, a couple is more likely to prefer having one spouse stay at home to having both spouses work in the market. Also, a couple is more likely to decide to have one more child when having a fertility shock.

3.2.2 Value Functions

An *older* couple's value functions are simpler than a *younger* couple's value functions because an *older* couple makes only labour supply decisions. Also, *older* married individuals are independent from each other in their labour supply decisions, because an *older* couple does not derive utility from home production. Thus, in this section, a *younger* couple's value functions are mainly discussed, while an *older* couple's value functions are presented in Appendix B.

Three types of stochastic events affect a married individual. First, when a married individual $i \in \{f, m\}$ is non-employed, the individual receives a job offer from an employer with probability p_u^i. A job offer is represented by a worker i's match-specific productivity with an employer. Let q_i be the match-specific productivity, which is randomly drawn from a distribution $G(q_i)$. Second, an employed spouse i receives a new job offer with probability p_e^i. A new match-specific productivity q_i' with a new employer is drawn from the distribution G as well. Lastly, job separation happens to an employed spouse with probability δ^i. An employed spouse facing a job separation shock becomes non-employed.

In addition, three stochastic events affect a *younger* couple at the household level. First, a married couple's efficiency factor of home production ν changes with probability η. A new efficiency factor of home production ν' is stochastically determined following a Markov process. Second, a married couple has a fertility choice with probability π and decides whether or not to have one more child. Third, a *younger* couple becomes *older* with probability ϕ. This shock is called a children-aging shock. The fertility shock and the aging shock do not affect a couple in which a married woman is on leave after childbirth.

Time is continuous. In continuous time, only one stochastic event happens at any given time. Before a stochastic event is realized, a couple's value stays the same. Once a shock occurs, a couple updates labour supply and/or fertility decisions.

A *younger* couple makes decisions taking a household employment state, Ω, and a set of state variables $\mathscr{S}$ as given. The household employment state takes one of the four states: neither spouse is employed, U; only a wife is employed, W; only a husband is employed, T; and both a husband and wife are employed, V. A set of state variables $\mathscr{S} = (q^f, q^m, k, l, \nu)$ indicates employed wife's and husband's match-specific productivity with their own current employer, q^f and q^m, the number of children, k, take-up of maternity leave, l, and an efficiency factor of home production, ν. If a spouse is non-employed, his or her q is zero. A value to a couple is denoted as $\Omega(\mathscr{S})$.

The value to a *younger* couple when neither spouse is employed, denoted as U, is defined as follows:

$$\begin{aligned}
U(0,0,k,0,\nu) = & (\beta + p_u^f + p_u^m + \eta + \pi + \phi)^{-1} \\
& \Big\{ 2z - gk + \gamma log(1+k) + Z(g,1,1,k,\nu) \\
& + p_u^f \, \mathbb{E}_{q^f} \Big[\max\{W(q^f,0,k,0,\nu), U(0,0,k,0,\nu)\} \Big] \\
& + p_u^m \, \mathbb{E}_{q^m} \left[\max\{T(0,q^m,k,0,\nu), U(0,0,k,0,\nu)\} \right] \\
& + \eta \, \mathbb{E}_{\nu'|\nu} \left[U(0,0,k,0,\nu') \right] \\
& + \pi \max\{U(0,0,k,0,\nu), U(0,0,k+1,0,\nu)\} \\
& + \phi \, U^o(0,0,0,0,0) \Big\}.
\end{aligned}$$

The second line of the value function shows an instantaneous utility. When neither spouse is employed, both wife's and husband's match-specific productivity with their own current employer are zero. Both spouses spend their time in home production. A wife (a husband) receives a job offer at a job arrival rate of p_u^f (p_u^m), and then she (he) decides whether or not to accept the job offer. When a couple faces a shock to the efficiency factor of home production with probability η, the couple updates the efficiency factor. When a fertility shock happens with probability π, a couple decides whether to have one more child or not. When an aging shock occurs with probability ϕ, all children are grown up and thus the number of children and the efficiency factor of home production become zero. Let U^o be the value function of an *older* couple when neither spouse is employed.

The value to a couple in which only a wife is employed is denoted as W. First, the value to the couple when the wife is not on leave is defined, $l = 0$, as follows:

$$
\begin{aligned}
W(q^f,0,k,0,\nu) = {} & (\beta+\delta^f+p_e^f+p_u^m+\eta+\pi+\phi)^{-1} \\
& \Big\{ w^f(q^f)+z-gk+\gamma log(1+k)+Z(g,0,1,k,\nu) \\
& +\delta^f\, U(0,0,k,0,\nu) \\
& +p_e^f\, \mathbb{E}_{q'^f}\Big[\max\{W(q'^f,0,k,0,\nu),W(q^f,0,k,0,\nu)\}\Big] \\
& +p_u^m\, \mathbb{E}_{q^m}\Big[\max\{V(q^f,q^m,k,0,\nu),T(0,q^m,k,0,\nu),W(q^f,0,k,0,\nu)\}\Big] \\
& +\eta\, \mathbb{E}_{\nu'|\nu}\Big[\max\{W(q^f,0,k,0,\nu'),U(0,0,k,0,\nu')\}\Big] \\
& +\pi\, \max\{W(q^f,0,k,0,\nu),W(q^f,0,k+1,1,\nu),W(q^f,0,k+1,0,\nu), \\
& \qquad U(0,0,k+1,0,\nu)\} \\
& +\phi\, W^o(q^f,0,0,0,0)\Big\}.
\end{aligned}
$$

Let q^f be an employed wife's match-specific productivity with her current employer. Her wage w^f is determined by her productivity q^f. This couple earns the wife's wage and her husband's unemployment benefit z. Only the non-employed husband spends time in home production. If a wife faces a job separation shock, neither spouse is considered to be employed. When she is given a new job offer, she decides whether to accept the offer with match-specific labour productivity q'^f with a new employer. When a non-employed husband receives a job offer, a couple decides whether to have him accept the offer and, if accepting it, whether both spouses work or only the husband works. If a shock increases a couple's efficiency factor of home production, a wife may quit her job to participate in home production. When a couple has a pregnancy opportunity, a couple decides whether to have one more child and, if so, whether the wife will take leave, continue working, or quit. Lastly, a *younger* couple may face an aging shock. Let W^o represent the value to an *older* couple when only a wife is employed.

The value to a couple in which only a husband is employed, denoted as T, is defined in a similar way to the value to a couple in which only a wife is employed and she is not on leave.

Next, the value to a couple with only a wife employed when the wife is *on leave* after childbirth, $l = 1$, is defined as follows:

$$
\begin{aligned}
W(q^f,0,k,1,\nu) = (\beta + p_u^m + \eta + \psi)^{-1} & \\
& \Big\{ \rho \cdot w^f + z - gk + \gamma log(1+k) + Z(g,1,1,k,\nu) \\
& + p_u^m \, \mathbb{E}_{q^m} \Big[\max\{V(q^f,q^m,k,1,\nu), T(0,q^m,k,0,\nu), W(q^f,0,k,1,\nu)\} \Big] \\
& + \eta \, \mathbb{E}_{\nu'|\nu} \Big[\max\{W(q^f,0,k,1,\nu'), W(q^f,0,k,0,\nu'), U(0,0,k,0,\nu')\} \Big] \\
& + \psi \, \max\{W(q^f,0,k,0,\nu), U(0,0,k,0,\nu)\} \Big\}.
\end{aligned}
$$

The couple's income is the sum of a wife's leave benefits ρw^f and her husband's unemployment benefits. When a husband receives a job offer, the couple makes a decision about the couple's employment status. A shock may occur to a couple's efficiency factor of home production. On the one hand, when the shock lowers the efficiency factor, a wife may return to work. On the other hand, when the shock increases the efficiency factor, a wife may quit her job to participate in home production. Lastly, when a wife's leave expires with probability ψ, a couple decides whether a wife returns to her pre-birth job represented by a match-specific labour productivity q^f with her pre-birth employer or whether a wife quits and stays at home to raise children. While a wife is on leave, she does not face a job separation shock and a couple does not face fertility and aging shocks.

Finally, the value to a dual-earner couple is denoted as V. The value to a dual-earner couple when a wife is not on leave, $l = 0$, is defined as follows:

$$
\begin{aligned}
V(q^f,q^m,k,0,\nu) = (\beta + \delta^f + \delta^m + p_e^f + p_e^m + \eta + \pi + \phi)^{-1} & \\
& \Big\{ w^f + w^m - gk + \gamma log(1+k) + Z(g,0,0,k,\nu) \\
& + \delta^f T(0,q^m,k,0,\nu) \\
& + \delta^m W(q^f,0,k,0,\nu) \\
& + p_e^f \, \mathbb{E}_{q'f} \Big[\max\{V(q'^f,q^m,k,0,\nu), V(q^f,q^m,k,0,\nu)\} \Big] \\
& + p_e^m \, \mathbb{E}_{q'm} \Big[\max\{V(q^f,q'^m,k,0,\nu), V(q^f,q^m,k,0,\nu)\} \Big] \\
& + \eta \, \mathbb{E}_{\nu'|\nu} \Big[\max\{V(q^f,q^m,k,0,\nu'), W(q^f,0,k,0,\nu'), T(0,q^m,k,0,\nu')\} \Big] \\
& + \pi \, \max\{V(q^f,q^m,k,0,\nu), V(q^f,q^m,k+1,1,\nu), V(q^f,q^m,k+1,0,\nu), \\
& \quad T(0,q^m,k+1,0,\nu), W(q^f,0,k+1,1,\nu), W(q^f,0,k+1,0,\nu)\} \\
& + \phi \, V^o(q^f,q^m,0,0,0) \Big\}.
\end{aligned}
$$

A couple with both spouses employed earns income and does not produce output from home production. When an employed spouse encounters a job separation shock, the spouse becomes unemployed and the other spouse remains employed. When an employed spouse receives a new job offer, a couple makes an acceptance decision. When a shock to the efficiency factor of home production happens, a couple adjusts its employment status. A couple may remain as a dual-earner couple or switch into a single-earner couple. Neither spouse being employed is dominated by these two cases. When a fertility shock occurs, a couple decides whether to have one more child, which spouse works after childbirth, and whether a wife takes a leave. Lastly, a *younger* couple becomes older with probability ϕ. Let V^o represent the value to an *older* couple when both spouses are employed.

The value to a dual-earner couple when a wife is on leave, $l = 1$, is defined as follows:

$$\begin{aligned} V(q^f, q^m, k, 1, \nu) = (\beta + \delta^m + p_e^m + \eta + \psi)^{-1} \\ \Big\{ \rho \cdot w^f + w^m - gk + \gamma log(1+k) + Z(g, 1, 0, k, \nu) \\ + \delta^m \max\{W(q^f, 0, k, 1, \nu), W(q^f, 0, k, 0, \nu)\} \\ + p_e^m \, \mathbb{E}_{q'^m} \Big[\max\{V(q^f, q'^m, k, 1, \nu), V(q^f, q^m, k, 1, \nu)\} \Big] \\ + \eta \, \mathbb{E}_{\nu'|\nu} \Big[\max\Big\{ \max_{l \in \{1,0\}} V(q^f, q^m, k, l, \nu'), \max_{l \in \{1,0\}} W(q^f, 0, k, l, \nu'), \\ T(0, q^m, k, 0, \nu') \Big\} \Big] \\ + \psi \max\{V(q^f, q^m, k, 0, \nu), T(0, q^m, k, 0, \nu)\} \Big\}. \end{aligned}$$

A wife on leave receives leave benefits replacing her usual income at a rate of ρ, while she stays at home to take care of her children. When her husband is laid off, she has an option to return to work. Also, a husband may receive a new job offer. When a shock occurs to a couple's efficiency factor of home production, a couple updates their employment status. A couple may remain as a dual-earner couple or switch into a single-earner couple. Also, a wife on leave may remain on leave or return to work. When her leave expires with probability ψ, a wife may return to work or quit to raise children.

3.2.3 Wage Determination

In this partial equilibrium economy, a worker's wage is proportional to the worker's match-specific productivity with his or her employer. Particularly, a male worker's wage, w^m, is equal to his match-specific productivity, q^m. However, a female worker's wage, w^f, is lower than her match-specific productivity, q^f, if gender wage discrimination exists in the labour market.

$$w^m(q^m) = q^m \quad \text{and} \quad w^f(q^f) = (1-\omega)q^f,$$

where ω is the degree of gender wage discrimination in the labour market.

3.2.4 Characterization of a Younger Couple's Labour Supply Decisions

Next, I characterize accept/reject decisions made by a *younger* couple who can produce output from home production, and explain interactions between spouses in their decisions. A job offer given to a married individual $i \in \{f, m\}$ is represented by his or her match-specific productivity q^i. A couple's acceptance rule for a job offer given to an employed worker is simple in this model. An offer is accepted and a worker switches his or her job if and only if a new offer brings a new match-specific productivity higher than the current job. Thus, in this subsection, I mainly discuss a *young* couple's acceptance decisions when a non-employed spouse receives a job offer.

Reservation productivity summarizes a married couple's acceptance decision rules when a job offer arrives. A non-employed spouse accepts a job offer if and only if the match-specific productivity of the job offer is higher than his or her reservation productivity. Without gender wage discrimination, reservation productivity is the same as reservation wages. For this part of the analysis, I assume no gender wage discrimination in the labour market and use reservation productivity and reservation wage interchangeably.

Let us start with defining notation used in the reservation productivity characterization. Let $R^i_\Omega(\mathscr{S})$ be the reservation productivity of a spouse $i \in \{f, m\}$ in a *younger* couple, which has a vector of state variables $\mathscr{S}$ and a value in status quo equal to $\Omega(\mathscr{S})$, where Ω represents a couple's value function in their current employment status ($\Omega \in \{U, W, T, V\}$).

A. Couple with Neither Spouse Employed. For a couple with neither spouse employed, a married individual's reservation wage is a function of the number of children and the couple's efficiency factor of home production. A couple will accept an offer if the value from acceptance is greater than the value from rejection. The reservation productivity is determined by these equations:

$$R^f_U(0,0,k,0,\nu) : W(R^f_U, 0, k, 0, \nu) = U(0,0,k,0,\nu)$$
$$R^m_U(0,0,k,0,\nu) : T(0, R^m_U, k, 0, \nu) = U(0,0,k,0,\nu).$$

The reservation productivity increases as a couple has more children and as a couple's efficiency factor of home production increases.

B. Couple with Only One Spouse Employed. The reservation productivity of a non-employed married individual when only his or her spouse is employed shows interesting interdependence between a husband and wife in their labour supply decisions. This interdependence is a distinguishing feature of a household search model, compared to an individual search model. To address the interdependence, let us consider a married couple in which only a husband is employed and his match-specific productivity is q^m. This couple's current value is represented by $T(0,q^m,k,0,\nu)$. When his wife receives a job offer bringing a new draw of match-specific productivity, q^f, they make an acceptance decision. The wife will accept the job offer if and only if acceptance results in a higher value to the couple than rejection does. When the wife accepts the offer, the couple chooses either for both spouses to work or for only the wife to work while her husband quits his job to raise their children. When only a husband works in the labour market, his non-employed wife accepts a job offer given to her if and only if

$$V(q^f,q^m,k,0,\nu) > T(0,q^m,k,0,\nu) \quad \text{or} \quad W(q^f,0,k,0,\nu) > T(0,q^m,k,0,\nu).$$

Thus, the reservation productivity is defined as follows:

$$R_T^f(0,q^m,k,0,\nu) : \max\{V(R_T^f,q^m,k,0,\nu),\ W(R_T^f,0,k,0,\nu)\} = T(0,q^m,k,0,\nu). \tag{3.3}$$

If the match-specific productivity of a job offer given to a wife, q^f, is so low as to satisfy $T(0,q^m,k,0,\nu) > \max\{V(q^f,q^m,k,0,\nu),\ W(q^f,0,k,0,\nu)\}$, then the wife rejects the offer and the couple remains in the status quo.

I define $r_V^f(0,q^m,k,0,\nu)$ as the lowest productivity of a new offer given to a non-employed wife at which a couple weakly prefers both spouses working to rejecting the offer, satisfying

$$V(r_V^f,\ q^m,k,0,\nu) = T(0,q^m,k,0,\nu). \tag{3.4}$$

Similarly, $r_W^f(0,q^m,k,0,\nu)$ is defined as the lowest productivity of an offer given to a non-employed wife at which a couple weakly prefers only the wife working to rejecting the offer, satisfying

$$W(r_W^f,0,k,0,\nu) = T(0,q^m,k,0,\nu). \tag{3.5}$$

The reservation productivity of a non-employed wife when only her husband is employed,

$R_T^f(0, q^m, k, 0, \nu)$, can be defined as

$$R_T^f(0, q^m, k, 0, \nu) = \min\{r_V^f(0, q^m, k, 0, \nu),\ r_W^f(0, q^m, k, 0, \nu)\}, \tag{3.6}$$

as well. This reservation productivity of a non-employed wife depends on her husband's productivity as well as the number of children and the couple's home production productivity.

Proposition 3.1 *There exists a threshold of an employed husband's productivity* $\bar{q}^m(k, 0, \nu)$ *such that 1) if an employed husband's productivity* $q^m <$ *the threshold* $\bar{q}^m$*, then* $V(q^f, q^m, k, 0, \nu) < W(q^f, 0, k, 0, \nu)$*,* $\forall q^f$*; and 2) if* $q^m > \bar{q}^m$*, then* $V(q^f, q^m, k, 0, \nu) > W(q^f, 0, k, 0, \nu)$*,* $\forall q^f$*.*

Proof Given the number of children k, the leave status l, and home production productivity ν, the value $W(q^f, 0, k, 0, \nu)$ is constant in q^m and the value $V(q^f, q^m, k, 0, \nu)$ is strictly increasing in q^m. Therefore, there exists the unique threshold satisfying the property.

In words, if an employed husband's match-specific productivity q^m is greater than the threshold $\bar{q}^m$, the couple prefers both spouses working to only the wife working and her husband quitting. However, when his productivity q^m is lower than the threshold $\bar{q}^m$, the couple prefers only the wife working to both spouses working and giving up home production.

Corollary 3.1 *There exists a threshold of an employed husband's productivity* $\bar{q}^m(k, 0, \nu)$ *such that 1) if* $q^m < \bar{q}^m$*, then* $R_T^f = r_W^f$*, which satisfies* $W(r_V^f, 0, k, 0, \nu) = T(0, q^m, k, 0, \nu)$*; and 2) if* $q^m > \bar{q}^m$*, then* $R_T^f = r_V^f$*, which satisfies* $V(r_V^f, q^m, k, 0, \nu) = T(0, q^m, k, 0, \nu)$*.*

Proof Directly from the definition of equations (2), (3), (4), and (5).

The solid line in Figure 3.1 is the reservation productivity of a wife in a couple in which only her husband is employed when the husband and the wife are equally productive in home production (θ=0.5), given the number of children k and the efficiency factor of home production, ν. A husband would accept a job offer given to him in the first place only when match-specific productivity q^m of the offer is greater than his reservation productivity when neither spouse is employed, R_U^m.

In the area (b) where an employed husband's productivity is greater than the threshold $\bar{q}^m$, the couple have dual earners if the wife accepts a job offer. In this area, a wife's reservation productivity is flat. However, when a husband's productivity at work has a value between R_U^m and the threshold $\bar{q}^m$, which happens in the area (a), the wife's reservation productivity is not flat any more. It is strictly increasing in her husband's productivity. In this case, the wife who accepts a job offer given to her becomes the breadwinner in the couple. This shift of a breadwinner in a household is the noteworthy interaction in the area (a).

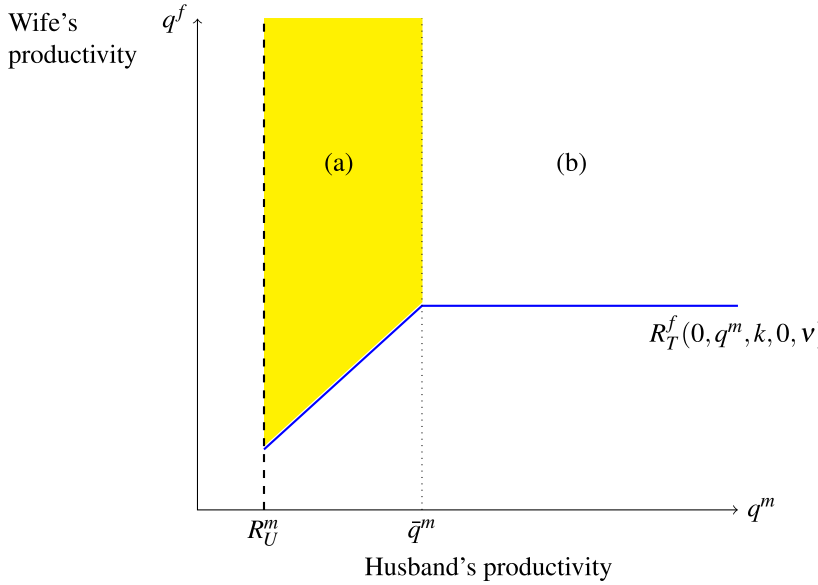


Figure 3.1: Reservation productivity of a wife when only her husband is employed (θ=0.5)

The same explanation is applied to the reservation productivity of a husband when only his wife is employed. For a couple with only a wife employed, her husband's reservation wage is similarly determined:

$$R^m_W(q^f,0,k,l,\nu) : \max\{V(q^f,R^m_W,k,l,\nu),\ T(0,R^m_W,k,0,\nu)\} = W(q^f,0,k,l,\nu).$$

However, the non-employed husband's reservation wage also depends on whether his employed wife is on leave ($l=1$) or not ($l=0$).

3.2.5 Comparison to an Individual Search Framework

I compare my household search model including home production and endogenous fertility choice to individual search models which lack the concept of a married couple. I mainly discuss an individual search model corresponding to Erosa et al. (2010). Let the economy be populated by two types of married individuals: females f and males m. In this economy, only females have children, gain utility from having children, and produce output from home production. Females face stochastic shocks to their efficiency factor of home production. Males make only labour supply decisions.

A married individual $i \in \{f,m\}$ is either employed or non-employed. A non-employed individual receives unemployment benefit z. Also, a job offer arrives to the individual with probability p^i_u. After observing match-specific productivity q^i of the offer, the individual makes an acceptance decision. An employed individual earns wages. The employed individual receives a new job offer with probability p_e^i. In addition, an employed worker faces a job separation shock with probability δ and becomes non-employed. When a female with children is not employed, she spends her time raising her children at home. Her home production technology is summarized by the function $Z(k,g,h_f,\nu) = \nu(kg)^{\alpha}(\theta h_f)^{1-\alpha}$.

In this individual search model, the two types of married individuals independently make their labour supply decisions. A non-employed male's reservation productivity depends only on the amount of unemployment benefits z, because he does not have an outside option of home production. A non-employed mother's reservation productivity depends on the number of her children and her home production productivity.

I call a pair of one married male and one married female a couple, even though they do not share their labour incomes, to compare this couple's decisions to a couple's decisions in a household search framework. The reservation productivity of a married individual does not depend on his or her spouse's employment status or productivity. For a couple in which only a husband is employed, when the wife accepts a job offer, both members always work. A shift of a breadwinner from a husband to the wife does not exist in this individual search model. The reservation productivity of a non-employed wife $R^f(k,0,\nu)$ satisfies the following condition which is written in terms of the value functions in my household search model:

$$V(R^f, q^m, k, 0, \nu) = T(0, q^m, k, 0, \nu).$$

Because a wife's reservation productivity does not depend on the husband's employment status in the individual search model, the reservation productivity $R^f(k,0,\nu)$ also satisfies

$$W(R^f, 0, k, 0, \nu) = U(0, 0, k, 0, \nu).$$

In an individual search model, a married person's reservation productivity is flat against his or her spouse's productivity, whereas it is not flat in a household search model. This contrast is shown in Figure 3.2. A solid line is a wife's reservation productivity and a dashed line is her husband's reservation productivity when only his spouse is employed. This contrast between a household search model and a individual search model is similar to that in Guler et al. (2012). In particular, reservation wage functions for my model look very similar to the case with the constant absolute risk aversion (CARA) utility in their paper.

