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Female labor supply and why women need to be included in economic models

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Women contribute a large fraction of aggregate labor hours, earnings, and labor force participation. Yet, many models used to study the effects of government policy ignore gender differences and use data on men only. These models are used extensively for examining the effects of government policies and programs—including Social Security, taxation, and welfare programs. Before evaluating how people respond to such policies, it is important to construct a reliable model of how people behave and why.

A model's credibility is heavily dependent on how well it reproduces key features of the data, including aggregate earnings, hours, and output. Constructing a model that accurately estimates these aggregates will likely yield more reliable predictions of how people react to changes in the economic environment, such as changes in wages and taxes. Because women now participate extensively in the labor market, the exclusion of women from models aimed at understanding reality and the consequences of policy likely undermines the credibility of the lessons that we learn from these models.

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This *Chicago Fed Letter* summarizes research from several papers related to these issues. Borella, De Nardi, and Yang (BDY)[1] study the cohort of households born in 1941–45 using the *Panel Study of Income Dynamics* (PSID). This cohort has by now completed its working period and has retired, and thus constitutes a useful benchmark. BDY first quantify the labor supply of women, including the fraction of total hours, earnings, and participation by women. Second, they show that the aggregate patterns of hours, earnings, and participation over the life cycle depend on gender and marital status.

Figure 1 reports data from BDY on participation, hours, and earnings for women in the 1941–45 birth cohort at different ages during their working lives. The fraction of women in the labor force is large and their labor contributes a substantial part of the aggregate economy. The first row of the figure shows that the fraction of women workers by age increases from 37% at age 25 to 44% by age 65. The second row shows that the hours of work supplied by women also increases over the life cycle, from 28% at age 25 to 40% at age 65. Earnings also increase with age and hover around 25% to 30% for the entirety of women's working period. Thus, these important aggregates—number of workers, hours, earnings—include a large fraction of women, who are typically not included in the

1. Participation, hours, and earnings of women born in 1941–45

| Share of total	Age 25	Age 35	Age 45	Age 55	Age 65	Ages 25–65
	(- percent -)					
Women among workers	37	40	46	46	44	42
Hours worked by women	28	31	39	40	40	35
Earnings by women	24	22	30	27	27	26

Source: Margherita Borella, Mariacristina De Nardi, and Fang Yang, 2016, "The aggregate implications of gender and marriage," National Bureau of Economic Research, working paper, No. 22817, November.

2. Yearly hours worked and labor earnings
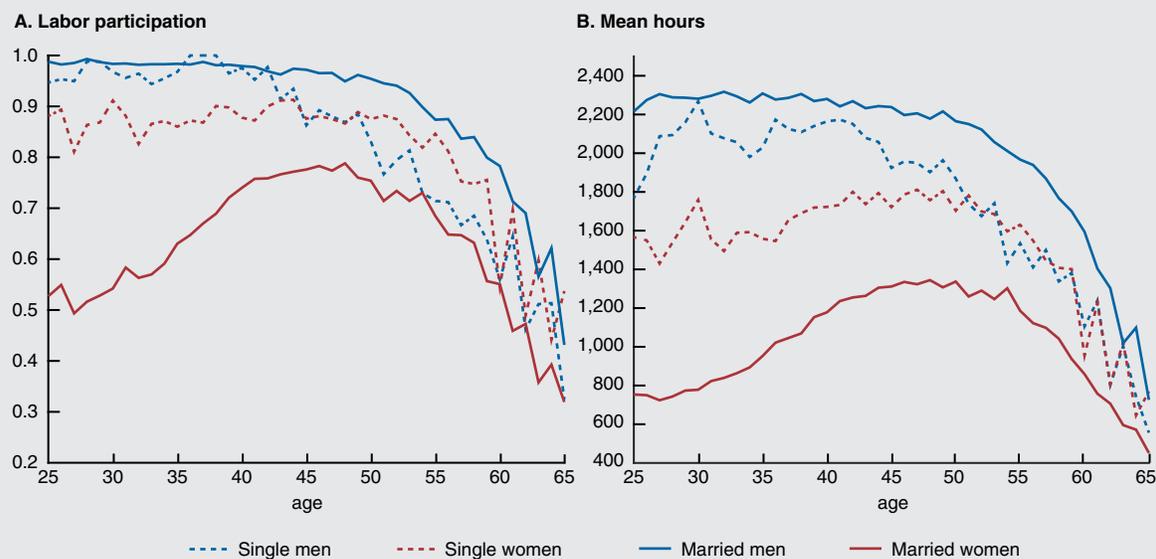
Source: Margherita Borella, Mariacristina De Nardi, and Fang Yang, 2016, "The aggregate implications of gender and marriage," National Bureau of Economic Research, working paper, No. 22817, November.

standard models. If women behave differently from men as a group, then the standard calibration will miss aspects of the data that are important to correctly gauge the effects of government taxes, transfers, and even shocks to the economy more generally.

