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Effects of Parental Leave Policies on Female Career and Fertility Choices

Shintaro Yamaguchi*

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Abstract

This paper constructs and estimates a dynamic discrete choice structural model of female employment and fertility decisions that incorporates job protection and cash benefits of parental leave legislation. The estimated structural model is used for ex ante evaluation of policy reforms that change the duration of job protection and/or the arrangement for cash benefits. Counterfactual simulations indicate that introducing an initial one-year job protection policy increases maternal employment significantly, but extending the existing job protection period from one to three years has little effect. The employment effects of cash benefits also seem modest. Overall, parental leave policies have little effect on fertility.

Keywords: parental leave, female labor supply, discrete choice model, structural estimation

JEL Codes: J13, J22, J24

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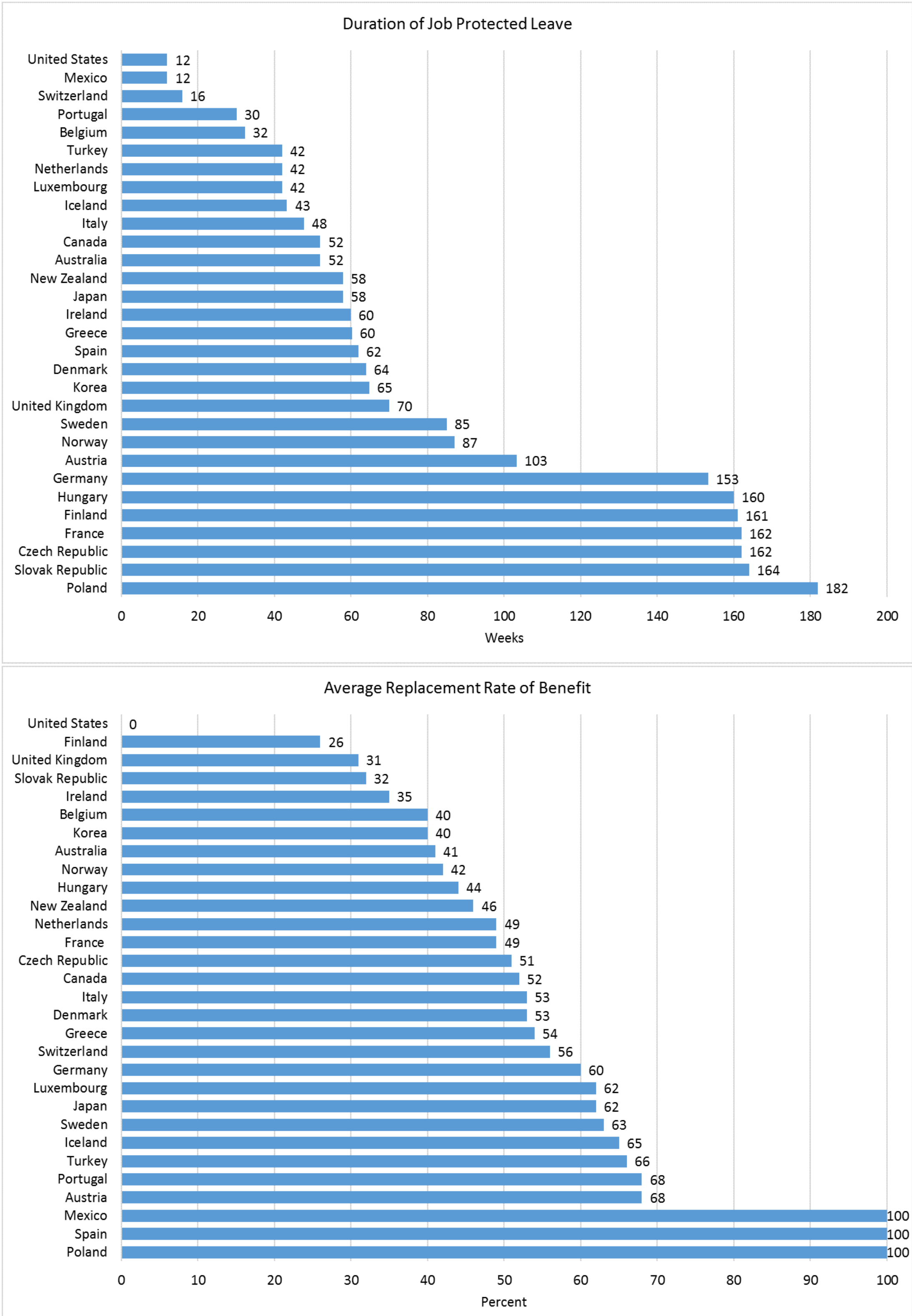
1 Introduction

Parental leave (PL) is mandated in most developed countries, but the generosity of PL legislation varies significantly across countries. Figure 1 presents international differences in the duration of job-protected leave and the replacement rate of cash benefits. The U.S. mandates only 12 weeks of unpaid job-protected leave, but many other countries such as Germany, France, and Finland mandate job-protected leave for more than three years. The generosity of cash benefits also differs considerably across countries. The U.S. is the only developed country where no mandated benefit is paid, while Mexico, Spain, and Poland pay 100% of pre-leave earnings to PL takers.

Policy makers in countries that mandate a shorter job-protected leave and/or less generous cash benefits may be interested in expanding their PL policies to resolve the conflict between work and family life, which may lead to a higher fertility and labor force participation rate of mothers of young children. Predicting likely outcomes before a policy reform could help policy makers, but it is not necessarily straightforward. One can learn from experiences of countries where most generous PL policies are already mandated, but their experiences may not be fully generalizable to other countries due to differences in institutions, etc. Another way to assess the policy effects is to conduct a small-scale social experiment, but it may be costly and politically infeasible. Yet another approach to ex ante policy evaluation is to construct and estimate a structural model and conduct counterfactual simulations, which is the approach this paper takes.

In this paper, I construct and estimate a structural dynamic discrete choice model of women's employment and fertility that incorporates job protection and cash benefits of PL. In each period, a woman decides on her employment sector, PL take-up, and conception. When a mother of a young child works, she not only pays childcare costs, but also derives negative non-pecuniary utility of work, because she values the time with her young child. Human capital increases with work experience through learning-by-doing, but it depreciates when she remains at home for PL. The model also incorporates the entry cost to employment for women who have stayed at home in the previous period. These features can be seen in some of the previous papers in the literature on the life cycle model of female labor supply. Examples include, but are not limited to, Eckstein and Wolpin (1989), van der Klaauw (1996), Altug and Miller (1998), Francesconi (2002), Sheran (2007), Keane and Wolpin (2007, 2010), Adda, Dustmann, and Stevens (2011), and Gayle and Miller (2012).

The contribution of this paper is to model job protection and cash benefits of PL legislation. Job protection of PL allows mothers of newborns to stay at home without losing their jobs. In the model, PL takers can return to the pre-leave employment sectors without paying the entry costs, while those who quit their jobs without taking PL must pay the entry cost to re-enter employment sectors. Cash benefits of PL replace a fraction of her pre-leave earnings while on PL and affect her



Source: OECD Family Database

Figure 1: International Comparison of Parental Leave Legislation

decisions through the budget constraint.

The model is taken to the panel data on Japanese women, for the period 1993 to 2012. During that period Japan experienced a series of PL reforms that expanded the coverage of the PL legislation and raised cash benefits. These policy variations allow me to identify the model without solely relying on the functional form assumptions, which is a criticism to the structural estimation approach.

The estimation algorithm is based on the sequential algorithm proposed by Kasahara and Shimotsu (2011). Because the model allows for permanent unobserved heterogeneity using finite mixture, the Kasahara-Shimotsu algorithm is combined with the EM algorithm developed by Arcidiacono and Jones (2003). To further accelerate computation, I also approximate the value function based on sieves using the method by Arcidiacono, Bayer, Bugni, and James (2013). As far as I know, this is the first paper that combines these three methods. The proposed algorithm makes model estimation tractable, despite the complexity of the model.

The estimated model is used for counterfactual simulations to assess PL policies. In the first set of simulations, I evaluate the effects of job protection. This is particularly relevant in the context of real policy: The Prime Minister of Japan, Shinzo Abe, proposed to extend the duration of job protection from one to three years to raise female labor force participation and the birth rate.[1] This proposal initiated a heated debate on whether Japan should reform its PL policies or not. The proposed reform has not been legislated yet, and likely outcomes of the reform are still not well understood. The simulations in this paper provide the best estimates for the effects of the proposed policy reform based on the structural estimation approach.

The counterfactual simulations indicate that one-year job protection increases maternal work after childbearing and the effects last for several years, compared with no mandated PL. Without job protection, many women quit their jobs at childbirth and slowly (or even never) come back to work. Job protection allows women to be off work at childbirth without losing their jobs. Because PL takers maintain their employment contracts and do not pay entry costs, they return to work quickly after childbearing. However, extending the duration of job protection from one to three years has little effect on maternal work. This is because non-pecuniary utility of work is a large negative when the child is a newborn, but it is much smaller when the child grows to age one or older. Mothers of newborns avoid this large disutility of work by taking PL, but mothers of older children do not take PL even if they are eligible for PL for three years because the utility loss is small. The simulations also indicate that policy effects on fertility seem modest for both one- and three-year job protection.

In the second set of simulations I evaluate the effects of cash benefits. The simulation results indicate that raising the replacement rate of cash benefits and requiring PL takers to return to work

[1] See Abe (2013).

has modest effects on maternal work and fertility. Overall, neither the duration of job protection nor cash benefits in the current PL legislation present a binding constraint for mothers of a young child.

There is a literature on PL policies and maternal labor supply. Most previous papers in this literature identify the policy effects by the difference-in-differences estimator (Ruhm (1998), Baum (2003), Baker and Milligan (2008a) and Asai (2015)) or by the regression discontinuity designs (Lalive and Zweimüller (2009), Schönberg and Ludsteck (2014), and Lalive, Schlosser, Steinhauer, and Zweimüller (2014)). The main difference from these previous papers is that this paper conducts ex ante evaluation of PL reforms by taking a structural estimation approach.

Another difference from the previous papers is that the structural approach sheds light on the mechanism by which the PL policies affect mothers' labor supply. Understanding the mechanism is important when interpreting the lessons from a particular country. The key finding of this paper is that non-pecuniary utility of work is a large negative for mothers of newborns, which is why one-year job protection helps women return to work after childbirth. This finding on non-pecuniary utility of work is consistent with international evidence including the U.S..[2] It should be noted, however, that differences in childcare and labor market institutions can affect the effectiveness of PL policies. On the one hand, job protection may be more effective in countries such as the U.S. where childcare is not heavily subsidized, if other things remain equal. On the other hand, job protection may be less effective in the U.S. because the labor market is more flexible and the entry costs to the employment sector seems smaller. The structural model helps one understand how PL policies affect maternal work and speculate about the potential policy effects in a given country.

The rest of the paper is structured as follows. Section 2 describes the institutional background. Section 3 describes the data. Section 4 lays out the structural model. Section 5 outlines the estimation method. Section 6 presents the estimates of the structural parameters. The model's ability to fit to key aspects of the data is also demonstrated. Section 7 shows the effects of job protection and the cash benefits of parental leave through counterfactual simulations. Section 8 concludes the paper. Details of data, estimation method, and additional results are available in appendices.

2 Institutional Background

The employment sector in Japan consists of two sub-sectors: the regular and non-regular employment sectors. The regular employment is typically under a permanent contract and a full-time job, while the non-regular employment is typically under a limited-term contract and a part-time job. They also differ in hourly wages, non-wage benefits, employer-sponsored training, and eligibility for the mandated PL (see Kambayashi and Kato (2013)).

[2] See the discussion in Section 6.1 and papers cited there.

PL was first enforced in 1992 in Japan. The legislation mandated job protection until the child reached age one, with no cash benefit. At the time, to be eligible for the mandated leave, individuals must have been employed in the regular employment sector and were expected to return to work after the completion of PL.[3]

Cash benefits were first introduced in 1995 with the replacement rate at 25%, and then, raised to 40% in 2001. Like many other countries including Austria, Canada, and Germany, cash benefits are paid not from employers, but from the employment insurance. An important difference from some other countries is that PL takers were expected to return to the pre-leave job, in order to receive cash benefits. This requirement is imposed to encourage women to stay in the labor market after their childbearing. PL takers must apply through employers to receive cash benefits so that employers provide proof of expectation for returning to work. Although there is no legal penalty for not returning, about 90% of PL takers are employed one year after childbearing (see Table 5).

The next major PL reform took place in 2005 when non-regular workers became eligible for mandated PL for the first time. Since then, the PL legislation has treated regular and non-regular workers equally. In 2007, the replacement rate was raised to 50%. Table 1 summarizes the changes in the PL policies.