Another individual search model which can be used to study married women's labour supply decisions is the model where married women take their husband's employment status and income as exogenously given. In this model, a married woman's reservation productivity is positively related to her husband's income through an income effect. However, his employment status does not respond to his wife's decisions, because a husband's employment status

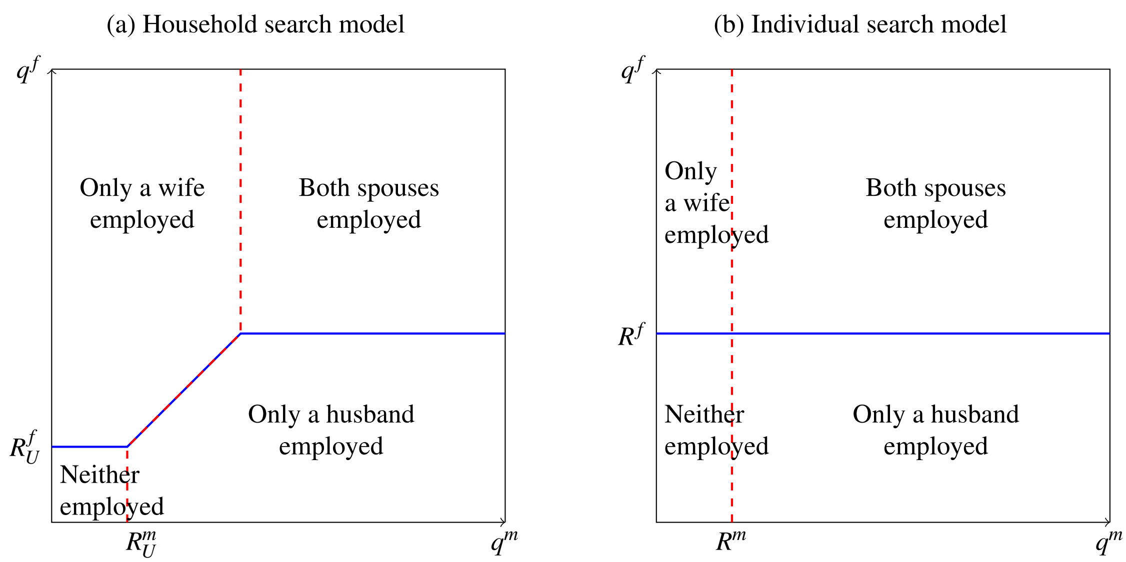


Figure 3.2: Household search model vs. Individual search model

and income may be fixed or exogenously change. This individual search model cannot describe the reciprocal effect of the wife's decisions on her husband's employment status.

3.3 Numerical Analysis

In this section, I parameterize the household search model described in the previous section to numerically characterize the model. Within the parameterized model, I discuss the role of wife's relative advantageousness in home production, θ, in a married couple's labour supply decisions, especially reservation productivities.

3.3.1 Parameterization

In this analysis, a unit of time is a month. Table 3.2 displays the parameter values used to characterize the model. Some parameter values are borrowed from previous studies. Job arrival rates and job separation rates are the estimates for married couples with children under 18 in a household search model in Flabbi and Mabli (2018). That model does not include home production but does have leisure. Labour decisions affected by home production in my model are explained by their estimated parameters of preference for leisure. Thus, using their estimates for the labour shock parameters for my numerical exercise seems reasonable. The elasticity of substitution between the wife's and the husband's time at home, ζ, is borrowed from Knowles (2013).

The contribution of market goods to home production α is set to 0.4, which is close to

Table 3.2: Parameterized Parameters

Parameter	Description	Values
γ	Preference for having children	1
β	Discount factor	0.997
z	Unemployment benefit	0.7
g	Goods cost of raising one child	0.5
Home production : $Z(g,h_f,h_m,k,v) = v(k\cdot g)^{\alpha}[\theta\cdot h_f^{\zeta}+(1-\theta)\cdot h_m^{\zeta}]^{\frac{1-\alpha}{\zeta}}$		
α	The contribution of market goods to home production	0.4
ζ	The elasticity of substitution between the wife's and husband's time at home	2/3
θ	Wife's relative productivity in home production	0.5 or 0.55
v	$v' = (1-\lambda)\bar{v}+\lambda v+e$ where $e\sim N(0,\sigma_e^2)$ $v\in[1,2]$, λ = 0.7 , $\bar{v}$ = 1.5 , σ_e = 0.12	
Shocks		
p_u^f, p_u^m	Job arrival rate when unemployed	0.2991,0.3032
p_e^f, p_e^m	Job arrival rate when employed	0.1556,0.1627
δ^f, δ^m	Exogenous job destruction rate	0.0211, 0.262
η	Probability of a home production productivity shock	1/12
π	Probability of a fertility shock	1/48
ϕ	Probability of a children-aging shock	1/300
$G(q)$	Distribution of match-specific productivity Bounded support [1, 2], N(0.35, 1/10) to set the mean at 1.42	lognormal
ω	Gender wage discrimination	0 or 0.12

the calibrated parameter for the contribution of market goods to child development production of 0.38 in Caucutt, Guner, and Knowles (2002). The parameter for parents' preference for children, γ, is set to one, which is less than the calibrated value 1.26 in Erosa et al. (2010). In my model, home production explains some of the part explained by parents' utility from children in their model.

The discount factor, β, is set equivalent to an annual discount rate of 4%. The probability of a home production productivity shock, η, is chosen to deliver an annual shock, on average. The probability of children becoming grown up, ϕ, is set to reproduce, on average, 25 years of raising children. The probability of a fertility shock, π, is selected to make couples have a pregnancy opportunity on average in four-year-long intervals.

The distribution of match-specific productivity, $G(q)$, to be assumed as a lognormal distribution with the support of the distribution normalized to the bounded interval $[1,2]$. The standard deviation of the distribution is set to $1/10$ while the mean of the match-specific productivity is set to 1.42. The unemployment benefit, z, is set to 0.7, which is equivalent to 50% of the mean of the match-specific productivity distribution. The goods cost for one child, g, is selected to be 0.5, which is equivalent to 35% of the mean of the match-specific productivity distribution.

The model is solved on a discrete grid of productivities. I use value function iterations to find a fixed point. To compute the stationary equilibrium, the model is simulated with the parameterized values in Table 3.2. Each couple starts as a couple with neither spouse employed, with no children, and with their efficiency factor of home production, v, randomly drawn from the unconditional distribution. A job offer stochastically arrives to either a wife or a husband. Then, the couple makes an acceptance decision. When accepting the offer(s), the couple updates their employment status and an employed spouse's match-specific productivity in the job.

All the shocks in this model follow Poisson processes. An event history for each couple is generated by pseudo-random number generators from exponential distributions. Each exponential distribution has probability of one possible stochastic event as the parameter of the distribution. A random number generated from an exponential distribution for a stochastic event is the length of time passed before the stochastic event occurs. Once a set of lengths of time passed for all possible stochastic events at a moment is generated, the event with the shortest time passed is the shock that affects a couple. After the shock is realized, a couple makes decisions and updates their state variables. This procedure is repeated to generate a simulated history for a couple until the couple retires. Once a *younger* becomes *older*, then the *older* couple faces a retirement shock. Retirement makes the couple have no income any longer and thus no utility, the *older* couple is replaced with a new *younger* couple with neither spouse employed, with no children, and with its initial efficiency factor of home production randomly drawn. This replacement keeps the sample size unchanged. I simulate event histories long enough for the economy to reach the stationary equilibrium.

One advantage of a household search framework over an individual search framework in studying married couples' decisions is that a household search framework is able to generate the employment patterns of couples as a result of interactions between a husband and wife in their labour supply decisions. An individual search model where married males and married females independently make decisions can identify a married individual's employment state. However, the model cannot distinguish a married couple's employment status, such as both spouses employed, only the wife employed, only the husband employed, or neither spouse employed. In the following quantitative exercises, I show the employment patterns of the couples, as well as the employment-to-population ratios.

Table 3.3: Statistics for *younger* Couples in the Economy with Three Month Unpaid Leave

	Benchmark ψ=1/3, ρ=0 θ=0.55, ω=0	**U.S. Data** (2011) -	**Model II** ψ=1/3, ρ=0 θ=0.5, ω=0	**Model III** ψ=1/3, ρ=0 θ=0.5, ω=0.12
Fertility rate (%)	1.5	2.1	1.5	1.6
Employment patterns (%)				
Both spouses employed	54.3	57.5	62.0	35.1
Only husband employed	34.3	30.5	20.4	52.6
Only wife employed	9.7	7.6	16.1	9.8
Neither spouse employed	1.7	4.5	1.5	2.6
Employment/Population ratio (%)				
Male	88.6	88.0	82.4	87.7
Female	63.9	65.1	78.1	44.8

3.3.2 Results for a Benchmark Economy

The parameterized model with the parameter values in Table 3.2 can generate similar patterns to married couples' employment patterns in the United States when the wife's relative productivity in home production θ is set to 0.55. Table 3.3 presents the employment statistics for *younger* couples from the parameterized model and those from U.S. Current Population Survey in 2011. The employment patterns of married couples with children at home simulated from the parameterized model are similar to the data. However, the model generates a lower fertility rate than in the data.

In this model, asymmetry between a wife and a husband is allowed in several ways. First, a wife and a husband encounter labour shocks with different probability ($p_e^m \neq p_e^f$, $p_u^m \neq p_u^f$, $\delta_e^m \neq \delta_e^f$). Second, a husband and a wife may not be equally productive in home production ($\theta \neq 1/2$). Lastly, even though married individuals have identical match-specific productivity in the labour market, a wife may be paid less than is a husband in the labour market because of gender wage discrimination ($\omega > 0$).

When $\theta = 1/2$ (Model II), the employment patterns of married couples are not consistent with the data. The percentage of couples with only the wife employed is relatively similar to that of couples with only the husband employed. Also, the percentage of couples with both spouses employed is higher. In Model III, I consider gender wage discrimination and assume that women are paid 12% less. For younger individuals, women's earnings is about 90 percent of men's earnings after controlling hours and weeks (Goldin, 2014). In this case, the fraction of dual-earner couples is much lower than in the data. Therefore, I view the asymmetry in the employment patterns of single-earner couples in the benchmark economy as the main contributor to the asymmetry between the two spouses in home production in this model.

Table 3.4: Simulation Results for *younger* Couples by Number of Children

	The number of children					All
	None	One	Two	Three	Four+	couples
MODEL (Benchmark)						
Percentages of couples	13.8	26.7	53.1	5.2	-	100
Employment patterns (%)						
Both spouses employed	78.1	77.1	40.7	16.4	-	54.3
Only husband employed	11.1	13.4	47.0	67.7	-	34.3
Only wife employed	10.4	8.0	10.1	11.2	-	9.7
Neither spouse employed	0.4	0.9	2.2	4.6	-	1.7
Employment/Population ratio (%)						
Female	88.5	85.7	50.8	27.6	-	63.9
DATA (United States, 2011)*						
Employment patterns (%)						
Both spouses employed	-	61.1	59.8	50.1	37.9	57.5
Only husband employed	-	25.6	29.5	37.7	51.1	30.5
Only wife employed	-	9.0	6.5	7.3	5.3	7.6
Neither spouse employed	-	4.4	4.1	4.9	5.7	4.5
Employment/Population ratio (%)						
Female	-	70.1	66.4	57.4	43.2	65.1

* Census, "Table FG1. Married Couple Family Groups, by labour Force Status of Both Spouses, and Race and Hispanic Origin/1 of the Reference Person: 2011." In this table, couples without children under the age of 18 includes the couples which are categorized under *older* couples. Thus, the statistics of the couples with no children under age 18 is not reported in this table.

Table 3.4 shows the employment patterns of married couples conditional on the number of children. The model predicts that as a married couple has more children, the female employment-to-population ratio falls. Even though the ratios more rapidly fall in the model, this pattern can be also found in the data.

In the model, most *younger* couples without children have dual earners. Because the couples have no children to care for, the percentages of the single-earner couples with only the husband employed and with only the wife employed are similar. When couples have children, the gap between the measures of the single-earner couples grows.

Couples with two children are more likely to prefer one spouse staying at home to produce output from home production. The percentage of these couples with only a husband employed increased dramatically, compared to couples with one child. More couples choose to have a wife who is relatively advantageous in home production, stay at home. However, the percentage of couples with only the wife employed also increases. That is, fathers are also more likely to stay at home. This pattern becomes stronger among couples with three children.

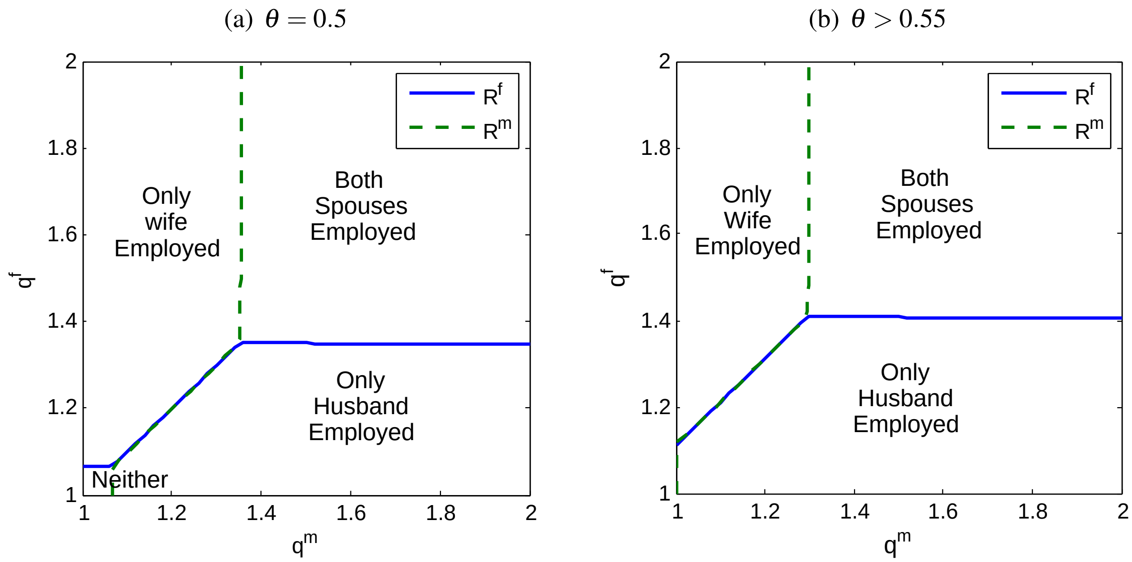


Figure 3.3: Relative Home Productivity and Reservation Market Productivity

3.3.3 Asymmetry Between a Wife and a Husband in Home Production

I compare the reservation productivities of married individuals when only the probability of labour shocks is asymmetrical to the reservation productivities when relative home productivity is asymmetrical as well. For this part of the analysis, I assume no gender wage discrimination in the labour market ($\omega = 0$) to focus on the effect of the relative productivity in home production. Also, I assume no parental leave given to a mother.

Figure 3.3 shows that the reservation productivity of non-employed spouses for two values of relative home productivity between a husband and wife. The graph on the left side is the reservation productivity when a husband and the wife are equally productive in home production. That is, when $\theta = 0.5$. The differences between the husband's and the wife's reservation productivity is driven solely by the gender differences in labour shocks. The left graph suggests that the two spouses' labour supply decision rules are almost identical. Thus, if the parameter $\theta = 1/2$, the percentage of couples with the wife as breadwinner is not very different from that of couples with the husband as breadwinner.

However, the graph on the right side is the reservation productivity when a wife is advantageous in home production relative to her husband, in addition to the differences in probability of labour shocks. For the graph, the parameter θ is set to 0.55. This graph indicates that the wife's reservation productivity is higher and at the same time the husband's reservation productivity is lower than in the left graph. This change in reservation productivities is due to the asymmetry between a husband and a wife in home productivity. The change implies that when $\theta > 1/2$, married women may not accept job offers that they may accept when $\theta = 1/2$. At the

Table 3.5: Simulated Statistics across the Generosity of Parental Leave Policies

	None ψ=1 ρ=0.00 (1)	**Unpaid** ψ=1/3 ρ=0.00 (2)	**Paid 1** ψ=1/3 ρ=0.55 (3)	**Paid 2** ψ=1/12 ρ=0.55 (4)	**Paid 3** ψ=1/12 ρ=0.80 (5)
Fertility rates	1.5	1.5	1.8	1.9	2.5
Employment patterns (%)					
Both spouses employed	54.7	54.3	48.8	46.5	32.3
Only husband employed	34.3	34.3	38.1	39.5	46.1
Only wife employed	9.1	9.7	10.9	11.9	18.9
Neither spouse employed	1.9	1.7	2.1	2.1	2.7
Employment/Population ratio (%)					
Male	89.0	88.6	86.9	86.0	78.4
Female	63.8	63.9	59.8	58.4	51.1
On leave	0	0	0.8	2.8	12.3
At work	63.8	63.9	59.0	55.6	38.3

same time, their husbands are more likely to accept job offers that they may not accept when $\theta = 1/2$. Through this intra-household interaction due to the asymmetry in home productivity, a wife may quit her job to raise her children even if the productivity of her job is higher than that of her husband's job. This intra-household interaction is unique in the household search framework featuring home production. In my model, this situation is explicitly caused by married individual's difference in home production, while household search models without home production explain that this situation is implied by a wife's stronger preference for leisure than her husband.

3.4 Policy Experiments

The generosity of parental leave policies is represented by the length and the labour income replacement rate of statutory parental leave. In this model, an exogenous leave expiration shock with probability ψ determines the average length of a parental leave to $1/\psi$ months. The labour income replacement rate is denoted as ρ. I simulate the model by changing the two parameters for the generosity of parental leave policies, ψ and ρ, while keeping other parameters the same as in the benchmark economy.

Column (2) in Table 3.5 presents the results from the benchmark economy with an unpaid three-month leave, which is the mandatory child-related leave policy in the United States at the federal level. Column (1) shows that results from the simulation of the economy with no maternity leave are the same as when 3 months of unpaid maternity leave are available. It suggests that a short unpaid leave barely influences married couples' fertility and labour supply decisions. In the United States, the total fertility rates barley changed between 1992 and 1994.[7] Columns (3) and (4) shows the statistics from the simulation of the economy with a paid three-month leave and twelve-month leave replacing 55 percent of usual salary ($\rho = 0.55$), respectively. Column (4) mimics the statutory child-related leave policy in Canada except Quebec at the federal level. The fertility rate increases as the parental leave policy is more generous. When a couple is hit by a fertility shock, some couples with the wives employed decide to have another child and take the leave after childbirth. One noticeable change in the employment patterns of married couples with children under the age of 18 is the increase in the percentage of couples with only the wives employed. As parental leave partially replaces a leave-taker's usual salary, a couple with the wife as a breadwinner is more likely sustainable.

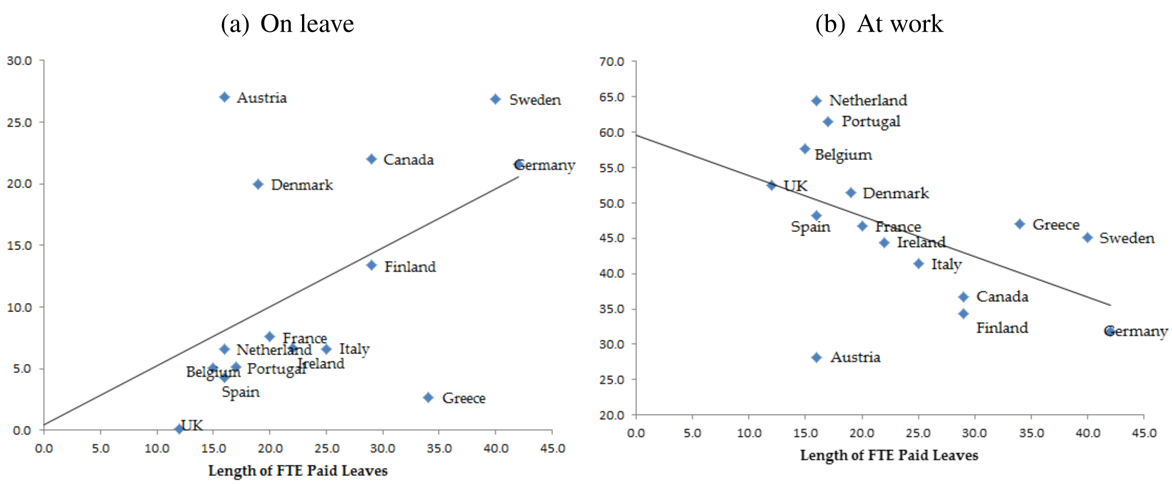
However, the employment-to-population ratio of married females falls in the economy with the Canadian type of paid parental leaves. This fall is driven by the increase in the fertility rate. As a married couple, on average, has more children by taking a leave after childbirth, the couple is able to produce more output from home production. Because the wife's relative productivity in home production θ is assumed greater than one half, the wife has higher reservation productivity and eventually she is less likely to return to pre-birth jobs. In addition, as more mothers take leaves after childbirths, the rate of married females at work decreases.

The last column contains the statistics from the simulation with the policy parameters ψ = 1/12 and ρ = 0.80. This income replacement rate mimics the generosity of parental leaves given to mothers in Sweden.[8] As parental leave benefits replace 80 percent of a mother's usual salary, more couples prefer having another child and thus the fertility rate increases. This increase lowers the percentage of dual-earner couples. As a couple has more children, on average, a couple is more likely to have a single earner and have the other spouse at home. Also, a higher percentage of couples designate the wives as breadwinners.

In the comparisons of employment-to-population ratios across the three types of parental leaves, the ratios of both married males and females fall. This fall is because couples in the model economy with a more generous parental leave policy tend to have more children and prefer to produce output from home production. In these employment ratios, the workers on leave are also counted as employed. When the person on leave and the person at work are distinguished, a higher percentage of married females is on leave and thus a lower percentage of them are at work in an economy with a more generous leave policy. The lower rates of married females at work in the model with more generous parental leaves are consistent with the data in Figure 3.4.

[7] World Bank, Fertility Rate, Total for the United States [SPDYNTFRTINUSA], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/SPDYNTFRTINUSA, June 4, 2018

[8] This exercise does not cover a non-transferable parental leave for fathers in Sweden.



Sources: Length of Full-Time Equivalence (FTE) paid leaves from Ray, Gornick, and Schmitt (2009) and the maternal rates from OECD Family database (2008).

Figure 3.4: Fraction of Mothers with Children under Age 3 on Leave and at Work

The right graph in the figure shows that the maternal rate at work is negatively related to the length of Full-Time Equivalent (FTE) paid leaves. The length of FTE paid leaves is a measure of the generosity of paid leaves. This measure is calculated by combining the length and the labour income replacement rate of paid leaves. For example, one-year leave replacing 50 percent of a pre-birth salary is equivalent to half-year FTE paid leaves. The left graph in Figure 4 shows the positive relationship between the rates of mothers on leave and the generosity of paid parental leaves from cross-country comparisons.

3.5 Conclusion

To investigate the effects of the generosity of child-related leave policies on married couples' fertility and labour supply decisions, I build a household search model that includes home production and endogenous fertility choice. The interactions between a husband and wife in their decisions suggest that, when home productivity is asymmetric between a husband and wife, the wife with match-specific productivity higher than the husband may quit for child-care at home. Policy experiments suggest that more generous parental leave policies help more married couples to have more children, whereas married women become more likely to specialize in home production.

This paper provides a framework in which the social welfare for child-related leave policies can be analyzed. Erosa et al. (2010) concluded losses in social welfare as the improvement in females' welfare is surpassed by welfare losses among males. The losses of males' welfare comes from paying taxes for leave benefits without sharing the benefits, and from having lower job arrival rates as more women participate in the labour market. In my household search model, a husband and wife share the value from home production as well as utility from children and their incomes. A paid parental leave policy affects a wife's labour supply decisions, and the wife's decisions may make her husband choose to stay at home as his optimal decision.

However, my model has a few limitations. First, the labour choice and time allocation are quite simplified. In the model, a married individual chooses to be either employed or non-employed. An employed individual is assumed not to spend time in home production. However, in time use data, full-time workers also spend time in home production. Some married women choose part-time jobs to spend more time in home production while being employed. Moreover, in this model, non-participation and unemployment are categorized under the one classification "non-employment." It would be useful to include part-time employment or divide labour states into three states so that the model would give additional implications about participation and work hours decisions.

Second, I assume all employed mothers are eligible for maternity leave and apply this model to mimic the U.S. economy with maternity leave under the FMLA. In Chapter 2, I documented eligibility criteria for FMLA leave and showed that not all mothers met the eligibility criteria. Because only eligible workers can use an extended parental leave policy in reality, my policy experiment results may overstate the aggregate impact of an extended paid parental leave policy on employment and fertility rates. This study would be more relevant to high-educated people who show higher eligibility rates.

Also, my model does not include human capital accumulation. Human capital accumulation is related to parental leaves in two ways. First, while a worker is on leave, the worker's human capital may depreciate or stagnate. Human capital depreciation is one reason employers prefer to provide a shorter leave. Second, when a worker quits, the worker loses the firm-specific or the job-specific human capital. This loss may lead to a wage loss in a new job because the worker needs to start over in accumulating job-specific human capital in a new job. If my model is extended to include human capital accumulation, which makes wages grow, married women may be more likely to choose to return when their leaves expire. This would be especially the case if a married woman has already accumulated a non-trivial amount of human capital.

My model can be extended to investigate the effects of "daddy leave" in Sweden and Iceland on married couples. In this paper, I assume that only employed females are entitled to child-related leaves. In most countries, fathers' take up rate is very low. In Sweden, Iceland, and Quebec, a non-transferable paid child-related leave is given to a father with a newborn child to enhance gender equality both at work and at home. As this daddy leave is based on a "take-it-or-lose-it" policy, about 85 to 90 percent of Swedish and Icelandic fathers take parental leave. Patnaik (2016) found that in Quebec, which has a new paternity-leave quota, fathers are more involved in child-care and housework after the reform.