Figure 2, also from BDY, helps address our point by illustrating how some important economic choices change over the life cycle. The figure plots the data for labor participation and yearly hours worked by four types of people at different ages (single men, single women, married men, and married women) and confirms that labor dynamics vary by gender and marital status over the life cycle. On average, married women participate less than single women, single men, and married men (panel A). Their participation rate starts growing around age 30 and continues growing until age 50. In contrast, single women start participating at higher rates at age 25 and their participation stays flat past age 50. Married men and single men have high and stable labor force participation rates until ages 50 and 40, respectively, when their participation starts to decline. These patterns hold true for the other economic aggregates, particularly yearly hours worked (panel B) and labor earnings. The conclusion we reach from these two sets of facts is that both gender and marital status have large impacts on labor supply choices over the life cycle. We underscore this point by examining the outcome of a standard structural model of household behavior over the life cycle when these dimensions are ignored and comparing it with models that account for these characteristics.

3. Economy 1: Only one type of household and data for men only
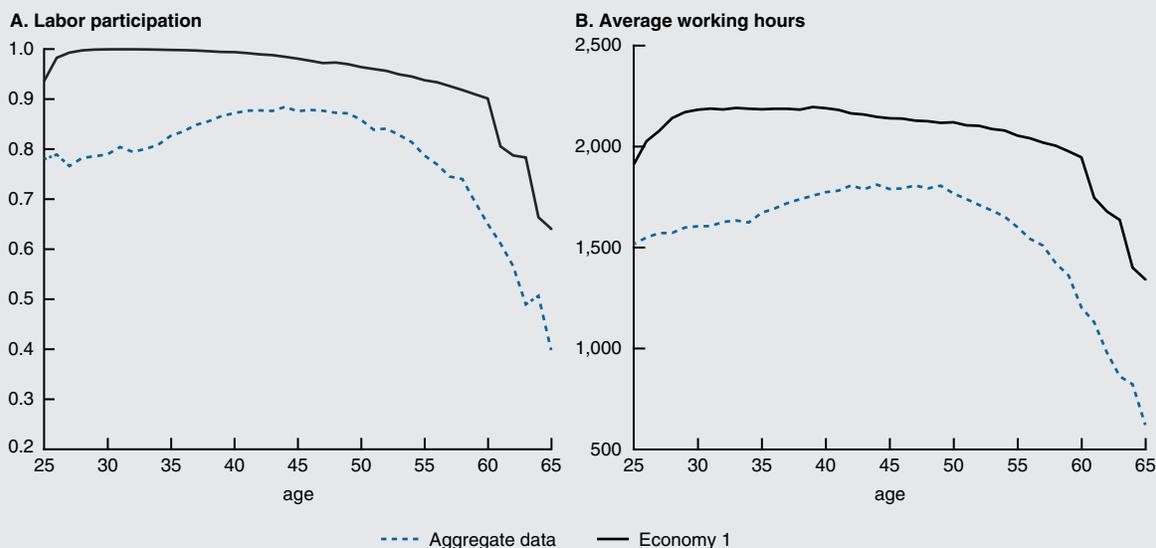
A. Labor participation

B. Average working hours

- - - Aggregate data   —— Economy 1

SOURCE: Margherita Borella, Mariacristina De Nardi, and Fang Yang, 2016, "The aggregate implications of gender and marriage," National Bureau of Economic Research, working paper, No. 22817, November.