Table 1: Changes in Parental Leave Policies

Years	**Eligibility**		**Job Protection**	**Replacement Rate**	**Legislated On**	**Enforced On**
	Regular	Non-Regular				
1992-1994	✓		1 Year	0%	1991/05/15	1992/04/01
1995-2000	✓		1 Year	25%	1994/06/29	1995/04/01
2001-2004	✓		1 Year	40%	2000/05/12	2001/01/01
2005-2006	✓	✓	1 Year	40%	2004/12/08	2005/04/01
2007-2012	✓	✓	1 Year	50%	2007/04/23	2007/04/01

3 Data

3.1 Overview of the Data Structure

The analysis is based on the data from Japanese Panel Survey of Consumers (JPSC) conducted by The Institute for Research on Household Economics. JPSC starts in 1993 with a representative sample of 1,500 women ages 24-34 and asks respondents about marriage, fertility, and their and their spouse's work every survey year. JPSC added 500 women at age 24-27 in 1997, 836 women

[3]Strictly speaking, the legal eligibility for parental leave is determined by whether the employment contract is limited or indefinite term. The data does not ask the term of the employment contract, but asks whether the job is regular or non-regular employment. Because an indefinite term employment is usually regular employment and vice versa, I determine eligibility by employment type.

at age 24-29 in 2003, and 636 women at age 24-28 in 2008. As of 2008, JPSC includes 2,284 women.

I draw a sample of married women who completed schooling and are not self-employed. After omitting observations with missing values except for own earnings, I take the longest spell of consecutive observations for each individual. The sample includes 1,826 women and about eight observations per person (14,907 person-year observations in total). Appendix A provides the detailed variable definitions.

Table 2 presents summary statistics for the pooled sample. The age of sampled individuals ranges from 24 to 52, which means the sample covers more than 89% of childbirths, according to the Vital Statistics 2011.[4] Average years of education is 13.211, while average years stayed at home and experiences in the regular and non-regular sectors are 5.580, 6.573, and 3.271, respectively. The average number of children is 1.720. The average earnings of husbands are 5.103 million yen, which is approximately equal to 51,030 U.S. dollars. The average earnings of the wives are 0.859 million yen.

3.2 Descriptive Analysis

3.2.1 Life-Cycle Profiles

Table 3 shows the average labor market and fertility outcomes by age. The probability of staying at home at age 30 is high at 0.591, but it gradually decreases with age. At age 45, 31% of married women stay at home. These statistics are comparable with those from the Labor Force Survey 2010.[5] The fractions of mothers working in the regular and non-regular sectors at age 30 are similar, at 0.178 and 0.194, respectively. While the fraction of regular workers slowly increases after age 35, that of non-regular workers grows much more rapidly. At age 45, the fraction of regular workers is 0.235, but that of non-regular worker is higher at 0.454. These statistics suggest that women gradually return to the labor market after childbearing, but largely to non-regular employment.

The fraction of PL takers is small at 0.037 at age 30 and gradually decreases with age. The fraction of pregnant women is 0.166 at age 30, and it decreases to 0.053 at age 35. No women at age 45 in the sample are pregnant. Own and husbands' earnings increase over time. Own earnings are 0.673 at age 30, but it increases to 1.302 at age 45 as more and more individuals participate in the labor force. Husbands' earnings grow from 4.482 at age 30 to 6.022 at age 45. The number of children of married women at age 30 is 1.407. It grows over time and the completed fertility rate

[4] 89% of childbirth occurs for mothers age 25 or older.

[5] According to the Labor Force Survey in 2010, the fractions of married women out of labor force are 0.56 for age 30-34, 0.45 for age 35-39, and 0.33 for age 40-44.

Table 2: Summary Statistics

	Mean	Std. Dev.	Min.	Max.
Individual Characteristics				
Age	35.239	5.976	24	52.000
Education	13.211	1.634	9	18.000
Years in Home	5.580	4.791	0	26.000
Years in Reg Work	6.573	5.091	0	34.000
Years in Non-Reg Work	3.271	4.135	0	26.000
No. of Children	1.720	0.966	0	4.000
Husband's Earnings	5.103	2.027	0	45.000
Earnings	0.859	1.423	0	8.964
Employment and Fertility Choices				
Home	0.503	0.500	0	1.000
Reg Work	0.188	0.391	0	1.000
Non-Reg Work	0.292	0.455	0	1.000
PL	0.017	0.130	0	1.000
Pregnancy	0.081	0.274	0	1.000

No. of Obs. (Person-Year)	14907
No. of Persons	1826

Source: JPSC

Note: The sample includes married women who completed schooling and are not self-employed. Earnings are in million Yen (≈10,000 USD) in 2010 constant price. The earnings of those who do not work are counted as zero.

(at age 45) for married women is 2.089.

Table 3: Labor Market and Fertility Outcomes by Age

	Age			
	30	35	40	45
	N=916	N=907	N=592	N=293
Home	0.591	0.535	0.419	0.311
	(0.016)	(0.017)	(0.02)	(0.027)
Reg Work	0.178	0.172	0.208	0.235
	(0.012)	(0.013)	(0.017)	(0.025)
Non-Reg Work	0.194	0.276	0.367	0.454
	(0.013)	(0.015)	(0.02)	(0.03)
PL	0.037	0.018	0.007	0
	(0.006)	(0.004)	(0.003)	(—-)
Pregnancy	0.166	0.053	0.012	0
	(0.012)	(0.008)	(0.004)	(—-)
Earnings	0.673	0.755	1.067	1.302
	(0.041)	(0.044)	(0.067)	(0.102)
No. of Children	1.407	1.867	2.007	2.089
	(0.03)	(0.031)	(0.036)	(0.051)
Husband's Earnings	4.482	5.172	5.723	6.022
	(0.062)	(0.06)	(0.093)	(0.136)

Source: JPSC
Note: The sample includes married women who completed schooling and are not self-employed. Earnings are in million Yen (≈10,000 USD) in 2010 constant price. Standard errors clustered at individual level and calculated by bootstrapping with 1,000 replications.

3.2.2 Employment Transitions

Table 4 shows the transition matrix for employment choices. The rows indicate employment choices in year $t-1$, and the columns indicate employment choices in year t. Employment choices are serially correlated except for PL. For those who stayed at home in $t-1$, 88.6% of them stay at home in t again. Similarly, 82.6% of those worked in the regular sector and 84.7% of those who worked in the non-regular sector in year $t-1$ work in the same sector in year t again. This serial correlation can be driven by heterogeneity or state dependence, or both.

Sector-specific human capital is a possible explanation for state dependence. Individuals lose their sector-specific human capital when they leave the current employment sector, which discourages them from switching sectors. Another possible explanation is an entry barrier to employment sectors. If finding new employment requires a significant search effort, chances of entering a new employment sector are low.

For those who stayed at home, entering the regular sector seems harder than entering to the non-regular sector. Among those who stay home this year, 10.9% start working in the non-regular employment sector, but only 1.0% find a job in the regular employment sector.

The vast majority of PL takers in $t-1$ return to work in t. Only 10.3% of them quit the job and stay at home in year t. 65.3% of them return to work in the regular sector, while 12.2% of them return to work in the non-regular sector. Finally, 12.2% of them continue to be on PL for another year.

Table 4: Transition Matrix for Employment Choice

	Choice in t			
	Home	Reg	Non-Reg	PL
Choice in $t-1$				
Home	0.886	0.01	0.104	0
	(0.005)	(0.001)	(0.004)	(—-)
Reg	0.066	0.826	0.038	0.071
	(0.005)	(0.01)	(0.004)	(0.006)
Non-Reg	0.109	0.037	0.847	0.007
	(0.006)	(0.003)	(0.008)	(0.001)
PL	0.103	0.653	0.122	0.122
	(0.021)	(0.035)	(0.025)	(0.024)

Source: JPSC
Note: The sample includes married women who completed schooling and are not self-employed. Standard errors clustered at individual level and calculated by bootstrapping with 1,000 replications.

3.2.3 Parental Leave Take-Up Rate

Table 5 shows summary statistics about PL take-up. Only about 30% of women hold a job eligible for PL when they give birth. Although the majority of those eligible for the mandated PL take a leave, about 30% of eligible women quit the job without taking a PL. The remaining 12% of eligible women continue to work without taking a PL. Although the recipients of PL cash benefits are expected to return to work, there is no penalty for not returning. Nevertheless, about 90% of leave takers return to employment a year after childbearing.

Table 5: Summary Statistics for PL Take-Up

	Mean	Std. Error
Among Those Who Give Birth		
(1) Eligible for PL	0.293	0.016
Among Those Who Are Eligible for PL		
(2) Quit and Stay Home	0.296	0.027
(3) Take Up PL	0.584	0.030
(4) Work	0.119	0.020
Among Those Who Took PL Last Year		
(5) Employed	0.898	0.021

Source: JPSC
Note: The sample includes married women who completed schooling and are not self-employed. Standard errors clustered at individual level and calculated by bootstrapping with 1,000 replications.

4 Model

4.1 Setup

The labor supply and fertility decisions of married women are modeled using the dynamic discrete choice framework. In each calendar year t, a forward-looking woman maximizes her present value of life time utility by deciding on labor supply and fertility. She retires from the labor market and receives the terminal value of zero at age 65.[6] Individuals differ in their unobserved characteristics including permanent skills in regular and non-regular sectors, non-pecuniary utility from work and children, and their husbands' permanent skills.

4.1.1 Choices

There are four employment choices: (1) staying at home, (2) working in the regular employment sector, (3) working in the non-regular employment sector, and (4) taking a parental leave. Let $d_{h,it} = 1$ if individual i in year t stays at home and $d_{h,it} = 0$ otherwise. The decision variables for working in the regular sector $d_{r,it}$, working in the non-regular sector $d_{n,it}$, and taking a PL $d_{l,it}$ are similarly defined. The labor supply choices are exhaustive and mutually exclusive.

PL is in the choice set only when an individual has a child of age between zero and two and has been employed in the last year, whether in the regular or non-regular sector. This restriction is less strict than the legislation requiring an individual to have a child less than one year old and to have been employed in the eligible employment sector in the last year. This is because many women in

[6] All the results are qualitatively unchanged when the retirement age is set at 70.

the data who have been employed in the non-covered sector and/or have a child aged one or older report their PL take-up.

Individuals also decide on whether they conceive or not. If a woman conceives in year t, she will give birth in the following year $t+1$. Let $d_{f,it}=1$ if individual i conceives in year t and $d_{f,it}=0$ otherwise. A woman does not make a fertility decision after age 45..

Because there are four labor supply choices and two fertility choices, there are eight choices in total. Therefore, a vector of decision variables is $d_{it}=(d_{h,it},d_{r,it},d_{n,it},d_{l,it},d_{f,it})$.

4.1.2 State Variables

The current period payoff for individual i from her choice in year t is affected by a vector of her state variables S_{it} that include sector-specific experiences ($x_{h,it}$, $x_{r,it}$, and $x_{n,it}$), her own age a_{it}, age of the youngest child $a_{k,it}$, number of children n_{it}, earnings of the male spouse $y_{m,it}$, lagged choices d_{it-1}, lagged employment status e_{it-1}, and calendar year t.

In order to keep track of the employment sector of PL takers, the employment status is distinguished from labor supply choices and included in the state variables. Note that PL takers are not currently working, but maintain their employment contract. Let $e_{r,it}=1$ if individual i is employed in the regular sector and $e_{r,it}=0$ otherwise. The indicator for employment in the non-regular sector $e_{n,it}$ is similarly defined. One cannot be employed in more than one sector, implying that $e_{r,it}+e_{n,it}\leq 1$. Define a vector of variables for employment status $e_{it}=(e_{r,it},e_{n,it})$.

The transition of state variables is deterministic except for the earnings of the male spouse (see Section 4.3). Individuals form expectations for the state variables in the next period according to the model, but policy changes are assumed exogenous and unexpected. This assumption is consistent with the fact that individuals are unlikely to be able to time their childbearing to benefit from more generous PL policies, because the new policies were enforced at most nine months after legislation.[7] Technically, this is implemented by assuming that individuals expect that the calendar year as a state variable does not change from this year to next year, which also implies that individuals expect the unemployment rate will remain at the current level.

[7] See Table 1 for timing of legislation and enforcement. The PL was first legislated on May 15, 1991 and enforced on April 1, 1992. Because there is more than ten months between legislation and enforcement, timing birth to take advantage of the reforms was possible. However, the survey used in this paper started after this reform, this does not affect my analysis.

4.2 Preference

4.2.1 Consumption

The utility from consumption u is given by

$$\begin{aligned} u(C_{it}, n_{it}, d_{it}) &= \alpha(d_{it}, n_{it}) \cdot C_{it} \\ &= [\alpha_1 + \alpha_2 d_{r,it} + \alpha_3 d_{n,it} + \alpha_4 \sqrt{n_{it}}] \cdot C_{it}. \end{aligned} \tag{1}$$

This specification implies that the marginal utility of consumption varies with non-market time and the number of children. This non-separability of consumption and non-market time was introduced by Eckstein and Wolpin (1989) and also adopted by the subsequent papers in the literature. If $\alpha_2 < 0$ and $\alpha_3 < 0$, then women having higher-income husbands are less likely to work, which is widely observed across countries.

The household consumes all the income earned in a given year. The budget constraint is

$$C_{it} = y_{m,it} + d_{r,it} y_{r,it} + d_{n,it} y_{n,it} + d_{l,it} b_{it} - (d_{r,it} + d_{n,it}) K(a_{k,it}), \tag{2}$$

where $y_{m,it}$ is earnings of husband, $y_{r,it}$ is earnings in the regular employment sector, $y_{n,it}$ is earnings that individual i would make in year t if she works in the non-regular employment sector, b_{it} is the cash benefit for PL, and $K(\cdot)$ is the childcare cost that depends on the age of the youngest child.[8] Details of earnings and childcare costs are given in Section 4.3.

