Coresidence with Husband's Parents, Labor Supply, and Duration to First Birth

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Abstract

This paper investigates the time to first birth treating coresidence with husband's parents and labor supply as endogenous using representative data on Taiwanese married women born over 1933-1968. We utilize a full information maximum likelihood estimator for a duration model with endogenous binary variables. Results controlling for endogeneity suggest that both coresidence and working result in a delay of childbearing, reversing the effect of coresidence on the timing of first birth, but not that of working. We also find that women in earlier cohorts tend to choose coresidency and not working, but an increasing number of women from later cohorts choose to do both or work only.

JEL classification: J12, J13

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1 Introduction

A key factor that facilitates the childbearing and labor supply of married women is the availability of childcare. Working mothers rely on formal childcare institutions as well as informal private childcare, such as help from extended family members or non-relatives. In this paper, we focus on the family-provided childcare, especially that from the child's grandparents. It has been reported that married women's childbearing and labor supply are positively associated with the geographic proximity of their parents and in-laws. Using German data, Hank and Kreyenfeld (2004) show that for women who have parents living in the same town have an increased probability of giving birth. Compton and Pollak (2011) document that married women with young children in the United States are more likely to work if they live in close proximity to their mothers or their mothers-in-law compared to those living farther away.

In developing countries, the role of married women's parents or parents-in-law is more important as institutional child care opportunities are limited. In general, the availability of family childcare can provide attractive means for women to pursue both childbearing and labor force participation. However, in a Chinese society, the proximity of a married woman's parents and parents-in-law may also have other effects. Living close by often means cohabitation, and the coresiding grandparents of her children are in most cases her husband's parents. It follows that when there is coresidence, while a woman's parents-in-law can provide help in housework and childcare, they can exert more control over her behavior. Thus, women confront important decisions at the time of marriage regarding coresidence with their parents-in-law, participation in the labor force, and childbearing and childrearing.

Parts of the relationship among these three choices have been explored in previous papers. For instance, Rosenbaum and Gilbertson (1995) explore how coresidence affects labor force participation and conclude that coresidence with other adults increases the labor supply of certain groups of immigrant women in New York City. Recognizing that coresidence is not exogenously assigned, Sasaki (2002) reevaluates the effect of endogenous coresidence choice on married women's work decisions using Japanese data and finds that coresidence has a positive impact on married women's labor supply. Maurer-Fazio, Connelly, Chen, and Tang (2011) find that coresidence with parents or parents-in-law increases the labor supply of married women using Chinese data for 1982-2000.[1] Similar to Sasaki (2002), their results are robust to controlling for potential endogeneity of coresidency.

There are also papers that explore the effect of coresidence or work status on the timing of childbearing. Tsay and Chu (2005), using Taiwanese data, find that coresidence with parents-in-law can shorten a woman's duration to first birth at early stages of marriage. Heckman, Hotz, and Walker (1985) find that working women substantially delay childbearing. Heckman and Walker (1990) use a semiparametric reduced-form model to find a strong negative impact of females' wage on the time to first birth in Sweden. Using Canadian data, Merrigan and St.-Pierre (1998) find similar results. These studies, however, do not account for the endogeneity of the coresidence or work decision.

This paper investigates the effects of cohabitation with husband's parents and labor supply on married women's duration to first birth. The analysis examines the choices of Taiwanese married women born over 1933-1968 and treats the coresidence and work decisions as endogenous. We specifically focus on the duration to first birth because, as documented in Schultz (1997), the timing of the first birth may be a critical threshold for predicting the pace of subsequent childbearing in many parts of the world. For example, Marini and Hodsdon (1981) find that a short first birth interval from marriage increases the probability of having a second birth in a short interval. Another reason for analyzing the effects on the time to first birth is to make our results comparable with the findings of others. A large literature that explores the duration to birth or the effect of childbearing on labor market outcomes mostly focus on the time to first birth.

By treating the coresidence and labor supply decisions as endogenous, we can also learn about unobserved attitudes about cohabitation and working. It is important to note that

[1]They provide an extensive literature review on this topic.

marriage in a Chinese society is often an agreement between the husband's family and the wife rather than between the husband and wife. For example, Freedman, Chang, and Sun (1982) point out that parents-in-law in a traditional Chinese society often emphasize the notion of lineage preservation and influence young coresiding couples' childbearing decisions. In modern society, however, it may also be the case that career-driven young married women choose not to coreside with parents-in-law and seek success in their careers. It is also possible that there may exist a third group of women who care about their career success, but also try to accommodate the traditionalism of the family. We call these three attitude types, traditional, career-driven, and have-it-all, respectively.

Methodologically, we develop a full information maximum likelihood (FIML) estimator to evaluate the endogenous treatment effects of coresidence and labor market activity on the timing of first birth. This method helps us to achieve two main objectives. First, by estimating the error covariance structure of the model, we can learn about how the distribution of attitudes of women toward coresidence and labor force participation has changed across cohorts. Second, by controlling for the endogeneity induced by these different attitude types, we can consistently estimate the effects of coresidency and working on the duration to first birth.

Our results controlling for the endogeneity suggest that both cohabitation and working result in a delay of childbearing, reversing the effect of coresidence on the timing of first birth, but not that of labor supply. This implies that an analysis that does not control for the endogeneity would find that the duration to first birth is shortened by coresidence simply because women who tend to coreside with their husbands' parents are the women who also tend to give earlier birth. Our findings suggest that there may be other sources, such as pressure, stress, or bargaining with husbands' parents, that affect the duration to birth for women coresiding with in-laws. We also find that coresidency and working are negatively correlated for older cohorts, but this correlation disappears for younger cohorts. Accompanied by other evidence, these observations suggest that the majority of older cohort women are traditional type while the share of career-driven and have-it-all type women has increased among younger cohort women.

The remainder of this paper is organized as follows. Section 2 provides background for this study by showing the trends of first marriage in modern Taiwan and suggesting three possible attitudes toward cohabitation with in-laws and labor force participation. Section 3 introduces the data and discusses findings from summary statistics. In Section 4, we specify the model including the three different attitudes. This section develops the FIML estimator for the duration model with endogenous dummy variables as an estimation device. Section 5 presents the empirical results concerning the impact of coresidence with husband's parents and labor supply on the childbearing behavior of Taiwanese married women. In this section, we contrast the results from models that control for and those that ignore the endogeneity of coresidence and work decisions. Section 6 concludes.