4. Economy 2: Only one type of household but data on both men and women
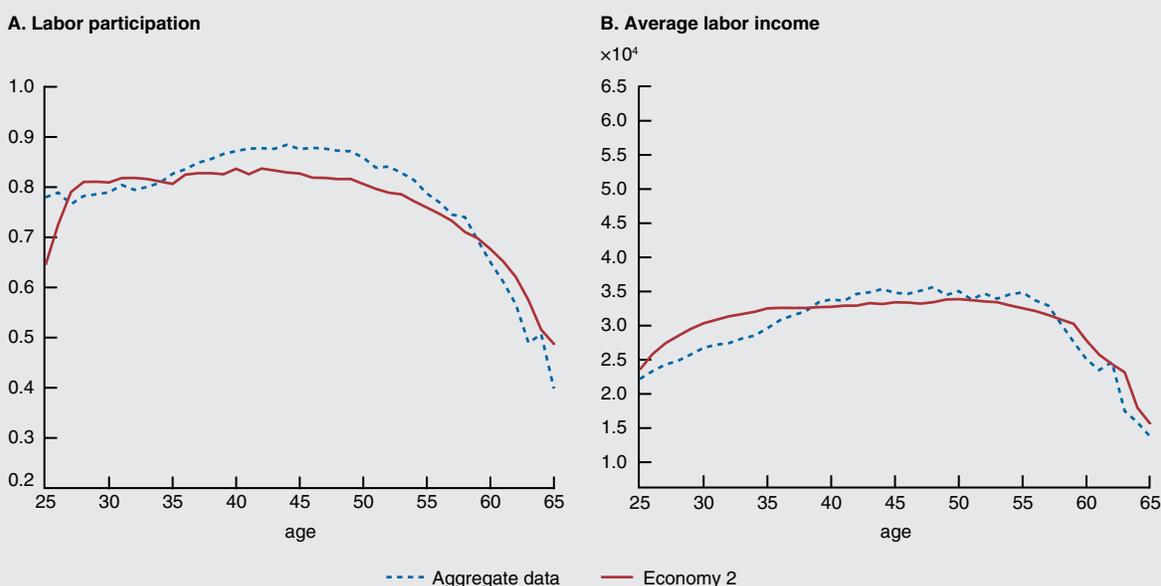
A. Labor participation

B. Average labor income

- - - Aggregate data   —— Economy 2

SOURCE: Margherita Borella, Mariacristina De Nardi, and Fang Yang, 2016, "The aggregate implications of gender and marriage," National Bureau of Economic Research, working paper, No. 22817, November.

To do so, we report the implications from BDY of a model of saving and labor supply over the life cycle. This model is a standard framework that is widely used and assumes that each household that makes economic decisions is single and that there are no gender differences. We first take this model to data by: 1) only using data for men, as usually done; 2) using individual-level data for both men and women together, regardless of marital status; and 3) explicitly accounting for marriage and gender. The last uses an enriched version of the model that explicitly allows for four types of households: single men, single women, married men, and married women, rather than one genderless type, as in the standard approach. We now compare the actual aggregate data to the results of the model to illustrate how accounting for gender and marriage improves model results.

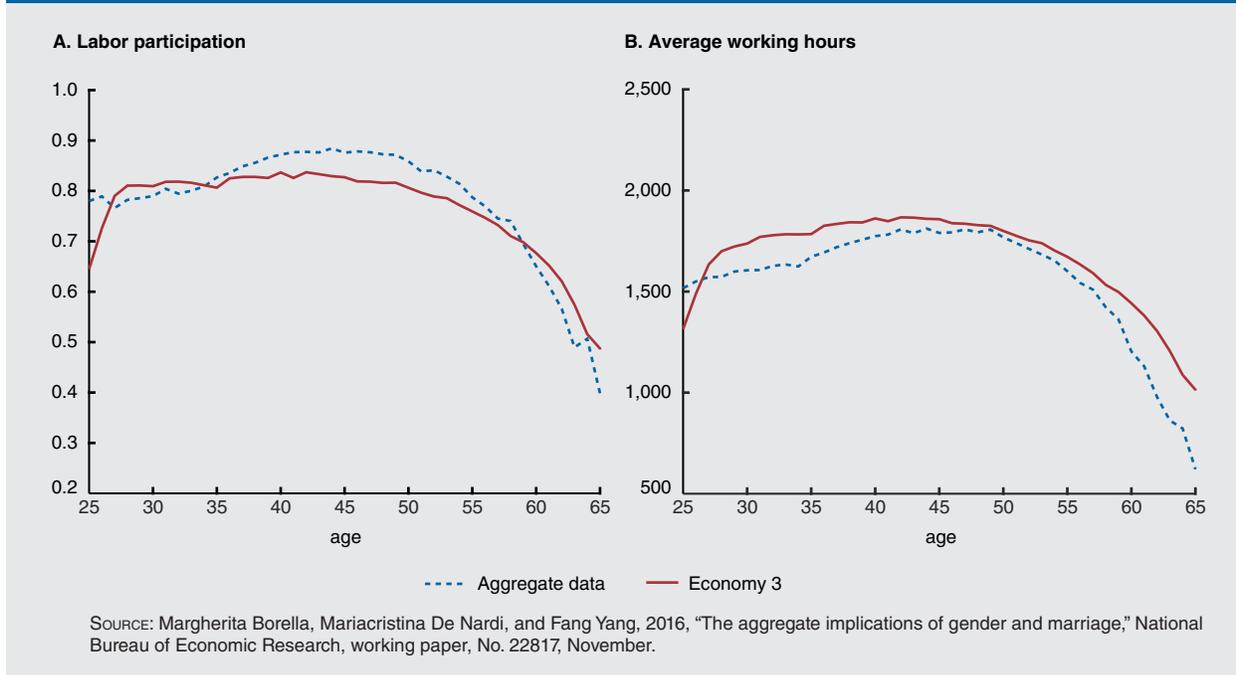**5. Economy 3: Four types of households—single men and women and married men and women**