To achieve computational tractability, saving decisions are assumed away. This assumption may be restrictive, but is common in the literature of female life-cycle labor supply (see Eckstein and Wolpin (1989), van der Klaauw (1996), Francesconi (2002), and Keane and Wolpin (2007, 2010), for example). This is because female life-cycle labor supply models need to incorporate fertility decisions and the effects of children, which is substantially more complicated than male labor supply models. The potential biases from ignoring saving decisions are not well understood.

4.2.2 Non-Pecuniary Utility from labor supply choices

Working in the Regular or Non-Regular Sector Individuals derive non-pecuniary utility from work that depends on the lagged dummy for staying at home $d_{h,it-1}$, the lagged employment sectors e_{it-1}, the number of children n_{it}, the age of the youngest child $a_{k,it}$, and the unemployment rate UR_t. The non-pecuniary utility from employment choices is normalized by setting the utility of

[8] For computational tractability, I am unable to include the age of older children in the state variables, which may result in underestimating the true cost for daycare. This potentially biases the effects of the number of children on the non-pecuniary utility from the labor supply choice, which will be described in the next subsection.

staying at home zero and parametrized as follows:

$$
\begin{aligned}
& v_{ij}(a_{k,it}, n_{it}, e_{it-1}, t) \\
= \quad & \gamma_{ij,1} + \gamma_{j,2} d_{h,it-1} + \gamma_{j,3} e_{k \neq j,it-1} + \gamma_{j,4} d_{l,it-1} e_{j,it-1} + \gamma_{j,5} \sqrt{n_{it}} + \gamma_{j,6}(a_{k,it}) + \gamma_{j,7} UR_t, \quad (3)
\end{aligned}
$$

where $j = n, r$.

The intercept $\gamma_{ij,1}$ varies across individuals to allow for heterogeneous preference for work. The second, third, and fourth terms are the entry costs to the employment sector j, when the woman stayed at home, when she was employed in the other sector k, and when she took PL in the same sector in the last year, respectively. I expect that the estimated entry cost for PL takers $\gamma_{j,4}$ is close to zero, because PL takers maintain their employment contracts while on PL. Hence, job protection helps women after childbearing return to work and is particularly useful in countries where the labor market is rigid such as Japan and Southern European countries.[9] These entry costs are consistent with the serially correlated employment transition in Table 4 and included in many previous lifecycle models of labor supply (e.g. Keane and Wolpin (1997)).

The fifth and sixth terms are the effects of the number of children and the age of the youngest child on non-pecuniary utility from work. Children may affect non-pecuniary utility from work, because mothers care about the health and development of their children and believe that their market work may affect these outcomes. Social norms may also lower mothers' non-pecuniary utility from work by making them feel guilty. In addition, mothers may need rest for their own health right after childbirth.

The sixth term (or function $\gamma_{j,6}(\cdot)$) takes six different values depending on which of the following six age groups the age of the youngest child falls in: 0, 1, 2, 3-5, 6-11, and 12 and older. This functional form is more flexible than previous structural models[10] and motivated by the literature on child development. Waldfogel, Han, and Brooks-Gunn (2002), Baum II (2003), James-Burdumy (2005), and Bernal (2008) find that maternal work affects child development differently depending on the age group the child is in and that it has detrimental effect when the child is aged less than one year. In addition, World Health Organization and UNICEF (2003) recommend exclusive breastfeeding up to six months of age, with continued breastfeeding along with foods up to age two. As shown by Baker and Milligan (2008b), maternal work can prevent breastfeeding, which may affect mothers' disutility from work while the child is young.

Taking Parental Leave The model incorporates PL as a choice unlike previous papers that assume all child-bearers receive a cash benefit automatically. The key assumption here is that there

[9] See Del Boca, Aaberge, Colombino, Ermisch, Francesconi, and Pasqua (2003).

[10] As far as I know, Keane and Wolpin (2010) and Gayle and Miller (2012) allow for a newborn child to affect mothers' utility from work differently from older children. Other papers treat newborns and older children equally.

is a transaction cost for taking up PL, which is motivated by the fact that not all eligible women take PL (see Table 5).

Incomplete take-up is common to many social benefits. Currie (2006) surveys the literature on the take-up of social benefits and reports that low take-up is a problem not only with means-tested benefits, but also with non means-tested benefits. In the literature, the rationale for low take-up includes stigma, transaction cost, and cost to acquire information, although these are not entirely separate explanations.

For PL in Japan, stigma is unlikely to account for the low take-up, because it is not means-tested. Instead, transaction cost and cost of information acquisition may prevent women from taking PL. Workers requesting a leave need to speak to their supervisor to discuss work arrangement while they are on leave and when they return. Employers may be reluctant to provide information and make arrangements regarding PL take-up because PL take-up increases the employment cost for hiring a temporary replacement. Co-workers may also not be supportive because someone's PL take-up may imply more work on their shoulders particularly in a smaller establishment.

The non-pecuniary utility for PL take-up is parametrized as

$$v_{il} = v_{il,1} + v_{l,2} e_{r,it-1} + v_{l,3} ELG_{it} + v_{l,4} d_{l,it-1}(1 - ELG_{it}), \tag{4}$$

where ELG_{it} is a dummy variable that takes one if individual i is legally entitled to PL in year t and takes zero otherwise. An individual is legally entitled to PL if (1) the age of the youngest child is zero and (2) she has been employed in the eligible sector in the last year. The regular employment sector is the eligible sector throughout the period of analysis, but the non-regular sector was not until 2005.

The first term is the baseline transaction cost for PL take-up that varies across individuals. The second term is the transaction cost difference for regular workers, because employers are more willing to award PL for regular workers. The third term is the effect of legal eligibility on the transaction cost. Legal entitlement is expected to decrease the take-up cost of parental leave, because it makes their PL take-up more justifiable. The fourth term is the additional PL take-up cost when PL is repeated by an ineligible individual. This is relevant mostly for those who take PL for an extended period after the child reaches age 1.

4.2.3 Non-Pecuniary Utility from Children

At the time of conception a married woman derives utility from children as lump-sum utility, , which is specified as;

$$v_{if} = \gamma_{if,1} + \gamma_{f,2} d_{r,it} + \gamma_{f,3} d_{n,it} + \gamma_{f,4}(a_{it}) + \gamma_{f,5}(a_{k,it}, n_{it}). \tag{5}$$

The first term is the intercept and varies across individuals to account for heterogeneous preference for children. The second and third terms are the effects of working in the regular and non-regular sectors in the current year, respectively. The fourth term is a quadratic function of own age. The fifth term is a flexible function of the age of the youngest child and the number of children. The age of the youngest child is included to account for birth-spacing.

4.3 Income and Cost of Childcare

Own Earnings The earnings functions are sector-specific and given by

$$y_{j,it} = \omega_{ji,1} + \omega_{j,2}(x_{j,it}, x_{k\neq j,it}) + \omega_{j,3}(x_{h,it}) + \omega_{j,4}(d_{it-1}) + \omega_{j,5}UR_t + \eta_{j,it}. \tag{6}$$

where $j = n, r$. The intercept varies across individuals to account for heterogeneous sector-specific skills. The second term is a function of experiences in the current and the other sectors. The third term is a quadratic function of years spent at home and account for permanent human capital depreciation. The fourth term is the transitory change in human capital and a function of lagged labor supply choices. The fifth term is the effects of the unemployment rate. The last term $\eta_{j,it}$ is a measurement error that follows a normal distribution with zero mean and variance σ_y^2.

Cash Benefit To be eligible for the cash benefit, a PL taker must satisfy two conditions: (1) the age of the youngest child is zero and (2) she has worked (not just been employed) in the eligible sector in the last year. Changes in the replacement rate of the cash benefit R_t over time is summarized in Table 1.

The cash benefit replaces a fraction R_t of pre-leave earnings up to 5.112 million yen per year, net of the bonus. In JPSC, gross labor earnings including bonus are reported. According to Basic Survey on Wage Structure 2008, regular workers' bonus per year is worth about their three-month earnings,[11] while that of non-regular workers is worth about their one-month earnings. Given these statistics, the cash benefit of parental leave is given by

$$b_{it} = R_t \min\left[5.112,\ d_{r,it-1}\frac{12}{15}\hat{y}_{r,it} + d_{n,it-1}\frac{12}{13}\hat{y}_{n,it}\right], \tag{7}$$

where R_t is the replacement rate and $\hat{y}_{j,it}$ $(j = i, n)$ is the predicted earnings in sector j. Because the exact pre-leave salary is not included in the state variable to reduce computational burden, it is approximated by the predicted earnings in year t.

[11] For regular workers, the average monthly earnings without a bonus was 243,900 JPY and the average bonus in 2008 was 724,000 JPY. For non-regular workers, the average monthly earnings without a bonus was 170,500 JPY and the average bonus in 2008 was 140,800 JPY.

Earnings of Husband The earnings of husbands are modeled by a flexible function of state variables with little emphasis on a structural interpretation. It is specified as

$$y_{m,it+1} = \omega_{mi,1} + \omega_{m,2} y_{m,it} + \omega_{m,3}(a_{it}) + \omega_{m,4}(a_{k,it}, n_{it}) + \omega_{m,5}(d_{it}) + \omega_{m,6} UR_t + \eta_{m,it}. \quad (8)$$

The first term $\omega_{mi,1}$ varies across individuals to allow for difference in husband's unobserved permanent skills. The lagged earnings of husband are included to allow for serial correlation. The third term is a quadratic function of the age of the wife. The fourth term is a function of the age of the youngest child and the number of children. The fifth term is the current labor supply and fertility choices. The sixth term is the effect of the unemployment rate in year t. The last term $\eta_{m,it}$ is an i.i.d. income shock that follows a normal distribution with zero mean and variance σ_m^2.

Cost for Childcare The cost for childcare $K(a_{k,it})$ is a function of the age of the youngest child. The Survey of Regional Child Welfare Services 2003 reports the average monthly fees for non-accredited childcare by child's age. The actual childcare costs vary by individuals for a variety of reasons, but using the reported childcare costs raises the concern of endogeneity biases. My approach is to use the average of the list prices. The childcare cost is given by

$$\begin{aligned} K(a_{k,it}) = & [I(a_{k,it} = 0) \cdot 43739 + I(a_{k,it} = 1) \cdot 40660 + \\ & I(a_{k,it} = 2) \cdot 38179 + I(3 \leq a_{k,it} \leq 5) \cdot 34181] \times 12/1000000, \end{aligned} \quad (9)$$

where $I(\cdot)$ is an indicator function that takes the value one if the condition in the parenthesis is satisfied and takes zero otherwise. The monthly childcare service for children age zero is only 43,739 Yen ($\approx$ 437 USD), because it is heavily subsidized. The fee tends to be higher for younger children, but the fee difference across ages is not large.

4.4 Utility Maximization

The objective of a married woman is to maximize the present discount value of her lifetime utility. Her value function V is recursively defined as

$$V(S_{it}, \varepsilon_{it}) = \max_{j \in \{h,r,n.l\}, f \in \{0,1\}} U_j^f(S_{it}) + \varepsilon_{j,it}^f + \beta E[V(S_{it+1}, \varepsilon_{it+1}) | S_{it}, d_{it}] \quad (10)$$

where β is a discount factor. Her current payoff is also affected by a preference shock $\varepsilon_{j,it}^f$ specific to a choice $j \in \{h, r, n, l\}$ and $f \in \{0, 1\}$.

The choice-specific shocks follow a generalized extreme value distribution so that they can be correlated with each other. The choice probability is modeled by the generalized nested logit model that allows for overlapping nests, following Wen and Koppelman (2001). Eight choices are grouped by whether to work or not and whether to conceive or not. There are four nests of alternatives labeled as $B_1, \cdots, B_4$. Nest B_1 includes alternatives for non-conception ($d_{f,it} = 0$) regardless of labor supply choices, nest B_2 includes alternatives for conception ($d_{f,it} = 1$) regardless of labor supply choices, nest B_3 includes alternatives for work ($d_{r,it} = 1$ or $d_{n,it} = 1$) regardless of fertility choices, and nest B_4 includes alternatives for non-work ($d_{h,it} = 1$ or $d_{l,it} = 1$) regardless of fertility choices. Detailed explanation for the generalized nested logit model is given in the Appendix B.1.

4.5 Unobserved Heterogeneity

Permanent unobserved heterogeneity is modeled as a finite mixture. Individuals are one of K types, but the type of an individual is not observed. Following Wooldridge (2005), to address the initial condition problem, I allow for the probability of being type k to depend on the observed choice in year $t = \tau_i$ that is the first year when individual i is observed in the data. Define $z_{i\tau_i}$ as a vector of observed characteristics and choice in year τ_i: $z_{i\tau_i} = (d_{i\tau_i}, S_{i\tau_i}, edu_i)$ where edu_i is years of education. The probability that individual i is type k is given by

$$p_k(z_{i\tau_i}) \quad = \quad \frac{\exp(\pi_k' z_{i\tau_i})}{\sum_{\kappa=1}^{K} \exp(\pi_\kappa' z_{i\tau_i})}. \tag{11}$$

For normalization, the parameters for the first type is set zero so that $\pi_{\kappa=1} = 0$.