2 Background

2.1 Trends in First Marriage among Taiwanese Women

We use Taiwanese data in this paper since Taiwan is a well-known developing society and has experienced significant socioeconomic changes during recent decades. This subsection discusses the changes in the timing of first marriage of Taiwanese women as we confine our sample to ever married women in our main analysis.[2] Trends in the age at first marriage among Taiwanese women are well documented in Chang and Li (2011). Overall, their estimates suggest that women born in more recent cohorts marry later and less often than those born in earlier cohorts. About 98% of women born between 1930-1939 married by age 30. The share drops to 96% for the 1940-1949 cohort of women, 91% for the 1950-1959 cohort of women, and 83% for the 1960-1969 cohort of women. By age 40, 99%, 98%, 95%, and

[2]See Schultz (1973) and Thornton, Freedman, Sun, and Chang (1986) for a summary about the recent past of Taiwan. For an analysis of the changes in married women's employment in Taiwan, see Yu (2005).

89% of women in each cohort have ever married. For our analysis, there might be some concern that women select into marriage, but we see that the share of women who marry by their mid-30s is sufficiently high in every cohort suggesting that this selection problem is not severe.

When this trend of first marriage is further broken down by educational groups, Chang and Li (2011) find that more highly educated women tend to marry later and less often than their less educated counterparts. This pattern is more pronounced among younger cohort women. For example, among female college graduates born between 1960-1969, 62% marry by age 30 and 75% marry by age 40, while among female college graduates born between 1930-1939, the figures are 91% and 94%, respectively. This would be a concern for our analysis if more educated unmarried women in the younger cohort retain some unobservable characteristics, such as attitudes, preferences, or ability, that correlate with their decisions of coresidence, working, or childbearing. For example, it is possible that, by limiting our analysis to married women, we disproportionately exclude women who are more productive in the labor market. Even if this is the case, however, our results do not change qualitatively. As we find that an increasing number of women from later cohorts choose to do both or work only in Section 5, this selection will strengthen, if any, the significance of our findings.

2.2 Attitudes toward Coresidency and Working

In a Chinese society, we can immediately think of two possible scenarios that may be correlated with the unobservable factors behind the choice of coresidence, labor force participation, and duration to birth:

- Some married women may value traditionalism. In this paper, a traditional woman is characterized by two factors. First, she lives with her husband's parents to take care of them (filial piety) and do household chores. Second, she gives birth as early as possible in order to preserve the family lineage.[3] These two factors make it harder

[3] See for instance Chu, Xie, and Yu (2011).

for her to participate in the labor force. Even if she participates, she lives with her parents-in-law and gives birth earlier. We name individuals belonging to this scenario as *traditional*.

- Some married women may possess the desire or ability for career success. A woman of this type can be characterized by the following two factors. First, she participates in the labor force. Second, she is willing to delay childbearing since her career is her first priority and having children would limit her labor market activities. As a consequence of these two factors, she is likely to not live with her parents-in-law. Even if she lives with her parents-in-law, she cares about her career and delays the timing of childbearing. We name individuals belonging to this scenario as *career-driven*.

The role of a married woman and her parents-in-law is very different in each of the above mentioned cases. In the first scenario, parents play the roles of norm setters. In the second scenario, the married woman is the key decision maker in the family. However, there may exist a third group of women who care about their career success, but also try to accommodate the traditionalism of the family. In this case, parents are actually an element of the household division of labor sharing the burden of housework and child care, but may also influence childbearing. This scenario can be described as follows:

- Consider a woman who balances traditionalism and career success at the same time. We characterize this type of women using three factors. First, they do not delay the time of childbearing. Second, they choose to work in the labor market. Third, to compromise their first two choices, they live with their husbands' parents so as to allow the latter to share the household work and the childrearing cost. We name this group of women as *have-it-all*.

These three scenarios, of course, cannot exhaust all possible unobservable factors, but we expect that they are consistent with practices in many developing countries. It is also likely that the proportion of women in each of these three groups differs over location and time of the society considered, and changes over time cannot occur abruptly. Which type of women coresides with their parents-in-law is an empirical question, and this will affect the interpretation of estimation results.

3 Data and Descriptive Statistics

Our sample is drawn from the Panel Study of Family Dynamics (PSFD), a nationally representative panel sample of families living in Taiwan.[4] The PSFD is an annual survey, but we employ the first waves of the 1999, 2000, and 2003 panel samples of the PSFD, as the first waves include information on past fertility history. Each of these samples consists of adult males and females born over 1953-1963, 1934-1954, and 1964-1976, respectively. If an individual is selected, his or her families are included in the sample. As a result, the oldest woman in the sample was born in 1933. We exclude individuals born outside of Taiwan to minimize variation in the childhood backgrounds of respondents. In addition, we drop interviewees with missing or incomplete records, and accordingly, the number of observations decreases from 4,105 to 2,256. Then, we further restrict our sample to married women aged 35 or above at the time of the survey. After applying these criteria, our sample consists of 1,814 married women born over 1933-1968.

To proceed with an accurate analysis of fertility transition, we adopt a strategy proposed by Tsay and Chu (2005) to compute the duration between marriage and first birth, T, as $T = T_1 - T_0 + 1$, where T_0 and T_1 represent the recorded time of marriage and first birth, respectively. The rationale is that the time for pregnancy takes nearly a year. We assume that there is no childbearing after age 45, but changing this age to 50 does not alter our results qualitatively. This is because 98.6% of married women in our sample have had at

[4]These survey data have been used previously by Tsay and Chu (2005) to investigate the fertility behavior of married Taiwanese women. For details, please see http://psfd.sinica.edu.tw.

least one birth by age 45.[5]

Table 1 presents summary statistics of the variables used in this analysis separately for the two birth cohorts, 1933-1954 and 1955-1968.[6] This grouping will help to evaluate the relative importance of the various scenarios across cohorts. By comparing older (1933-54) and younger (1955-68) cohorts of women in Table 1, it appears that women's labor supply at the time of marriage has risen substantially from 42% to 54%, while coresidence with parents-in-law at the time of marriage has exhibited a modest decline from 48% to 43%. The coresidence rate did not change much between cohort groups even after classifying women into two groups by work status. Further tabulation not reported in Table 1 reveals that the coresidence rate dropped by 3 percentage points from 43% to 40% among those who work and by 6 percentage points from 53% to 47% among those who do not work. In Section 5, however, we show that there has been a distinct change in the attitudes of women who choose to coreside with their parents-in-law.