In addition, another interesting topic related to parental leave is to study the firms' responses to the generosity of statutory parental leave policies. If leave benefits should be paid by employers, then more generous parental leave policies make the employers bear a higher cost. Even if the benefits are funded by the taxes that employees pay, the provision of parental leaves for employees requires the costs of hiring and training temporary workers. To avoid these costs, employers may reduce demand for female workers. Moreover, to pass the costs on to employees, employers may lower wages offered to female workers. To evaluate the effects of parental leaves on social welfare, it would be useful to study the firm side as well.

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Chapter 4

Why Don't Married Men Take Parental Leave?

4.1 Introduction

Paid parental leave, including maternity and paternity leave, is a family policy that helps working parents care for a newborn or newly adopted child by guaranteeing their return to the pre-birth job and providing financial support. In Canada, outside of Québec, paid parental leave is available to employed parents through the federal program Employment Insurance (EI). In addition to 17 weeks of maternity leave only for mothers who gave birth, 35 weeks of paid parental leave can be shared between a mother and a father as long as eligibility criteria are met. The intended purpose of shareable parental leave is to help working parents spend more time with their children for successful child development (Speech from the Throne, 1999; Cools, Fiva, and Kirkebøen, 2015) and to provide fathers the option to share more of the responsibilities of caring for babies (Human Resources and Skills Development Canada, 2005). Also, it may lead to more involvement of fathers in the future (Kotsadam and Finseraas, 2011).

The take-up of parental leave by fathers has two potential benefits. First, a father's take-up has positive effects on child development by allowing the child to spend extensive time with the father (Addati, Cassirer, and Gilchrist, 2014). The second benefit of a father taking up parental leave is to improve his wife's position in her career. While a father on leave looks after his child at home, his wife may return to work earlier and reduce the duration of her career interruption (Pylkkänen and Smith, 2003).[1]

[1] A mother and father cannot receive parental benefits under EI at the same time. However, it is possible that a mother is on maternity leave receiving EI maternity benefits and at the same time a father is on parental leave receiving EI parental benefits. In this case, when a mother uses up 17 weeks of maternity leave, a couple may choose for the husband to return to work, while the wife takes parental leave. Alternatively, a couple may choose for the wife to return to work while the husband continues on parental leave.

Despite its positive effects on child development and career development of married women, many married couples choose to only have the wife take up the parental leave. In Canada excluding Québec, the take-up rate of eligible married fathers remains low at 13%, whereas that of eligible married mothers is 91% [Employment Insurance Coverage Survey (EICS), 2004–2011].[2] In Québec, which has provided five weeks of paternity leave to fathers since 2006, 84% of married fathers used paternity and/or parental leave in 2011 (Moss, 2015). In this paper, I examine why many fathers do not use paid parental leave in the rest of Canada.

Most research about parental leave focuses on leaves specific either to a mother or a father. One strand of research studies the effects of mothers' use of parental leave, including maternity leave, on child outcomes, mothers' labour market outcomes, and social welfare.[3] These studies abstract from fathers' use of parental leave. Recently, others have focused on the effects of the introduction of paternity leave (Dahl, Løken, and Mogstad, 2014, Ekberg, Eriksson, and Friebel, 2013, Rege and Solli, 2013, Patnaik, 2016). Ekerberg et al. (2013) and Patnaik (2016) investigate empirically the effects of the introduction of paternity leave on the intra-household division of labour in the short run in Sweden and Québec, respectively. I add to this literature by taking into account parental leave that is not specific to mothers nor fathers and studying how a husband and wife divide parental leave. My study helps to understand why shareable parental leave has not been effective in raising fathers' participation in parental leave.

Some studies suggest reasons for a gender difference in the take-up behaviour of parental leave. Using the General Social Survey in Canada, Beaupré and Cloutier (2007) document that financial reasons and working conditions are important factors affecting parents' take-up decisions. Using the Employment Insurance Coverage Survey in Canada, Marshall (2008) finds that fathers are more likely to use parental leave if their wives have the same or higher earnings and if their wives do not claim parental leave. Using data from Sweden, Albrecht, Edin, Sundstrom, and Vroman (1999) find that the negative effect of career interruptions due to parental leave on subsequent wages is four times greater for men than for women. To date, the literature has not yet quantified the role of multiple factors in married couples' take-up decisions within a unified life-cycle framework.

As possible explanations for the division of paid parental leave within married couples, I consider gender differences in wages upon entry into the labour market, wage growth processes, wage penalties for time off from work, preferences for leisure, and relative productivities in home production. The labour market and home productivities determine whether the husband or wife has a comparative advantage in either market or non-market activities as in a

[2]For women, parental leave includes maternity leave.

[3]Ruhm (1998), Sakiko (2005), Baker and Milligan (2008), Lalive and Zweimüller (2009), Schönberg and Ludsteck (2014), Erosa, Fuster, and Restuccia (2010), Lalive et al. (2014), Asai (2015), Carneiro, Løken, and Salvanes (2015), Geyer, Haan, and Wrohlich (2015), Thomas (2015)

Beckerian model of the allocation of time (Becker, 1965, 1981). I provide empirical evidence for these possible reasons and disentangle the role of these factors in a life-cycle model of family labour supply.

My model has two key features. First, a husband and wife jointly allocate their time across labour supply, leisure, and home production. As in Knowles (2013), I consider joint labour supply with home production and exploit time allocations for the calibration. Whereas Knowles focuses on the importance of intra-household bargaining in marriage-divorce decisions, I let married couples have unitary utility and a life-long marriage. The second key feature is that human capital stochastically evolves via a learning-by-doing process. Hours of work in the market in a period determine current earnings and the evolution of human capital. As in Guner, Kaygusuz, and Ventura (2014), a husband and wife jointly decide their labour supply at the extensive and intensive margins, and the wife's labour market productivity endogenously evolves. My model is distinguished from Guner et al. (2014) in that a husband's labour productivity endogenously evolves as well.[4] When a child is born, a married couple makes decisions taking into account the gender differences I consider.

I calibrate the model with Canadian data by minimizing the distance between simulated and data moments. The baseline parental leave policy in the model mimics Canadian parental leave policy at the federal level under EI. Targeted moments include the moments associated with the take-up of parental leave, average hourly wage levels and growth, time allocations, and labour market transitions by gender and education. Calibrated parameters imply that compared to mothers, fathers have lower home productivity in the presence of an infant, higher rental rates of human capital, and higher wage penalties for not working.

I quantify the relative importance of the different factors for the low take-up rates of married fathers, using the calibrated model. I calculate the changes in take-up rates from the benchmark to the symmetry economy, where all gender differences are removed, and decompose the changes into the possible explanations. In particular, I let men and women have same parameter values for the explanation under consideration and leave the other parameters the same as in the benchmark. I then simulate the take-up behaviour of married couples and calculate the percentage of the changes that are narrowed for each explanation. I find that the gender differences in home productivity, rental rates of human capital, and wage penalties for not working are three major contributors to the low take-up of fathers. Due to positive interactions among the three explanations, these three explanations together explain all the gender difference in the take-up rates among high-educated parents.

Next, I examine the role of gender differences in paid parental leave policies and the role of cash benefits in married couples' decisions regarding parental leave. The baseline policy

[4] In their model, a couple accumulates financial assets instead of husband's human capital.

embodies a gender difference in maximum lengths of parental leave available to a mother and a father due to lack of paternity leave. I find that introducing paternity leave without an increase in cash benefits leads to only small changes in fathers' take-up of parental leave. I show that fathers' take-up rates are responsive to an increase in an income replacement rate combined with the introduction of paternity leave. In a set of policy experiments, I explore various parental leave policies that aim to increase high-educated fathers' take-up rates. I consider policies that keep the total number of weeks of leave available to a couple the same as the baseline policy. I find that, among these policies, a combination of introducing paternity leave and providing higher replacement rates during maternity and paternity leaves increases fathers' take-up rates with a small increase in aggregate spending.

This paper is organized as follows. In Section 4.2, I briefly present empirical background about Canadian parental leave policy and supporting evidence for the possible explanations I consider for the low take-up rates of fathers. In Section 4.3 and 4.4, I present my framework for quantitative analyses and calibration results, respectively. Using the calibrated model, I carry out a decomposition analysis and policy experiments in Sections 4.5 and 4.6, respectively. In Section 4.7, I present conclusions including policy implications of the main findings.

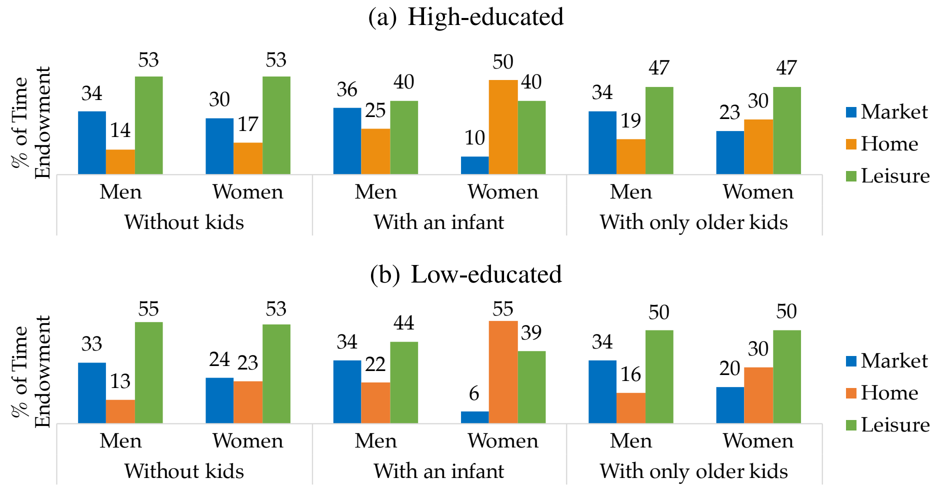
4.2 Empirical Evidence for Explanatory Factors

This study uses paid parental leave policy in Canada at the federal level under EI as a baseline policy. In Chapter 2, I document a stark difference in take-up rates between married fathers and mothers under the Canadian federal EI program (Table 2.2). Whereas 91% of the eligible mothers received maternity and/or parental benefits, only 13% of the eligible mothers answered that their husband had used or planned to use paid parental leave. As possible explanations for the gender gap in take-up rates of parental leave, I consider gender differences in wages upon entry into the labour market, wage growth processes, wage penalties for time off from work, preferences for leisure, and relative productivities in home production. Before exploring the role of these explanations in a life-cycle framework, I provide empirical evidence for these explanations in Canada.

4.2.1 Time Allocations Between Market and Home Work

The purpose of parental leave is to help parents take time off work and spend their time at home with their newborn child. I conjecture that the division of parental leave is closely related to the allocation of time within married households. As in Chapter 2, I document patterns of married people's time allocations across market work, home work, and leisure in Canada, using two

Figure 4.1: Time Allocations of Married Individuals



cycles of the GSS collected in 2005 and 2010 on the subject of time use. The sample of interest is restricted to married people aged between 25 and 64.[5] People who live in Québec and whose youngest child is born in 2006 or afterwards are excluded from the sample. The sample is grouped into three categories by the characteristics of their children: those without any children, those with an infant less than two years old, and those with only older children.[6]

Figure 4.1 displays the average amount of weekly time spent by married people on market work, home production, and leisure expressed as a percentage of the time endowment.[7] This figure shows that specialization between market and home production is much stronger among those with an infant than those without any children or with only older children. Before having children, compared to high-educated men, high-educated women spend less time on market work and more time on home production, while spending the same amount of time in leisure. When they have an infant at home, married women drastically reduce time spent on market work and increase time on home production. Although men also increase the amount of time they spend on home production, women spend twice as much time on home production as men do. When married people have only older children, the specialization declines as they reduce time spent in home production and married women return to market work. The same patterns are seen among the low-educated, although their specialization is stronger even before having children compared to the high-educated. Clearly, these patterns suggest that female compar-

[5]Public-use data provide age grouped in 5-year or 10-year bins.

[6]Since GSS collects the number of children living in a respondent's household, young married couples who have not yet had children cannot be distinguished from empty-nesters. Thus, I classify married people who are aged 45 or older and have no children at home as married people with older children.

[7]These statistics are not conditional on participation and include zeros in calculation. The time endowment is discretionary time that excludes time dedicated to sleeping and other necessary personal care. It is equivalent to 112 hours per week.

Table 4.1: Descriptive Statistics of Hourly Wages at Age 23

	High-educated			Low-educated		
Statistics	Men (M)	Women (W)	Ratio (W/M)	Men (M)	Women (W)	Ratio (W/M)
Median	15.3	12.5	.817	13.0	9.2	.708
Mean	17.1	13.5	.789	13.5	10.6	.785

Cross-sectional data from Survey of Labour Income Dynamics (2001–2011) are used for the calculation. The sample is restricted to married people who were not a student and worked at least 300 hours for a year. Hourly wages are deflated to 2002 Canadian dollars.

ative advantage in home production may be a contributing factor for the gender differences in parental leave take up rates. However, it is likely not the only factor. The next subsection examines evidence for differences in market work factors.

4.2.2 Wages upon Entry into the Labour Market

The gender wage gap is closely related to specialization within a couple (Hersch and Stratton, 1994). I separate the gender wage gap in two parts: gender differences in rental rates of human capital conditional on educational attainment and gender differences in human capital gained from market experiences. The first part of the gender wage gap can impact specialization, and the second part can be influenced by specialization. As in Olivetti (2006), I label gender differences in the rental rates "pure" gender wage differences. I provide empirical evidence of the pure gender wage gap using hourly wages upon entry into the labour market.

I use public-use cross-sectional data from Survey of Labour Income Dynamics (SLID) collected between 2001 and 2011. SLID is a Canadian household longitudinal survey that contains a broad range of information on the histories of labour market activities, educational attainment, and demographic characteristics of individuals and families. The annual cross-sections consist of two overlapping panels. Each panel is surveyed for six consecutive years. Every three years, a new panel is added. For a measure of wages, I use the hourly wage from the main job at which a respondent works for most hours during the reference year. Hourly wages are deflated to 2002 Canadian dollars using the federal Consumer Price Index. Throughout this paper, all monetary values are deflated to 2002 Canadian dollars unless mentioned otherwise.

Hourly wages of 23-year-old high-educated individuals are used as a proxy for rental rates of human capital. The assumptions behind this approach are that most high-educated people at age 23 are in their early careers and that both men and women have similar levels of human capital gained from market experiences upon entry into the labour market conditional on education. Among 23-year-old high-educated married people, 99% of men and 90% of women were employed for any positive number of hours during the reference year, whereas 91% of men and 78% of women were employed full-time at least for a week.

Table 4.1 reports the average and median hourly wages of married individuals at age 23. It shows considerable differentials between men and women. Among the high-educated, the median hourly wage of women is 82% of that of men, and the average hourly wage earned by women is 79% of that earned by men.[8] These gender differentials in the means and medians are consistent with the presence of pure gender wage differentials. Because this study abstracts from the choices of majors and occupations, I report the statistics that are not conditional on occupations and fields of study. Therefore, the statistics reflect different choices in college majors and occupations between men and women.[9]

4.2.3 Returns to Experience and Wage Penalty for Taking Time out of Work

To demonstrate gender differences in returns to experience and wage penalties for taking time off work, I run Mincerian wage regressions using the SLID data. For this estimation, I combine cross-sectional data from SLID in 2001–2011. SLID contains self-reported retrospective information about educational attainment and market experience. Hourly wages from the main job during the reference year are used as a measure of wages. The real hourly wage rates expressed in natural logs are used as my dependent variable. Control variables include a quadratic in market experience, the accumulated amount of time off from work, educational attainment, the number of children, and an indicator variable for a private sector job.

SLID records a respondent's market experience accumulated since their first full-time job as the number of years as a full-year full-time equivalent.[10] This variable is denoted by *Experience*. This measure of experience excludes any part-time employment before the first full-time job. Those who have never had a full-time job have zero as its value. I measure foregone experience in two parts: potential foregone experience before the first full-time job, denoted by *TimeOut1*, and actual foregone experience after the first full-time job, denoted by *TimeOut2*. *TimeOut1* is defined as the age at which a person started to work full-time minus the number

[8] Table C.2 in Appendix compares the statistics of the married sample to the same statistics for a sample of all individuals. When the sample is not restricted to married individuals, the gender gap in the median hourly wages of high-educated people is similar to that of the married sample and the gap in the average hourly wages is smaller. In contrast, among the low-educated, the gap in the median wages is smaller and the gap in the average wages is similar.

[9] The literature on gender wage gap and gender differences in college majors includes Altonji(1993), Brown and Corcoran (1997), Paglin and Rufolo(1990). Section 5 and section 7 in Altonji and Blank (1999) provide the summary of the literature.

[10] In Canada, full-time work means at least 30 hours of work over a period of one week.

Table 4.2: Log Wage Regressions

Dependent variable	All		Low-edu		High-edu	
: ln(Wage)	Men	Women	Men	Women	Men	Women
Experience	0.0270	0.0272	0.0178	0.0163	0.0281	0.0274
	(22.75)	(26.06)	(9.04)	(9.31)	(17.36)	(19.57)
$\text{Experience}^2/10^3$	-0.5178	-0.5273	-0.2841	-0.1818	-0.6984	-0.7229
	(-15.59)	(-15.73)	(-5.40)	(-3.40)	(-14.83)	(-15.72)
TimeOut1	-0.0102	-0.0065	-0.0103	-0.0081	-0.0120	-0.0129
	(-18.79)	(-15.22)	(-12.78)	(-12.90)	(-15.64)	(-21.22)
TimeOut2	-0.0204	-0.0156	-0.0219	-0.0155	-0.0244	-0.0217
	(-21.13)	(-28.83)	(-14.38)	(-18.17)	(-18.61)	(-29.65)
Constant	2.663	2.5012	2.8092	2.7027	3.076	3.0277
	(200.33)	(198.20)	(135.54)	(-29.05)	(224.93)	(289.34)
Adjusted R^2	0.2434	0.3575	0.1102	0.2056	0.1060	0.1964

t-statistics are in parentheses. Data is from Survey of Labour Income Dynamics, 2001–2011. The sample of interest is married people aged between 25 and 49 with paid employment who are not a student and do not have any disability in the reference year. Hourly wages are deflated to 2002 Canadian dollars. Education is controlled for the first two columns. The number of children and a private sector job indicator are controlled for all columns. A complete table is reported in Table C.4 in Appendix C.

of years of schooling minus six.[11] *TimeOut2* is defined as the number of years since the first full-time job minus *Experience*. Because *TimeOut1* does not distinguish part-time employment from non-employment and thus overstates the amount of time off from work, the coefficient on *TimeOut2* is my preferred estimate of wage penalties for foregone experience.

The sample of interest is limited to married people aged between 25 and 49 with paid employment who are not students and do not have any disability in the reference year. Observations that have any missing information about education and experience are excluded from the sample. The final sample consists of 35,826 male observations and 36,692 female observations. Men had accumulated 3.37 more years of market experience compared to women, whereas women had taken 1.76 more years off of work since their first full-time job. These gender differences in market experience and foregone experience are related to the fact that in most case mothers take time off work due to childbirth and childcare and the fact that part-time employment is more common among women than among men. Other main characteristics of the sample are reported in Table C.3 in Appendix C.

Table 4.2 presents the estimation results. The negative coefficients on variable *TimeOut2* show wage losses for an additional year of foregone experience after the first full-time job. Both men and women receive statistically significant penalties for taking time out. The absolute values of the coefficients for men are greater than those for women. That is, for the same

[11] I replace negative values of *TimeOut1* with zero under the assumption that these respondents started their first full-time job before receiving the highest level of degree or went back to school in the midst of their career.

amount of time off from work, married men face greater wage penalties than married women do. When log wage regressions are separately estimated by educational group, the results are similar. However, there are some differences between the two education groups. In both education groups, men and women have similar returns to experience and receive statistically significant wage penalties for taking time out. Meanwhile, the adverse effect of time out of work on subsequent wages is larger among the high-educated, compared to the low-educated. For gender differences in the wage penalties, men have a larger wage penalty than women do for taking time off in both educational groups, whereas the gender difference is bigger among the low-educated. This is because high-educated women face a wage penalty that is as high as that for high-educated men.

To sum up, 13% of eligible married fathers use parental leave whereas 91% of eligible married mothers use maternity and parental leave. Married men and women allocate their time differently when they have children, especially an infant. Men have higher average hourly wages upon entry into the labour market than women do. Finally, men receive higher wage penalties for taking time off work than women do.

In the remainder of the paper, all these possible explanations are incorporated into a unified life-cycle framework. In addition, I consider a gender difference in preferences for leisure as possible reasons. In the framework, parameters related to the possible explanations are allowed to differ by gender. By calibrating the model, I can quantitatively assess the role of each gender difference in married couples' decisions on how to divide parental leave between a husband and wife.

4.3 Model

This section describes a life-cycle model of married couples. This model is a partial equilibrium model. The period length is annual. In the model, I take various gender differences as exogenously given and quantify their contribution to a couple's take-up of parental leave. These gender differences are the result of choices, social norms, and history, which are beyond the scope of this research. For simplicity, the model abstracts from the formation and dissolution of marriage and educational and occupational choices.[12]

[12] As the model abstracts from marriage and divorce decisions, this model misses the effect of the fathers' take-up on marriage stability or family structure. Bernal and Fruttero (2008) use a general equilibrium model of marriage and divorce to assess the effects of maternity leave on intra-household decision making, family structure, and the distribution of income. Also, my model abstracts educational and occupational choices. As the job protection provided by parental leave helps women retain their pre-birth employment after childbirth, parental leave encourages women to anticipate longer work lives. The expanded horizon of career influences human capital investment and occupational choices (Goldin, 2006). Although their focus is on female's labour supply, Adda, Dustmann, and Stevens (2017) take career decisions into account quantifying the career costs associated

4.3.1 Economic Environment

Demographics. The model economy is populated by married households. Each married household consists of a husband and a wife. A marriage is lifelong, and a married couple has a working life of 40 years from age 23 to age 62. Each person is either high-educated, *hi*, or low-educated, *lo*. While preferences and home production technology are assumed to be the same across education types, human capital evolution processes and fertility shocks will depend on education types. A household's education type is a pair of husband's and wife's education types. In each period, a married couple jointly makes decisions.

Children do not make any decisions. However, the decisions of a married couple are influenced by the characteristics of their children, especially the number of children and the age of the youngest child. The age of the youngest child, a, is tracked until the age of two.[13] We define a child under two an "infant" and a child who is two years old or older an "older child." When a couple has an infant at home, $a = 1$. When a couple has only older children, $a = 2$. Children stay with their parents throughout their parents' whole life.

Fertility is exogenous and stochastic. Based on fertility, the life-cycle is split into three stages: the pre-fertile, fertile, and post-fertile stages. A married couple without any children begins in the "pre-fertile" stage. In this stage, the married couple does not face any birth shock. A married couple in the pre-fertile stage enters the fertile stage with probability π_f. The concept of fertility in this set-up does not relate to the biological ability to reproduce but rather to the state of considering having a child. The pre-fertile stage is needed in this model, where all couples begin married at age 23, to match the timing of having the first child in the data.

In the fertile stage, a couple faces a birth shock at the beginning of each period. The probability of a birth, $\pi_b(t,k,a,\varepsilon_w)$, depends on the age of the couple, t, the number of children, k, the age of the youngest child, a, and the wife's education level, ε_w. A birth shock occurs every period until the couple enters the post-fertile stage in which a birth shock no longer occurs.

A couple enters the post-fertile stage in three ways. First, a couple enters when a couple becomes 43 years old. Thus, a couple can be in the fertile stage for at most 20 periods. Although the fertility rate of women aged 40 or higher is positive, the probability of a birth beyond age 43 is small. My estimation results show that the probability of having a newborn child at age

with children using a dynamic life cycle model incorporating occupational choices with different human capital growth and atrophy paths. My model misses the effects of parental leave on educational and occupational choices especially in policy experiments. Instead, I take these choices as given in quantifying the contribution of various factors to the take-up of parental leave. I directly takes the distribution of couples across household educational types from the data. I implicitly assume that gender differences in occupations are reflected in gender differences in rental rate distributions and human capital evolution processes.

[13] I choose the age of two to keep the state space small. Due to this assumption, my model misses gradual changes in married women's behaviour until their children start school.

42 is less than two percent when a married couple has no child or one child. The probability is almost zero when a couple has two or more children (Table C.7). Second, couples stop being able to have children once the number of children in a married household reaches three. Lastly, couples under the age of 43 with only older children enter the post-fertile stage with probability π_{post}. The transitional probabilities into the fertile stage π_f and into the post-fertile stage π_{post} depend on a wife's educational level.