4.6 Comparison with Previous Structural Models

A few previous structural estimation papers model and/or simulate PL policies. Gayle and Miller (2012) simulate the effects of cash benefits on fertility and labor supply, but the role of job protection or PL take-up is not considered. Adda, Dustmann, and Stevens (2011) include job protection and cash benefits in their model, but they do not model the PL take-up behavior and assume that all women giving birth take PL and receive job protection and cash benefits. In addition, Adda, Dustmann, and Stevens (2011) do not study the effects of PL policies specifically. Modeling PL take-up is fruitful if PL is not universal or the take-up rate is less than 100%. The Family and Medical Leave Act (FMLA) in the U.S. provides job protection, but it applies to public sectors and private companies with 50 or more employees. Although PL is universal, the take-up rate[12] is about 50% in Germany, according to Schönberg and Ludsteck (2014). Given these facts, not modeling the PL take-up and instead assuming that all women take PL, may result in biased estimates

[12]Measured by the number of PL take-up divided by the number of birth.

for the effects of PL policies.

Lalive, Schlosser, Steinhauer, and Zweimüller (2014) appear to be the structural estimation paper closest to this paper. Their model, however, is based on the continuous-time job search model by Frijters and van der Klaauw (2006), instead of a discrete choice framework adopted by this paper. This paper differs from Lalive, Schlosser, Steinhauer, and Zweimüller (2014) in three important ways. First, this paper models PL take-up, the importance of which is explained above. Second, my model allows for fertility choices as well. If a PL reform affects fertility decisions as in Lalive and Zweimüller (2009) and fertility affects labor supply decisions, the estimated policy effects on maternal labor market outcomes may be biased if fertility is taken exogenous. Third, my model considers not only labor force participation decisions, but also occupational choices (regular vs non-regular jobs). The simulation results below indicate that the policy effects are different between the two jobs.

5 Model Estimation

The model is estimated by the maximum likelihood. I describe the details of the likelihood function in Section B.1 for interested readers.

The maximum is found by combining the three algorithms that accelerate computation. The main algorithm is developed by Kasahara and Shimotsu (2011), and their algorithm sequentially updates the parameter and the value function estimates. For each likelihood evaluation, the value function is iterated for a small number of times rather than until convergence, which significantly reduces the computational time. To accelerate the computation for the value function iteration in evaluating the likelihood, the value function is approximated based on sieves, using the method proposed by Arcidiacono, Bayer, Bugni, and James (2013). When the state space is large, this sieve approximation can reduce the computational time dramatically.

To account for unobserved heterogeneity modeled as a finite mixture, I combine the sequential algorithm above and the Expectation-Maximization algorithm with a sequential maximization step developed by Arcidiacono and Jones (2003). Combining these algorithms makes the model estimation tractable. The details are described in Section B.2.

Because the computation of standard errors for the proposed algorithm is analytically complex, I take the converged estimates from this algorithm as a starting value for the full information maximum likelihood with the nested fixed point algorithm.

6 Estimation Results

6.1 Parameter Estimates

Marginal Utility of Consumption Table 6 reports the parameter estimates for marginal utility of consumption. The estimated marginal utility of consumption is positive, but it decreases when women work either in regular or non-regular sectors. This is consistent with the fact that a wife's labor force participation decreases with her husband's earnings, all else being equal. The estimates also indicate that the marginal utility of consumption increases with the number of children, which implies that labor supply increases with the number of children.

Table 6: Parameter Estimates for Marginal Utility of Consumption

	Estimate	S.E.
Home or On-Leave	0.072	0.013
Reg.	−0.031	0.007
Non-Reg.	−0.034	0.007
Sqrt. of No. Children	0.050	0.005

Non-Pecuniary Utility of Work There are two important findings from the estimates for non-pecuniary utility of work shown in Table 7. First, the entry costs from home to employment sectors are large, which is particularly true for the regular employment sector. This is suggested by the large negative non-pecuniary utility (see the coefficients for lagged home). The effect of entering from home to the regular sector on non-pecuniary utility (-4.851) is most negative among all factors in the model. The large entry cost implies that returning to work after quitting a job is difficult, and hence, job protection is expected to help mothers of young children return to the labor market quickly.

Second, having a young child decreases the non-pecuniary utility of work in both sectors, and the negative effect is particularly large when the child is age 0. This is consistent with empirical evidence that maternal work in the first year of a child's life may have negative effects both on children and mothers themselves. Waldfogel, Han, and Brooks-Gunn (2002), Baum II (2003), James-Burdumy (2005) find that maternal work during the first year of a child's life has a negative effect on the child's test score. Baker and Milligan (2008b) find that maternal work can prevent breastfeeding that improves health of both children and mothers, according to World Health Organization.[13] Moreover, Wray (2011) argues that mothers need a year to fully recover from childbirth

[13] World Health Organization recommends exclusive breastfeeding for the first six months.

to be ready to work. If mothers care about the development of their children and their own health and believe that maternal work has detrimental effects on these outcomes, non-pecuniary utility from work is a large negative in the first year of the child's life.[14]

The large negative effect of a newborn on non-pecuniary utility of work implies that PL is valuable for mothers of children aged 0, because it allows mothers to be off work to stay with their new baby without losing their jobs. However, PL may not be as valuable for mothers of children age one or older, because the negative effect on non-pecuniary utility quickly fades as soon as the child grows to age one. This difference between newborns and older children explains why one-year job protection increases female labor supply, but expanding it to three years will not do so in counterfactual simulations in Section 7.

Other estimates are also worth mentioning. As expected, the costs of returning from PL are small and not significantly different from zero in both sectors. The costs of switching between employment sectors are large, although they are smaller than the costs of entering from home. The unemployment rate decreases the non-pecuniary utility of work in the regular employment sector, while it has almost no effects for the non-regular sector.

Transaction Cost of PL Take-Up Legal eligibility for PL reduces the transaction cost of PL take-up, which is implied by the positive effects on non-pecuniary utility in Table 7. Even though some employers grant PL voluntarily, mandating it can increase the PL take-up. It is also found that the transaction cost of PL take-up is lower in the regular sector than in the non-regular sector. This is because regular workers are more skilled and harder to find than non-regular workers, and hence, employers are more willing to offer an additional PL for retaining regular workers.

Utility from Children The last column in Table 7 reports parameter estimates for utility from children received as a lump sum at the time of conception. The utility decreases with the number of existing children and when the mother has a child age 0. It also decreases with the mother's age at the quadratic rate.

Correlation Structure of Error Terms Table 8 presents the parameter estimates that govern the correlation structure of the error terms. The correlation of the error terms is modeled by the generalized nested logit. Four overlapping nests are constructed depending on the work and fer-

[14]The literature does not fully agree on the effects of maternal work on child development. For example, using the changes in parental leave legislation, Baker and Milligan (2010, 2015) and Dustmann and Schönberg (2011) find no effects for Canada and Germany, while Carneiro, Løken, and Salvanes (2015) find negative effects of maternal work in Norway. In addition, Baker and Milligan (2008b) find no effects of breastfeeding on self-reported maternal and child health. Even if maternal work has no effect on these outcomes, mothers derive large negative utility from work if they believe it has detrimental effects.

Table 7: Parameter Estimates for Non-Pecuniary Utility from Labor Supply and Fertility Choices

	Reg.		Non-Reg.		PL		Fertility	
	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
Intercept (Type 1)	0.197	0.152	−0.101	0.142	−2.594	0.726	0.424	0.765
Intercept (Type 2)	−0.075	0.110	0.250	0.064	0.410	0.296	−0.770	0.315
Intercept (Type 3)	0.353	0.114	0.557	0.092	−0.884	0.344	0.394	0.298
Intercept (Type 4)	0.069	0.105	0.157	0.067	0.014	0.300	−0.065	0.320
Reg.							0.717	0.195
Non-Reg.							0.233	0.197
Lagged Home	−4.851	0.634	−2.656	0.347				
Lagged PL in Reg.	−0.325	0.234						
Lagged PL in Non-Reg.			0.276	0.439				
Lagged Reg. Empl.			−1.586	0.315	0.719	0.377		
Lagged Non-Reg. Empl.	−2.355	0.379						
PL Legally Eligible					1.360	0.398		
Lagged PL * Ineligible					0.764	0.386		
Sqrt. of No. Children	−0.003	0.028	0.080	0.027			−0.503	0.352
Child Age 0	−2.694	0.397	−2.826	0.374			−0.447	0.454
Child Age 1	−0.078	0.184	−0.414	0.109			0.988	0.422
Child Age 2	−0.166	0.168	−0.485	0.105			1.152	0.411
Child Age 3-5	−0.081	0.076	−0.191	0.049			0.841	0.373
Child Age 6-11	−0.010	0.060	−0.123	0.045			0.231	0.349
Age							−0.061	0.040
Age-sq							−0.233	0.078
Unempl. Rate	−0.056	0.028	0.005	0.030				

tility alternatives (see Section 4.4 for details). Equation (22) in Appendix B.1 shows the choice probabilities using these parameters.

The dissimilarity parameters $\lambda_1, \ldots, \lambda_4$ measure the degree of independence among alternatives within the nest and take the value between zero and one. The estimates are smaller than one, implying that choices are correlated within each nest. The allocation parameters μ_b measure the extent to which an alternative is a member of nest b. The estimate is significantly above zero and below one, implying that the nests are overlapped. Ignoring this correlation structure, or the use of multinomial logit model, biases the parameter estimates of the utility functions and can make unrealistic predictions arise from the assumption of independence from irrelevant alternatives.

Table 8: Parameter Estimates for Error Terms

	Estimate	S.E.
Dissimilarity Parameter		
λ_1	0.601	0.114
λ_2	0.820	0.132
λ_3	0.661	0.407
λ_4	0.925	0.198
Allocation Parameter		
μ_1	0.741	0.187

Note: Dissimilarity parameters measure the degree of independence among alternatives within the nest and take the value between zero and one. The allocation parameters measure the extent to which an alternative is a member of each nest. It is assumed that $\mu_1 = \mu_2$, $\mu_3 = \mu_4$, and $1 - \mu_1 = \mu_3$. See Equation (22) in Appendix B.1 for choice probabilities using these parameters.

Earnings Functions The parameter estimates for the earnings functions are shown in Table 9. For both regular and non-regular sectors, experiences in individual's own sector increases earnings. Experiences in the other sector also increases earnings, but at a lower rate than the experiences in one's own sector. Years at home reduce earnings in both sectors, which implies earnings capacity depreciates while at home or on leave. There was also a temporary earnings penalty for those who stayed at home or had been on leave in the last year. New workers switching from the non-regular to the regular sector earn less than those already in the regular sector. In contrast, workers newly switching from the regular to the non-regular sector earn more than those already in the non-regular sector.

Husband's Earnings and Type Probability Functions The parameter estimates for husband's earnings and type probability functions are reported in the Appendix C, because they do not have

Table 9: Parameter Estimates for Log Earnings Functions

	Reg.		**Non-Reg.**	
	Estimate	S.E.	Estimate	S.E.
Intercept (Type 1)	−0.433	0.158	−2.472	0.065
Intercept (Type 2)	1.028	0.128	−1.364	0.060
Intercept (Type 3)	0.348	0.131	−0.625	0.058
Intercept (Type 4)	0.715	0.139	−0.015	0.061
Years in Reg.	0.029	0.006	0.023	0.002
Square of Years in Reg. / 100	−0.025	0.013		
Years in Non-Reg.	0.010	0.003	0.088	0.006
Square of Years in Non-Reg. / 100			−0.271	0.027
Years in Home	−0.022	0.017	−0.053	0.009
Square of Years in Home / 100	0.030	0.177	0.146	0.078
Lagged Home or On-Leave	−0.489	0.043	−0.675	0.020
Lagged Reg			0.161	0.054
Lagged Non-Reg.	−0.290	0.062		
Unempl. Rate	0.033	0.028	−0.005	0.012

structural interpretation.

6.2 Model Fit

I present evidence on how well the model is able to fit selected features of the data. For each individual in the data, her employment and fertility choices, earnings, and earnings of her husband are simulated for 30 times, given her initial conditions, until the year when she last appeared in the data.

Figure 2 shows the observed and predicted age profiles of choice probabilities, own and husband's earnings, and the number of children. The solid lines are observed profiles, and the dashed lines are predicted profiles. In all of the eight panels in the figure, the predicted age profiles are similar to the actual age profiles, although profiles are noisier for both left and right tails because of the small sample size for these age groups.

Tables 10 and 11 show model fit for employment transitions and PL take-up rates along with employment status around childbearing, respectively. For both sets of statistics, the model is able to predict the observed patterns in the data.