Table 2 presents average duration to first birth by coresidence and work status. We find that coresidence does not seem to have any relationship with the timing of first birth for older cohort women, but for the younger cohort coresidence seems to shorten the duration to first birth. Among working women in younger cohort, coresiding women are likely to give birth 8.9 months (=(3.05-2.31)×12) earlier than women who do not coreside. Among non-working women in the younger cohort, coresidence is associated with 1.6 months (=(2.21-2.08)×12) of shorter duration. This negative association, however, does not necessarily imply causality as it is also possible that traditional type women simultaneously choose to coreside and

[5]Our estimates of fertility rates are consistent with the findings of previous research. Feeney (1991) shows that levels of marriage and motherhood in Taiwan have been high and almost constant from the 1950s through the late 1980s. He uses period parity progression ratios for 1979-1988 to find that 99% of all women marry and that 98% of married women give birth at least once.

[6]The principle for dividing the data is to make the size of each subsample roughly equal.

Table 1. Summary Statistics

Birth Cohort	1933-1954	1955-1968	1933-1968
Duration to First Birth	2.35 (1.70)	2.48 (1.90)	2.41 (1.80)
Coreside (=1 if lived with parents-in-law right after marriage)	0.48 (0.50)	0.43 (0.49)	0.45 (0.49)
Work (=1 if worked in the labor market right after marriage)	0.42 (0.49)	0.54 (0.49)	0.48 (0.50)
Wife's Years of Education			
0-9	0.76 (0.43)	0.40 (0.49)	0.57 (0.50)
10-12	0.13 (0.34)	0.38 (0.48)	0.26 (0.44)
13^+	0.10 (0.30)	0.22 (0.41)	0.16 (0.37)
Wife's Age at Marriage	22.27 (3.52)	24.26 (3.86)	23.27 (3.83)
Husband's Years of Education			
0-9	0.66 (0.48)	0.34 (0.47)	0.50 (0.50)
10-12	0.15 (0.36)	0.33 (0.47)	0.24 (0.43)
13^+	0.18 (0.38)	0.32 (0.46)	0.25 (0.43)
Husband's Age at Marriage	25.88 (4.78)	27.31 (4.02)	26.60 (4.47)
Observations	905	909	1814

Note: Numbers in parentheses are the standard deviation of the corresponding data.

Table 2. Average Duration to First Birth
by Coresidence with Parents-in-Law and Labor Supply Status

	Older Cohort (1933-1954)		Younger Cohort (1955-1968)	
	Coreside	Do Not Coreside	Coreside	Do Not Coreside
Work	2.42	2.50	2.31	3.05
	[164]	[220]	[201]	[298]
Do Not Work	2.29	2.24	2.08	2.21
	[275]	[246]	[193]	[217]

Notes: The entry in square parentheses is the number of observations belonging to that category. The total number of observations is 1,814.

have children. One has to account for potential endogeneity, and in Section 5 we show that coresidence actually lengthens the duration to first birth. Working has a small effect on the duration for women in the older cohort, but working women in the younger cohort have much longer durations to first birth of 10.1 months (=(3.05-2.21)×12) if they do not live with their parents-in-law. Working in the labor market seems to delay childbearing, and in Section 5 we find that this observation is not affected by potential endogeneity.

The variables listed in Table 1 are by and large the same as those used in the previous birth duration literature. In general, however, coresidence would depend on the characteristics of both married children as well as their parents.[7] We also acknowledge another weakness of the data: there are no job or earnings data at the time of marriage or first birth. Chu, Xie, and Yu (2011) report that low-earning couples tend to coreside with parents. Moreover, low-earning couples may also pursue early childbearing. Therefore, it is possible that the

[7]See, for example, Takagi and Silverstein (2011). We do not use parents information because of lack of data.

observed association between coresidence and early childbearing is caused jointly by low socioeconomic status.

Overall, the summary statistics suggest interesting relationships, but as we discussed previously, the effects of coresidence and working on the duration to childbearing may be confounded by other observable variables and unobservable interactions among family members. Therefore in the next section we develop a full information maximum likelihood (FIML) estimator to shed more light on such an interrelationship to identify the relative importance of these factors behind an individual's fertility behavior. We compare the FIML results with estimation results that are based on models that do not control for endogeneity.

4 Empirical Strategy

This section develops an estimation strategy for the duration to first birth from first marriage treating coresidence with husband's parents and labor supply as endogenous.

4.1 Modeling the Duration to First Birth

We employ a random variable T to denote the duration to first birth from first marriage and let a scalar t be the realization of T. The duration is determined by a set of observed economic and demographic variables, represented by a vector x_d. These variables include endogenous binary variables, such as coresidence with parents-in-law and labor market status. The duration is also affected by unobserved heterogeneity, denoted as a scalar ε. If all the elements of vector x_d were exogenous, one may use standard parametric or nonparametric methods to estimate the duration model with heterogeneity.[8] If some elements of vector x_d are correlated with ε, however, these methods will result in inconsistent estimation. To highlight the distinction between exogenous and endogenous variables, we use $f(t|x, d_1, d_2, \varepsilon)$

[8] See Hausman, Hall, and Griliches (1984) and Heckman and Singer (1984) for details of these two estimation methods.

to represent the conditional probability density function of the duration dependent variable t given exogenous variables, x, and endogenous binary variables, (d_1, d_2).[9]

To estimate the model consistently, we propose a FIML estimator for a duration model with multiple endogenous binary explanatory variables.[10] We use a Weibull distribution following the literature modeling fertility duration. Then, the associated hazard function is given by

$$\lambda(t|x, d_1, d_2, \varepsilon) = p \left\{\exp\left(-x^\top\beta - c_1 d_1 - c_2 d_2 + \varepsilon\right)\right\}^p t^{p-1}, \tag{1}$$

where p denotes the duration dependence of the Weibull distribution, and c_1 and c_2 represent the coefficients of the endogenous dummy variables d_1 and d_2, respectively.[11] A detailed presentation of the FIML estimator is provided in the Appendix.