Preferences. A married couple has unitary utility from consumption, c, husband's and wife's leisure, l_h and l_w, respectively, and output from home production, z. Per-period household utility, $u(c_t, l_{ht}, l_{wt}, z_t)$, is additively separable and concave. Consumption and output from home production are public goods within a household. Let the set of parameters γ_c, γ_h, γ_w and γ_z denote weights on consumption, husband's leisure, wife's leisure and output from home production. The functional form used in the quantitative analysis is:

$$u(c, l_h, l_w, z) = \gamma_c \frac{c^{\sigma_c}}{\sigma_c} + \gamma_h \frac{{l_h}^{\sigma_l}}{\sigma_l} + \gamma_w \frac{{l_w}^{\sigma_l}}{\sigma_l} + \gamma_z \frac{z^{\sigma_z}}{\sigma_z}.$$

The parameters σ_c, σ_l and σ_z denote elasticity parameters on consumption, leisure, and output from home production, respectively. Each period, an individual is endowed with discretionary time E and allocates it across three activities: paid work, n, home production, e, and leisure, l. Household incomes consist of labour earnings and parental leave benefits. Married couples live hand to mouth. They do not save nor borrow. Most people in their 20s and 30s have small amount of net worth and add only a small amount to their net worth (Macdonald 2015). To focus on the role of husband's and wife's human capital accumulation in their decisions, I abstract asset accumulation from the model.[14]

Couples with an infant at home must purchase childcare services for every hour that both parents are simultaneously working in the labour market. As in Domeij and Klein (2013), the amount of market childcare services to be purchased is determined as $\min\{n_h, n_w\}$ where n_h and n_w denote husband's and wife's hours of work, respectively. Let κ represent an hourly rate for market childcare services for an infant.[15] Although some parents have an option of unpaid childcare services provided by grandparents or siblings, unpaid childcare services are beyond

[14] Guner et al. (2014) have a model where a couple accumulates financial assets instead of husband's human capital. Mazzocco, Ruiz, and Yamaguchi (2013) and Bayot and Voena (2015) have a model include wealth and husband's and wife's human capital accumulation. As Mazzocco et al. (2013) emphasize the wealth dynamics, they use two points for experience.

[15] This model tracks the age of the youngest child up to two and categorizes all older children into one group. Because I assume all children stay with their parents though their parents' whole life, I assume the childcare costs for the older children are relatively negligible. A weakness of the assumption is that the model understates the benefit of a parent staying at home to save childcare costs especially for older children.

the scope of this paper.[16] In the cases in which either a husband or a wife does not work in the market, a couple does not purchase market childcare services but produces childcare services as a part of home production.

Home production technology. The output from home production includes not only general household chores such as cleaning, maintenance, and cooking but also childcare.[17] Home production requires inputs of market goods, g, and time from each spouse, e_h and e_w. The productivity of the husband's time in home production relative to the wife's time is denoted by $\eta(k,a)$. The wife's relative home productivity is denoted by $1-\eta(k,a)$. If the husband's time and the wife's time are equally productive, $\eta(k,a) = 1/2$. If the wife's time produces more output than the same amount of her husband's time, $\eta(k,a) < 1/2$. This relative productivity may vary upon the presence of an infant in a family. When a couple has an infant, $\eta(k,a) = \eta_1$; otherwise, $\eta(k,a) = \eta_0$.

For the quantitative analysis, I use a nested Cobb-Douglas function for the home production technology:

$$z = z(g, e_h, e_w, k, a) = (1 + k\zeta(k,a))\, g^{1-\alpha} \left(e_h^{\eta(k,a)} e_w^{1-\eta(k,a)} \right)^{\alpha},$$

where k is the number of kids and a is the age of the youngest kid. The efficiency factor of home production, $(1 + k\zeta(k,a))$, increases with the number of kids. Also, the efficiency factor is allowed to vary by the presence of an infant at home. If a couple has an infant $\zeta(k,a) = \zeta_1$ with $\zeta(k,a) = \zeta_0$ otherwise.

Rental rates of human capital. A worker earns an hourly wage which is defined as the product of a quantity of human capital and a rental rate per unit of human capital. Let p_i denote the rental rate of human capital for spouse i. A rental rate is randomly drawn from an exogenous gender-specific log-normal distribution. The means of husbands' rental rates, μ_h, and wives' rental rates, μ_w, are allowed to differ. I call this gender difference in the means of rental rates the "pure" gender wage gap. The argument about why the pure gender wage gap exists upon the entry into the labour market is beyond the scope of this paper, but one explanation is occupational gender segregation. Intended fertility and career interruptions influence women's occupational choices and lead to self-selection into more child-friendly occupations (Adda, Dustmann, and Stevens, 2017, Görlich and de Grip, 2009). Although occupational gender

[16] Bick (2016) builds a model in which a married couple chooses the type of childcare services to evaluate the effect of childcare subsidy on parental labour supply, fertility, and social welfare.

[17] Cardia and Gomme (2018) develop a life-cycle model where childcare is distinguished from household chores and show that childcare plays an important role in matching the life-cycle patterns of women's market work in the U.S. In this chapter, both childcare and household chores are included in home production.

segregation has declined since 1970s, it still remains present in the labour market (Blau, Brummund, and Liu, 2013). For my quantitative analysis, the distribution of rental rates follows a log-normal distribution $G_i(p_i) \sim lnN(\mu_i, \sigma_i^2)$ for $i = h, w$.

A person draws a new rental rate from the same distribution G_i after a full year of non-employment or after a wage shock. A full year (period) of non-employment is either due to one's voluntary choice or due to a full-year non-employment shock at the end of the preceding period. A non-employment shock occurs at the end of a period with probability ν_e to an employed person and with probability ν_n to a non-employed person. If this shock is realized, then the person is involuntarily non-employed for a full year in the following period. After the period, a worker draws a new rental rate. In addition, a wage shock may occur to an employed worker with probability λ at the end of a period. This shock is independent of the non-employment shock. If a wage shock is realized, a worker redraws a new rental rate at the beginning of the following period. This shock allows employed workers to change their rental rates without experiencing a full year of non-employment.

Evolution of human capital. Human capital, x, depends on formal education and market experience. An educational type, ε, remains fixed at either low-educated, lo, or high-educated, hi, over the life cycle. Human capital gained from market experience, x^{exp}, stochastically evolves via a learning-by-doing process.

The level of human capital from market experience takes a value on the finite set $\mathscr{X}^{exp}(\varepsilon) = \{x_0^{exp}, x_1^{exp}, ..., x_{max}^{exp}(\varepsilon)\}$. Each level is expressed not as the number of years but rather as the efficiency units of human capital gained from market experience. In the finite set, x_1^{exp} represents a baseline experience level which a worker at age 23 has upon entry into the labour market. Human capital may depreciate below the baseline level to the lowest level x_0^{exp}. The baseline level x_1^{exp} is normalized to one. There is a constant growth rate between the lowest level, x_0^{exp}, and the maximum level, x_{max}^{exp}. By allowing the maximum level, x_{max}^{exp}, to vary by education level, ε, the finite set $\mathscr{X}^{exp}$ differs between the two educational levels.

Transition probabilities of human capital depend on its level, x_j^{exp}, and time worked in the labour market, n, in a period. The human capital evolves by one grid point at a time. The following functional form is a variant of a stochastic process of labour productivity in Caucutt, Guner, and Knowles (2002): for $\varepsilon \in \{lo, hi\}$ and $i \in \{h, w\}$,

$$\begin{aligned}
Pr(Up) &= X_i^{\varepsilon}(x_{j+1}^{exp} \mid x_j^{exp}, n_i) = \psi_i^{\varepsilon}\tilde{n}_i/(x_j^{exp})^{\tau},\ j \in \{1,...,N-1\}, \\
Pr(Down) &= X_i^{\varepsilon}(x_{j-1}^{exp} \mid x_j^{exp}, n_i) = (1-\tilde{n}_i)\,\delta_i^{\varepsilon},\ j \in \{1,...,N\}, \\
Pr(Same) &= X_i^{\varepsilon}(x_j^{exp} \mid x_j^{exp}, n_i) = 1 - Pr(up) - Pr(down),\ j \in \{1,...,N-1\}, \\
Pr(Same) &= X_i^{\varepsilon}(x_0^{exp} \mid x_0^{exp}, n_i) = 1 - X_i^{\varepsilon}(x_1^{exp} \mid x_0^{exp}, n_i), \\
Pr(Same) &= X_i^{\varepsilon}(x_N^{exp} \mid x_N^{exp}, n_i) = 1 - X_i^{\varepsilon}(x_{N-1}^{exp} \mid x_N^{exp}, n_i),
\end{aligned} \tag{4.1}$$

where $\tilde{n}$ is hours of work expressed as a fraction of the maximum amount of time available for market work, $\bar{n}$, which is set to 40% of time endowment. That is, $\bar{n} = 0.4E$ and $\tilde{n}_i = n_i/\bar{n}$.

The transitional probabilities incorporate two key parameters. Let ψ_i^{ε} denote the maximum probability of human capital growth. It is the likelihood of human capital increasing when a person spends all available time for market work $\bar{n}$ in the labour market. Let δ_i^{ε} represent the maximum probability of human capital depreciation. It is the likelihood that human capital falls when a person is non-employed for a year. The parameter τ is related to the rate at which returns to experience diminish. As the possible explanations I consider for the gender gap in take-up rates, ψ_i^{ε} and δ_i^{ε} are allowed to be gender-specific.

Parental leave policy (PL). Upon the birth of a child, an employed parent who meets the requirements for entitlement to EI is guaranteed paid parental leave. An eligible parent determines the number of weeks of paid parental leave to take. When a parent takes d weeks of parental leave, the parent is available for market work during at most $52-d$ weeks during the period. The maximum number of weeks available for market work restricts the total amount of time available for market work to $(\frac{52-d_i}{52})\bar{n}$.

Given the job protection provided by parental leave, a mother who uses a full year of parental leave retains her pre-birth rental rate. I assume that a mother on a full year of parental leave does not search for a new job, her probability of drawing a new rental rate is zero, and a full-year non-employment shock occurs with probability ν_e. If a parent uses less than a full year of parental leave and does not return to work during the period, I view this as voluntary non-employment and let the parent draw a new rental rate with probability one at the beginning of the following period. If a parent does not use parental leave or if a parent uses less than a full year of parental leave and returns to work during the period, I let the parent draw a new rental rate with probability λ and a full-year non-employment shock occur with probability ν_e. The function of job protection is summarized by the probability of drawing a new rental rate, denoted by $\tilde{\lambda}_i$, as follows:

$$\tilde{\lambda}_i = \begin{cases} 0 & \text{if } n_i = 0 \text{ and } d_i = 52 \text{ (Job protection after a full year of PL)}, \\ 1 & \text{if } n_i = 0 \text{ and } d_i < 52 \text{ (Voluntary non-employment after a part year of PL)}, \\ \lambda & \text{if } n_i > 0 \text{ and } 0 \leq d_i < 52 \text{ (Return to work after a part year of PL or not using PL)}. \end{cases} \tag{4.2}$$

The second function of parental leave is financial support through cash benefits. The amount of weekly benefits, B, is determined based on hours worked and earnings in the previous period. Specifically it is given by the following updating rule:

$$B' = \mathbb{1}\{n_{it} \geq 600\} \min\left\{\rho \frac{p_{it}x_{it}n_{it}}{52}, \bar{B}\right\}, \tag{4.3}$$

for $i \in \{h, w\}$. To be eligible for paid parental leave under EI, a parent must meet the minimum requirement of 600 hours of work within the last 52 weeks. The indicator variable $\mathbb{1}\{n_{it} \geq 600\}$ is equal to one if person i meets the requirement and zero otherwise. Conditional on being eligible, the parental benefits replace the pre-birth earnings, $p_{it}x_{it}n_{it}$, at a rate of ρ with a maximum amount $\bar{B}$. As a state variable, $B_i = 0$ if person i is not eligible for EI. A positive value of B_i represents the weekly benefit amount that person i can receive.

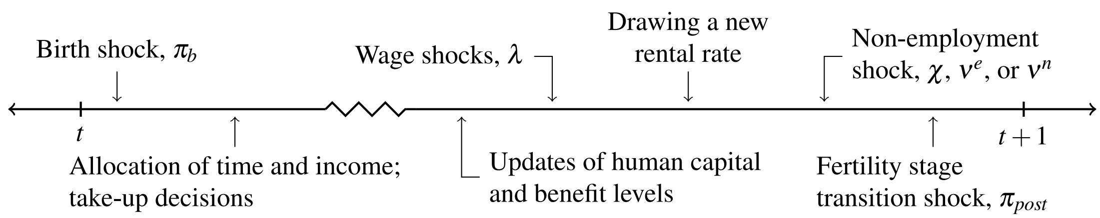
4.3.2 Household Problem

I present in detail the household problem in a fertile period in which a married couple faces a birth shock. Because household problems in pre-fertile and post-fertile periods are similarly defined except for the continuation values, only continuation values are presented in these cases.

A couple starts a fertile period with a given set of state variables $\mathscr{S} = (\mathbf{p}, \mathbf{x}, \varepsilon, \mathbf{B}, k, a, \Upsilon, t)$ indicating the rental rates of human capital, $\mathbf{p} = (p_h, p_w)$; levels of human capital from market experience, $\mathbf{x} = (x_h^{exp}, x_w^{exp})$; education types, $\varepsilon = (\varepsilon_h, \varepsilon_w)$; the weekly amounts of parental benefits, $\mathbf{B} = (B_h, B_w)$; the number of children at home, k; the age of the youngest child, a; non-employment risks, Υ; and the age of the couple, t.

Non-employment risks are exogenous and stochastic. A spouse experiences a part-year non-employment shock with probability χ at the end of a period. In this case, a person can work up to $\frac{1}{2}\bar{n}$ during half of the following period. This state is denoted by P. If a spouse experiences a full-year non-employment shock, the person cannot participate in the labour market in the following period. This state is denoted by F. The probability of a full-year

Figure 4.2: Timeline of Events in a Fertile Period



non-employment shock depends on an individual's current employment status. The shock for an employed person is realized with probability ν^e and for a non-employed person is with probability ν^n. If neither non-employment shock is realized, denoted by N, a person can work in the labour market up to $\bar{n}$ hours of work.

The non-employment risks at the household level, denoted by Υ, are a pair of husband's and wife's non-employment risks. For example, $\Upsilon = PN$ represents a state where the husband experiences a part-year non-employment shock and the wife experiences neither non-employment shock. Assuming that the husband's and wife's non-employment risks are dependent, I allow Υ to take one of the five states: $\{NP, NF, PN, FN, NN\}$, where for each state the first and the second letters stand for the husband's and wife's non-employment risks, respectively.

$$\Upsilon = \begin{cases} NP & \text{with probability } \chi_w \text{ (part-year non-employment shock to the wife)} \\ NF & \text{with probability } \nu_w \text{ (full-year non-employment shock to the wife)} \\ PN & \text{with probability } \chi_h \text{ (part-year non-employment shock to the husband)} \\ FN & \text{with probability } \nu_h \text{ (full-year non-employment shock to the husband)} \\ NN & \text{with probability } 1 - \chi_w - \nu_w - \chi_h - \nu_h, \end{cases}$$

where $\chi_i = \chi$ and ν_i is either ν^e or ν^n for $i = h, w$.

Figure 4.2 displays the timeline of decisions and stochastic events during a fertile period. A birth shock is realized at the beginning of a fertile period. If a birth does not occur, $b = 0$, a couple jointly allocates their time and income. If a birth occurs, $b = 1$, and parents are eligible for parental leave, they also make decisions on how to use their parental leave. After a couple makes decisions, levels of human capital are updated, and a new rental rate is drawn if applicable. Next, non-employment shocks are realized. Lastly, if a couple has only older children, a transition shock into the post-fertile stage is realized with probability π_{post}.

Given a set of state variables, $\mathscr{S}$, the value to a couple in which both a husband and wife experience neither non-employment shock, denoted by $\Upsilon = NN$, before the realization of a birth shock is

$$W^f_{NN}(\mathscr{S}) = \pi_b(t,k,a,\varepsilon_w)V^{b=1}_{NN}(\mathscr{S}) + (1-\pi_b(t,k,a,\varepsilon_w))V^{b=0}_{NN}(\mathscr{S}),$$

where $V^{b=1}_{NN}$ is the value to a couple when a birth occurs, and $V^{b=0}_{NN}$ is the value to a couple when a birth does not occur. The value to a couple when a birth occurs, $V^{b=1}_{NN}$, is given by

$$\begin{aligned}
&V^{b=1}_{NN}(p_h, p_w, \mathbf{x}, \varepsilon, \mathbf{B}, k, a_k, t) \\
&= \max_{\substack{d_h,d_w,n_h,n_w,\\ c,g,e_h,e_w,l_h,l_w \geq 0}} u(c, l_h, l_w, z(g, e_h, e_w);\ k+1, 1) \\
&\qquad + \beta\Big\{\tilde{\lambda}_h\tilde{\lambda}_w \mathbb{E}_{p'_h,p'_w}\Big[\mathbb{W}^f(p'_h, p'_w)\Big] + \tilde{\lambda}_h(1-\tilde{\lambda}_w)\mathbb{E}_{p'_h}\Big[\mathbb{W}^f(p'_h, p_w)\Big] \\
&\qquad\qquad + (1-\tilde{\lambda}_h)\tilde{\lambda}_w \mathbb{E}_{p'_w}\Big[\mathbb{W}^f(p_h, p'_w)\Big] + (1-\tilde{\lambda}_h)(1-\tilde{\lambda}_w)\mathbb{W}^f(p_h, p_w)\Big\}
\end{aligned}$$

subject to

$$\begin{aligned}
&c + g + \left(\tfrac{52-d_h-d_w}{52}\right)\kappa \min\{n_h, n_w\} = p_h x_h n_h + p_w x_w n_w + B_w d_w + B_h d_h, \\
&d_h \leq 35, \quad d_w \leq 52, \quad d_h + d_w \leq 52, \\
&n_i \leq (\tfrac{52-d_i}{52})\bar{n}, \quad n_i + e_i + l_i = E,
\end{aligned}$$

where $\mathbb{W}^f(p_h, p_w) = \mathbb{E}_{\Upsilon', x', B'}\Big[W^f_{\Upsilon'}(p_h, p_w, \mathbf{x}', \varepsilon, \mathbf{B}', k+1, 1, t+1)\Big]$ and the probability of drawing a new rental rate, $\tilde{\lambda}_i$, is determined by equation (4.2).

Parents with $B_i > 0$ determine the length of their parental leave, d_h and d_w, from a menu of 0, 6.5, 17, 26, and 35 weeks for a father and a menu of 0, 6.5, 17, 26, 35, 45.5, and 52 weeks for a mother. A parent who chooses to use parental leave allocates time taken away from market work between home production and leisure. As a result, a couple gains increased output from home production and increased leisure time. Additionally, while a spouse is on leave, a couple does not pay childcare costs. When a couple does not use all 52 weeks, the couple must purchase market childcare services for every hour that both parents work in the market at an hourly rate κ. In this case, the childcare services cost $\left(\frac{52-d_h-d_w}{52}\right)\kappa \min\{n_h, n_w\}$.

When a parent uses parental leave to care for children, the parent gives up work experience. The couple incurs costs from this reduction in hours of work. First, as the reduction in hours of work raises the likelihood of human capital depreciation according to a learning-by-doing process, a parent on leave is more likely to experience a wage penalty. All other things being equal, a couple would choose to have the spouse with the lower wage penalty take time off through parental leave. Also, as the reduction in hours worked lowers the probability of human capital accumulation, the couple anticipates wage losses in the future due to the foregone experience. All other things being equal, a couple would choose to have the spouse with the lower return to experience use parental leave. The other cost is an income loss in the current period. Because cash benefits replace 55% of the pre-birth earnings with a cap, to minimize household income losses, a couple is likely to let the spouse with with lower wage rate use parental leave.

The value to a couple in a fertile period without the realization of a birth shock, $V_t^{b=0}$, is similarly defined. For a couple with only older children, a stochastic transition into the post-fertile stage is realized with probability π_{post}. Their continuation value is $\pi_{post}\mathbb{E}\left[W^{post}(\mathscr{S}_{t+1})\right] + (1-\pi_{post})\mathbb{E}\left[W^f(\mathscr{S}_{t+1})\right]$, where W^{post} is the value to a couple in a post-fertile period. The value, W^{post}, is similarly defined as $V_t^{b=0}$. In a pre-fertile period, a couple makes a transition into the fertile stage with probability π_f, and their continuation value is $\pi_f\mathbb{E}\left[W^f(\mathscr{S}_{t+1})\right] + (1-\pi_f)\mathbb{E}\left[W^{pre}(\mathscr{S}_{t+1})\right]$, where W^{pre} is the value to a couple in a pre-fertile period.

4.4 Calibration

The goal of the calibration is to provide a unified framework to quantify the relative importance of the various factors I consider for the low take-up rates of fathers and to carry out policy experiments. The model is calibrated to match Canadian data. Given a set of the parameters determined outside the model, the remaining parameters are jointly determined within the model by minimizing the sum of squared errors between simulated and data moments. The calibrated economy is set as the benchmark economy.

4.4.1 Externally Determined Parameters

Table 4.3 displays the parameters determined outside the model. Parameters related to the parental leave policy are set to mimic Canadian parental leave policy under EI. The maximum duration is 52 weeks for a mother and 35 weeks for a father.[18] The income replacement rate ρ is 0.55, and the weekly benefit maximum $\bar{B}$ is \$413 as it was between 2001 and 2006. I let the weekly benefit amount B_i take a value on the finite set $\mathscr{B} = \left\{0, \frac{1}{3}\bar{B}, \frac{2}{3}\bar{B}, \bar{B}\right\}$.[19] The discount factor is set to 0.96. I set the utility curvature parameters σ_c and σ_l to -1. There is little guidance in the literature on the value of the curvature parameter for home output σ_z. I set the curvature parameter for home output σ_z to the utility curvature parameter for human capital investment on children as in Caucutt et al. (2002). Although their environment is not the same as here,

[18] A mother and a father cannot take leave simultaneously, so the maximum duration of leave per couple is 52 weeks.

[19] As I use a discrete menu for parental leave choices, I choose to let the state variable of weekly benefits be discrete as well. In quantitative analysis, I let the weekly benefit amount B_i take a value on the finite set $\mathscr{B} = \{B_1, B_2, B_3, \bar{B}\}$ and be stochastically updated on the finite set. Transitional probabilities of the weekly benefits amount depend on the updating rule in equation (4.3). If $B' = \bar{B}$, $B_{i,t+1} = \bar{B}$ with probability 1. If $B' \in [B_j, B_{j+1}]$ for $j = 1,2,3$, $B_{i,t+1} = B_j$ with probability $\frac{B_{j+1}-B'}{B_{j+1}-B_j}$ and $B_{i,t+1} = B_{j+1}$ with probability $\frac{B'-B_j}{B_{j+1}-B_j}$.

Table 4.3: Externally Determined Parameters

Parameters	Description	Sources
$\bar{d}_{PL} = 35$	Maximum length of parental leave (weeks)	EI
$\rho = 0.55$	Income replacement rate	EI
$\bar{B} = 413$	Maximum weekly benefits ($)	EI
$\beta = 0.96$	Discount rate	-
$\sigma_c = -1.0$	Elasticity of consumption	-
$\sigma_l = -1.0$	Elasticity of labour supply	-
$\sigma_z = 0.3$	Elasticity of output from home production	Caucutt et al. (2002)
$\gamma_c = 1.0$	Weight on consumption	Normalization
$\alpha = 0.67$	Elasticity of substitution between goods and time	-
$\kappa = 6.69$	Hourly cost of childcare services ($)	-
$\pi_b(t,k,a,x_w^{edu})$	Stochastic fertility process	Estimates from SLID
$\pi_f = 0.417$	Prob. a transition to the fertile stage (low)	Estimates from SLID
$\pi_f = 0.277$	Prob. a transition to the fertile stage (high)	Estimates from SLID
$\pi_{post} = 0.029$	Prob. a transition to the post-fertile stage (low)	Estimates from SLID
$\pi_{post} = 0.069$	Prob. a transition to the post-fertile stage (high)	Estimates from SLID
$lnN(\mu_h, \sigma^2)$	Dist. log rental rates at age 23	MLE from SLID
$p_h \sim lnN(2.69, 0.39^2)$	(men) $p_h \in \{9.39, 12.97, 16.63, 23.00\}$	
$p_w \sim lnN(2.52, 0.37^2)$	(women) $p_w \in \{8.10, 11.06, 14.05, 19.19\}$	
$\omega^{edu} = 0.850$	Relative efficiency of the low-educated (men)	MLE from SLID
$\omega^{edu} = 0.814$	Relative efficiency of the low-educated (women)	MLE from SLID
x_{max}^{ε}	Maximum experience level	Wage regressions
$= 2.276$	(low) $\mathscr{X}^{exp} = \{0.81, 1.00, 1.23, 1.51, 1.85, 2.28\}$	for males
$= 2.296$	(high) $\mathscr{X}^{exp} = \{0.81, 1.00, 1.23, 1.52, 1.87, 2.30\}$	in Table 4.2
$\pi_x = 1.00$	Fraction of men beginning with x_2	SLID
$\Gamma(\varepsilon_h, \varepsilon_w)$	Distribution of household education levels	SLID
$= \{21.0, 20.6, 15.5, 42.9\}$	$\{(lo,lo),(lo,hi),(hi,lo),(hi,hi)\}$	

using their parameter value is not unreasonable in the sense that home production in my model includes childcare activities and requires goods and time inputs as with their children human capital production.