A. Labor participation

B. Average working hours

- - - Aggregate data ——— Economy 3

SOURCE: Margherita Borella, Mariacristina De Nardi, and Fang Yang, 2016, "The aggregate implications of gender and marriage," National Bureau of Economic Research, working paper, No. 22817, November.

Figure 3 plots aggregate labor force participation and yearly hours by age (dotted blue lines) for our cohort and compares it with the model taken to data using data for men (solid black lines). This comparison makes clear that the implications of the model taken to data on men only are very different from what the *actual* aggregate data look like. Overall, labor force participation (panel A) is severely overestimated, and the patterns of increasing participation that are evident at the start of the life cycle are not reflected in the model. The aggregate estimates for hours worked (panel B) and labor income are similarly high. Importantly, while the models are good at matching the data for men only (including labor force participation for all men), they do not accurately depict an economy that includes all participants.

Figure 4 reports a similar comparison when the model (solid red line) is taken to data (dotted blue line) that include men and women regardless of their marital status. Including data for women yields a model that matches the aggregate data closely from age 45 onward but overestimates participation early in the life cycle (panel A); the same holds true for hours. The same model accurately estimates labor income (panel B) over the life cycle. This is an improvement over the model in figure 3, which consistently overestimates the key aggregates over the entire working life cycle.

The model can be further refined if men and women, both single and in couples, are explicitly modeled (figure 5). Here, the overestimation of participation in the middle years of the working life cycle is small, and hours worked and aggregate labor income are closely matched.

To summarize the evidence in BDY, figure 6 provides the aggregate estimates that the models yield for all workers from age 25 through 65, detailing the hits and misses of each calibration against the aggregates.

The observation that labor choices of individuals vary by gender and marital status also implies that their responses to changes in the economic environment will likely vary along these dimensions. Indeed, the empirical literature on labor supply and incentives reveals that the labor supply of women responds to changes to wages and taxes much more strongly than that of men. For instance, in an extensive review of the literature, Meghir and Phillips[2] find that if wages increase 10%, the yearly hours worked by men hardly adjust, while annual hours increase about 10% for women overall (thus, the labor supply elasticity is close to zero for men and close to 1 for women). Blundell et al.[3] quantify the effects of female labor supply in the UK on single mothers and find large effects.

6. Comparing the data for all workers with the models' implications

Variable (ages 25–65)	Data	Men only		Single men and women		Single and married men and women	
		Model estimate	Difference (%)	Model estimate	Difference (%)	Model estimate	Difference (%)
Participation (%)	0.78	0.94	16.0	0.86	8.0	0.76	−2.0
Hours	1,562	2,050	31.2	1,725	10.4	1,656	6.0
Earnings ($)	29,628	42,566	43.7	30,392	2.6	31,653	6.8

SOURCE: Margherita Borella, Mariacristina De Nardi, and Fang Yang, 2016, "The aggregate implications of gender and marriage," National Bureau of Economic Research, working paper, No. 22817, November.

Determinants of labor supply for women

This heterogeneity in behavior across men and women stresses the importance of studying what generates these different behaviors. To shed light on these issues, we turn to research discussing the determinants of labor supply for single and married women. This work highlights the importance of child-care costs and increasing female wages, education, and returns to work experience.