We specify the coresidence, d_1, and work, d_2, decisions by

$$d_1 = \begin{cases} 1, & \text{iff} \quad z_1^\top\alpha_1 + u_1 > 0, \\ 0, & \text{otherwise,} \end{cases} \qquad \text{and} \qquad d_2 = \begin{cases} 1, & \text{iff} \quad z_2^\top\alpha_2 + u_2 > 0, \\ 0, & \text{otherwise,} \end{cases} \tag{2}$$

where z_1 and z_2 are vectors of exogenous variables in determining the values of d_1 and d_2, respectively. In general, the z variables include exogenous variables in x and other additional exogenous variables.[12] An important assumption we make is that coresidence and

[9]Our method can be easily extended to estimate a duration model with more than two endogenous dummy variables.

[10]This FIML estimator is designed under the frequently adopted hazard framework and thus permits the occurrence of right censoring. Olsen and Farkas (1989) consider the endogenous covariates in duration models via the regression methodology.

[11]The notation used here follows exactly the one adopted in Greene (2000, p. 941). If $p > 1$, the hazard is monotonically increasing, and it is monotonically decreasing when $p < 1$. If $p = 1$, the hazard is a constant.

[12]The model is identified by the Gaussian distributional assumption used for our FIML estimator, and exclusion restrictions based on the Proposition in Heckman (1978, p. 936) are not necessary.

work decisions are made at the time of marriage. Therefore, the childbearing decision does not appear in (2).[13]

Conditional on all of the exogenous variables contained in x, z_1, and z_2, we assume that the joint distribution of ε, u_1, and u_2 is normal with mean zero and covariance matrix Σ, i.e.,

$$N(0,\Sigma) \equiv N\left(\begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}, \begin{bmatrix} \sigma^2 & \sigma\rho_1 & \sigma\rho_2 \\ \sigma\rho_1 & 1 & \gamma \\ \sigma\rho_2 & \gamma & 1 \end{bmatrix}\right), \quad \text{and} \quad -1 < \rho_1, \rho_2, \gamma < 1. \tag{3}$$

To predict the signs of ρ_1, ρ_2, and γ, we need to understand what ε, u_1, and u_2 represent. First, ε reflects a married woman's preference for having a baby conditional on all exogeneous variables in x, z_1, and z_2. Second, u_1 measures the degree of traditionalism conditional on observable demographic controls. Finally, u_2 reflects the heterogeneity in labor market productivity conditional on observable human capital variables.

4.2 Covariance Structure and Attitude Types

This subsection discusses how the parameters in the error covariance structure can be linked to three attitude types regarding cohabitation and working. The signs of ρ_1, ρ_2, and γ in (3) are indicative of the attitudes of women in the sample. We will use the estimation results to identify the three different attitudes of women in terms of coresidence with parents-in-law, labor supply, and duration to first birth. Table 3 summarizes the relationship between the attitude types and the correlation structure.

The sign of γ is the key factor that identifies women's attitudes toward coresidence and work choices. For example, negative γ implies that married women choose between coresiding and working. Positive γ implies that they coreside and work at the same time or they do not coreside and do not work at the same time. Therefore, negative γ is indicative of traditional

[13]In fact, this is the typical modeling framework adopted in Terza (1998) for other endogenous treatment effects models.

Table 3. Interactions among the Error Components and the Three Preference Types

Type:	Traditional	Have-It-All	Career-Driven
ρ_1	+	+	
ρ_2		+	-
γ	-	+	-

and career-driven type women and positive γ is indicative of to have-it-all type women.

The correlation between the unobserved heterogeneity in the coresidence equation and the birth hazard equation is measured by ρ_1. Positive ρ_1 is consistent with traditional and have-it-all type women since the former reside with parents-in-law and give birth to preserve the family lineage and the latter live with husbands' parents to share household work and child care. If d_1 is instead assumed to be exogenous, positive ρ_1 (and zero γ for simplicity) implies that the estimated effects of coresidence on birth duration will be biased toward increasing the hazard or shortening the time to first birth.

Similary, ρ_2 measures the correlation between unobserved heterogeneity in labor market status and the birth hazard. Negative ρ_2 is expected for career-driven type women because more productive women in the labor market would also prefer a smaller birth hazard (or longer duration to first birth). Positive ρ_2 is associated with have-it-all type women as they tend to work in the labor market and prefer having children earlier. If ρ_2 is positive (and γ is zero again for simplicity), not accounting for the endogeneity of participation would overstate the hazard or understate the duration to first birth.

Conditional on observable demographic controls, traditional type women tend to live with husbands' parents and give birth earlier ($\rho_1 > 0$). They also prefer not working ($\gamma < 0$).

The sign of ρ_2 is uncertain because labor market productivity is not a defining characteristic for this type of women. For example, a traditional woman with high u_2 may participate in the labor force, but she still tries to have a baby as early as possible.

Career-driven type women aim for career success. It is reasonable to assume that the larger the error term in the labor supply decision, the more likely a woman is to pursue career success and therefore, the more likely she is to delay the timing of first birth ($\rho_2 < 0$). These women also prefer living apart from their husbands' parents ($\gamma < 0$). The sign of ρ_1 is uncertain. Even if a career woman lives with her husband's parents due to high u_1, her first priority is always career success, and she will delay childbearing.

Have-it-all type women aim to balance traditionalism and career success. Therefore, the higher her degree of traditionalism, the earlier a have-it-all type woman gives birth ($\rho_1 > 0$). Moreover, the higher her labor market productivity, the earlier she gives birth ($\rho_2 > 0$) because she can reduce her input into her career and spend more time in childrearing. Finally, γ is positive as these women both coreside and work.

5 Coresidence, Work, and the Duration to First Birth

This section evaluates the effects of coresidence with parents-in-law and labor supply status on the timing of first birth using the preceding FIML estimator. For comparison purposes, we first consider the case where coresidence and work decisions are assumed to be exogenous as in previous papers and then present results where those decisions are treated as being made endogenously.

5.1 Estimation of the Duration Model Treating Coresidence and Work Decisions as Exogenous

In Table 4, we first present the estimation results for older and younger cohort women not accounting for the endogeneity of coresidency and working. Each equation in (2) is estimated independently using a probit model. The probit results for older cohort women are reported in the first two columns and those for younger cohort women are in the fourth and fifth columns. The duration to first birth in (1) is investigated under the Weibull distribution assumption treating the coresidence and work decisions as exogeneous. The hazard model estimates for older cohort women are presented in the third column and those for younger cohort women are in the last column.