The share of goods input to time input is set to 0.67. There is little guidance in the literature on this parameter value. I assume that this share is the same as the labour income share that is commonly used for the aggregate production technology in the macroeconomics literature. The hourly rate for childcare services is set to $6.69 dollars. Macdonald and Friendly (2016) reported the median monthly fees for full-time childcare in big cities in Canada in 2016. The average of the reported median fees for an infant, excluding cities in Quebec where low-cost subsidized day care has been available since 1997, is $843 in 2002 dollars. By assuming the full-time care corresponds to 126 hours per month (30 hours per week), I get the hourly rate of $6.69.

The probability of a birth and the transitional probabilities between fertility stages are estimated using SLID outside the model. Details are presented in Section C.2 in Appendix.

Lastly, parameters related to hourly wage levels are determined outside the model using SLID. Assuming that rental rates of human capital follow a log-normal distribution, I estimate the means and variances with wage data of 23-year-old married individuals (Table C.9 in Appendix). For quantitative analysis, the 12.5, 37.5, 62.5, and 87.5 percentiles of the estimated distribution for the high-educated are used as four possible rental rates $\{p_1, p_2, p_3, p_4\}$ with equal probability 1/4, for each gender. The estimation results show that the average hourly wages of the low-educated are 85% and 81% of that of the high-educated for men and women, respectively.

The upper bound of human capital gained from market experience, x^{exp}_{max}, is set to replicate the maximum experience premium of married men in the data for each educational group. I calculate the maximum experience premium using the wage regression estimates reported in Table 4.2. The maximum experience premium is 130% for the high-educated and 128% for the low-educated, respectively.[20] For each education group, the finite set $\mathscr{X}^{exp} = \{x^{exp}_0, x^{exp}_1, ..., x^{exp}_{max}\}$ is set such that with the normalization of x^{exp}_1 to one, the elements have a constant growth rate between x_0 and the maximum x^{exp}_{max}.

In my sample of married couples between 23 and 62 in SLID, the median age difference between husband and wife is two years. I use the wife's age as the age of the couple in quantitative analyses. I let the wife's experience level be x_1 and the husband's experience level be x_2 to reflect a possible difference in experience level due to an age difference between husband and wife.[21] For the distribution of household educational types, $\Gamma(\varepsilon_h, \varepsilon_w)$, I use the empirical distribution of married couples by educational types in the cross-sectional sample of SLID.

4.4.2 Internally Calibrated Parameters

Given the set of externally determined parameters, the remaining 20 parameters are jointly determined within the model. These include preference parameters (γ_h, γ_w, γ_z), home production technology parameters (ζ_1, ζ_0, η_1, η_0), parameters governing the transitional probabilities of human capital gained from market experiences (τ, ψ^{ε}_h, ψ^{ε}_w, δ^{ε}_h, δ^{ε}_w for $\varepsilon \in \{hi, lo\}$), and wage and non-employment shocks (λ, χ, ν_e, ν_n).

These parameters are jointly determined to minimize the distance between the simulated and data moments. The measure of distance I use is the sum of squared percentage deviations of the simulated moments from the data moments: $\sum_j \left(\frac{d_j - m_j}{d_j}\right)^2$ where d_j is the j^{th} data mo-

[20] According to the wage regression in Table 4.2, the experience premium is peaked at 19 years of market experiences for the high-educate, while it continues growing for the low-educated. I assumed that experience premium is peaked at 19 years of market experience for both education groups.

[21] In the data the ratio of the average hourly wage of 25-year-old men to that of 23-year-old men is 1.24, which is greater than the parameterized value of x_2 in the model. $\bar{w}_{wife23}/\bar{w}_{own23} = 1.244$

ment and m_j is a corresponding simulated moment. I use the number of targeted moments that is larger than the number of parameters to be calibrated. The targeted moments include take-up rates, average hourly wages and employment rates by age group, wage growth rates conditional on continuous employment and conditional on foregone experience, time allocations by children characteristics, and labour market transitions. All of the moments are calculated separately by sex and educational attainment.

Because there is not an one-to-one mapping from a parameter to a data moment, I provide a brief argument about how each parameter to be calibrated is affected by subsets of the targeted moments. Parameters in preferences (γ_h, γ_w, γ_z) are related primarily to married individuals' time allocations across market work, leisure, and home production by sex, especially those without any children (Table C.10).

Parameters in home production technology, ζ_1, ζ_0, η_1, η_0, are pinned down primarily by matching average amounts of time spent on home production. The efficiency parameters of home production technology as a function of the number of children, ζ_1 and ζ_0, guide the model to match the average amounts of time spent on home production by the number of children and the presence of an infant at home (Figure 4.3). Husbands' relative home productivities, η_1 and η_0, help the model match gender ratios of the amount of time spent on home production. For example, the relative home productivity in the presence of an infant, η_1, guides the gender ratio in the presence of an infant.

Parameters in human capital accumulation technology, τ, ψ_h^ε, ψ_w^ε, δ_h^ε, δ_w^ε for $\varepsilon \in \{hi, lo\}$, jointly govern the dynamic decisions on household labour supply. The parameter governing the probability of an increase in human capital, ψ_i^ε, is pinned down by matching the five-year wage growth rate conditional on working full-year full-time for five consecutive years (Table C.11). The parameter governing the probability of a decline in human capital, δ_i^ε, is determined by the five-year wage growth rate of those who have experienced at least one year of full-year-full-time equivalent non-employment within five years.

In addition, together with the parameters in the transition probabilities of human capital, part-year and full-year non-employment shocks, χ, ν_e, ν_n, help the model match the labour market transition rates across non-employment, part-year employment, and full-year employment (Table C.12). The probability of a wage shock, λ, is pinned down by the fraction of people who experience negative wage growth after full-year full-time employment (Table C.13). Given the externally determined distributions of rental rates and the finite set of human capital levels, $\mathscr{X}^{exp}$, all of these parameters together shape the average hourly wages and employment rates by age group.

Table 4.4: Calibrated Parameters

Parameters	Description	Values
γ_h	Weight on a husband's leisure	0.777
γ_w	Weight on a wife's leisure	0.629
γ_z	Weight on output from home production	1.718
ζ_1	Home productivity per children with an infant	61.846
ζ_0	Home productivity per children without an infant	3.196
η_1	Relative home productivity of husband's time with an infant	0.262
η_0	Relative home productivity of husband's time without an infant	0.491
τ	Curvature of HC growth probability	4.883
ψ_{lo}	Probability of HC growth (low, husbands)	0.350
ψ_{lo}	Probability of HC growth (low, wives)	0.150
ψ_{hi}	Probability of HC growth (high, husbands)	0.706
ψ_{hi}	Probability of HC growth (high, wives)	0.717
δ_{lo}	Probability of HC depreciation (low, husbands)	0.840
δ_{lo}	Probability of HC depreciation (low, wives)	0.421
δ_{hi}	Probability of HC depreciation (high, husbands)	0.429
δ_{hi}	Probability of HC depreciation (high, wives)	0.156
χ	Probability of a part-year unemployment shock	0.040
ν_e	Conditional prob. of a FY nonemployment shock (employed)	0.017
ν_n	Conditional Prob. of a FY nonemployment shock (non-employed)	0.735
λ	Probability of a wage shock	0.223

Table 4.5: Take-up Rates by Education Level

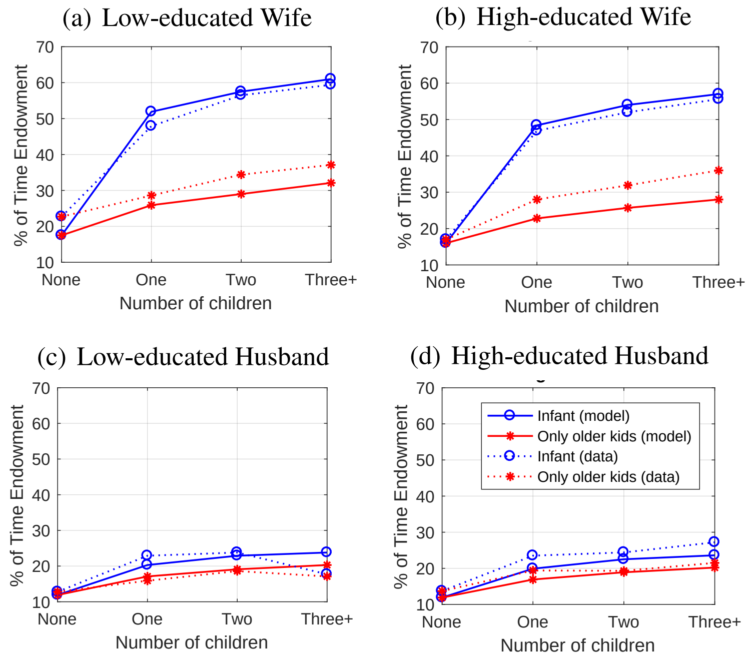
	Individual				Household (Husband's, Wife's)							
	Fathers		Mothers		(lo, lo)		(lo, hi)		(hi, lo)		(hi, hi)	
	Low	High	Low	High	Husb	Wife	Husb	Wife	Husb	Wife	Husb	Wife
Data	11.8	13.6	90.6	90.8	11.2	89.6	12.3	91.2	10.2	91.8	14.2	90.7
Model	11.4	10.2	93.4	93.4	6.8	93.5	14.1	89.9	6.4	93.2	11.0	95.3

4.4.3 Calibration Results

Table 4.4 displays the calibrated parameter values. Table 4.5 and Figures 4.3 and 4.4 show selected sets of simulated moments and their empirical counterparts. Other moments that are continued in Appendix C (Section C.4).

Combined with time allocations of married people in Table C.10, Table 4.5 and Figure 4.3 show that the model replicates decisions regarding take-up of leave and time allocations. Table 4.5 contains the take-up rates by sex and educational level. Although the calibrated model slightly overpredicts mothers' take-up rates and underpredicts take-up rates of fathers with a high-educated wife, it matches overall levels of take-up rates in the data. In particular, the model can clearly capture the pattern that fathers take up far less than mothers. Figure 4.3 shows the average amount of time married people spend on home production by number of

Figure 4.3: Average Time Allocation on Home Production by Number of Children



children and presence of an infant. Although the calibrated model slightly underpredicts the statistics of mothers with only older children, the model is able to match the pattern that fathers spend much less time on home production with an infant at home, compared to mothers.

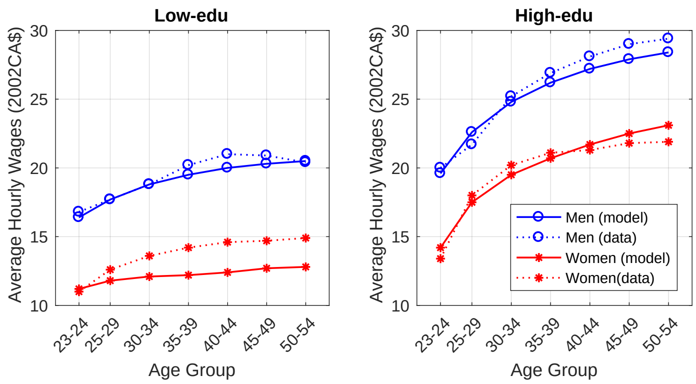
The model does less well at matching the average durations of leave conditional on take-up. The model predicts that fathers use longer leave and mothers use shorter leave compared to the data. For example, the model predicts the average duration of 25 weeks for high-educated fathers and 41 weeks for high-educated mothers, whereas the empirical counterparts are 14 and 46 weeks, respectively.

The model matches the targeted moments related to the labour market activities. Figure 4.4 display the age-profiles of average hourly wages and employment rates by sex and education level. Due to abstracting from savings, the model does not replicate a rapid decline in employment rates near the end of a working life. For this reason, statistics by age group are reported up to age 54. This figure indicates that this model is able to replicate the life cycle profiles of hourly wages and employment rates, except those for low-educated women. For this subgroup, the model predicts a slight flattening of average wages and a continuous decline in employment relative to the data.

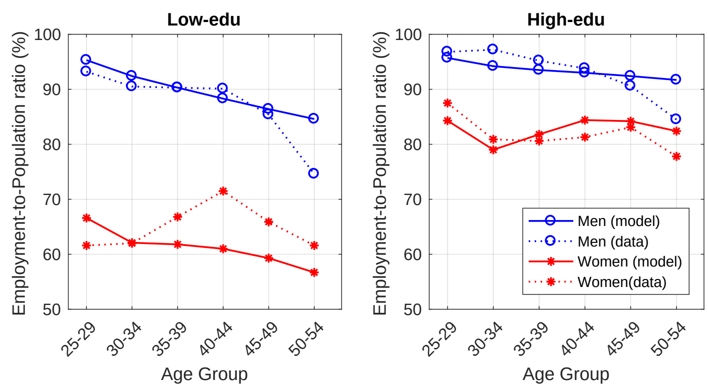
Next, let us look at the calibrated values of the parameters of interest. I find the calibrated weights on a husband's leisure and a wife's leisure show a small difference. A couple puts 20% more weight on the husband's leisure time than on the wife's leisure time; $\gamma_h/\gamma_w = 1.24$.

Figure 4.4: Age Profiles of Hourly Wages and Employment Rates

(a) Hourly Wages



(b) Employment Rates



This explains why husbands enjoy roughly the same leisure as their wives although they on average have a higher wage than their wives, especially among couples having no infant at home. Second, the calibrated relative home productivity of a husband's time without an infant at home, η_0, is close to 0.5, which means that the husband's time and the wife's time are almost equally productive in home production when they do not have an infant at home. The ratio of the husband's home productivity to the wife's is $\eta_0/(1-\eta_0) = 0.96$. The calibrated value is similar to the value in Knowles (2013).

In contrast, the calibrated relative home productivity with an infant at home shows a stark gender difference. The ratio of husband-to-wife's home productivity $\eta_1/(1-\eta_1) = 0.36$. That is, when a newborn child is born, the husband's time is much less productive in home production than the wife's time. In addition to the parameters in transition probabilities of human capital, this parameter influences the accumulation of human capital for mothers through career interruptions due to motherhood.

While gender differentials in rental rates are externally determined, the remaining gender differences in the calibrated transitional probabilities of human capital determine gender differences in the evolution of human capital. Among the high-educated, the calibrated values of the probability of human capital accumulation show almost no difference. Husbands' expected return from full-year full-time employment are almost the same as wives' return: $\psi_h^{hi}/\psi_w^{hi} = 0.98$. In contrast, the calibrated values for the probability of human capital depreciation show a large difference. In particular, the parameters imply that husbands face higher wage penalties than wives do for taking time off. For the high-educated, husbands have a wage penalty 175% higher than wives do: $\delta_h^{hi}/\delta_w^{hi} = 2.75$. This result is qualitatively consistent with the empirical evidence demonstrated in Section 4.2 and the findings in Albrecht et al. (1999). Although my model abstracts from career choices, I can relate this gender difference to the gender difference in career choices. The calibrated parameter values are consistent with the findings that because of potential time off for children, women choose occupations with low skill depreciation (Polachek, 1981, Adda et al. 2017).

4.5 Explaining the Gender Gap in the Use of Parental Leave

In this section, I conduct counterfactual exercises to decompose the division of paid parental leave into the different explanations. Among the various gender differences featured in the calibrated model, I focus on those in 1) preferences for leisure, 2) relative home productivity with an infant, 3) rental rates of human capital, 4) probabilities of an increase in human capital, and 5) probabilities of a decrease in human capital. First, I describe the take-up behaviour of married couples when men and women are symmetric. Second, I quantify the contributions of the above gender differences to the gender gap in the take-up rates. Third, I examine the interactions among these explanations.

4.5.1 Take-up Behaviour When All Gender Differences Are Removed

In this symmetry scenario, all the gender differences in the model are removed.[22] I present two scenarios of eliminating gender differences: 1) when everyone has men's parameter values and 2) when everyone has women's parameter values.[23] Compared to the second scenario, in the first scenario married couples have higher household incomes and put more emphasis on leisure. Also, both husbands and wives have a higher probability of a decline in human capital when taking time off work.

[22] In addition to the five listed before, these also include relative home productivity with no infant at home, education premium, educational composition, and initial human capital gained from market experience due to the average age gap within a couple.

[23] I have the baseline policy of maternity and parental leave unchanged for these counterfactuals.

Table 4.6: Take-up Rates When All Gender Differences Are Removed

	Benchmark		1) Men's values		2) Women's values	
Education	Fathers	Mothers	Fathers	Mothers	Fathers	Mothers
Individual type						
Low	11.4	93.4	60.3	57.1	69.5	65.4
High	10.2	93.4	50.8	49.8	60.2	64.6
Household type						
(lo, lo)	6.8	93.5	46.2	46.0	51.7	51.3
(lo, hi)	14.1	89.9	72.3	28.2	83.8	36.7
(hi, lo)	6.4	93.2	27.2	73.2	27.4	85.6
(hi, hi)	11.0	95.3	56.8	59.4	68.2	76.9

Table 4.6 shows that, for both scenarios, the gender gap in take-up rates is almost closed. However, the two scenarios show different patterns. First, take-up rates of fathers and mothers converge to different values. Both fathers' and mothers' take-up rates are higher in the second scenario. Among the high-educated, the take-up rates of fathers and mothers converge to around 50% when women have men's values, while they converge to around 62% when men have women's values. Second, the two scenarios show differences in the sum of husbands' and wives' take-up rates. When everyone has men's values, the sum is less than or just above 100%, whereas in the other scenario the sum exceeds 100%. This pattern implies that in the first scenario many couples choose to have only one spouse use parental leave or to leave parental leave on the table, compared to the second scenario.

The divergence between the two scenarios is mainly due to differences in probabilities of human capital depreciation. When everyone has the men's values for the probabilities of human capital depreciation, wage penalties for taking time off work are high for both fathers and mothers. The high dynamic costs of taking time off work lead to fewer parents taking parental leave to avoid a fall in human capital. In a scenario where everyone has women's values for the probabilities of human capital depreciation and men's values for the remaining parameters, take-up rates converge to values that are higher than when everyone has men's values for all parameters.[24]

One thing to note is that even when a husband and wife have the same educational attainment, especially when both spouses are high-educated, the wives' take-up rate is still higher than the husbands' take-up rate. The remaining gap in the take-up rates is explained by a gender difference embodied in the baseline parental leave policy. The maximum durations of parental leave available to a father and a mother are different due to maternity leave. I explore alternative gender-neutral parental leave policies in Section 4.6.

[24]See Table C.15 in Appendix C.

4.5.2 Decomposition

To quantify the roles of the possible explanations I consider, I examine each explanation separately. Table 4.7 shows results from the decomposition analysis. The first two columns report the take-up rates in the benchmark economy and in the symmetric economy where everyone has men's values from Section 4.5.1. Column (3) displays the changes in take-up rates from the benchmark to the symmetric economy. The changes are decomposed into five possible factors. In particular, I let women have men's parameter values for the explanation under consideration and leave the other parameters the same as in the benchmark. An exception is relative home productivity. Due to the specification of the home production technology, relative home productivity is set to 1/2 when both men and women are equally productive. Given a change in a parameter specification, I then simulate the take-up behaviour of married couples and calculate the percentage of the change that is narrowed for each explanation. Each cell in columns (4) to (8) presents a simulated take-up rate and in parentheses a percentage of the change in column (3) that is accounted for by each possible explanation for education groups. The last two rows report gender differences in the take-up rates for each education group. Panels (a) and (b) show the results by individual educational type and by household educational type, respectively.

First, I examine the role of relative home productivity in the presence of an infant at home. The calibrated value of η_1 implies the ratio of husbands' to wives' productivities, $\eta_1/(1-\eta_1)$, equals 0.35. I eliminate the gender difference in relative home productivities by setting $\eta_1 = 0.5$ so that $\eta_1/(1-\eta_1) = 1$. Among the five factors considered, this factor results in the largest changes in both fathers' and mothers' take-up rates. Fathers' take-up rate increases from the benchmark from 10% to 29% for the low-educated and from 11% to 29% for the high-educated. At the same time, mothers' take-up rate decreases from 93% to 82% for the high-educated. The largest proportion of the change in take-up rates is explained by this factor. In particular, among the high-educated, this factor accounts for 46% of the change for fathers and 27% of the change for mothers. Also, this factor makes up about 36% of the overall gender gap among the high-educated (column (4), row (6)). The remaining gender gap in take-up rates is explained by gender differences in labour market factors and presence of maternity leave that only mothers can use.

Couples with a high-educated wife contribute greatly to the significant changes in the take-up behaviour (Panel (b)). When husbands and wives become equally productive in the presence of an infant, the take-up rate of husbands with a high-educated wife increases from 14% to 40% for the low-educated and from 11% to 33% for the high-educated. These changes make up about half of the change in column (3) for these husbands. For high-educated wives, a resulting decrease in their take-up rate explains a third and a fifth of the change for those with a low-educated husband and with a high-educated husband, respectively. Among these couples,

Table 4.7: Decomposition of the Gender Gap in Take-up Rates

(a) by Individual Educational Type

	Benchmark	All Removed*	Change (2)-(1)	Home Productivity (Infant), η_1	Rental Rates of Human Capital, μ	Prob. a Fall in Human Capital, δ^{ε}	Prob. a Rise in Human Capital, ψ^{ε}	Weight on Leisure, γ
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Fathers' take-up rates (%)								
Low-edu (a)	11.4	60.3	48.9	28.8(35.7)	19.6(16.8)	15.6(8.7)	12.0(1.3)	10.1(-2.6)
High-edu (b)	10.2	50.8	40.6	28.8(45.9)	17.7(18.4)	13.5(8.0)	10.3(0.1)	8.5(-4.1)
Mothers' take-up rates (%)								
Low-edu (c)	93.4	57.1	-36.3	89.0(12.0)	92.4(2.7)	89.9(9.5)	92.3(3.1)	93.3(0.2)
High-edu (d)	93.4	49.8	-43.6	81.7(26.9)	87.8(12.9)	85.5(18.2)	93.3(0.4)	95.3(-4.2)
Gender differences (%p)								
Low-edu (c)-(a)	82.0	-3.2	-85.2	60.2(25.6)	72.8(10.8)	74.3(9.1)	80.3(2.1)	83.2(-1.4)
High-edu (d)-(b)	83.2	-0.9	-84.2	52.9(36.0)	70.2(15.5)	72.1(13.3)	83.0(0.2)	86.8(-4.2)

* In column (2) everyone has men's parameter values, except the maximum durations of leave available to mothers and fathers due to maternity leave. Values in parentheses present percentages of the change in column (3) that is explained by each gender difference in columns (4) to (8).

(b) by Household Educational Type

$(\varepsilon_h, \varepsilon_w)$	Benchmark (1)	All Removed* (2)	Change (2)-(1) (3)	Home Productivity (Infant), η_1 (4)	Rental Rates of Human Capital, μ (5)	Prob. a Fall in Human Capital, δ^{ε} (6)	Prob. a Rise in Human Capital, ψ^{ε} (7)	Weight on Leisure, γ (8)
(lo, lo)								
Husband (a)	6.8	46.2	39.5	11.2(11.1)	8.8(5.1)	7.8(2.5)	7.8(2.7)	6.9(0.4)
Wife (b)	93.5	46.0	-47.5	88.4(10.8)	91.7(3.7)	88.8(9.9)	92.0(3.1)	93.5(-0.1)
(lo, hi)								
Husband	14.1	72.3	58.2	40.0(44.4)	26.9(21.9)	20.5(10.9)	14.5(0.7)	12.0(-3.6)
Wife	89.9	28.2	-61.7	70.7(31.1)	77.8(19.7)	78.7(18.1)	90.1(-0.3)	93.4(-5.7)
(hi, lo)								
Husband	6.4	27.2	20.8	9.5(15.1)	7.5(5.2)	6.2(-0.9)	7.1(3.4)	6.0(-1.8)
Wife	93.2	73.2	-20.0	90.2(14.9)	93.6(-2.1)	92.2(4.9)	92.7(2.4)	92.9(1.5)
(hi, hi)								
Husband (c)	11.0	56.8	45.7	32.8(47.6)	19.8(19.2)	14.9(8.5)	10.9(-0.3)	9.1(-4.3)
Wife (d)	95.3	59.4	-35.9	87.4(22.0)	92.9(6.9)	89.2(17.1)	95.0(1.0)	96.3(-2.8)
Gender differences (%p)								
(lo, lo) [(b)-(a)]	86.7	-0.3	-87.0	77.2(11.0)	82.9(4.4)	81.0(6.5)	84.2(2.9)	86.6(0.1)
(hi, hi) [(d)-(c)]	84.3	2.7	-81.6	54.6(36.3)	73.1(13.8)	74.2(12.3)	84.1(0.3)	87.3(-3.6)

* In column (2) everyone has men's parameter values, except the maximum durations of leave available to mothers and fathers due to maternity leave. Values in parentheses present percentages of the change in column (3) that is explained by each gender difference in columns (4) to (8).

removing the gender difference in η_1 accounts for 36% of the overall gender gap in take-up rates.

It is noteworthy that when I condition on the wife's educational attainment, the husbands' take-up rate does not show significant variation given their own educational attainment. In other words, in terms of husbands' take-up rate, their wives' educational attainment is the first-order determinant, and their own educational attainment is the second-order determinant. This result remains the same in other columns as well.