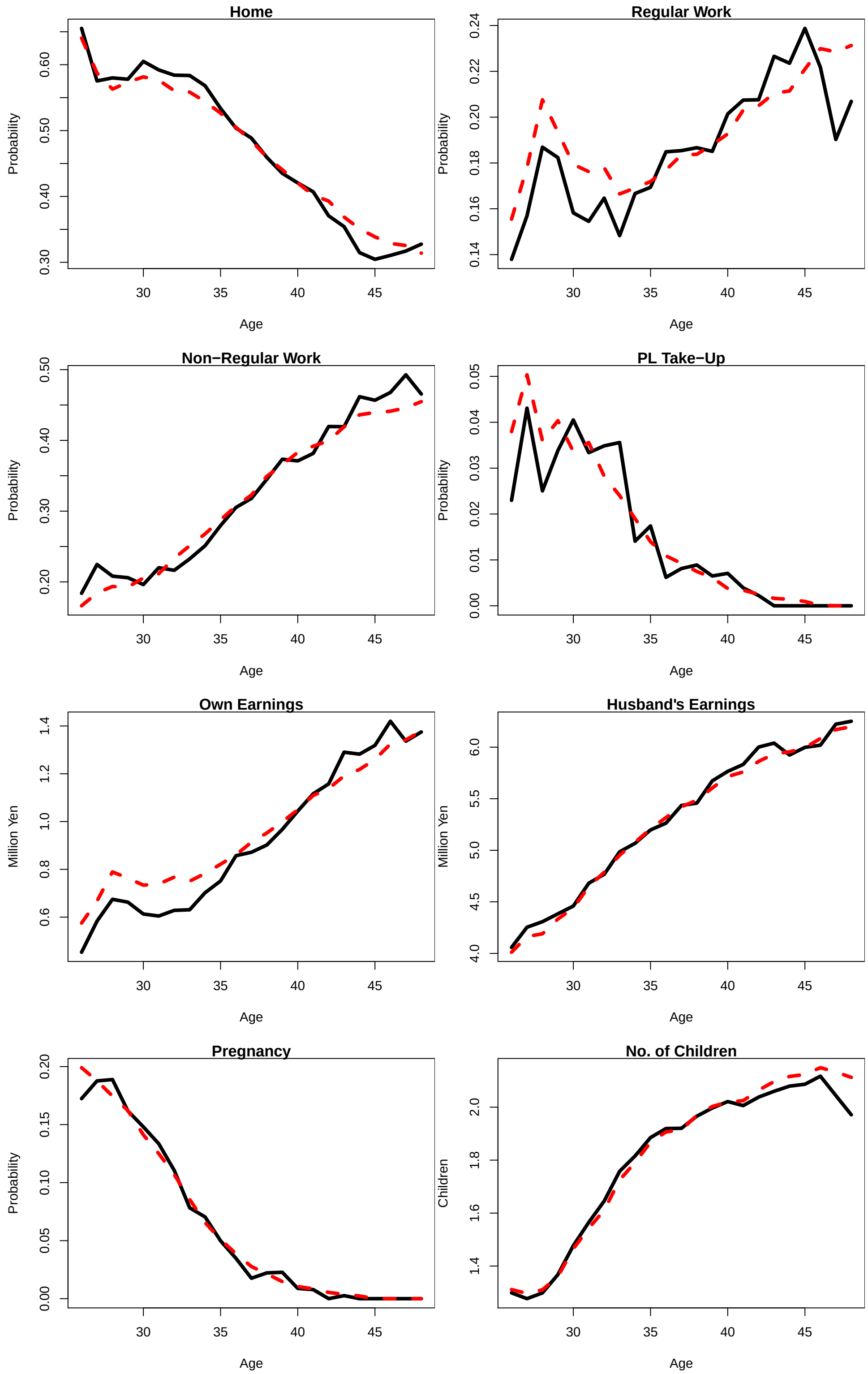


Figure 2: Age Profiles For Labor Market Outcomes
Note: The solid lines are observed profiles, while the dashed lines are predicted profiles.

Table 10: Model Fit for Transition Matrix

	Home	Reg	Non-Reg	PL
Data				
Home	0.886	0.010	0.104	0.000
Reg	0.066	0.826	0.038	0.071
Non-Reg	0.109	0.037	0.847	0.007
PL	0.103	0.653	0.122	0.122
Model				
Home	0.885	0.010	0.105	0.000
Reg	0.063	0.831	0.036	0.069
Non-Reg	0.110	0.038	0.844	0.007
PL	0.104	0.668	0.113	0.116

Table 11: Model Fit for PL Take-Up Rate

	Data	Model
Among Those Who Give Birth		
(1) Eligible for PL	0.292	0.289
Among Those Who Are Eligible for PL		
(2) Quit and Stay Home	0.297	0.280
(3) Take Up PL	0.584	0.601
(4) Work	0.119	0.119
Among Those Who Took PL Last Year		
(5) Employed	0.897	0.896

7 Counterfactual Simulations

Using the estimated model, I simulate labor supply and fertility decisions of women under different policy scenarios. In each hypothetical scenario, a new policy is legislated and enforced in 2010, in order to preclude announcement effects. No further PL reform takes place, which is known by individuals.

In evaluating policies, I simulate those women who were pregnant and worked in 2009, because they are most directly affected by a policy change in 2010. Each individual is simulated for 1,000 times.

7.1 Job Protection

Three policy scenarios are simulated: (1) no PL, (2) one-year job protection, and (3) three-year job protection. In all scenarios, no cash benefit is paid. The results do not change qualitatively regardless of the arrangement of cash benefits. I simulate different durations of job protection by changing the legal eligibility requirement for PL. For one-year job protection, individuals must have been employed last year and the age of the youngest child must be 0. For three-year job protection, the age requirement is relaxed so that the youngest child must be age two or younger, which allows a woman to take a job-protected leave for at most three years.

Simulated responses are graphically presented in Figure 3.[15] Panel (a) shows the probability of work. The probability of work in the year of childbearing drops to 0.20 without mandated PL. It is lower under one- or three-year job protection, because more women are on leave. Mothers gradually return to work after childbearing. The probability of work a year after childbearing is 0.33 without mandated PL. Under one- and three-year job protection, it increases to 0.54 and 0.53, respectively. These policy effects on maternal work last even ten years after childbearing. One- and three-year job protection increases the probability of work ten years after child birth from 0.59 to 0.66 and 0.68, respectively. Note that policy effects are similar between one- and three-year job protection, which implies that expanding job protection from one to three years has little marginal effects.

Panel (b) shows the PL take-up rates. Even if PL is not mandated, the take-up rate is 0.12 in the year of childbearing, because some employers voluntarily offer a job-protected PL. One- and three-year job protection boost the take-up rates by more than four times. However, the take-up rates a year after childbearing drop substantially, although the take-up rate is higher under three-year job protection than one-year job protection. The results indicate that most women take PL just for one year even if PL is available for three years, which explains why expanding job protection from one to three years has little marginal effects on maternal work.

[15] Detailed simulations results are available in Tables 18 and 19 in Appendix C.

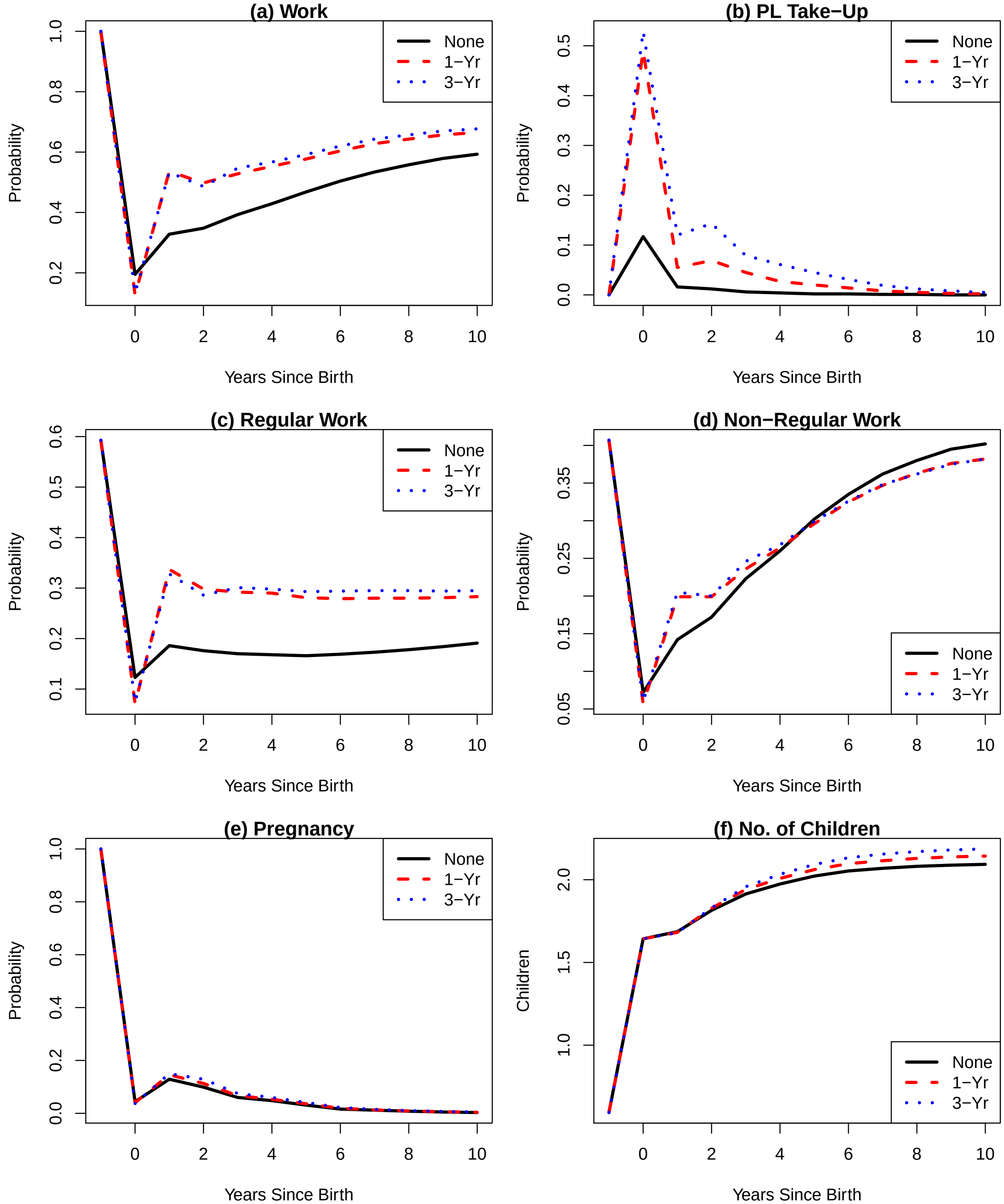


Figure 3: Effects of Job Protection

Table 12: Effects of Parental Leave Policies on Accumulated Income, Consumption, and Welfare

	Income	Consumption	Utility (Rank)
(1) JP:0, RR:0%	10.52	73.91	16.24 (8)
(2) JP:1, RR:0%	14.44	77.03	16.69 (6)
(3) JP:3, RR:0%	14.61	77.11	16.93 (3)
(4) JP:0, RR:50%	10.09	75.2	16.35 (7)
(5) JP:1, RR:50%	14.75	79.24	16.84 (4)
(6) JP:3, RR:50%	14.96	79.41	17.09 (1)
(7) JP:1, RR:50% + Return	15.29	79.2	16.8 (5)
(8) JP:3, RR:50% + Return	15.28	79.28	17.05 (2)

Note: JP and RR stands for job protection and replacement rate of cash benefits, respectively. The label "Return" in rows 7 and 8 means that expectation to return to work is required for PL. Income and consumption are the present values of labor income and consumption streams for 15 years since childbearing. The discount rate is 5% per annum. Utility is the present value of life-time utility and given by the value function.

Panels (c) and (d) show the fractions of mothers working in the regular and non-regular employment sectors, respectively. Job protection increases the fraction of mothers working in the regular sector, and the policy effects persist ten years after child birth. In contrast, job protection slightly decreases the fractions of mothers working in the non-regular sector. These results indicate that the rise in the probability of work is mostly due to the rise in the fraction of mothers working in the regular sector. These differential effects between sectors are consistent with the observation that the entry cost from home is higher for the regular sector than the non-regular sector.

Panels (e) and (f) show the probability of pregnancy and the number of children, respectively. The probability of pregnancy rises to 0.13-0.15 a year after childbearing and then decreases. It varies little between policies, although more generous job protection increases fertility. The number of children in Year 10 is 2.09 without job protection. It increases to 2.14 and 2.19 when one- and three-year job protection is mandated, respectively. Thus, job protection appears to have a small positive effects on fertility.

Policy effects on accumulated income, accumulated consumption, and welfare are also evaluated and presented in Table 12. Income and consumption are the present values of women's labor income and household consumption streams for 15 years since childbearing. Utility is the present discounted value of life-time utility given by the value function. The discount rate is 5% per annum. The introduction of one-year job protection increases the accumulated income from 10.52 to 14.44 or by 37% (see rows 1 and 2). It also increases the accumulated consumption from 73.91 to 77.03 or modestly by 4%. The introduction of one-year job protection and the expansion to three years increase welfare in the model, because these policies have no side effects by construction.

The simulation results indicate that introducing one-year job protection significantly increases maternal work after childbearing, but expanding job protection from one to three years has little effects. As shown in Table 7, the non-pecuniary utility of work is large negative when the youngest child is age 0. When job-protected leave is not mandated, women quit their jobs due to the large negative non-pecuniary utility of work. They return to the labor market after childbearing, but the pace is slow due to the high entry costs to employment sectors. The introduction of one-year job protection allows women to be off work and take a PL when the non-pecuniary utility of work is a large negative. They can return to the labor market after childbearing at a faster pace, because they do not pay the high entry cost to employment sectors. When a child grows one year of age or older, the non-pecuniary utility of work is still negative, but much smaller than that for a mother of a newborn. Hence, most women return to work a year after childbearing even if they can take a PL for three years.

7.1.1 Ex Ante Evaluation of PL Reform Proposed by the Prime Minister Abe

Japanese Prime Minister Abe proposed a PL reform to raise the labor force participation rate of mothers of young children. Under the legislation at the time (April 2013), the duration of job protection was one year, the replacement rate of the cash benefit was 50%, the PL takers must be expected to return to work after the completion of PL. The Prime Minister proposed to extend job protection to three years without changing the arrangement for the cash benefit. His proposal initiated a heated policy debate and although it has not been legislated as of the writing of this paper, the likely outcomes of the policy reform are not well understood. The structural estimation approach taken in this paper is suitable to assess the potential effects of the proposed reform before its implementation.