In the first and fourth columns of Table 4, we find that couples with higher levels of human capital measured by age and education at the time of marriage are less likely to live with the husband's parents. Specifically, the husband's age at the time of marriage is negatively associated with coresidence with his parents for both older and younger cohort women. We also find that older cohort women married to highly educated men are less likely to coreside with their husband's parents, but own education level is more important for younger cohort women for not living with parents-in-law. This pattern seems quite reasonable as the wife's role as a major decision maker in the household is expanding for younger generations.

The second and fifth columns of Table 4 display the probit results concerning the choice of labor supply. As is predicted by theory, labor supply is an increasing function of human capital. For both cohort women, we find that the higher her educational attainment or her age at the time of marriage, the more likely she is to work in the labor market. We also find that the possibility for a married woman to participate in the market will be higher if her husband attains the highest level of education. Moreover, the effect of the husband's educational attainment in increasing his wife's labor force participation is more pronounced for younger women. Since education may also enlighten the egalitarian perception of the husband, the positive coefficient and its changing pattern may represent this attitude change.

The third and last columns of Table 4 indicate that married women participating in the labor market significantly delay their timing of first birth. Due to the Weibull distribution assumption, we can interpret the coefficient estimates as semi-elasticities of the covariates on the expected duration. Working in the labor market seems to lengthen the duration to first birth. The duration for working women as compared to non-working women is longer by 12.0% ($= e^{0.113} - 1$) for the older cohort and by 23.6% ($= e^{0.212} - 1$) for the younger

Table 4. Coresidence, Labor Supply, and First Birth Duration Models Estimated Separately

	Older Cohort			Younger Cohort		
Variables	Coreside	Work	Duration	Coreside	Work	Duration
Coreside			0.013 (0.37)			-0.209 (5.71)***
Work			0.113 (3.53)***			0.212 (5.77)***
Wife						
10-12 Years of Education	0.158 (1.07)	0.115 (0.75)	-0.110 (1.69)*	-0.165 (1.43)	-0.111 (0.95)	0.075 (1.67)*
13^+ Years of Education	-0.072 (0.34)	1.209 (5.10)***	-0.139 (2.04)**	-0.306 (1.87)*	0.387 (2.34)**	0.464 (6.96)***
Age at Marriage/10	0.077 (0.51)	0.519 (3.28)***	0.002 (0.07)	0.106 (0.65)	0.472 (3.14)***	-0.114 (2.72)***
Husband						
10-12 Years of Education	-0.153 (1.19)	-0.065 (0.48)	0.007 (0.18)	-0.067 (0.57)	0.162 (1.39)	-0.077 (1.78)*
13^+ Years of Education	-0.388 (2.26)**	0.045 (0.25)	0.048 (1.07)	-0.121 (0.84)	0.511 (3.56)***	-0.076 (1.28)
Age at Marriage/10	-0.706 (5.82)***	-0.186 (1.60)		-0.652 (4.55)***	-0.138 (1.12)	
Constant	1.688 (5.14)***	-0.996 (2.96)***	0.936 (14.34)***	1.539 (4.54)***	-0.889 (2.63)***	1.196 (12.78)***
p			1.599 (40.94)***			1.676 (41.23)***
-Loglikelihood	589.078	566.946	1516.762	595.563	579.986	1511.922
Observations	905	905	905	909	909	909
Completed Spell			902			886

Notes: Older cohort women are born over 1933-1954. Younger cohort women are born over 1955-1968. Numbers in parentheses are the absolute value of t statistics. ***, **, and * denote significance at the 1%, 5%, and 10% levels in a two-tailed test, respectively.

cohort. If these estimates are applied to the average duration to first birth, older cohort working women delay the first birth around 3.4 months (=12.0%×2.353×12) and younger cohort working women around 7.0 months (=23.6%×2.484×12). These results are consistent with Heckman, Hotz, and Walker (1985) in which the endogeneity of coresidence and labor supply is not taken into account.

Coresidence does not seem to have a statistically significant effect on the duration to first birth for older cohort women, but for younger cohorts, coresiding women have a shorter duration by 18.9% ($= e^{-0.209} - 1$) or about 5.6 months (=18.9%×2.484×12). This phenomenon is consistent with the findings in the literature.[14] However, as discussed previously, the causal effect of coresidence and working on fertility behavior cannot be understood clearly without considering the endogeneity of these two binary variables in the duration model. We thus postpone all discussions about the influence of endogenous and exogenous variables on the timing of first birth until we control the endogeneity of these two binary variables.

5.2 Endogenous Treatment Effects of Coresidence and Work on the Timing of First Birth

Now we consider the case when both coresidence with husband's parents and labor supply decisions are allowed to be endogenous. For these purposes, we employ the FIML estimator discussed before. Table 5 presents the results.

After controlling for the endogeneity, the results show the opposite effect of coresidence with husband's parents on the timing of first birth, but no change on that of labor supply, suggesting that both coresidence and working result in a delay of childbearing. The effect of coresidence on delaying the timing of birth is more pronounced for younger cohort women. The results suggest that the duration to first birth is longer among working women by 16.2% ($= e^{0.150} - 1$) or 4.6 months (=16.2%×2.353×12) for the older cohort and by 102.6% ($= e^{0.706} - 1$) or 30.6 months (=102.6%×2.484×12) for the younger cohort. The finding that

[14] See, for example, Tsay and Chu (2005) for more details.