Gender differentials in rental rates explain the second largest proportion of the change in the take-up rates for fathers (column (5)). When these differentials are removed, high-educated mothers draw a rental rate from a distribution with a higher mean than that in the benchmark. It implies that now mothers have a higher opportunity cost of taking time off work. As a result, slightly fewer high-educated mothers take parental leave. The reason why the change in their take-up rate is small is that their husbands, who are mostly high-educated, are still more likely to have higher hourly wages because of age differences between a husband and wife. In contrast, husbands' take-up rates considerably increase in reaction to the change. In particular, the interaction within married couples is strong among couples with a high-educated wife and husband. While wives' take-up rate barely decreases, an increase of their high-educated husbands' take-up rate makes up one fifth of the change for the husbands.

The third most significant contributor is gender differences in the probability of human capital depreciation. Column (6) reports how take-up behaviour reacts to making mothers face as a high probability of losing human capital as fathers do. In this scenario, mothers face a probability more than twice as high as in the benchmark. This change causes significant reactions of fathers' take-up behaviour to the change. Because of higher wage penalties for taking time off, the mothers' take-up rate falls to 90% for the low-educated and 86% for the high-educated. In reaction to the changes in wives' take-up behaviour, the husbands' take-up rate slightly increases. As in columns (4) and (5), couples with a high-educated wife contribute greatly to the significant changes in husbands' take-up rates. The husbands' take-up rate increases from 14% to 20% for the low-educated and from 11% to 15% for the high-educated.

One thing to note is that in terms of absolute values the decrease in high-educated wives' take-up rate is greater than the increase in their husbands' take-up rate. This pattern implies that some couples substitute a mother with a father or even give up using paid parental leave because increasing the dynamic cost of mothers taking time off work makes taking parental leave too costly for these couples. If instead, fathers have low probabilities of losing human capital similar to mothers, mothers' take-up behaviour barely changes while fathers' take-up rates almost double. In this case, this explanation accounts for the second largest proportion of the gender gap in the take-up rates.

Lastly, eliminating the gender differences in probabilities of human capital growth and in preferences for leisure has very small impacts on take-up rates. However, it is noteworthy that when the weight on a wife's leisure is raised to the level of the weight on a husband's leisure, the gender gap in the take-up rates widens. Because a couple gains more utility from a wife's leisure time compared to the benchmark, more couples choose to have a wife use parental leave. Among high-educated couples, while the wives' take-up rate goes up, their high-educated husbands' take-up rate goes down. That is, some of these couples switch the parent in charge of caring for their baby from husband to wife.

4.5.3 Interactions among Explanations

The above results indicate that gender differences in relative home productivity, rental rates of human capital, and the probability of a decline in human capital are the more influential determinants of the gender gap in the take-up rates of parental leave among the explanations I consider. Clearly none of the explanations can fully explain the gender gap in parental leave take-up. In the following exercises, I examine interactions among these three explanations by removing two or more differences simultaneously. I show three combinations of the three explanations in Table 4.8.

First, gender differences in relative home productivity and the means of rental rates are simultaneously removed (column (4)). The percentage of the change explained by combining these two factors is greater than the sum of the percentages explained by each factor. This implies a large positive interaction between the two factors. Because a husband and wife become equally good at home production in the presence of an infant and their wages become similar, comparative advantage and specialization between a husband and wife become substantially weaker than in the benchmark. Due to weak specialization, a higher fraction of married couples choose to have a husband at home with a newborn child. Among the four household educational types, the positive interaction is largest among couples with a high-educated husband and wife, because these couples have the smallest gender differences in hourly wages.

Next, I remove the gender difference in the probability of human capital depreciation, which is related to the dynamic costs of taking parental leave (column (6)). Combining the probability of human capital depreciation and the two other explanations exhibits a large positive interaction. For high-educated people, combining these three explanations accounts for more than 100% of the gender gap in take-up rates. That is, high-educated fathers' take-up rate exceeds high-educated mothers' take-up rate. The reason for this pattern is that, given the gender parity in the three major factors, the remaining gender differences make parental leave more favorable to a father in some couples.

Table 4.8: Interactions among Explanations

(a) by Individual Educational Type (%)

	Benchmark (1)	All Removed (2)	Change (2)-(1) (3)	$\eta_1+\mu$ (4)	$\eta_1+\delta$ (5)	$\eta_1+\mu+\delta$ (6)
Fathers' take-up rates (%)						
Low-edu (a)	11.4	60.3	48.9	43.3(65.4)	37.4(53.2)	51.1(81.3)
High-edu (b)	10.2	50.8	40.6	46.0(88.3)	37.2(66.4)	54.9(110.2)
Mothers' take-up rates (%)						
Low-edu (c)	93.4	57.1	-36.3	83.1(28.4)	82.0(31.3)	70.5(62.9)
High-edu (d)	93.4	49.8	-43.6	65.8(63.3)	62.0(72.1)	43.0(115.7)
Gender differences (%p)						
Low-edu (c)-(a)	82.0	-3.2	-85.2	39.7(49.6)	44.7(43.8)	19.4(73.4)
High-edu (d)-(b)	83.2	-0.9	-84.2	19.8(75.4)	24.9(69.3)	-11.9(113.0)

(b) Take-up Rates by Household Educational Type (%)

$(\varepsilon_h,\varepsilon_w)$	Benchmark (1)	All Removed (2)	Change (2)-(1) (3)	$\eta_1+\mu$ (4)	$\eta_1+\delta$ (5)	$\eta_1+\mu+\delta$ (6)
(lo,lo)						
Husband (a)	6.8	46.2	39.5	19.1(31.2)	14.4(19.2)	24.8(45.6)
Wife (b)	93.5	46.0	-47.5	80.1(28.3)	78.9(30.7)	65.3(59.3)
(lo,hi)						
Husband	14.1	72.3	58.2	61.5(81.4)	52.0(65.1)	71.1(97.9)
Wife	89.9	28.2	-61.7	47.8(68.2)	48.4(67.2)	27.6(100.9)
(hi,lo)						
Husband	6.4	27.2	20.8	14.9(41.1)	10.3(18.8)	18.2(56.8)
Wife	93.2	73.2	-20.0	88.4(24.0)	88.0(25.7)	80.4(64.0)
(hi,hi)						
Husband (c)	11.0	56.8	45.7	52.7(91.2)	42.9(69.6)	62.7(113.0)
Wife (d)	95.3	59.4	-35.9	74.7(57.4)	69.2(72.8)	50.6(124.5)
Gender differences (%p)						
(lo,lo) [(b)-(a)]	86.7	-0.3	-87.0	61.0(29.6)	64.5(25.5)	40.5(53.1)
(hi,hi) [(d)-(c)]	84.3	2.7	-81.6	22.0(76.3)	26.3(71.1)	-12.1(118.1)

Values in parentheses present percentages of the change in column (3) that is explained by each column. Parameter η_1, μ, and δ_i denote relative home productivity in the presence of an infant, means of rental rates, and probabilities of a fall in human capital, respectively.

4.6 Policy Experiments

In this section, I explore the role of paid parental leave policies in the division of parental leave within married households. Specifically, I study the role of gender differences in paid parental leave policy and the role of cash benefits, especially income replacement rates. Then, based on the lessons from this analysis, I explore various paid parental leave policies to increase fathers' participation in parental leave.

4.6.1 Role of Gender Difference in Parental Leave Policy

The baseline policy in the benchmark economy embodies a gender difference in maximum lengths of parental leave available to a mother and a father. While a mother can use at most 52 weeks of parental leave including maternity leave, a father can use at most 35 weeks of parental leave. To explore the role of gender differences in parental leave policy, I consider three alternative parental leave policies. They feature a smaller or no gender difference in maximum lengths of parental leave while keeping the total number of weeks of leave available to a couple the same as the baseline policy.

First, I consider a policy featuring a short paternity leave of 6.5 weeks with 17 weeks of maternity leave and a total of 52 weeks of leave available to a couple. Although this policy still has a gender difference in the maximum durations, it provides non-transferable leave to fathers as well.[25] The other two alternative policies feature an equal number of weeks available to a mother and father. In that sense, these two policies are gender neutral. One policy includes an equal length of maternity and paternity leave. I let both the mother and the father have 17 weeks of non-transferable leave. The maximum durations of leave available to a mother and a father are the same at 35 weeks.[26] The other policy allows a couple to share all 52 weeks at their discretion.[27] Under this policy, their maximum durations are the same at 52 weeks.

Table 4.9 demonstrates two sets of simulated take-up rates. In these simulations, the income replacement rate and the maximum insured earnings remain the same as the baseline policy. The first set of take-up rates are from the policy experiments with the calibrated parameter values, and the other set of take-up rates are from the policy experiments with all gender

[25] In the simulations, fathers choose a duration of parental leave from the menu of 0, 6.5, 17, 26, and 35 weeks, and mothers choose it from the menu of 0, 6.5, 17, 26, 35, and 45.5 weeks. The sum of the mother's and father's durations cannot be more than 52 weeks. As in the benchmark economy, assuming that a mother and father use parental leave sequentially, I let the reduction in market childcare costs be proportional to the sum of the mother's and father's durations.

[26] In the simulations, both the husband and wife choose a duration of parental leave from the menu of 0, 6.5, 17, 26, and 35 weeks.

[27] In the simulations, both a husband and wife choose a duration of parental leave from the menu of 0, 6.5, 17, 26, 35, 45.5, and 52 weeks, keeping the sum of their durations less than or equal to 52 weeks.

Table 4.9: Take-up Rates under Alternative Policies

(a) With the Calibrated Parameter Values

	Fathers		Mothers	
	Low	High	Low	High
(1) Baseline Policy	11.4	10.2	93.4	93.4
(2) Short Paternity Leave	12.1	11.8	93.1	93.2
(3) Equal Mat./Pat. Leave	12.5	12.6	93.3	93.4
(4) All Shareable Par. leave	11.7	10.3	93.4	92.8

(b) With All Gender Differences Removed

	Individual				Household (Husband's, Wife's)							
	Fathers		Mothers		(lo, lo)		(lo, hi)		(hi, lo)		(hi, hi)	
	Low	High	Low	High	Husb.	Wife	Husb.	Wife	Husb.	Wife	Husb.	Wife
(1) Baseline Policy	60.3	50.8	57.1	49.8	46.2	46.0	72.3	28.2	27.2	73.2	56.8	59.4
(2) Short Paternity Leave	60.6	52.4	56.2	49.7	47.2	46.0	72.2	28.4	29.5	71.3	58.2	59.2
(3) Equal Mat./Pat. Leave	60.5	52.9	57.2	49.8	47.0	46.4	72.0	28.4	29.0	73.1	59.0	59.3
(4) All Shareable Par. leave	59.9	50.3	56.8	47.4	46.1	46.5	71.9	26.6	26.9	72.1	56.3	56.6

differences removed. Statistics in the first row with the baseline policy are the same as those in columns (1) and (2) of Table 4.7, and the remaining rows report the statistics from policy experiments.

The results with the calibrated parameter values show only small changes in take-up rates in response to changes in parental leave policies. The main reason for this result is that the introduction of paternity leave does not provide most couples with enough incentive to change in the environment where specialization within married couples with an infant is strong.

When all 52 weeks are shareable and all gender differences are removed, the high-educated mothers' take-up rate is lower than in the case with the baseline policy. Specifically, among high-educated couples, wives' take-up rate decreases while husbands' take-up rate remains unchanged. This means that in some couples a high-educated wife uses maternity leave because the time is not transferable to her husband under the baseline policy. When all leave is shareable, those couples choose to have a wife stay at her work and her husband take longer parental leave.

To sum up, some couples' choices are constrained by the baseline parental leave policy. The introduction of a gender-neutral policy leads to small increases in fathers' take-up of parental leave. However, the small changes are in contrast to evidence from the countries and states which have introduced paid paternity leave, as they show much higher take-up rates of fathers. For example, after Québec introduced paid paternity leave in 2006, fathers' take-up rate increased from 28% in 2005 under EI to 56% in 2006 and 78% in 2014 (Doucet, Tremblay, and Lero, 2010, Statistics Canada, 2015).[28] A key feature of paid parental leave policies in these places is higher cash benefits, especially higher income replacement rates. For example, during parental leave parents in Québec and Sweden are paid 70–75% and 80% of their pre-birth income, respectively. I examine the role of cash benefits in the following section.

4.6.2 Cash Benefits

In this subsection, I explore the role of cash benefits in the division of parental leave within married households. Under the baseline policy, parental benefits replace the pre-birth earnings at the baseline rate of 55% with a weekly cap. Those who earn more than $39,000 a year receive the capped amount of weekly benefits. Thus, a worker who uses parental leave loses at least 45% of earnings every week on leave. Such income losses could be critical to their decisions regarding parental leave. Because in many couples a husband usually outearns his wife, the amounts of parental benefits may be too low for a couple to have a husband take parental leave. Taking the maximum insurable earnings of $39,000 a year as given, I explore

[28] These statistics are unconditional on eligibility.

Table 4.10: Take-up Rates by Income Replacement Rate

	(a) Baseline Policy						(b) Short Paternity Leave					
	Fathers (F)		Mothers (M)		Gap (M-F)		Fathers (F)		Mothers (M)		Gap (M-F)	
Replacement rate	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
Baseline (0.55)	11.4	10.2	93.4	93.4	82.0	83.2	11.4	10.2	93.4	93.4	82.0	83.2
0.01	10.9	8.7	89.0	85.5	78.2	76.9	11.1	8.5	89.0	85.6	77.9	77.1
0.33	10.7	9.4	91.9	90.3	81.1	80.9	11.0	9.5	91.8	90.2	80.8	80.7
0.70	11.2	11.2	94.6	96.5	83.3	85.3	13.6	15.9	95.1	96.4	81.5	80.5
0.85	12.5	13.8	96.1	97.7	83.6	83.9	16.1	21.9	96.3	97.8	80.2	75.9
1.00	13.9	17.0	97.0	98.9	83.1	81.9	19.9	29.3	96.8	98.8	77.0	69.5

"High" denotes the high-educated who are college graduates. "Low" denotes a lower education level.

five different levels of income replacement rates, denoted by ρ.[29]

Table 4.10 displays take-up rates from simulations with income replacement rates of 1%, 33%, 55%, 70%, 85%, and 100%. Panel (a) reports the statistics from simulations with the durations of maternity and parental leave the same as the baseline policy. Panel (b) reports the same statistics from simulations under an alternative parental leave policy with short paid paternity leave as in the preceding subsection.

The case of $\rho = 0.01$ is close to unpaid parental leave. When a worker is barely paid during parental leave, slightly fewer parents take parental leave for all subgroups while the overall division of parental leave remains more or less the same as in the benchmark. Although parental leave is almost unpaid, many mothers still use it, but for a shorter period. Under the baseline policy, 92% of mothers use parental leave for more than 40 weeks. Under unpaid parental leave, 89% of low-educated mothers use parental leave, on average, for 33 weeks, and 85% of high-educated mothers do so, on average, for 29 weeks. Given the gender differences in the benchmark economy, once a couple has a newborn child, a mother is much more likely to be the parent who specializes in home production.

In contrast, when parents receive 100% of their pre-birth earnings up to the maximum insurable earnings, take-up rates go up for all subgroups. Mothers' take-up rates become close to 100%, and fathers' take-up rates increase by 22% to 14% for the low-educated and by 62% to 17% for the high-educated. Because increasing a replacement rate does not change the comparative advantages between a husband and wife, mothers are still much more likely to take parental leave than fathers. Also, husbands are more likely to have earnings higher than the maximum insurable earnings. Many husbands with high earnings have an effective income replacement rate below 100%.

[29] Because the maximum insurable earnings are fixed at $39,000, as the income replacement rate increases, the maximum weekly benefit amount increases proportionally.

In terms of percentage changes in take-up rates, the change is greatest among high-educated fathers. Even though they are more likely to earn more than the threshold amount, among all subgroups, they gain the most benefits from a fully paid parental leave policy because their earnings are the highest. Also, compared to low-educated fathers, they are more likely to have a high-educated wife. Fathers with a high-educated wife are more responsive to changes in income replacement rates.[30] As more fathers use parental leave even for a short period, the average duration of fathers' use becomes shorter than in the benchmark.

In the simulations for panel (b), an eligible father has an option of taking 6.5 weeks off or leaving it on the table, reducing the maximum duration of shareable parental leave by 6.5 weeks. In this case, fathers' take-up behaviour becomes more responsive to changes in income replacement rates than under the baseline policy. Under a parental leave policy with short paternity leave, an increase of the income replacement rate from the baseline rate to 100% results in a 75% increase to 20% for the low-educated and a 187% increase to 29% for the high-educated. Meanwhile, mothers' take-up rates remain the same as with Table 4.10.

To sum up, providing greater financial incentives through an increase in the income replacement increased both mothers' and fathers' take-up rates. In addition, the results showed that when increasing the income replacement rate is combined with introducing short paternity leave, an increase in fathers' take-up rates becomes more responsive to an increase in the income replacement rate. In particular, high-educated fathers are more responsive to these changes than others.

4.6.3 Parental Leave Policies to Increase Fathers' Take-up of Leave

An aim of sharable parental leave is to provide fathers the option to be more involved in caring for new babies. However, the take-up rate of fathers remains low even after parental leave was extended. Putting the findings in the two preceding subsections together, I conduct policy experiments to increase fathers' take-up of parental leave. I set a target for fathers' take-up rates and explore various combinations of durations and replacement rates that can achieve the target. Because high-educated fathers are more responsive to policy changes, I set the target of high-educated fathers' take-up rate to be 20%. This target is almost twice the rate in the benchmark economy. In the experiments, I also consider policies that provide different replacement rates among maternity, paternity, and shareable parental leaves and between fathers and mothers. As before, the maximum insured earnings remain the same as in the benchmark policy. I compare the policies that meet the target in terms of their monetary costs by looking at percentage changes in aggregate parental benefit expenses from the benchmark economy. Also, I look at

[30] See Panel (b) of Table C.18 in Appendix C.

changes in the amount of time newborn children spend with their parents during the first year of their life. In this set of simulations I take all the gender differences, including the three major contributors, in the benchmark economy as given. Table 4.11 summarizes the results.

I find that under a policy with baseline maximum durations, a parental leave policy to achieve the target need to provide a higher replacement rate for fathers than for mothers. Without paternity leave, even applying a 100% replacement for all does not meet the target (Table 4.10). When the replacement rate for mothers remains at the baseline rate of 55%, the replacement rate for fathers must be at least 90%. The higher replacement rate for fathers is necessary to increase the husband's marginal benefit of taking leave relative to the wife's marginal benefit. Compared to the benchmark, this policy increases aggregate EI spending by 12%.[31] Children spend more time with their fathers. On average, children receive 1.5 more weeks of full-time care from their father. Although they spend less time with their mother, overall, they receive 1.1 more weeks of full-time care from parents. A drawback of this policy is that it may not be politically viable.[32]

As mentioned above, a combination of introducing paternity leave and raising replacement rates for all can increase fathers' take-up rates. However, this policy is costly. The replacement rate of 80% increases high-educated fathers' take-up rates to 20%. The policy costs about 1.5 times the benchmark aggregate spending. This policy might be unaffordable without a large increase in the EI premium.[33]

A more affordable option is to increase replacement rates only during non-transferable leaves. For example, increasing the replacement rate to 80% only during paternity leave doubles high-educated fathers' take-up rate, while it requires less aggregate spending than the benchmark level. Increasing a replacement rate during paternity leave to 100% still costs less than the benchmark policy, while high-educated fathers' take-up rate is tripled to 30%.

Finally, a policy that offers higher replacement rates during maternity and paternity leaves may be politically viable and an affordable option to increase fathers' take-up of leave. Combined with a short paternity leave, providing 80% of income replacement during maternity and paternity leaves increases high-educated fathers' take-up rates to 20%. Implementing this policy implies a 13.5% increase in aggregate spending on parental benefits. Under a policy with an equal length of maternity and paternity leaves, a replacement rate of 76% achieves the target. This policy only increases aggregate spending by 1%. A caveat of these policies is

[31]No general equilibrium effect is considered in this exercise.

[32]However, considering a gender-based public policy is not unusual in economics. Gender-based taxation has been studied in the optimal taxation literature. Alesina, Ichino, and Karabarbounis (2011) argue that because women's labour supply is more elastic due to higher male wages and higher female home productivity, imposing higher marginal tax rates on men is optimal.

[33]Because the experiments here do not mandate balanced EI budget, the indirect effect of increasing replacement rates on labour supply decisions through an increase in the EI premium is not included in this analysis.

Table 4.11: Policy Experiments

Duration type &	Take-up rates				% changes in aggregate parental benefit expenses[†]			Changes in full-time care for a baby (weeks)[‡]		
	Fathers		Mothers							
$(\rho_h^{pat}, \rho_w^{mat}, \rho_h^{par}, \rho_w^{par})$	Low	High	Low	High	Fathers	Mothers	Total	Fathers	Mothers	Total
Baseline durations										
$(-, 0.55, 0.90, 0.55)$	17	20	93	94	160.7	-1.7	12.2	1.5	-0.5	1.1
All Shareable Par. Leave										
$(-, -, 0.90, 0.55)$	17	20	93	93	188.9	-3.7	12.9	1.6	-0.5	1.1
Short Paternity Leave										
$(0.80, 0.80, 0.80, 0.80)$	15	20	96	97	83.4	45.4	48.6	0.7	-0.5	0.2
$(0.80, 0.80, 0.55, 0.55)$	16	20	95	97	35.6	11.4	13.5	0.5	-2.4	-2.0
$(0.80, 0.55, 0.55, 0.55)$	16	20	93	94	37.7	-11.0	-6.8	0.5	-3.1	-2.6
Equal Mat./Pat. Leave										
$(0.76, 0.76, 0.76, 0.76)$	16	20	95	97	76.0	12.5	18.0	0.8	-4.7	-4.0
$(0.76, 0.76, 0.55, 0.55)$	16	20	95	97	57.5	-4.6	0.8	0.7	-5.5	-4.8

$(\rho_h^{pat}, \rho_w^{mat}, \rho_h^{par}, \rho_w^{par})$ denotes replacement rates for paternity, maternity, and father's and mother's parental leaves, respectively. [†] compared to the aggregate budget in the benchmark economy. [‡] When a mother or father does not work during the period, their duration is counted as 52 weeks regardless of eligibility and take-up of leave. Otherwise, the choices of leave are used in the calculation.

that the average amount of time parents spend with their newborn child slightly declines. The policies with short paternity leave and with longer paternity leave reduce the number of weeks parents provide full-time care during the first year of their child's life by 2 and 5 weeks, respectively. This is because many fathers do not use the non-transferable paternity leave, while many mothers who used to take a full year of leave now take shorter leaves.

Haas and Rostgaard (2011) compared parental leave policies and take-up from five Nordic countries. They suggest that introducing paternity leave is more important than generous compensation during paternity leave in promoting fathers' take-up of parental leave.[34] All five countries have income replacement rates that are higher than the Canadian benchmark policy. Based on my results from the policy experiments, I argue that fathers' take-up rates in the Nordic countries might not be as high as in the data if paternity leave is not accompanied with generous income replacement rates.

4.7 Conclusion

In this paper, I examine quantitatively the contribution of several possible explanations for the division of paid parental leave within married households in a life-cycle model of family labour supply. I document that despite its availability only a small fraction of married men use parental leave and demonstrate empirical evidence for explanatory factors to understand the low take-up rates of married men. Then, I calibrate a life-cycle model of family labour supply that features labour/leisure/home production choices and learning-by-doing human capital accumulation. In the quantitative analyses, I find that lower home productivity in the presence of an infant, higher rental rates of human capital, and higher wage penalties for not working for fathers than for mothers are major contributors to the low take-up rates of fathers. Among high-educated people, the three gender differences account for about 36%, 15%, and 13%, respectively. Eliminating gender differences in the three factors results in fathers' take-up rate exceeding mothers' take-up rates among the high-educated. Also, I find that when increasing the income replacement rate is combined with introducing short paternity leave, an increase in fathers' take-up rates becomes more responsive to an increase in the income replacement rate.

This study is motivated by the low take-up rate of fathers even after parental leave was extended. The aims of the extension were to help working parents spend more time with their children for successful child development and to provide fathers the option to share more of the responsibilities of caring for babies. My findings suggest policies to achieve these goals. First, the policy experiments show that a combination of introducing paternity leave and offering

[34] The five countries are Denmark, Finland, Iceland, Norway, and Sweden. Policies and fathers' take-up in 1998, 2007, and 2010 are compared.

higher replacement rates during maternity and paternity leaves is an effective way of promoting fathers' participation in parental leave. Despite a slight decrease in the total amount of time newborn children spend with their parents, this policy could increase fathers' take-up with a small increase in aggregate spending.

Further, the findings on the three major factors determining the low take-up rates of fathers have policy implications for fulfilling the goal of encouraging fathers to take parental leave. First, initiatives to reduce gender differences in the rental rates of human capital would increase fathers' take-up rates. In many countries, employment and pay discrimination by gender has been prohibited by law such as the Canadian Human Rights Act in Canada and the Equal Pay Act in the U.S. Although there has been a large increase in women's labour force participation and a decline in gender wage gaps over the past several decades, gender wage gaps still remain (Goldin, 2014).