Table 13: Ex Ante Evaluation of PL Reform Proposed by Prime Minister Abe

	Mean	**Policy Effects**
	1Yr + 50% + 'Return'	1Yr + 50% + 'Return'$\rightarrow$ 3Yr + 50% + 'Return'
On PL in $t = 0$	0.53	0.03
Work in $t = 5$	0.60	0.01
Earnings in $t = 5$	1.44	-0.02
No of Children in $t = 10$	2.17	0.05

Note: The first column labeled as "Mean" shows mean of outcomes variables before the PL reform. The second column labeled as "Policy Effects" shows the mean changes of outcomes variables caused by the PL reform.

Table 13 summarizes the main simulation results.[16] As expected from the previous simulations, the policy reform will not have sizable effects on maternal work or fertility. Table 12 presents the policy effects on the accumulated income, consumption, and welfare (see rows 7 and 8). The expansion improves these outcomes modestly.

The main limitation of these simulations is that they are a partial equilibrium analysis. Although cash benefits are paid by the Employment Insurance, not by employers, mandating three-years job protection may be costly for employers. This is because employers may have to hire additional workers or re-assign existing workers temporarily to undertake the tasks of the PL takers while they are on leave. Hence, the PL reform is likely to decrease the demand for female workers in the childbearing ages. The partial equilibrium analysis assumes that the demand stays the same after the policy reform, which implies that the simulations provide upper bounds for the labor market outcomes. In conclusion, the proposed reform is unlikely to improve mothers' labor market outcomes.

7.1.2 Role of Human Capital Depreciation

In this subsection I examine how policy effects would change if human capital does not depreciate while staying at home or being on leave. Human capital depreciation affects the opportunity cost of taking PL, which may explain why the extension of job protection from one to three years does not increase maternal employment.

Table 14: Policy Effects Under Different Setup

	Mean	**Policy Effects**		
	(1) Before Change	(2) Baseline	(3) No HC Depreciation	(4) Low Entry Cost
No PL → 1-Yr JP (w/ No Benefit)				
On PL in $t = 0$	0.12	0.37	0.38	0.29
Work in $t = 5$	0.47	0.11	0.12	0.02
Earnings in $t = 5$	0.87	0.48	0.60	0.12
No of Children in $t = 10$	2.09	0.05	0.08	0.04
1-Yr JP → 3-Yr JP (w/ 50% + Ret.)				
On PL in $t = 0$	0.53	0.03	0.03	0.04
Work in $t = 5$	0.60	0.01	0.01	−0.01
Earnings in $t = 5$	1.44	−0.02	0.01	−0.03
No of Children in $t = 10$	2.17	0.05	0.06	0.03

Note: Column (1) shows mean of outcomes variables before the PL reforms. Columns (2)-(4) show the mean changes of outcomes variables caused by the PL reforms under different assumptions. JP stands for job protection.

Two policy changes are simulated. In the first policy change, one-year job protection is first

[16] The full results are available in Tables 18 and 19 in Appendix C.

introduced, but no cash benefits are paid. In the second policy change, job protection is extended from one to three years as in Section 7.1.1 in which the replacement rate of cash benefits is at 50% and the PL takers are expected to return to work.

The policy effects are compared between the baseline model and the model without human capital depreciation. In the baseline model, all parameters are at the estimated values. In the model without human capital depreciation, the coefficients for years at home and lagged sectors in the earnings functions (6) are set zero.

In Table 14, Column (2) shows policy effects in the baseline model, while Column (3) shows policy effects when human capital does not depreciate. Although the policy effects are stronger when human capital does not depreciate, they are similar to those of the baseline model. Hence, human capital depreciation does not explain why most women do not take PL for three years even when three-year job protection is mandated.

The estimates in Table 9 indicate that one year spent at home decreases the earnings by 2-5%, which may not be large enough to prevent women from taking a PL for an extended period. Human capital depreciation may be crucial for highly skilled women, but it does not seem so for women with average skill. Indeed, only 14% in the sample graduated from a four-year university. It should also be noted that this result is consistent with previous findings in other countries. For example, Lalive, Schlosser, Steinhauer, and Zweimüller (2014) find no evidence for human capital depreciation among the group of mothers exposed to longer leave regimes.

7.1.3 Role of Entry Cost to Employment Sectors

The simulation indicates that the effect of job protection is concentrated in the regular sector and lasts for several years after childbirth. This is because the entry cost from home to the regular employment sector is high.

To see how entry costs influence the effects of job protection, I simulate the model under the assumption that the entry costs to employment sectors are reduced by 50%. The other setup is identical with that in the last subsection 7.1.2, and the results are presented in Table 14.

As expected, policy effects on maternal work are weaker than the baseline model if the entry costs are low. This implies that difference in labor market friction and/or flexibility across countries must be taken into account when one tries to generalize findings in this paper to other countries. Lin and Miyamoto (2012) find that the monthly job finding and separation rates in Japan are about 14% and 0.4%, respectively, while they are 25-32% and 3-5% in the U.S, respectively, according to Yashiv (2008). These statistics suggest that the labor market is more flexible and the entry cost is smaller in the U.S. than Japan, and hence, the employment effect of job protection is also expected to be smaller.

7.2 Cash Benefit

I evaluate the effects of the arrangement for PL cash benefit by simulating three scenarios in which the duration of job protection and benefit payment is one year. In the first scenario, no cash benefit is paid. In the second scenario, the replacement rate of cash benefit is 50%, but unlike the actual legislation the recipients are not expected to return to work. This is implemented by giving cash benefits to all eligible women even when they choose to stay at home, rather than to take up a PL. This scenario tries to replicate the PL system seen in other countries such as Canada and Germany. In the third scenario, the replacement rate is 50% and the recipients are expected to return to work, which corresponds to the current Japanese PL system. Eligible individuals must take up a PL to receive cash benefits.

Cash benefits are expected to increase the number of mothers staying at home in the short run, but the long-run effects on maternal work are ambiguous. On the one hand, cash benefits may increase maternal work, because women want to become eligible for cash benefits. On the other hand, they may decrease maternal work, because mothers lose their human capital while on PL. Whether PL takers are expected to return to work or not also matters to their labor supply after childbearing. If PL takers need to return to work, cash benefits increase incentive to take up PL, which helps women to return to work.

Table 15: Marginal Effects of Cash Benefit Arrangement

	Mean	**Policy Effects**	
	No Benefit	0%→50%	50%→ 50% + ‘return’
On PL in $t = 0$	0.49	0.02	0.02
Work in $t = 5$	0.58	0.01	0.01
Earnings in $t = 5$	1.35	0.04	0.06
No of Children in $t = 10$	2.14	0.03	0.00

Note: The first column labeled as “Mean” shows mean of outcomes variables when no cash benefits are paid. The second and third columns labeled as “Policy Effects” show the mean changes of outcomes variables caused by the policy changes.

Table 15 summarizes the simulation results.[17] The effects on the PL take-up rate are modest. When the replacement rate is raised from 0% to 50%, the take-up rate increases by two percentage points. When expectation to return to work becomes a requirement, the take-up rate further increases by two percentage points. The effects on the probability of work, earnings, and fertility are also modest, although they are positive. These results are in line with Asai (2015) who estimates

[17] Detailed results are available in Appendix C.

the effects of cash benefit by the difference-in-differences approach and finds little employment effects of cash benefit in Japan.

Effects on accumulated income, accumulated consumption, and welfare are presented in Table 12 (see rows 2, 5, and 7). Raising the replacement rate from 0% to 50% improves the accumulated income, consumption, and welfare. Requiring a return to work increases the income and consumption, but it decreases welfare for lost time at home. Yet, cash benefits with requirement to return are preferred to no cash benefits.

8 Conclusion

I construct and estimate a dynamic discrete choice structural model of female employment and fertility decisions. The contribution of this paper is to model job protection and cash benefits of PL. Job protection allows women to return to work after childbearing without paying entry costs to employment sectors, while cash benefits provide financial incentives to take-up PL.

The model is estimated by the sequential estimation algorithm based on Kasahara and Shimotsu (2011) and the EM algorithm by Arcidiacono and Jones (2003). The sieve approximation for the value function by Arcidiacono, Bayer, Bugni, and James (2013) is also applied to further reduce computational burden. As far as I know, this paper is the first application that combines these three methods. The estimated model seems to fit to selected features of the data.

The model is used to conduct counterfactual simulations for evaluating PL policies. Effects of one-year job protection on maternal work are significant, but extending the duration of job protection from one to three years has little effect. This is because the non-pecuniary utility of work is a large negative only in the first year of a child's life.

Evidence suggests that the large negative non-pecuniary utility of work for mothers of newborns is not specific to Japanese women, but policy effects may depend on labor market institutions. The effect of job protection tends to be strong when the entry cost to the labor market is high, and hence, job protection may have smaller employment effects in the U.S. where the labor market is significantly more flexible than in Japan.

Yet, the model and estimation method offer a useful tool to predict potential effects of PL in other countries such as U.S. where the FMLA offers only 12 weeks of unpaid parental leave. The model could be used to conduct an ex ante evaluation of extending the job protection period and an introduction of cash benefits.

One area to examine in future work is the interaction effects with other pro-family policies such as childcare expansion that are intended to support working mothers. Such policies are likely to affect the cost of children for labor force participation, and hence, the effects of parental leave policies.

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A Details of Data

A.1 Variable Definitions

A.1.1 Labor Market Status

The choice variable for labor market status has four possible, mutually exclusive states. It is determined by the following hierarchical rule. First, I determine if a woman is on parental leave. If not, I examine whether she works in the regular or non-regular sector. If she is not on leave or does not work, I consider she stayed at home.

Parental Leave Take-Up For those who report childbearing, JPSC asks whether an individual took a PL or not. If yes, she is considered on PL for the year. If not, I check her employment status as of October and whether she had a baby. The employment status as of October includes information on whether the respondent is on PL or not, but this answer alone does not seem reliable. Women are considered on PL, if they (1) give birth and (2) are on PL or leave other than parental, caregiving, and medical leave as of October.

A woman may be on PL even when she does not deliver a baby, because the leave can be for older children. To determine if their reported PL is correct, I check if they have a child and the age of the youngest child. Ten women report PL as of October, but they have no child. These respondents seem to be on pregnancy leave, because they had a baby in the next year. They are not considered to be on PL.

For those who have a child and report PL, the age of the youngest child is four or less. For those who have a child aged four, the reported PL seems false, because they have a baby in the following year and the child is too old for a PL. They are likely to be on pregnancy leave, not on PL. For two out of three women who have a child age three, the reported PL seems false for the same reason as above. One exception is the woman with ID number 766, who does not deliver a baby in the following year and works full-time for the whole year. I consider her PL is true. For those who have children aged one or two, I consider their reported PL is all true, because the child is reasonably young for PL and they report PL in the previous year.

Work in the Regular and Non-Regular Employment Sectors If a woman is considered not on PL according to the criteria above, I determine if she works in the regular or non-regular sector. If a woman works as a regular or non-regular employee as of October, I consider that she works in the reported employment sector for the year. If a woman is employed, reports PL or leave other than parental (caregiving,or medical) and gives birth in the next year, she is considered to work in her reported employment sector. This is because she is likely to be on short pregnancy leave in October and work most of the year.

Stay at Home If a woman is considered not on PL and not at work according to the criteria above, I determine if she stays at home. If a woman was on some kind of leave, a homemaker, or did not do any work as of October, she is considered to stay at home.

A.1.2 Sector-Specific Experiences

Retrospective labor market status from age 18 is available for the 1997 and newer cohorts in the year they first appear in the survey. It is also available for the 1993 cohort in 1997. Part-time job, dispatched work, and minor paid-work at home are all considered as the non-regular work. The labor market status constructed subsection A.1.1 is used to construct the sector specific experiences for years when individuals are surveyed. Years stayed at home is topcoded at ten.

A.1.3 Other Variables

Childbearing is identified if an individual reports that she had a baby or if the reported age of the youngest child is zero. In constructing the number of children and the age of the youngest child, I count all children regardless of whether they live with the survey respondent. This is relatively innocuous, because most children age ten or younger live with their mothers. Years of education is constructed from the completed education level. Junior high-school is nine years, high school is 12 years, two-year college and vocational school are 14 years, four-year university is 16 years, and advanced degree is 18 years. Finally, own and husband's labor income are deflated by the 2010 CPI.

B Details of Model Estimation

This subsection explains the estimation of the structural model. In subsection B.1, I define the likelihood function. In subsection B.2, I describe the estimation algorithm.