Table 5. Coresidence, Labor Supply,
and First Birth Duration Models Estimated Jointly with the FIML Estimator

	Older Cohort			Younger Cohort		
Variables	Coreside	Work	Duration	Coreside	Work	Duration
Coreside			0.150 (2.95)***			0.706 (14.31)***
Work			0.203 (3.76)***			0.083 (2.59)***
Wife						
10-12 Years of Education	0.152 (1.00)	0.116 (0.74)	0.057 (0.86)	-0.218 (1.80)*	-0.111 (0.94)	0.118 (3.43)***
13^+ Years of Education	-0.033 (0.15)	1.243 (5.08)***	-0.053 (0.56)	-0.498 (2.98)***	0.395 (2.34)**	0.451 (9.60)***
Age at Marriage/10	0.057 (0.36)	0.502 (3.03)***	-0.123 (3.26)***	0.113 (0.72)	0.484 (3.08)***	-0.001 (0.03)
Husband						
10-12 Years of Education	-0.166 (1.26)	-0.071 (0.51)	-0.026 (0.52)	-0.005 (0.04)	0.156 (1.32)	0.005 (0.14)
13^+ Years of Education	-0.416 (2.38)**	0.025 (0.14)	0.042 (0.78)	-0.033 (0.23)	0.504 (3.45)***	0.006 (0.148)
Age at Marriage/10	-0.699 (5.71)***	-0.172 (1.45)		-0.568 (4.10)***	-0.167 (1.23)	
Constant	1.705 (4.99)***	-1.000 (2.87)***	1.023 (11.25)***	1.302 (3.66)***	-0.804 (2.42)**	0.397 (3.82)***
ρ_1	0.220 (2.95)***			0.752 (31.86)***		
ρ_2	0.123 (1.52)			-0.068 (1.47)		
γ	-0.118 (2.15)**			-0.038 (0.60)		
σ	0.354 (22.94)***			0.459 (29.37)***		
p	2.628 (17.34)***			2.898 (24.24)***		
-Loglikelihood	2604.237			2607.748		
Observations	905			909		
Completed Spell	902			886		

Notes: Older cohort women are born over 1933-1954. Younger cohort women are born over 1955-1968. Numbers in parentheses are the absolute value of t statistics. ***, **, and * denote significance at the 1%, 5%, and 10% levels in a two-tailed test, respectively.

coresidence indeed postpones the woman's first birth is in sharp contrast to that presented in Table 4. This suggests that, in Table 4, coresidence mistakenly reflects the behavioral pattern of traditional women due to the endogeneity of coresidence in the duration model.[15] This also implies that the seemingly positive effect of coresidence on accelerating childbearing is explained by traditional type women. Specifically, the majority of women who prefer coresiding also happen to prefer early childbearing.

We find that the unobservables behind the remaining heterogeneity ε in (1) and u_1 and u_2 in (2) are correlated with each other, which supports the approach that coresidence with parents-in-law and labor supply decisions cannot be taken as exogenous variables in the birth duration analysis. On the left panel of Table 5, positive ρ_1 and negative γ indicate that the majority of older cohort women are the traditional type. The estimates of ρ_1, ρ_2, and γ suggest a substantial change in the proportion of the three types of women. We find that positive and significant ρ_1 becomes even larger for younger cohort women. The sign of ρ_2 changes from positive to negative, although neither estimate is statistically significant. Negative and significant γ becomes positive and insignificant for younger cohort women. These changes can be explained by the increasing share of women of career-driven and have-it-all types in recent years. An increasing share of career-driven type women contributes to negative ρ_2 and γ. These negative effects are offset by positive ρ_2 and γ from have-it-all type women, making the estimate of γ not statistically different from 0. The have-it-all type women also contribute to a more positive ρ_1, making the estimate of ρ_1 more positive and significant. This result is also consistent with the common observation that the ratio of women with strong career attachment should not be widespread for older Taiwanese women who faced an economy only just beginning to modernize.[16]

[15]The changing pattern of the sign of coresidence in Table 4 and Table 5 can also be explained by the arguments in the previous section, where we show that the effects of coresidence on birth duration are biased toward shortening the time to first birth given that $\rho_1 > 0$ and $\gamma = 0$ are imposed.

[16]Similar findings are reported from studies for other countries. Ruggles (1997), for ex-

The answer to why coresidence delays childbearing is beyond the scope of the current paper, but we provide some conjecture. Previous research by Freedman, Chang, and Sun (1982) explains the possible influence of parents' coresidence on a married woman's fertility by some unobservable family interactions, such as parents' pressure related to lineage preservation. Moreover, coresidence itself can increase the mental stress of a married woman as she must coordinate with her parents-in-law about the arrangement of daily family life, even though they may help her with the household work. We also note that mental stress has often been proposed as a cause of unexplained infertility and has been investigated with experiments.[17] Therefore, we suggest that the effect of coresidence on the timing of birth is through the increase of mental stress subsequently reducing her chance of conception.

Another possible explanation is that younger married women have more bargaining power in their fertility decisions. In the intra-household bargaining literature, the level of education or the education ratio between husbands and wives is often used as a proxy variable for bargaining power.[18] This explanation is consistent with the fact that women in the younger cohort are more educated than those in the older cohort as well as our findings on the changing proportions of the three types of women between cohorts.

Table 5 contains other interesting results for the duration model estimates. We first observe that the hazard of giving birth is monotonically increasing as the estimate of p is

---

ample, documents that the percentage of persons age 65 or older residing with their adult children has dropped from almost 70% in the 1850s to fewer than 15% in the 2000s in the United States. He concludes that more education and greater earning power as well as declining parental control over their children was the main reason for this decline.

[17]Among them, Sanders and Bruce (1997) find that psychosocial stress influences fertility in females, and Hjollund et al. (1999) conduct a follow-up study of time to first pregnancy and document that psychological distress may be a risk factor for reduced fertility.

[18]See Behrman (1997) or Fafchamps and Quisumbing (2007) for an overview of the literature on household bargaining.

greater than unity. Educational attainment of wife and husband does not play significant roles in determining the duration of the first birth for older cohort women, but are found to increase the duration for younger cohort women. Table 5 also shows that older cohort women's age at the time of marriage significantly accelerates the timing of birth, but this biological characteristic does not significantly affect the duration to birth of younger women. We find that the results concerning the choices of coresidence and working are more or less qualitatively similar to those found in Table 4.

Our results in Table 5 are robust. In these tables, we exclude husband's age at the time of marriage from the duration equation, but our equations without this exclusion restriction are still identified given that ε, u_1, and u_2 in (3) have a trivariate normal distribution as is suggested by Heckman (1978, p. 936). To demonstrate this fact, we adjust the duration model to include husband's age at marriage so that the exclusion restriction is not imposed. The results are robust, and the only qualitative change is that the estimates of ρ_2 in both estimations become insignificant.[19] We also add controls for birthplace into the model as the transmission of human capital is especially important during early childhood.[20] The results are again robust. We do not report these estimates, but details can be provided by the authors upon request.