Another key finding is that a large gender difference in home productivity with an infant is the most significant contributor to the division of parental leave. Eliminating the difference leads to a substantial increase in fathers' take-up rates. This finding implies that an initiative to improve men's skill in caring for a newborn child before their child is born can increase fathers' take-up rates. For example, parenting education for fathers may improve their parenting skill (Doherty, Erickson, and LaRossa, 2006). Early parenting education programs for new parents have a significant positive effect on parenting and child development (Pinquart and Teubert, 2010). Nonetheless, nearly all education programs about parenting primarily target mothers, and very few parent education programs are father-oriented (Matusicky and Russell, 2009, Gilmer et al., 2016).

Lastly, I find that men have a higher probability of human capital depreciation and that this probability matters for married couples' take-up decisions. The wage penalty for taking time off work may be partly because taking leave is perceived as signaling weak commitment to work (Wayne and Cordeiro, 2003). As statutory maternity leave reduced the motherhood penalty (Correll, 2013), providing statutory paternity leave may lessen the stigma effect of taking leave for fathers. We can anticipate a gradual increase in fathers' take-up rates in the long run due to the peer effects in taking paternity leave (Dahl et al., 2014).

While this study demonstrates that the gender difference in wage penalties for not working is a significant contributor to the low take-up of fathers, it still leaves some important areas for future research. In calibration, the probability of human capital depreciation is determined by the wage growth rates for those who have not worked for at least one year (full-year full-time equivalent) within five years. Only a few married men in my sample from SLID had such experience of non-employment. Therefore, the relative importance of the explanation may be due to selection based on unobserved heterogeneity, which is not considered in this paper.

Although Albrecht et al. (1999) find that the negative effect of men's career interruptions is greater for parental leave than for unemployment using a rich data set from Sweden, this has not been studied in the Canadian context due to lack of data. It would be useful to examine gender differences in wage penalties for not working using new administrative data in Canada.

A limitation of my model is that it does not include income taxation which is also closely related to labour supply decisions. EI benefits pay 55% of the pre-tax earnings and are taxable. As Canada has a system based on individual taxation of spouses, the division of parental leave within a married couple influences spouses' earnings and marginal tax rates and thus a total of after-tax incomes for the couple. Incorporating income taxation is an interesting area for future research.

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Chapter 5

Conclusion

In this thesis, I examine how married couples' decisions regarding time allocations, job search, fertility, and take-up of parental leave are related to parental leave policies. In Chapter 2, I document that parental leave policies and take-up behaviour in Canada and the U.S. are very different. Mothers in Canada, which has a longer paid parental leave, take longer leaves than mothers in the U.S., which has a short unpaid parental leave. Canadian working mothers allocate time off work across child care, household chores, and leisure. I also show that the two countries exhibit a large difference in high-educated mothers market work only in the presence of an infant, whereas Canada-U.S. differences in low-educated mothers market work are significant until the youngest child is aged 6 or older. These findings suggest that high-educated mothers in the U.S. maintain similar job continuity rates as those in Canada, whereas low-educated mothers in the U.S. may have difficulties in securing jobs after the birth of a child possibly due to lower eligibility rates for a FMLA leave.

In Chapter 3, I develop a unique household search model and study married couples' decisions regarding job search, household labour supply, and take-up of maternity leave. This household search model generates an interesting household interaction in job search through specialization based on comparative advantages between market work and home production within a married couple. Using the model, I find that a policy reform from short unpaid leave to longer paid leave increases fertility rates, lowers the fraction of dual-earner couples, and increases the fraction of single-earner couples. This model predicts that not only the fraction of couples with only a husband employed increases, but also the fraction of couples with only a wife employed increases. Married couples are more likely to specialize between market work and home production due to an increase in the number of children. This chapter demonstrates that married couples' fertility and labour supply decisions can be responsive to the generosity of maternity leave policies.

In Chapter 4, I examine what prevents fathers from taking paid parental leave under EI despite its availability. I find both market and home production factors contribute to married couples' specialization between market work and home production and their take-up of parental leave. In policy experiments, I find that an increase in the income replacement increases fathers' take-up rates. Fathers' take-up behaviour is more responsive to an increase in an income replacement rate when it is combined with the introduction of paternity leave. When paternity leave is available with small cash benefits, fathers' take-up rates barely change in my model. These policy experiment results suggest not only the availability of parental leave for fathers, but also money, is important to incentivizing fathers' take-up of parental leave.

My studies in this thesis have a few limitations and still leave some important areas for future research. First, exploring interactions between a parental leave policy and other policies and their impact on married couples' decisions is an interesting area for future research. Although I focus on parental leave policies in this thesis, other policies such as universal child care benefits, taxation, or the supply of child care services are also closely related married couples' labour supply decisions after the birth of a child. Such policies may complement or offset each other in terms of their impact on married couples' labour supply.

Second, the inclusion of child quality will be an important extension of the models in Chapters 3 and 4 for future research. One of the reasons why fathers' take-up of parental leave draws policymakers' interest is that not only mothers' time but also fathers' time spent with their children contribute to their baby's development. The lack of child quality production makes my analyses disregard a trade-off among mother's time, father's time, and money in a married couple's take-up decisions. In particular, this trade-off is crucial if mothers and fathers have different home productivity in child quality production. Also, the trade-off between the number and quality of children is crucial in understanding fertility decisions (Becker, 1960). Adding child quality production into the models will allow for these two important trade-offs in a married couple's decisions regarding labour supply, fertility, and take-up of parental leave.

Another interesting topic is to study firm responses to parental leave policies. In this thesis, I focus on only the relationship between parental leave and labour supply. However, labour demand may also respond to a parental leave policies. One of arguments against statutory paid parental leave in the U.S. is that paid parental leave will make employers bear a higher cost leading to a reduction in labour demand. Understanding the firm side, along with married couples' joint labour supply decisions, would be useful to evaluate the effects of changes in parental leave policies on social welfare.

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Appendix A

Chapter 2 Appendix

Table A.1: Results from OLS Regressions of Hours per Week – High-educated, Canada

	Market Work	Child Care	Household chores	Leisure
30-34	2.494	1.945	-1.568	-2.871
	(2.193)	(1.231)	(1.370)	(2.073)
35-39	4.310+	2.446*	-1.614	-5.143*
	(2.251)	(1.189)	(1.419)	(2.083)
40-44	5.796*	2.657*	-1.672	-6.781**
	(2.484)	(1.250)	(1.610)	(2.258)
45–49	3.026	2.905*	-1.680	-4.251+
	(2.782)	(1.278)	(1.885)	(2.526)
50–54	1.597	3.643**	-1.141	-4.099
	(3.261)	(1.344)	(2.274)	(2.859)
Wife	-24.513**	17.261**	8.347**	-1.095
	(2.761)	(1.520)	(1.793)	(2.412)
Two	1.101	2.059**	-1.812	-1.348
	(2.030)	(0.665)	(1.234)	(1.724)
Three+	0.588	0.643	1.761	-2.993
	(2.575)	(0.682)	(1.537)	(2.075)
Wife#Two	-3.254	0.025	4.845**	-1.617
	(2.570)	(1.001)	(1.644)	(2.156)
Wife#Three+	-8.665**	2.170	5.649**	0.846
	(3.229)	(1.340)	(2.113)	(2.709)
2–3	3.796	-1.342	-0.434	-2.020
	(2.818)	(1.275)	(1.568)	(2.376)
4–5	-3.218	-2.854*	1.896	4.176
	(3.233)	(1.370)	(1.825)	(2.616)
6–8	0.623	-6.219**	-0.199	5.795*
	(2.987)	(1.270)	(1.691)	(2.659)
9–11	0.413	-10.447**	1.353	8.681**
	(3.298)	(1.240)	(1.995)	(2.824)
12–14	-2.492	-12.170**	4.437*	10.224**
	(3.354)	(1.254)	(2.183)	(2.876)
15–17	4.607	-14.368**	4.022	5.739+
	(4.026)	(1.192)	(2.954)	(3.253)
Wife#2–3	5.938+	-8.972**	-2.238	5.272+
	(3.523)	(1.930)	(2.099)	(2.975)
Wife#4–5	14.585**	-13.869**	-1.879	1.163
	(3.989)	(1.932)	(2.480)	(3.254)
Wife#6–8	12.880**	-12.577**	0.113	-0.415
	(3.557)	(1.769)	(2.152)	(3.094)
Wife#9–11	14.517**	-12.630**	0.168	-2.056
	(3.817)	(1.746)	(2.394)	(3.267)
Wife#12–14	14.688**	-14.215**	-1.468	0.995
	(3.939)	(1.952)	(2.653)	(3.345)
Wife#15–24	12.146**	-17.654**	-2.246	7.754*
	(4.602)	(1.517)	(3.364)	(3.818)
Constant	35.389**	10.172**	16.031**	50.408**
	(2.861)	(1.262)	(1.638)	(2.583)

Data: General Social Survey (2005, 2010). Robust Standard Error in parenthesis. **Significant at the 1% level. *Significant at the 5% level. +Significant at the 10% level.

Table A.2: Results from OLS Regressions of Hours per Week – Low-educated, Canada

	Market Work	Child Care	Household chores	Leisure
30-34	-1.246	3.277*	1.300	-3.332
	(3.261)	(1.430)	(1.751)	(3.007)
35-39	5.421	3.465*	-1.678	-7.208*
	(3.369)	(1.490)	(1.854)	(3.050)
40-44	-0.685	3.728*	1.392	-4.435
	(3.522)	(1.472)	(1.981)	(3.330)
45–49	1.284	1.911	0.987	-4.182
	(3.877)	(1.423)	(2.240)	(3.697)
50–54	-3.425	3.600*	2.408	-2.584
	(4.727)	(1.618)	(2.741)	(4.327)
Wife	-29.606**	18.954**	16.786**	-6.134
	(4.270)	(2.483)	(2.605)	(4.052)
Two	-2.087	0.813	1.299	-0.025
	(2.855)	(0.793)	(1.506)	(2.538)
Three+	0.591	-1.089	0.860	-0.363
	(3.437)	(0.924)	(2.026)	(3.149)
Wife#Two	0.131	0.692	-0.367	-0.455
	(3.707)	(1.408)	(2.353)	(3.236)
Wife#Three+	-5.165	2.537	3.875	-1.247
	(4.436)	(1.789)	(3.030)	(3.983)
2–3	0.993	-2.086	1.360	-0.266
	(4.754)	(1.780)	(2.183)	(4.403)
4–5	2.111	-5.460**	1.458	1.891
	(4.698)	(1.731)	(2.501)	(4.473)
6–8	5.257	-6.921**	1.516	0.147
	(4.284)	(1.514)	(2.110)	(4.158)
9–11	2.279	-8.027**	4.037+	1.711
	(4.590)	(1.549)	(2.407)	(4.486)
12–14	2.890	-10.146**	1.247	6.010
	(4.569)	(1.486)	(2.374)	(4.472)
15–17	2.340	-12.056**	5.312+	4.403
	(4.970)	(1.439)	(2.986)	(5.041)
Wife#2–3	11.438*	-8.152**	-7.642*	4.357
	(5.671)	(3.140)	(3.488)	(5.410)
Wife#4–5	11.204+	-11.017**	-2.539	2.352
	(5.733)	(3.027)	(3.791)	(5.422)
Wife#6–8	7.257	-10.418**	-3.850	7.012
	(5.013)	(2.793)	(3.223)	(5.029)
Wife#9–11	10.068+	-14.829**	-6.244+	11.005*
	(5.156)	(2.851)	(3.424)	(5.105)
Wife#12–14	19.467**	-17.255**	-1.679	-0.533
	(5.350)	(2.649)	(3.274)	(4.911)
Wife#15–24	16.981**	-19.706**	-5.682	8.408
	(5.907)	(2.426)	(3.952)	(5.573)
Constant	37.578**	9.087**	11.750**	53.586**
	(4.183)	(1.550)	(1.970)	(3.784)

Data: General Social Survey (2005, 2010). Robust Standard Error in parenthesis. **Significant at the 1% level. *Significant at the 5% level. +Significant at the 10% level.

Table A.3: Results from OLS Regressions of Hours per Week – High-educated, The U.S.

	Market Work	Child Care	Household chores	Leisure
30–34	0.160	0.795	0.498	-1.453+
	(1.090)	(0.584)	(0.588)	(0.872)
35–39	-0.148	1.375*	1.469*	-2.695**
	(1.109)	(0.572)	(0.595)	(0.881)
40–44	-1.330	2.019**	2.201**	-2.890**
	(1.185)	(0.590)	(0.656)	(0.950)
45–49	-2.330+	2.413**	3.452**	-3.535**
	(1.292)	(0.607)	(0.718)	(1.028)
50–54	-1.655	1.955**	4.284**	-4.584**
	(1.447)	(0.633)	(0.819)	(1.148)
Wife	-16.843**	13.320**	6.972**	-3.449**
	(1.230)	(0.640)	(0.656)	(0.960)
Two	2.405**	1.228**	-0.514	-3.119**
	(0.870)	(0.319)	(0.450)	(0.712)
Three+	3.879**	1.408**	-0.375	-4.913**
	(1.042)	(0.397)	(0.560)	(0.843)
Wife#Two	-4.711**	1.426**	2.468**	0.817
	(1.146)	(0.464)	(0.640)	(0.913)
Wife#Three+	-9.845**	3.386**	5.763**	0.696
	(1.385)	(0.640)	(0.813)	(1.105)
2–3	1.452	-3.221**	-0.563	2.331**
	(1.126)	(0.483)	(0.599)	(0.899)
4–5	1.209	-5.030**	-0.661	4.482**
	(1.298)	(0.510)	(0.683)	(1.023)
6–8	-0.064	-6.193**	-0.057	6.314**
	(1.226)	(0.508)	(0.642)	(1.001)
9–11	4.227**	-8.916**	-0.242	4.931**
	(1.294)	(0.506)	(0.732)	(1.012)
12–14	2.185	-10.391**	0.054	8.152**
	(1.447)	(0.518)	(0.813)	(1.160)
15–17	5.879**	-11.584**	-0.705	6.410**
	(1.810)	(0.558)	(0.914)	(1.500)
Wife#2–3	2.313	-5.203**	1.364	1.526
	(1.514)	(0.774)	(0.851)	(1.187)
Wife#4–5	4.360*	-8.043**	1.623+	2.059
	(1.702)	(0.774)	(0.932)	(1.321)
Wife#6–8	7.215**	-9.878**	0.418	2.244+
	(1.559)	(0.735)	(0.846)	(1.271)
Wife#9–11	4.599**	-9.687**	1.877+	3.211*
	(1.625)	(0.734)	(0.959)	(1.258)
Wife#12–14	7.464**	-10.779**	2.647*	0.668
	(1.776)	(0.747)	(1.043)	(1.418)
Wife#15–24	4.366+	-11.698**	3.800**	3.533*
	(2.232)	(0.767)	(1.266)	(1.786)
Constant	38.845**	11.751**	12.875**	48.529**
	(1.255)	(0.604)	(0.636)	(0.996)

Data: American Time Use Survey (2003-2016). Robust Standard Error in parenthesis. **Significant at the 1% level. *Significant at the 5% level. +Significant at the 10% level.

Table A.4: Results from OLS Regressions of Hours per Week – Low-educated, The U.S.

	Market Work	Child Care	Household chores	Leisure
30-34	1.406	-0.424	0.833	-1.815*
	(0.919)	(0.463)	(0.547)	(0.805)
35-39	1.036	0.121	2.248**	-3.405**
	(0.946)	(0.471)	(0.571)	(0.812)
40-44	1.642	-0.282	2.913**	-4.273**
	(1.028)	(0.481)	(0.619)	(0.879)
45–49	-0.855	-1.045*	4.333**	-2.432*
	(1.136)	(0.493)	(0.688)	(0.978)
50–54	-2.671*	-1.682**	4.555**	-0.202
	(1.352)	(0.515)	(0.811)	(1.180)
Wife	-20.571**	11.062**	9.448**	0.061
	(1.546)	(0.781)	(0.947)	(1.351)
Two	0.664	0.629*	0.308	-1.601+
	(0.985)	(0.288)	(0.524)	(0.826)
Three+	-1.154	0.883*	0.538	-0.267
	(1.142)	(0.436)	(0.605)	(0.966)
Wife#Two	-3.374*	0.767	2.687**	-0.081
	(1.331)	(0.481)	(0.826)	(1.129)
Wife#Three+	-5.655**	2.056**	5.792**	-2.193+
	(1.493)	(0.667)	(0.945)	(1.299)
2–3	-0.747	-1.263*	-0.709	2.718*
	(1.351)	(0.616)	(0.702)	(1.134)
4–5	0.978	-2.720**	-0.527	2.269+
	(1.437)	(0.553)	(0.764)	(1.193)
6–8	0.264	-3.754**	-1.104	4.594**
	(1.368)	(0.526)	(0.710)	(1.158)
9–11	0.954	-5.718**	-1.308+	6.072**
	(1.436)	(0.504)	(0.774)	(1.213)
12–14	0.518	-6.481**	-0.734	6.696**
	(1.601)	(0.523)	(0.849)	(1.343)
15–17	1.509	-7.180**	-0.606	6.276**
	(1.896)	(0.530)	(1.042)	(1.608)
Wife#2–3	2.207	-4.574**	2.476*	-0.109
	(1.761)	(0.972)	(1.101)	(1.577)
Wife#4–5	0.919	-5.069**	2.039+	2.112
	(1.862)	(0.919)	(1.215)	(1.648)
Wife#6–8	5.649**	-5.615**	2.005+	-2.039
	(1.781)	(0.860)	(1.105)	(1.549)
Wife#9–11	6.135**	-6.748**	1.783	-1.169
	(1.836)	(0.829)	(1.168)	(1.603)
Wife#12–14	7.533**	-8.268**	2.359+	-1.624
	(2.003)	(0.856)	(1.228)	(1.717)
Wife#15–24	7.718**	-8.985**	2.536+	-1.269
	(2.411)	(0.849)	(1.522)	(2.042)
Constant	37.575**	9.602**	13.151**	51.672**
	(1.255)	(0.567)	(0.677)	(1.075)

Data: American Time Use Survey (2003-2016). Robust Standard Error in parenthesis. **Significant at the 1% level. *Significant at the 5% level. +Significant at the 10% level.

Appendix B

Chapter 3 Appendix

Value Functions of *older* Couples. An *older* does not have children to take care of and thus does not derive utility from children and home production (k=0, ν=0). Also, an *older* couple is non-fertile and thus the couple cannot be eligible for child-related leaves (l=0). For simplicity, the state variables of (k, l, ν) are omitted in the value functions because they are all zeros for all *older* couples.

An *older* couple makes only labour decisions. Only labour shocks affect an *older* couple. The labour shocks include retirement as well as job arrivals and job destruction. A retirement shock occurs with a probability δ_R. When the shock affects a couple, they retire together and have a constant value. For the simulation exercises the the paper, the value to a retired couple is set to zero.

The value of an *older* couple with both spouses employed, denoted as V^o, is defined as follows:

$$\begin{aligned} V^o(q^f, q^m) =& (\beta + \delta^f + \delta^m + p_e^f + p_e^m + \delta_R)^{-1} \Big\{ w^f + w^m \\ & + \delta^f T^o(0, q^m) \\ & + \delta^m W^o(q^f, 0) \\ & + p_e^f \, \mathbb{E}_{q'^f} \left[\max\{V^o(q'^f, q^m), V^o(q^f, q^m)\} \right] \\ & + p_e^m \mathbb{E}_{q'^f} \left[\max\{V^o(q^f, q'^m), V^o(q^f, q^m)\} \right] \\ & + \delta_R \cdot 0 \Big\} \end{aligned}$$

The value to an *older* couple with only a wife is employed, denoted as W^o, is defined as follows:

$$\begin{aligned} W^o(q^f, 0) =& (\beta + \delta^f + p_e^f + p_u^m + \delta_R)^{-1} \Big\{ w^f + z \\ & + \delta^f U^o(0, 0) \\ & + p_e^f \, \mathbb{E}_{q'^f} \left[\max\{W^o(q'^f, 0), W^o(q^f, 0)\} \right] \\ & + p_u^m \, \mathbb{E}_{q^m} \left[\max\{V^o(q^f, q^m), W^o(q^f, 0)\} \right] \\ & + \delta_R \cdot 0 \Big\} \end{aligned}$$

The value to an *older* couple with only a husband is employed, denoted as T^o, is defined as follows:

$$\begin{aligned} T^o(0,q^m) =&(\beta+\delta^m+p_e^m+p_u^f+\delta_R)^{-1}\Big\{ z+w^m \\ &+\delta^m U^o(0,0) \\ &+p_e^m\,\mathbb{E}_{q'^m}\left[\max\{T^o(0,q'^m),T^o(0,q^m)\}\right] \\ &+p_u^f\,\mathbb{E}_{q^f}\left[\max\{V^o(q^f,q^m),T^o(0,q^m)\}\right] \\ &+\delta_R\cdot 0\Big\} \end{aligned}$$

The value to an *older* couple with neither spouse employed, denoted as U^o, is defined as follows:

$$\begin{aligned} U^o(0,0) =&(\beta+p_u^f+p_u^m+\delta_R)^{-1}\Big\{ 2z \\ &+p_u^f\,\mathbb{E}_{q^f}\left[\max\{W^o(q^f,0),U^o(0,0)\}\right] \\ &+p_u^m\,\mathbb{E}_{q^m}\left[\max\{T^o(0,q^m),U^o(0,0)\}\right] \\ &+\delta_R\cdot 0\Big\} \end{aligned}$$

For the simulation exercises in this paper, the unemployment beneft z is set lower than the lowest match-specific productivity of the offer distribution. Therefore, an older married individual who receives a job offer always accept it. Also, because an older couple does not derive utility from home production, the reservation productivity of an *older* couple in this household search model is equivalent to that in an individual search model.

Appendix C

Chapter 4 Appendix

C.1 Empirical Evidence

Table C.1: Employment-to-population Ratios at Age 23

	High-educated		Low-educated	
Employment	Men	Women	Men	Women
$\mathbb{1}\{n_i \geq 300\}$	98.3	83.5	95.8	54.3
$\mathbb{1}\{n_i \geq 1,560\}$	81.6	55.5	83.4	27.4
All year	71.8	61.9	71.5	33.2
Part-year or more	93.6	79.7	92.1	53.1
Ever in the year	98.8	90.1	97.2	58.3

Annual hours worked is denoted by n_i. The first group is based on variable ”alhrp28” for total hours paid all jobs during the reference year. The second group is based on variable ”alfst28” for annual labour force status. Cross-sectional data from Survey of Labour Income Dynamics (2001-2010) are used for the calculation.

Table C.2: Descriptive Statistics of High-educated People’s Hourly Wages at Age 23

	Married			Any marital status		
	Men (M)	Women (W)	Ratio (W/M)	Men (M)	Women (W)	Ratio (W/M)
High-edu						
Median	15.3	12.5	.817	14.9	12.1	.812
Mean	17.1	13.5	.789	16.1	13.6	.845
S.D	8.9	5.1		7.5	6.3	
Low-edu						
Median	13.0	9.2	.708	12.3	9.6	.780
Mean	13.5	10.6	.785	13.4	10.8	.806
S.D	4.4	4.2		5.8	4.1	

Table C.3: Descriptive Statistics

	All				Low-educated				High-educated			
	Male		Female		Male		Female		Male		Female	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
ln(Wage)	3.07	0.44	2.83	0.47	2.90	0.40	2.58	0.41	3.16	0.42	2.93	0.45
Age	38.9	6.57	38.3	6.75	39.1	6.80	39.5	6.67	38.5	6.44	37.8	6.72
Years of schooling	14.2	3.20	14.4	2.89	11.5	2.06	11.8	2.05	15.5	2.62	15.4	2.51
Education - 2	0.23	0.42	0.23	0.42								
Education - 3	0.41	0.49	0.42	0.49								
Education - 4	0.25	0.44	0.29	0.45								
Experience (years)	16.5	7.93	13.1	7.69	18.5	8.07	14.0	8.39	15.5	7.66	12.7	7.35
TimeOut1 (years)	2.49	4.49	3.51	5.93	2.99	4.91	5.53	7.56	2.23	4.24	2.68	4.88
TimeOut2 (years)	0.87	2.11	2.63	4.01	0.83	2.22	2.97	4.60	0.89	2.06	2.48	3.73
Number of children	1.51	1.10	1.48	1.07	1.55	1.13	1.52	1.07	1.49	1.09	1.46	1.07
Private sector	0.80	0.40	0.69	0.46	0.88	0.32	0.84	0.36	0.76	0.43	0.63	0.48
Number of obs.	35,826		36,692									

Source: Survey of Labour Income Dynamics, 2001-2011 (Restricted Data).
Education is grouped into four categories: those who did not graduate high school (baseline group), high school graduates and college dropouts (Education-2), people with post-secondary certificates and university degrees below a bachelor's degree (Education-3), and those with a bachelor's degree or higher (Education-4). "High-educated" includes Education-3 and -4. "Low-educated" is its complement.