B.1 The Likelihood

Define d_i as a sequence of choices made by individual i from τ_i+1 to T_i where τ_i and T_i are the first and last years when individual i is observed in the data, respectively, i.e., $d_i = (d_{i\tau_i+1}, d_{i\tau_i+2}, \cdots d_{iT_i})$. Sequences of own and husband's (male spouse's) earnings are similarly defined and given by y_i and $y_{m,i}$, respectively. Let $\theta = (\theta_1, \cdots, \theta_K)$ be a vector of parameters for all K types where θ_k is a vector of parameters for type k. Let $\pi = (\pi_1, \cdots, \pi_K)$ be a vector of parameters for type probability. Define $z_{i\tau_i}$ as a vector of observed characteristics and choice in year $t = \tau_i$: $z_{i\tau_i} = (d_{i\tau_i}, S_{i\tau_i}, edu_i)$ where edu_i is years of education. The likelihood of observed sequences of choices, own earnings, and husband's earnings conditional on $z_{i\tau_i}$ is

$$\begin{aligned} & \mathscr{L}(d_i, y_{m,i}, y_i \mid z_{i\tau_i}; \theta, \pi) \\ = & \sum_{k=1}^{K} p_k(z_{i\tau_i}; \pi) L(d_i, y_{m,i}, y_i \mid d_{i\tau_i}, S_{i\tau_i}; \theta_k), \end{aligned} \tag{12}$$

where $p_k(\cdot)$ is the probability of being type k and $L(\cdot|\cdot;\theta_k)$ is the conditional likelihood of the sequences given being type k and the observed choices and state variables in the first year (i.e. $t = \tau_i$).

Given the first order Markov structure of the model, the likelihood of the observed sequences can be rewritten as a product of probability functions. The parameter vector for type k consists of the sub-parameter vectors such that $\theta_k = (\theta_k^y, \theta_k^{ym}, \theta_k^u)$, where θ_k^y is a parameter vector for own earnings functions, θ_k^{ym} is a parameter vector for husband's earnings function, and θ_k^u is a parameter vector for the utility function

$$\begin{aligned} & L(d_i, y_{m,i}, y_i \mid d_{i\tau_i}, S_{i\tau_i}; \theta_k) \\ = & \prod_{t=\tau_i+1}^{T_i} l(d_{it}, y_{m,it}, y_{it} \mid S_{it-1}, d_{it-1}; \theta_k) & (13) \\ = & \prod_{t=\tau_i+1}^{T_i} l^d(d_{it}|S_{it}; \theta_k^d, \theta_k^y, \theta_k^{ym}) \cdot l^y(y_{it}|S_{it}, d_{it}; \theta_k^y) \cdot l^{ym}(y_{m,it}|S_{it-1}, d_{it-1}; \theta_k^{ym}), & (14) \end{aligned}$$

where $l^d(\cdot)$ is the conditional choice probability given the structural model and state variables in year t, $l^y(\cdot)$ is the likelihood of earnings given the state variables and choice in year t, and $l^{ym}(\cdot)$ is the conditional likelihood for earnings of husband in year t given the choice and state variables in the previous year $t-1$, respectively,

The likelihood for individual's own and her husband's earnings is straightforward. Let $\hat{y}_{it}$ and $\hat{y}_{m,it}$ be the predicted values for y_{it} and $y_{m,it}$, respectively. The likelihood for y_{it} and $y_{m,it}$ is given by

$$
\begin{aligned}
l^y(\ln y_{it}|S_{it}, d_{it}; \theta^y) &= \phi((\ln y_{it} - \widehat{\ln y_{it}})/\sigma_y)/\sigma_y & (15)\\
l^{ym}(y_{m,it}|S_{it}, d_{it}; \theta^{ym}) &= \phi((y_{m,it} - \hat{y}_{m,it})/\sigma_m)/\sigma_m, & (16)
\end{aligned}
$$

where $\phi(\cdot)$ is the density function for the standard normal distribution and σ_y and σ_m are standard deviations. Note that I model the level, not log, of husband's earnings to allow for the value zero.

Next consider the likelihood for employment and fertility choices. The choice-specific error term $\varepsilon^f_{j,it}$ follows a generalized extreme distribution so that error terms may be correlated with each other. Specifically, I use the generalized nested logit model that allows for overlapping nests (see Wen and Koppelman (2001)). There are four nests of alternatives labeled, $B_1, \cdots, B_4$. Nest B_1 includes alternatives for non-conception ($d_{f,it} = 0$) regardless of labor supply choices, nest B_2 includes alternatives for conception ($d_{f,it} = 1$) regardless of labor supply choices, nest B_3 includes alternatives for work ($d_{r,it} = 1$ or $d_{n,it} = 1$) regardless of fertility choices, and nest B_4 includes alternatives for non-work ($d_{h,it} = 1$ or $d_{l,it} = 1$) regardless of fertility choices. Formally, the nests are defined as

$$
\begin{aligned}
B_1 &= \{(d_{h,it} = 1, d_{f,it} = 0), (d_{r,it} = 1, d_{f,it} = 0), (d_{n,it} = 1, d_{f,it} = 0), (d_{l,it} = 1, d_{f,it} = 0)\} & (17)\\
B_2 &= \{(d_{h,it} = 1, d_{f,it} = 1), (d_{r,it} = 1, d_{f,it} = 1), (d_{n,it} = 1, d_{f,it} = 1), (d_{l,it} = 1, d_{f,it} = 1)\} & (18)\\
B_3 &= \{(d_{r,it} = 1, d_{f,it} = 0), (d_{n,it} = 1, d_{f,it} = 0), (d_{r,it} = 1, d_{f,it} = 1), (d_{n,it} = 1, d_{f,it} = 1)\} & (19)\\
B_4 &= \{(d_{h,it} = 1, d_{f,it} = 0), (d_{l,it} = 1, d_{f,it} = 0), (d_{h,it} = 1, d_{f,it} = 1), (d_{l,it} = 1, d_{f,it} = 1)\} & (20)
\end{aligned}
$$

Denote by $\bar{V}^f_j(S_{it})$ the choice-specific value less the preference shock $\varepsilon^f_{j,it}$ such that

$$
\bar{V}^f_j(S_{it}; \theta) = U^f_j(S_{it}; \theta) + \beta E[V(S_{it+1}, \varepsilon_{it+1})|S_{it}, d_{it}]. \quad (21)
$$

Let $b = 1, \ldots, 4$ be an index for a nest. The likelihood of choosing labor supply choice $j \in \{h, r, n, l\}$ and fertility choice $f \in \{0, 1\}$ is given by

$$
l^d(d_{j,it} = 1, d^f_{it} = 1|S_{it}; \theta^d_k, \theta^y_k, \theta^{ym}_k)
$$

$$= \frac{\sum_b (\mu_b \exp(\bar{V}_j^f))^{1/\lambda_b} \left(\sum_{j,f \in B_b} (\mu_b \exp(\bar{V}_j^f))^{1/\lambda_b}\right)^{\lambda_b - 1}}{\sum_{b'=1}^4 \left(\sum_{j,f \in B_{b'}} (\mu_{b'} \exp(\bar{V}_j^f))^{1/\lambda_{b'}}\right)^{\lambda_{b'}}} \tag{22}$$

where $\bar{V}_j^f(S_{it};\theta)$ is denoted as $\bar{V}_j^f$ for brevity. The parameter λ_b is a dissimilarity parameter and indicates the degree of independence among alternatives within the nest. It takes the value between zero and one, and a higher value of λ_b implies greater independence and less correlation. The parameter μ_b is an allocation parameter that reflects the extent to which an alternative is a member of nest b. To facilitate interpretation, it is assumed that $\mu_1 = \mu_2$, $\mu_3 = \mu_4$, and $1 - \mu_1 = \mu_3$.

B.2 The Algorithm

I first describe the estimation algorithm for the model in which individuals are homogeneous, which is based on Kasahara and Shimotsu (2011). I then explain how this estimation algorithm can be applied to the model in which individuals are heterogeneous, using the ESM algorithm proposed by Arcidiacono and Jones (2003). Following Arcidiacono, Bayer, Bugni, and James (2013), the value function is approximated based on sieves in both cases.

B.2.1 Homogeneous Individuals

When individuals are homogeneous, the log-likelihood is given by

$$\begin{aligned} & \ln L\left(\{d_i, y_{m,i}, y_i\}_{i=1}^N | \{d_{i\tau_i}, S_{i\tau_i}\}_{i=1}^N; \theta\right) \\ = & \sum_{i=1}^N \sum_{t=\tau_i+1}^{T_i} \ln l^d(d_{it}|S_{it};\theta^d,\theta^y,\theta^{ym}) + \ln l^y(y_{it}|S_{it},d_{it};\theta^y) + \ln l^{ym}(y_{m,it}|S_{it-1},d_{it-1};\theta^{ym}) \end{aligned} \tag{23}$$

Consistent estimates for the parameter vectors θ^y and θ^{ym} are given by

$$\hat{\theta}^y \equiv \arg\max_{\theta^y} \sum_{i=1}^N \sum_{t=\tau_i+1}^{T_i} \ln l^y(y_{it}|S_{it},d_{it};\theta^y) \tag{24}$$

$$\hat{\theta}^{ym} \equiv \arg\max_{\theta^{ym}} \sum_{i=1}^N \sum_{t=\tau_i+1}^{T_i} \ln l^{ym}(y_{m,it}|S_{it},d_{it};\theta^{ym}) \tag{25}$$

Note that the consistent estimates for the parameters $\hat{\theta}^y$ and $\hat{\theta}^{ym}$ can be obtained separately from the parameters in the utility function. Because estimation of these parameters $\hat{\theta}^y$ and $\hat{\theta}^{ym}$ is straightforward, I focus on the algorithm for estimating θ^d in the following.

The Bellman equation (10) can be rewritten in terms of the expectation of the value function

$$\begin{aligned} EV(S_{it}) &= E\left[\max_{j,f} U_j^f(S_{it}) + \varepsilon_{j,it}^f + \beta E[V(S_{it+1}, \varepsilon_{it+1})|S_{it}, d_{it}]\right] && (26)\\ &= E\left[\max_{j,f} U_j^f(S_{it}) + \varepsilon_{j,it}^f + \beta \int EV(S_{it+1}) dF(S_{it+1}|S_{it}, d_{it})\right], && (27)\end{aligned}$$

where expectation is taken over $\varepsilon_{j,it}^f$ and $F(\cdot|\cdot)$ is the cumulative distribution function for S_{it+1}. The Bellman operator is defined by the right hand side of the above equation so that

$$[\Gamma(\theta, EV)](S_{it}) \equiv E\left[\max_{j,f} U_j^f(S_{it}) + \varepsilon_{j,it}^f + \beta \int EV(S_{it+1}) dF(S_{it+1}|S_{it}, d_{it})\right]. \quad (28)$$

The Bellman equation (27) is compactly rewritten as $EV = \Gamma(\theta, EV)$. I also define the mapping $\Lambda(\theta, EV)$ as

$$[\Lambda(\theta, EV)](d_{j,it} = 1, d_{it}^f = 1|S_{it}) \equiv l^d(d_{j,it} = 1, d_{it}^f = 1|S_{it}; EV, \theta^d, \hat{\theta}^y, \hat{\theta}^{ym}). \quad (29)$$

The consistent estimate for the parameter vector θ^d is given by

$$\hat{\theta}^d = \arg\max_{\theta^d} \frac{1}{N} \sum_{i=1}^N \ln \Lambda(\theta^d, \hat{\theta}^y, \hat{\theta}^{ym}, EV) \text{ subject to } EV = \Gamma(\theta, EV). \quad (30)$$

Computation of the likelihood function by the nested fixed point algorithm by Rust (1987) requires solving the fixed points of $EV = \Gamma(\theta, EV)$ at each trial parameter value in maximizing the objective function with respect to θ^d. The q-NPL algorithm proposed by Kasahara and Shimotsu (2011) iterates the Bellman operator for only q times rather than finding fixed points.

Define a q-fold operator of Γ as $\Gamma^q(\theta, EV)$. Denote by $\widetilde{EV}(M)$ the estimates for the expected value function in the M th iteration. Starting from an initial estimate $\widetilde{EV}(0)$ for the expectation of the value function, the q-NPL algorithm iterates the following steps until $\widetilde{EV}$ and $\tilde{\theta}^d$ converge:

1. Given $\widetilde{EV}(M-1)$, update $\tilde{\theta}^d$ by

$$\tilde{\theta}^d(M) = \arg\max_{\theta^d} \frac{1}{N} \sum_{i=1}^N \ln \Lambda(\theta^d, \hat{\theta}^y, \hat{\theta}^{ym}, \Gamma^q(\theta, \widetilde{EV}(M-1))). \quad (31)$$

2. Update $\widetilde{EV}$ using the obtained estimate $\tilde{\theta}^d(M)$

$$\widetilde{EV}(M) = \Gamma^q(\tilde{\theta}(M), \widetilde{EV}(M-1)), \quad (32)$$

where $\tilde{\theta}(M) = (\tilde{\theta}^d(M), \hat{\theta}^y, \hat{\theta}^{ym})$.

Kasahara and Shimotsu (2011) prove that this sequence converges when q is large enough and yields a consistent estimate for θ^d. I tried different values for q and find that $q = 6$ is a good choice in terms of the total computational time for the model and data in this paper.