[19]When exclusionary restrictions have little explanatory power, the information from distributional or functional form assumptions may still drive the results. However, we find that the excluded variable possesses substantial explanatory power. The coefficient on husband's age at the time of marriage is significant in the coresidence equations for both older and younger cohorts, further supporting our findings of coresidence delaying the duration to first birth.

[20]A woman's birth neighborhood characteristics are included according to the 2003 population for each of Taiwan's 366 different zip code. The data about the population of each zip code are from the Department of Household Registration Affairs, Ministry of the Interior, 2004.

6 Conclusion

This paper integrates three interrelated strands of literature by introducing a FIML estimator to evaluate the endogenous treatment effects of coresidence with husband's parents and female labor supply on the timing of first birth. Our first set of results, which does not account for endogeneity of coresidence and work decisions, shows that working significantly delays the timing of first birth. The results are robust to controlling for the endogeneity, and these findings are consistent with those in former studies. Our second set of results, which controls for the endogeneity, reverses the findings of previous literature in that coresiding with the husband's parents postpones the timing of first birth after controlling the endogeneity of coresidence status. Since individual characteristics determining whether to coreside with parents-in-law are correlated with those determining when to have a first birth, failing to control for such an endogeneity may distort the regression coefficient, as we show in our analysis.

We also identify three possible preferences behind the above-mentioned decision correlations: a married woman may live according to traditional values, may be career-driven and care for career success, or may aim to "have it all" such that she tries to balance both. Each of these attitudes identifies a distinct pattern of correlation among error terms. Our hypothesis is that, along with Taiwan's economic development, if women's attitudes have changed from the traditional type to the career-driven and have-it-all types between the older and younger cohorts, then this transition should be reflected in the correlation among error terms from regressions for each cohort. By separating our samples into younger and older cohorts, we find that the data do support our hypothesis. We also try various sensitivity analyses, by changing the threshold age of fertility, removing exclusion conditions, and controlling for wife's birth neighborhood effects, and find that all results hold intact.

Appendix

For ease of exposition, from now on we represent all the exogenous variables contained in x, z_1, and z_2 as w, where z_1 and z_2 are $(k_1 \times 1)$ and $(k_2 \times 1)$ vectors of exogenous variables in determining the values of d_1 and d_2, respectively. With the independently and identically distributed observations $(t_i, d_{1i}, d_{2i}|w_i)$, $i = 1, \ldots, N$, the log-likelihood function consists of four parts

$$\begin{aligned} \ln L = & \sum_{i=1}^{N} d_{1i} d_{2i} \ln f(t_i, d_{1i} = 1, d_{2i} = 1|w_i) \\ & + \sum_{i=1}^{N} d_{1i}(1 - d_{2i}) \ln f(t_i, d_{1i} = 1, d_{2i} = 0|w_i) \\ & + \sum_{i=1}^{N} (1 - d_{1i}) d_{2i} \ln f(t_i, d_{1i} = 0, d_{2i} = 1|w_i) \\ & + \sum_{i=1}^{N} (1 - d_{1i})(1 - d_{2i}) \ln f(t_i, d_{1i} = 0, d_{2i} = 0|w_i). \end{aligned} \tag{4}$$

Given that $f(t|x, d_1, d_2, \varepsilon)$ is a Weibull distribution, it can be shown that equation (4) implies the following log-likelihood function:

$$\begin{aligned} \ln L = & \sum_{i=1}^{N} d_{1i} d_{2i} \ln \left\{ \frac{1}{\sqrt{\pi}} \int_{-\infty}^{\infty} \left[f(t_i|w_i, d_{1i} = 1, d_{2i} = 1, \sqrt{2}\sigma\xi) \Phi_2^*(h_i, k_i, \rho) \right] \exp(-\xi^2) d\xi \right\} \\ & + \sum_{i=1}^{N} d_{1i}(1 - d_{2i}) \times \\ & \quad \ln \left\{ \frac{1}{\sqrt{\pi}} \int_{-\infty}^{\infty} \left[f(t_i|w_i, d_{1i} = 1, d_{2i} = 0, \sqrt{2}\sigma\xi) \Phi_2^*(h_i, -k_i, -\rho) \right] \exp(-\xi^2) d\xi \right\} \\ & + \sum_{i=1}^{N} (1 - d_{1i}) d_{2i} \times \\ & \quad \ln \left\{ \frac{1}{\sqrt{\pi}} \int_{-\infty}^{\infty} \left[f(t_i|w_i, d_{1i} = 0, d_{2i} = 1, \sqrt{2}\sigma\xi) \Phi_2^*(-h_i, k_i, -\rho) \right] \exp(-\xi^2) d\xi \right\} \\ & + \sum_{i=1}^{N} (1 - d_{1i})(1 - d_{2i}) \times \\ & \quad \ln \left\{ \frac{1}{\sqrt{\pi}} \int_{-\infty}^{\infty} \left[f(t_i|w_i, d_{1i} = 0, d_{2i} = 0, \sqrt{2}\sigma\xi) \Phi_2^*(-h_i, -k_i, \rho) \right] \exp(-\xi^2) d\xi \right\}, \end{aligned} \tag{5}$$

where

$$f(t_i|x_i, d_{1i}, d_{2i}, \sqrt{2}\sigma\xi) = \exp(-x_i^\top \beta + \sqrt{2}\sigma\xi) p \left[\exp(-x_i^\top \beta + \sqrt{2}\sigma\xi) t_i\right]^{p-1} \exp\left(-\left[\exp(-x_i^\top \beta + \sqrt{2}\sigma\xi) t_i\right]^p\right), \tag{6}$$

$$\Phi_2^*(h_i, k_i, \rho) \equiv \Phi_2\left(\frac{z_{1i}^\top \alpha_1 + \sqrt{2}\rho_1\xi}{\sqrt{1-\rho_1^2}}, \frac{z_{2i}^\top \alpha_2 + \sqrt{2}\rho_2\xi}{\sqrt{1-\rho_2^2}}, \frac{\gamma - \rho_1\rho_2}{\sqrt{(1-\rho_1^2)(1-\rho_2^2)}}\right), \tag{7}$$

and Φ_2 denotes the bivariate standard normal cumulative distribution function with correlation coefficient $\rho = (\gamma - \rho_1\rho_2)/\sqrt{(1-\rho_1^2)(1-\rho_2^2)}$.