Table C.4: Log Wage Regressions

Dependent variable	All		Low-edu		High-edu	
: ln(Wage)	Male	Female	Male	Female	Male	Female
Experience	0.0270	0.0272	0.0178	0.0163	0.0281	0.0274
	(22.75)	(26.06)	(9.04)	(9.31)	(17.36)	(19.57)
Experience$^2/10^3$	-0.5178	-0.5273	-0.2841	-0.1818	-0.6984	-0.7229
	(-15.59)	(-15.73)	(-5.40)	(-3.40)	(-14.83)	(-15.72)
TimeOut1	-0.0102	-0.0065	-0.0103	-0.0081	-0.0120	-0.0129
	(-18.79)	(-15.22)	(-12.78)	(-12.90)	(-15.64)	(-21.22)
TimeOut2	-0.0204	-0.0156	-0.0219	-0.0155	-0.0244	-0.0217
	(-21.13)	(-28.83)	(-14.38)	(-18.17)	(-18.61)	(-29.65)
Education - 2	0.0965	0.1606				
	(12.76)	(18.07)				
Education - 3	0.2299	0.2894				
	(12.76)	(33.51)				
Education - 4	0.5078	0.5862				
	(64.97)	(63.23)				
Number of children	0.0245	0.0064	0.0273	0.0143	0.0239	0.0006
	(12.90)	(3.34)	(9.15)	(4.26)	(9.16)	(0.22)
Private sector	-0.1249	-0.2599	-0.1384	-0.2816	-0.1670	-0.3172
	(-24.35)	(-58.19)	(-13.34)	(-29.05)	(-26.70)	(-60.04)
Constant	2.663	2.5012	2.8092	2.7027	3.076	3.0277
	(200.33)	(198.20)	(135.54)	(-29.05)	(224.93)	(289.34)
Adjusted R^2	0.2434	0.3575	0.1102	0.2056	0.1060	0.1964

t-statistics are in parentheses. Data is from Survey of Labour Income Dynamics, 2001-2010. The sample of interest is married people aged between 25 and 49 with paid employment who are not a student and do not have any disability in the reference year. Hourly wages are deflated to 2002 Canadian dollars.

C.2 Estimation of a Fertility Process

The probability of a birth shock, $\pi_b(t,k,a,x_w^{edu})$, is estimated using a logit model. The dependent variable is an indicator variable that is equal to one if a person has a newborn baby in the survey year. I estimate a logit regression of a birth as a function of a quadratic in a married woman's age, t, the number of children, k, and the age of youngest child, a, separately for each educational group. Married women between 23 and 42 years old in SLID between 2001 and 2010 are used as the sample of interest.

The estimates and the predicted probability of a birth shock by age of a mother, number of children, and age of the youngest child are displayed in Tables C.6 and C.7.

Table C.5: Distribution of Mothers by Number of Children (%)

		At age 30		At age 35		At age 40	
	N. of kids	data	model	data	model	data	model
Low-educated	None	22.9	23.1	12.3	13.1	11.4	9.2
	One	23.9	19.0	17.5	20.7	19.4	22.4
	Two	34.5	35.5	43.2	39.0	42.5	40.3
	Three +	18.8	22.5	27.0	27.3	26.6	28.0
High-educated	None	40.1	36.7	17.5	17.8	14.6	12.0
	One	26.6	22.8	19.9	20.4	18.6	19.0
	Two	25.9	25.9	44.7	37.3	45.1	41.7
	Three +	7.4	14.6	17.8	24.4	21.7	27.3

Given the estimated processes of a birth shock, the transitional probabilities between fertility stages, π_f and π_{post}, are determined by minimizing the sum of squared errors between the simulated and empirical distributions of mothers by their age and the number of children in Table C.5. The simulated distribution is generated by simulating birth histories of married women using the estimated birth shock process and the empirical distribution of married women at age 23 by children characteristics (Table C.8). In the simulation, whereas 23-year-old women with children start in the fertile stage, childless women begin in the pre-fertile stage. The transitional probabilities are also estimated separately for each educational group. The estimated probability π_f implies that high-educated women who were childless at age 23 do not consider having a child on average until 3.6 years later, and low-educated women wait on average for 2.4 years. In Canada, the average age of first-time mothers between 2001 and 2011 is 28 years old.[1] The estimated probability π_{post} implies that, on average, high-educated women choose to have no more child at an earlier age than low-educated women do.

The specification of the logit model for the probability of the birth shock:

$$\begin{aligned} Pr(birth=1) = \Lambda\Big(&\beta_0+\beta_1 age+\beta_2 age^2 \\ &+\beta_3\mathbb{1}\{k=1,a=1\}+\beta_4\mathbb{1}\{k=1,a=2\}+\beta_5 age\times\mathbb{1}\{k=1,a=2\} \\ &+\beta_6\mathbb{1}\{k=2,a=1\}+\beta_7\mathbb{1}\{k=2,a=2\}+\beta_8 age\times\mathbb{1}\{k=2,a=2\}\Big), \end{aligned}$$

[1] Author's own calculation using the raw data from "Fertility:Fewer children, older moms" http://www.statcan.gc.ca/pub/11-630-x/11-630-x2014002-eng.htm

where $\Lambda(\cdot)$ denotes the logistic function.

Table C.6: Estimates for the Probability of Having a Newborn Child

	β_0	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8
Low-educated	-12.866	7.573	-1.281	-.104	4.430	-1.297	-.878	3.623	-1.435
s.e.	. 1.931	1.259	.203	.228	.730	.244	.307	.880	.284
High-educated	-16.874	10.003	-1.636	-.602	2.858	-.638	-1.584	3.495	-1.274
s.e.	1.327	.845	.134	.142	.492	.155	.214	.782	.239

Table C.7: Predicted Probability of a Birth, $\hat{\pi}_b(t,k,a,x_w^{edu})$, (%)

		Mother's age									
		24	26	28	30	32	34	36	38	40	42
Low-educated	$k=0$	11	14	15	16	15	13	10	7	4	3
	$k=1,a=1$	10	13	14	14	14	12	9	6	4	2
	$k=1,a=2$	32	31	29	24	19	13	8	4	2	1
	$k=2,a=1$	5	6	7	7	7	6	4	3	2	1
	$k=2,a=2$	13	13	11	9	6	4	2	1	1	0
High-educated	$k=0$	9	13	16	17	17	14	11	8	5	2
	$k=1,a=1$	5	7	9	10	10	8	6	4	3	1
	$k=1,a=2$	28	33	35	34	31	25	18	11	6	3
	$k=2,a=1$	2	3	4	4	4	3	3	2	1	0
	$k=2,a=2$	14	15	15	13	10	7	4	2	1	0

Table C.8: Distribution of Women Aged 23 by Children Characteristics (%)

N. of children Have an infant	None -	One Yes	One No	Two Yes	Two No	Three+ Either
Low-educated	55.85	8.85	18.02	6.26	8.49	2.53
High-educated	73.31	8.18	11.47	3.96	1.55	1.54

The sample is not restricted to the "married".

C.3 Estimation of Rental Rates Distributions

For the distribution of rental rates, I use the hourly wage at age 23 as a proxy for the rental rate as in Section 4.2. A sample is restricted to married individuals aged 23 who are paid employee and not student. Assuming that the price of human capital follows a log-normal distribution, I estimate the mean and variance of the distribution using Maximum Likelihood. The following specification is estimated separately for men and women:

$$\ln p_i = \mu_0 + \mu_1 \mathbb{I}(LowEdu_i) + \varepsilon_i, \quad \varepsilon_i \sim N(0, \sigma^2).$$

The estimates are reported in Table C.9. In this paper, I view this gender wage gap as exogenously present upon the entry into the labour market. A discussion about what causes this exogenous gender wage gap is beyond the scope of this paper.

Table C.9: Estimates for the Distribution of Rental Rates

Estimates	μ_0	μ_1	σ
Married only (men)	2.714	-0.155	0.375
s.e.	(.044)	(.058)	(.020)
Married only (women)	2.546	-0.263	0.364
s.e.	(.026)	(.035)	(.013)
Any marital status (men)	2.687	-0.162	0.390
s.e.	(.016)	(.021)	(.007)
Any marital status (women)	2.523	-0.206	0.375
s.e.	(.014)	(.021)	(.007)

C.4 Calibration Moments

The procedure to calculate simulated moments is as follows. First, for a given set of parameter values, the household problem is numerically solved backward from age 62 to age 23. Then, 1,600,000 couples' life-cycles are simulated. Each couple begins with a set of initial state variables that is randomly selected based on the parameterized distributions. A couple makes decisions using the decision rules solved from the model, and their state variables are updated based on their decisions and the realizations of a series of stochastic shocks. I construct simulated cross-sectional data by letting the cross-sectional age structure of the simulated sample replicate the empirical counterpart in SLID. Also, I generate simulated six-year-long longitudinal data of the cross-sectional sample as in SLID.

Using the simulated data, I calculate simulated moments and the distance between the simulated and data moments. The measure of distance I use is the sum of squared percentage deviations of the simulated moments from the data moments: $\sum_j \left(\frac{d_j - m_j}{d_j}\right)^2$ where d_j is the j^{th} data moment and m_j is a corresponding simulated moment.

Table C.10: Time Allocations by Children Characteristics

		Without kids			With an infant			Older kids only		
		M	H	L	M	H	L	M	H	L
High-edu	data	33.6	13.7	52.7	35.6	24.6	39.8	34.0	18.9	47.1
Men	model	36.2	11.9	51.9	36.6	21.6	41.8	34.3	19.2	46.6
High-edu	data	30.3	17.0	52.7	9.8	50.4	39.8	23.3	29.5	47.2
Women	model	31.0	16.0	52.9	12.9	52.2	34.9	26.8	25.7	47.5
Low-edu	data	32.7	12.8	54.5	34.0	21.9	44.1	33.8	16.4	49.8
Men	model	35.5	11.9	52.6	35.4	21.9	42.7	32.3	19.7	47.9
Low-edu	data	24.4	22.7	52.9	6.4	54.9	38.7	19.7	30.2	50.1
Women	model	26.5	17.5	56.0	7.5	56.0	36.5	18.8	29.6	51.6

M=market work, H=home work, and L=Leisure. Unit: % of Time Endowment. Time endowment=5,840 hours per year.

Table C.11: Five-year Wage Growth Rates Conditional on Five Years of Full-year Full-time Employment

		Men			Women		
	Age group	25-34	35-44	45-54	25-34	35-44	45-54
Low-educated	data	7.7	5.4	4.9	10.6	6.7	5.4
	model	7.6	5.5	4.8	6.7	5.3	4.3
High-educated	data	14.3	11.1	6.3	17.6	12.7	9.0
	model	9.3	5.4	3.9	11.9	6.5	4.0

Table C.12: Employment Transition Rates

$t \to t+1$		Low-edu Men N	PY	FY	Low-edu Women N	PY	FY	High-edu Men N	PY	FY	High-edu Women N	PY	FY
N	data	79.6	10.2	10.2	86.2	10.2	3.6	76.8	8.1	15.1	79.2	12.1	8.7
	model	79.0	7.0	14.0	84.1	7.1	8.8	74.2	5.7	20.0	70.4	12.1	17.5
PY	data	10.4	31.4	57.7	12.4	58.4	29.1	8.1	33.9	58.0	7.3	64.2	28.5
	model	12.7	24.1	63.2	22.0	49.9	28.1	4.8	22.2	73.0	11.0	51.3	37.7
FY	data	1.4	5.4	93.2	2.2	10.8	87.0	0.8	3.3	95.9	2.1	9.8	88.2
	model	2.1	5.2	92.7	6.8	10.4	82.7	1.8	4.9	93.3	5.0	9.9	85.1

N= Non-employment, PY= Part-Year employment, and FY= Full-Year employment.

Table C.13: Fraction of People Having Negative Wage Growth after Full-year Full-time Work

	Men Lo	Men Hi	Women Lo	Women Hi
Data	12.0	11.0	10.0	9.0
Model	8.9	8.8	10.5	10.0

Figure C.1: Average Time Spent in Leisure by Number of Children

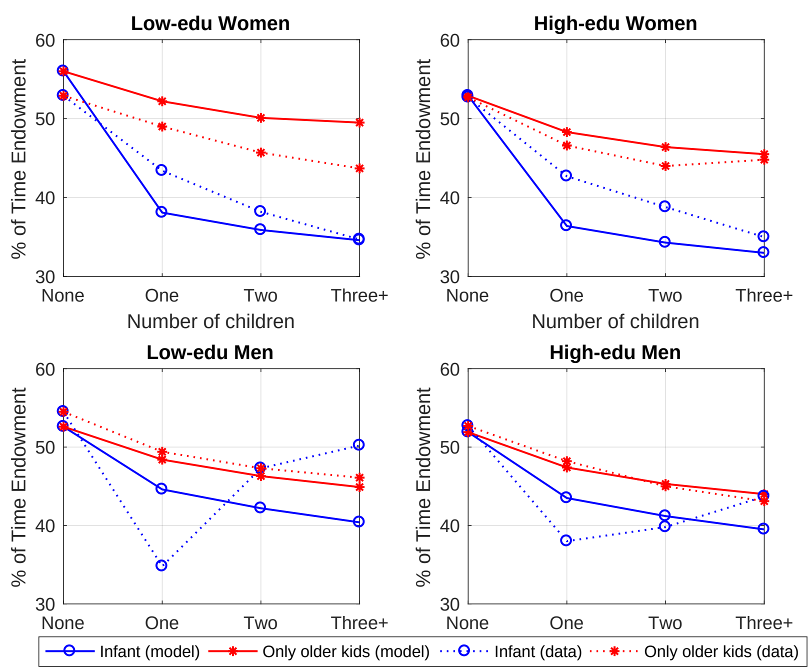

Table C.14: Employment Rates of Married Women by Number of Children

		None	One	Two	Three+
Low-edu	(data)	77.1	70.4	66.0	53.7
	(model)	76.6	62.6	61.7	54.7
High-edu	(data)	91.0	82.4	78.8	71.4
	(model)	92.2	81.5	79.8	77.2

C.5 Numerical Exercises

The Role of Probabilities of Human Capital Depreciation. I examine the role of the probability of human capital depreciation δ in the decomposition analysis and policy experiments. The results presented in the main text use the counterfactual economy where both men and women have men's parameter values. In the calibrated economy, men's δ is much higher than women's one. With the parameter values, many married couples decide to choose to have only one parent use parental leave. In this section, I present results of a decomposition analysis to explain the gap of take-up rates between the benchmark economy and a counterfactual economy where both men and women have men's parameter values, except for the probabilities of human capital depreciation δ. I let all people to have women's δ. I let both men and women have women's values for that parameter.

Table C.15: Take-up Behaviour When All Gender Differences Are Removed

	Benchmark		Men's values		Women's values		Men's values but δ	
Education	Fathers	Mothers	Fathers	Mothers	Fathers	Mothers	Fathers	Mothers
Individual type								
Low-educated	11.4	93.4	60.3	57.1	69.5	65.4	67.9	67.4
High-educated	10.2	93.4	50.8	49.8	60.2	64.6	68.2	72.7
Household type								
(lo, lo)	6.8	93.5	46.2	46.0	51.7	51.3	55.0	57.9
(lo, hi)	14.1	89.9	72.3	28.2	83.8	36.7	78.5	54.1
(hi, lo)	6.4	93.2	27.2	73.2	27.4	85.6	45.7	80.7
(hi, hi)	11.0	95.3	56.8	59.4	68.2	76.9	73.9	80.8

A pair of husband's and wife's education, $(\varepsilon_h, \varepsilon_w)$, represents a household education type. *hi* denotes the high-educated who are college graduates, and *lo* denotes a lower education level.

Table C.16: Decomposition of the Gender Gap in Take-up Rates

(a) by Individual Educational Type

	Benchmark (1)	All Removed* (2)	Change (2)-(1) (3)	Home Productivity (Infant), η_1 (4)	Rental Rates of Human Capital, μ_h (5)	Prob. a Fall in Human Capital, δ_w^ε (6)	Prob. a Rise in Human Capital, ψ_h^ε (7)	Weight on Leisure, γ_h (8)
Fathers' take-up rates (%)								
Low-edu (a)	11.4	69.5	58.1	28.1(28.7)	18.4(12.1)	19.0(13.1)	15.8(7.6)	9.1(-3.9)
High-edu (b)	10.2	60.2	50.0	28.7(36.9)	16.4(12.4)	21.6(22.8)	10.3(0.2)	8.2(-4.0)
Mothers' take-up rates (%)								
Low-edu (c)	93.4	65.4	-28.0	90.1(11.6)	91.6(6.3)	91.9(5.2)	91.8(5.8)	93.5(-0.5)
High-edu (d)	93.4	64.6	-28.8	81.7(40.8)	89.1(15.0)	93.2(0.8)	91.5(6.7)	94.7(-4.5)
Gender differences (%p)								
cmidrule1-1 Low-edu (c)-(a)	82.0	-4.1	-86.1	62.1(23.1)	73.2(10.2)	73.0(10.5)	75.9(7.1)	84.4(-2.7)
High-edu (d)-(b)	83.2	4.4	-78.8	53.0(38.3)	72.7(13.3)	71.6(14.7)	81.2(2.6%)	86.5(-4.2%)

Values in parentheses present percentages of the change in column (3) that is explained by each gender difference in columns (4) to (8).
In column (2) everyone has women's parameter values, except the maximum durations of leave available to them due to maternity leave.

(b) by Household Educational Type

$(\varepsilon_h, \varepsilon_w)$	Benchmark (1)	All Removed* (2)	Change (2)-(1) (3)	Home Productivity (Infant), η_1 (4)	Rental Rates of Human Capital, μ_h (5)	Prob. a Fall in Human Capital, δ_w^ε (6)	Prob. a Rise in Human Capital, ψ_h^ε (7)	Weight on Leisure, γ_h (8)
(lo, lo)								
Husband (a)	6.8	51.7	45.0	10.1(7.4)	8.9(4.6)	9.8(6.7)	7.6(1.9)	6.4(-0.8)
Wife (b)	93.5	51.3	-42.2	89.6(9.3)	90.7(6.6)	91.5(4.8)	91.4(4.9)	93.8(-0.7)
(lo, hi)								
Husband	14.1	83.8	69.6	39.4(36.3)	24.5(14.9)	24.5(15.0)	20.8(9.6)	10.8(-4.8)
Wife	89.9	36.7	-53.1	70.8(36.0)	81.0(16.7)	89.8(0.1)	84.6(9.9)	93.2(-6.2)
(hi, lo)								
Husband	6.4	27.4	21.0	9.4(14.5)	7.6(5.6)	9.1(13.0)	6.1(-1.4)	6.0(-1.6)
Wife	93.2	85.6	-7.6	91.1(26.9)	93.2(0.0)	92.8(4.7)	92.4(10.3)	93.0(2.4)
(hi, hi)								
Husband (c)	11.0	68.2	57.2	32.8(38.1)	18.2(12.6)	24.2(23.1)	11.2(0.3)	8.6(-4.1)
Wife (d)	95.3	76.9	-18.4	87.4(43.4)	93.2(11.3)	95.0(1.8)	95.2(0.6)	95.6(-1.4)
Gender differences (%p)								
(lo, lo) [(b)-(a)]	86.7	-0.5	-87.2	79.5(8.3)	81.8(5.6)	81.7(5.8)	83.8(3.4)	87.3(-0.7)
(hi, hi) [(d)-(c)]	84.3	8.8	-75.5	54.6(39.4)	75.0(12.3)	70.7(18.0)	84.0(0.4%)	86.9(-3.5%)

Values in parentheses present percentages of the change in column (3) that is explained by each gender difference in columns (4) to (8).

In column (2) everyone has women's parameter values, except the maximum durations of leave available to them due to maternity leave.

Table C.17: Interactions among Explanations

(a) by individual educational type

	Benchmark	All Removed	Change (2)-(1)	$\eta_1 + \mu_h$	$\eta_1 + \delta_w$	$\eta_1 + \mu_h + \delta_w$
	(1)	(2)	(3)	(4)	(5)	(6)
Fathers' take-up rates (%)						
Low-edu (a)	11.4	69.5	58.1	41.9(52.6)	45.5(58.8)	60.1(83.8)
High-edu (b)	10.2	60.2	50.0	44.7(69.0)	54.6(88.8)	70.6(120.8)
Mothers' take-up rates (%)						
Low-edu (c)	93.4	65.4	-28.0	82.7(38.2)	85.5(28.2)	75.8(62.9)
High-edu (d)	93.4	64.6	-28.8	69.0(84.7)	79.3(49.1)	67.1(91.3)
Gender differences (%p)						
Low-edu (c)-(a)	82.0	-4.1	-86.1	40.8(47.9)	40.0(48.9)	15.7(77.0)
High-edu (d)-(b)	83.2	4.4	-78.8	24.3(74.7)	24.7(74.3)	-3.5(110.0)

(b) Take-up rates by household educational type (%)

$(\varepsilon_h, \varepsilon_w)$	(1)	(2)	(3)	(4)	(5)	(6)
(lo, lo)						
Husband (a)	6.8	51.7	45.0	18.8(26.7)	21.1(31.9)	34.5(61.7)
Wife (b)	93.5	51.3	-42.2	79.8(32.6)	83.6(23.6)	70.8(53.7)
(lo, hi)						
Husband	14.1	83.8	69.6	57.6(62.4)	60.9(67.2)	77.1(90.5)
Wife	89.9	36.7	-53.1	52.6(70.2)	68.1(41.0)	52.5(70.4)
(hi, lo)						
Husband	6.4	27.4	21.0	15.5(43.3)	19.6(62.9)	33.8(130.8)
Wife	93.2	85.6	-7.6	87.6(74.1)	89.2(52.5)	83.9(122.1)
(hi, hi)						
Husband (c)	11.0	68.2	57.2	50.9(69.8)	61.9(89.0)	78.4(117.9)
Wife (d)	95.3	76.9	-18.4	77.3(97.9)	85.0(56.0)	74.3(114.3)
Gender differences (%p)						
(lo, lo) [(b)-(a)]	86.7	-0.5	-87.2	61.0(29.5)	62.4(27.9)	36.3(57.8)
(hi, hi) [(d)-(c)]	84.3	8.8	-75.5	26.4(76.6)	23.2(80.9)	-4.1(117.0)

Values in parentheses present percentages of the gap in column (3) that is explained by each column. Parameter η_1, μ, and δ_i denote relative home productivity in the presence of an infant, means of rental rates, and probabilities of a fall in human capital, respectively.

Table C.18: Take-up Rates by Income Replacement Rate

(a) Benchmark Durations: 17/0/35 weeks of Mat./Pat./Par. Leaves

$(\varepsilon_h, \varepsilon_w)$	(lo, lo)			(lo, hi)			(hi, lo)			(hi, hi)		
Replacement rate	Husb.	Wife	Gap	Husb.	Wife	Gap	Husb.	Wife	Gap	Husb.	Wife	Gap
Baseline (0.55)	6.8	93.5	86.7	14.1	89.9	75.8	6.4	93.2	86.8	11.0	95.3	84.3
0.01	6.0	88.6	82.6	13.8	79.0	65.2	6.1	89.9	83.8	9.2	89.1	79.8
0.33	6.6	92.1	85.5	13.3	85.8	72.5	5.8	91.6	85.8	10.2	92.7	82.6
0.70	7.4	94.1	86.7	13.5	94.7	81.2	6.7	95.4	88.7	12.2	97.4	85.2
0.85	7.5	95.9	88.3	15.5	96.3	80.8	7.7	96.5	88.8	15.0	98.4	83.4
1.00	8.4	96.8	88.4	17.2	98.1	80.9	8.8	97.3	88.6	18.7	99.3	80.6

(b) Short Paternity Leave: 17/6.5/28.5 weeks of Mat./Pat./Par. Leave

$(\varepsilon_h, \varepsilon_w)$	(lo, lo)			(lo, hi)			(hi, lo)			(hi, hi)		
Replacement rate	Husb.	Wife	Gap	Husb.	Wife	Gap	Husb.	Wife	Gap	Husb.	Wife	Gap
Baseline (0.55)	6.8	93.5	86.7	14.1	89.9	75.8	6.4	93.2	86.8	11.0	95.3	84.3
0.01	6.3	88.3	82.0	14.0	79.0	65.1	6.1	90.3	84.2	9.0	89.2	80.2
0.33	6.5	91.8	85.3	13.7	85.8	72.1	6.0	91.7	85.7	10.2	92.5	82.3
0.70	6.8	94.8	88.1	17.6	94.3	76.6	7.1	95.5	88.4	17.7	97.5	79.8
0.85	7.7	96.2	88.4	21.0	96.4	75.4	9.0	96.5	87.5	24.5	98.5	74.0
1.00	9.6	96.6	87.0	26.1	97.8	71.8	12.8	97.3	84.5	32.7	99.3	66.6

A pair of husband's and wife's education, $(\varepsilon_h, \varepsilon_w)$, represents a household education type. *hi* denotes the high-educated who are college graduates, and *lo* denotes a lower education level.

Curriculum Vitae

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