To further accelerate computation of a model with a large state space, I approximate the Bellman operator by a higher order polynomial function, which is proposed by Arcidiacono, Bayer, Bugni, and James (2013). Let $W(S_{it})$ be a vector of polynomials of the state variables. Let ρ be a vector of parameters that approximates the value function. For any state variable S_{it}, the sieve approximation satisfies

$$W(S_{it})'\rho \approx EV(S_{it}). \tag{33}$$

Because the error terms in the utility function follow a generalized extreme value distribution, the closed form solution to $EV(S_{it})$ is given by

$$EV(S_{it}) = \ln\left[\sum_{b'=1}^{4}\left(\sum_{j,f\in B_{b'}}(\mu_{b'}\exp(\bar{V}_j^f))^{1/\lambda_{b'}}\right)^{\lambda_{b'}}\right], \tag{34}$$

which implies that

$$W(S_{it})'\rho \approx EV(S_{it}) \tag{35}$$

$$= \ln\left[\sum_{b'=1}^{4}\left(\sum_{j,f\in B_{b'}}(\mu_{b'}\exp(U_j^f(S_{it})+\beta E[W(S_{it+1})'\rho|S_{it},d_{it}]))^{1/\lambda_{b'}}\right)^{\lambda_{b'}}\right] \tag{36}$$

$$= \ln\left[\sum_{b'=1}^{4}\left(\sum_{j,f\in B_{b'}}(\mu_{b'}\exp(U_j^f(S_{it})+\beta E[W(S_{it+1})|S_{it},d_{it}]'\rho))^{1/\lambda_{b'}}\right)^{\lambda_{b'}}\right]. \tag{37}$$

A key convenience of this approach based on a polynomial function is that the parameter ρ can be taken out of the expectation operator $E(\cdot)$ as it can be seen in the last equality. This can save the computational time, because the expectation of $E[W(S_{it+1})|S_{it},d_{it}]$ needs to be calculated only once as long as the parameters for transition probabilities remain the same.

B.2.2 Heterogeneous Individuals

In this subsection, I describe the algorithm for the case of heterogeneous individuals. The method described in the last subsection is combined with the EM algorithm developed by Arcidiacono and Jones (2003).

Expectation Step In the expectation step, I calculate the conditional probability of being in each unobserved type given the values of the parameters, choices, earnings, and observed state variables. Let $\tilde{\theta}(M-1)$ and $\tilde{\pi}(M-1)$ be the vectors of parameters obtained from the $(M-1)$-th iteration. The estimates for the expectation of the value function is denoted by $\widetilde{EV}(M-1)$. The likelihood of the observations on individual i given the parameters at the $(M-1)$-th iteration is

$$L_i^{(M-1)} = \mathscr{L}(d_i, y_{m,i}, y_i | z_{i\tau_i}; \widetilde{EV}(M-1), \tilde{\theta}(M-1), \tilde{\pi}(M-1)). \tag{38}$$

Similarly, I denote by $L_{ik}^{(M-1)}$ the likelihood of the observations and being type k for individual i so that $L_i^{(M-1)} = \sum_k L_{ik}^{(M-1)}$. At iteration M, following from the Bayes rule, the probability of individual i being type k, $q_{ik}(M)$ is given by

$$q_{ik}(M) = \frac{L_{ik}^{(M-1)}}{L_i^{(M-1)}}. \tag{39}$$

Maximization Step The parameter vector is updated to $\tilde{\theta}(M)$ by choosing θ and π to maximize

$$\begin{aligned}
&\sum_{i=1}^{N}\sum_{k=1}^{K} q_{ik}(M) \ln \mathscr{L}(d_i, y_{m,i}, y_i \mid d_{i\tau_i}, S_{i\tau_i}; \widetilde{EV}(M-1), \theta, \pi) \\
= &\sum_{i=1}^{N}\sum_{k=1}^{K} q_{ik}(M) \Bigg(\ln p_k(z_{i\tau_i}; \pi) + \sum_{t=\tau_i+1}^{T_i} \ln l^d(d_{it}|S_{it}; \widetilde{EV}(M-1), \theta_k) + \\
&\ln l^y(y_{it}|S_{it}, d_{it}; \theta_k^y) + \ln l^{ym}(y_{m,it}|S_{it-1}, d_{it-1}; \theta_k^{ym}) \Bigg).
\end{aligned} \tag{40}$$

Because of the additive separability, I can maximize the objective function sequentially. Specifically, the updated parameter vectors are given by

$$\tilde{\pi}(M) = \arg\max_{\pi} \frac{1}{N} \sum_{i=1}^{N}\sum_{k=1}^{K} q_{ik}(M) \ln p_k(z_{i\tau_i}; \pi) \tag{41}$$

$$\tilde{\theta}^y(M) = \arg\max_{\theta^y} \frac{1}{N} \sum_{i=1}^{N}\sum_{k=1}^{K}\sum_{t=\tau_i+1}^{T_i} q_{ik}(M) \ln l_k^y(y_{it}|S_{it}, d_{it}; \theta^y) \tag{42}$$

$$\tilde{\theta}^{ym}(M) = \arg\max_{\theta^{ym}} \frac{1}{N} \sum_{i=1}^{N}\sum_{k=1}^{K}\sum_{t=\tau_i+1}^{T_i} q_{ik}(M) \ln l_k^{ym}(y_{m,it}|S_{it-1}, d_{it-1}; \theta^{ym}) \tag{43}$$

$$\tilde{\theta}^d(M) = \arg\max_{\theta^d} \frac{1}{N} \sum_{i=1}^{N} q_{ik}(M) \ln \Lambda(\theta^d, \tilde{\theta}^y(M), \tilde{\theta}^{ym}(M), \Gamma^q(\theta, \widetilde{EV}(M-1))). \tag{44}$$

In updating θ^d, the Bellman operator Γ is approximated by a higher order polynomial function as outlined above for the case of homogeneous individuals. Finally, the estimate of the expectation of the value function is updated by

$$\widetilde{EV}(M) = \Gamma^q(\tilde{\theta}(M), \widetilde{EV}(M-1)). \tag{45}$$

C Additional Tables

Table 16: Earnings Function for Husband

	Estimate	S.E.
Intercept (Type 1)	−0.466	0.367
Intercept (Type 2)	−0.107	0.365
Intercept (Type 3)	−0.422	0.364
Intercept (Type 4)	−0.377	0.365
Husband's Earnings	0.825	0.003
Age	0.067	0.020
Age-sq	−0.072	0.027
Sqrt. of No. Children	0.001	0.023
Age of Youngest Child	−0.001	0.003
Reg.	−0.160	0.034
Non-Reg.	−0.088	0.030
PL	−0.098	0.099
Conception	0.052	0.038
Unempl. Rate	−0.014	0.016
Std. Dev. of Error Term	1.084	0.002

Note: The dependent variable is the level of earnings so that zero earnings can be included.

Table 17: Type Probability Function

	Type 2		Type 3		Type 4	
	Estimate	S.E.	Estimate	S.E.	Estimate	S.E.
Intercept	0.941	1.789	2.473	1.242	3.718	1.563
Some College	1.446	0.373	0.154	0.282	0.598	0.330
4-Yr College	3.078	0.982	0.485	0.969	1.735	0.988
Age	−0.160	0.085	−0.112	0.054	−0.132	0.073
Years in Home	0.022	0.101	−0.038	0.063	0.088	0.085
Years in Reg.	0.116	0.089	0.123	0.062	0.044	0.081
Years in Non-Reg.	0.052	0.102	0.076	0.065	−0.067	0.093
Husband's Earnings	0.461	0.096	0.023	0.085	−0.012	0.102
Sqrt. of No. Children	0.262	0.306	0.511	0.257	0.083	0.294
Age of Youngest Child	−0.011	0.068	0.052	0.047	0.017	0.062
Reg. in 1st Year	1.937	0.552	1.351	0.491	1.715	0.520
Non-Reg. in 1st Year	0.876	0.498	1.653	0.386	1.249	0.448
Conceived in 1st Year	−0.317	0.387	−0.533	0.350	−1.110	0.445

Table 18: Effects of Parental Leave Policies on Labor Market Outcomes

	Years Since Birth						
	-1	0	1	2	3	5	10
Work							
JP:0, RR:0%	1.00	0.20	0.33	0.35	0.39	0.47	0.59
JP:1, RR:0%	1.00	0.13	0.54	0.50	0.53	0.58	0.66
JP:3, RR:0%	1.00	0.13	0.53	0.49	0.55	0.59	0.68
JP:0, RR:50%	1.00	0.17	0.32	0.34	0.39	0.46	0.59
JP:1, RR:50%	1.00	0.12	0.55	0.50	0.53	0.59	0.68
JP:3, RR:50%	1.00	0.12	0.54	0.49	0.55	0.60	0.69
JP:1, RR:50% + Need to Return	1.00	0.12	0.56	0.52	0.55	0.60	0.68
JP:3, RR:50% + Need to Return	1.00	0.12	0.56	0.50	0.56	0.60	0.69
On PL							
JP:0, RR:0%	0.00	0.12	0.02	0.01	0.01	0.00	0.00
JP:1, RR:0%	0.00	0.49	0.06	0.07	0.04	0.02	0.00
JP:3, RR:0%	0.00	0.53	0.12	0.14	0.08	0.04	0.00
JP:0, RR:50%	0.00	0.13	0.02	0.01	0.01	0.00	0.00
JP:1, RR:50%	0.00	0.51	0.06	0.08	0.05	0.02	0.00
JP:3, RR:50%	0.00	0.55	0.12	0.15	0.09	0.05	0.01
JP:1, RR:50% + Need to Return	0.00	0.53	0.06	0.08	0.06	0.03	0.00
JP:3, RR:50% + Need to Return	0.00	0.57	0.12	0.16	0.09	0.06	0.01
Reg. Work							
JP:0, RR:0%	0.59	0.12	0.19	0.18	0.17	0.17	0.19
JP:1, RR:0%	0.59	0.07	0.34	0.30	0.29	0.28	0.28
JP:3, RR:0%	0.59	0.07	0.33	0.29	0.30	0.29	0.30
JP:0, RR:50%	0.59	0.10	0.18	0.17	0.16	0.16	0.19
JP:1, RR:50%	0.59	0.06	0.35	0.31	0.30	0.29	0.29
JP:3, RR:50%	0.59	0.06	0.34	0.29	0.31	0.30	0.31
JP:1, RR:50% + Need to Return	0.59	0.06	0.36	0.32	0.31	0.31	0.30
JP:3, RR:50% + Need to Return	0.59	0.07	0.35	0.30	0.32	0.31	0.32
Non-Reg. Work							
JP:0, RR:0%	0.41	0.07	0.14	0.17	0.22	0.30	0.40
JP:1, RR:0%	0.41	0.06	0.20	0.20	0.24	0.30	0.38
JP:3, RR:0%	0.41	0.06	0.20	0.20	0.25	0.30	0.38
JP:0, RR:50%	0.41	0.07	0.14	0.17	0.23	0.30	0.41
JP:1, RR:50%	0.41	0.05	0.20	0.20	0.23	0.30	0.38
JP:3, RR:50%	0.41	0.06	0.21	0.20	0.24	0.30	0.38
JP:1, RR:50% + Need to Return	0.41	0.06	0.20	0.20	0.23	0.29	0.38
JP:3, RR:50% + Need to Return	0.41	0.06	0.21	0.20	0.24	0.29	0.38
Earnings (mil. JPY)							
JP:0, RR:0%	2.62	0.53	0.70	0.79	0.81	0.87	1.11
JP:1, RR:0%	2.62	0.30	1.01	1.28	1.26	1.35	1.55
JP:3, RR:0%	2.62	0.32	0.99	1.18	1.25	1.36	1.60
JP:0, RR:50%	2.62	0.45	0.65	0.76	0.77	0.84	1.09
JP:1, RR:50%	2.62	0.26	1.03	1.31	1.29	1.38	1.60
JP:3, RR:50%	2.62	0.27	1.00	1.20	1.27	1.40	1.66
JP:1, RR:50% + Need to Return	2.62	0.27	1.07	1.36	1.34	1.44	1.65
JP:3, RR:50% + Need to Return	2.62	0.28	1.03	1.24	1.30	1.43	1.69

Table 19: Effects of Parental Leave Policies on Fertility

	Years Since Birth						
	-1	0	1	2	3	5	10
Pregnancy							
JP:0, RR:0%	1.00	0.04	0.13	0.10	0.06	0.03	0.00
JP:1, RR:0%	1.00	0.04	0.15	0.11	0.07	0.04	0.00
JP:3, RR:0%	1.00	0.04	0.15	0.13	0.08	0.04	0.00
JP:0, RR:50%	1.00	0.04	0.13	0.10	0.06	0.03	0.00
JP:1, RR:50%	1.00	0.04	0.15	0.12	0.07	0.04	0.00
JP:3, RR:50%	1.00	0.04	0.16	0.13	0.08	0.04	0.00
JP:1, RR:50% + Need to Return	1.00	0.04	0.15	0.12	0.07	0.04	0.00
JP:3, RR:50% + Need to Return	1.00	0.04	0.16	0.13	0.08	0.04	0.00
Number of Children							
JP:0, RR:0%	0.59	1.64	1.69	1.82	1.91	2.02	2.09
JP:1, RR:0%	0.59	1.64	1.68	1.83	1.94	2.06	2.14
JP:3, RR:0%	0.59	1.64	1.68	1.83	1.96	2.09	2.19
JP:0, RR:50%	0.59	1.64	1.69	1.82	1.92	2.03	2.10
JP:1, RR:50%	0.59	1.64	1.68	1.83	1.95	2.08	2.17
JP:3, RR:50%	0.59	1.64	1.68	1.84	1.97	2.11	2.22
JP:1, RR:50% + Need to Return	0.59	1.64	1.68	1.83	1.95	2.08	2.17
JP:3, RR:50% + Need to Return	0.59	1.64	1.68	1.84	1.97	2.11	2.22