After applying Hermite quadrature to the results in (5), (6), and (7), the log-likelihood function can be evaluated to estimate the parameters of interest.[21] Accordingly, the Gaussian error distribution assumption allows us to parametrically solve the estimation problems of the duration model with endogenous binary switching variables. Using the "textbook" selection model framework adopted by Heckman and Vytlacil (2000), we consider our FIML estimator as the starting point to evaluate the endogenous treatment effects under a hazard framework.

To evaluate the first term at the right-hand side of (4), first note that it can be represented as

$$f(t_i, d_{1i} = 1, d_{2i} = 1|w_i) = \int_{-\infty}^{\infty} f(t_i, d_{1i} = 1, d_{2i} = 1|w_i, \varepsilon_i) f(\varepsilon_i|w_i) d\varepsilon_i, \tag{8}$$

where $f(\varepsilon_i|w_i)$ is the conditional density function of ε_i given the exogenous variables. By (3), conditional on the exogenous variables w_i, we also note that the conditional distribution of $(u_{1i}, u_{2i})'$ given ε_i is normally distributed with mean μ_i^* and variance matrix Σ^*, i.e.,

$$N(\mu_i^*, \Sigma^*) \equiv N\left(\begin{bmatrix} (\rho_1/\sigma)\varepsilon_i \\ (\rho_2/\sigma)\varepsilon_i \end{bmatrix}, \begin{bmatrix} 1-\rho_1^2 & \gamma - \rho_1\rho_2 \\ \gamma - \rho_1\rho_2 & 1-\rho_2^2 \end{bmatrix}\right). \tag{9}$$

[21] See Butler and Moffitt (1982) about the implementation of Hermite quadrature.

This implies that

$$
\begin{aligned}
f(d_{1i}=1,d_{2i}=1|w_i,\varepsilon_i) &= \text{Prob}\left(z_{1i}^\top\alpha_1+u_{1i}>0, z_{2i}^\top\alpha_2+u_{2i}>0|w_i,\varepsilon_i\right)\\
&= \Phi_2\left(\frac{z_{1i}^\top\alpha_1+(\rho_1/\sigma)\varepsilon_i}{\sqrt{1-\rho_1^2}}, \frac{z_{2i}^\top\alpha_2+(\rho_2/\sigma)\varepsilon_i}{\sqrt{1-\rho_2^2}}, \frac{\gamma-\rho_1\rho_2}{\sqrt{(1-\rho_1^2)(1-\rho_2^2)}}\right)\\
&\equiv \Phi_2(h_i,k_i,\rho),
\end{aligned}
\tag{10}
$$

where Φ_2 denotes the bivariate standard normal cumulative distribution function with correlation coefficient $\rho=(\gamma-\rho_1\rho_2)/\sqrt{(1-\rho_1^2)(1-\rho_2^2)}$.

Since

$$
f(t_i,d_{1i}=1,d_{2i}=1|w_i,\varepsilon_i)=f(t_i|w_i,d_{1i}=1,d_{2i}=1,\varepsilon_i)\times f(d_{1i}=1,d_{2i}=1|w_i,\varepsilon_i), \tag{11}
$$

using (8), (10), and (11), we can show that

$$
f(t_i,d_{1i}=1,d_{2i}=1|w_i)=\int_{-\infty}^{\infty} f(t_i|w_i,d_{1i}=1,d_{2i}=1,\varepsilon_i)\Phi_2(h_i,k_i,\rho)f(\varepsilon_i|w_i)d\varepsilon_i. \tag{12}
$$

Following the preceding methodology, we can evaluate the other three terms at the right-hand side of (4) and obtain

$$
\begin{aligned}
\ln L &= \sum_{i=1}^{N} d_{1i}d_{2i}\ln\left\{\int_{-\infty}^{\infty} f(t_i|w_i,d_{1i}=1,d_{2i}=1,\varepsilon_i)\Phi_2(h_i,k_i,\rho)f(\varepsilon_i|w_i)d\varepsilon_i\right\}\\
&+\sum_{i=1}^{N} d_{1i}(1-d_{2i})\ln\left\{\int_{-\infty}^{\infty} f(t_i|w_i,d_{1i}=1,d_{2i}=0,\varepsilon_i)\Phi_2(h_i,-k_i,-\rho)f(\varepsilon_i|w_i)d\varepsilon_i\right\}\\
&+\sum_{i=1}^{N} (1-d_{1i})d_{2i}\ln\left\{\int_{-\infty}^{\infty} f(t_i|w_i,d_{1i}=0,d_{2i}=1,\varepsilon_i)\Phi_2(-h_i,k_i,-\rho)f(\varepsilon_i|w_i)d\varepsilon_i\right\}\\
&+\sum_{i=1}^{N} (1-d_{1i})(1-d_{2i})\ln\left\{\int_{-\infty}^{\infty} f(t_i|w_i,d_{1i}=0,d_{2i}=0,\varepsilon_i)\Phi_2(-h_i,-k_i,\rho)f(\varepsilon_i|w_i)d\varepsilon_i\right\}.
\end{aligned}
\tag{13}
$$

Based on the iid assumption of ε_i, we can apply the change of variable, $\varepsilon_i=\sqrt{2}\sigma\xi$, to derive the results in (5) and (7).

Finally, combining the assumption that $f(t_i|w_i, d_{1i}, d_{2i}, \varepsilon_i)$ is a Weibull distribution

$$
\begin{aligned}
f(t_i|w_i, d_{1i}, d_{2i}, \varepsilon_i) &= \lambda_i p(\lambda_i t_i)^{p-1} \exp\left(-(\lambda_i t_i)^p\right) \\
&= \exp(-x_i^\top \beta + \varepsilon_i) p \left[\exp(-x_i^\top \beta + \varepsilon_i) t_i\right]^{p-1} \exp\left\{-\left[\exp(-x_i^\top \beta + \varepsilon_i) t_i\right]^p\right\},
\end{aligned} \tag{14}
$$

and using the change of variable again, the value of $f(t_i|x_i, d_{1i}, d_{2i}, \sqrt{2}\sigma\xi)$ in (6) is thus obtained.

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