There is strong evidence that decreases in child-care costs over time, in conjunction with changes in wage structure, contribute to the observed increase in labor force participation by women and primarily married women. First, child-care costs are important determinants of female labor force participation. Figure 1 documents lower participation for young women during the child-rearing years. Figure 4, which most accurately models behavior for men and women who are single and in couples, includes the cost of child-rearing in the model for married women and confirms that such costs mostly affect women in couples.

Attanasio, Low, and Sánchez-Marcos[4] examine the determinants of labor supply for women over their life cycle for two different cohorts of American women: those born in the 1940s and the 1950s. They find that decreases in child-care costs and increases in women's wages affected women's labor force participation across and within cohorts. For both cohorts, the full-time employment rate is lowest during the child-rearing ages. A key difference, however, is that following childbirth, a higher fraction of women from the 1950s cohort return to work and do so much more quickly than from the 1940s cohort.

The decline in wages for child-care employees that occurred in the late 1970s supports the view that child-care costs fell during that period. Indeed, between 1977 and 1982, wages for child-care workers fell about 15% and only recovered partially afterward. During 1982–97, wages for child-care workers bounced back 11%, whereas wages for all women workers increased 79%. While the 1940s cohort of women was not exposed to this fall in child-care costs, the 1950s cohort was and reacted accordingly: Two-thirds of mothers with young children from this cohort are employed compared with less than half of the 1940s cohort.[5] Ahn and Mira[6] confirm these findings. The mechanism is intuitive: If the cost of child care accounts for a high fraction of labor earnings, women may forgo work to save on such costs. Later in life, however, these costs are no longer relevant and help explain rising participation rates for women. For cohorts after the 1940s that faced lower child-care costs and growing women's wages, the dip in participation during the child-bearing years virtually disappears.[7]

Education also plays a key role in affecting a woman's choice to work, and recent cohorts of women are more educated than their predecessors.[8] Looking at five different cohorts of American men and women using data from the *Current Population Survey* (CPS), 6% of women born in the 1930s had at least a college degree, compared with 37% for the 1970s birth cohort. Married women on average have increased their education level more than single women. Married women's wages

have also increased more than those of single women. Married women born in the 1930s cohort made on average 10% less than single women, but by the 1970s married women who worked made on average 7% more.

Increased educational attainment also yields better job prospects for women and thus has a positive effect on women's labor force participation. It is important to note that while male educational attainment has also increased in the past few decades, their aggregate labor force participation has remained relatively stable. This again highlights the importance of including data for women, both single and married, when building models for policy evaluation, because not only their labor market outcomes, but also their education patterns, have been evolving differently.

Turning back to BDY's 1940s cohort of workers, we observe that income rises over the course of the lifetime for single men, single women, married men, and married women. For married women, this is accompanied by an increase in average hours worked later in the working life cycle. A key point is that earnings are increasing in labor market experience and that the returns to experience differ by worker type, both within and across cohorts.

In recent years, returns to work experience have increased more for women than for men. In studying the increase in hours of work supplied by women over time, Olivetti[9] notes that the hike in marginal returns to experience encourages women (and especially mothers) to participate in the labor force. The logic is straightforward: When returns to experience were low, married women would likely cut hours or participation, which would reduce their labor market experience, and thus their potential wages. However, as returns to experience increased, the cost of forgoing work experience and staying at home also rose. This fact, in conjunction with higher wage growth for women and lower child-care costs, encouraged women to participate in the market. As men did not face the same increase in returns to experience, it is important to account for women, who choose their hours and participation based on different considerations.

Not only is it important to examine how women behave differently than men, but also the impact of being single or in a couple. Using panel data on women in the UK, Blundell et al. (2016) find that women with partners may reduce their labor supply in response to tax credits, because their earnings could reduce the family's entitlement to a tax credit. In contrast, tax credits positively affect labor force participation of single mothers, especially for part-time work, though this penalizes hourly earnings because of low returns to experience. Thus, the choices made by married and single people will have different economic effects, and models should account for this.

Conclusion

Models that account for women and marriage, which acknowledge that both groups face different incentives to work, do a much better job matching estimates of economic aggregates and their dynamics. This calls for including these features in models that study the economy's response to both government policy and economic shocks.

[1] Margherita Borella, Mariacristina De Nardi, and Fang Yang, 2016, "The aggregate implications of gender and marriage," National Bureau of Economic Research, working paper, No. 22817, November.

[2] Costas Meghir and David Phillips, 2010, "Labour supply and taxes," in *Dimensions of Tax Design: The Mirrlees Review*, James A. Mirrlees (ed.), Oxford, UK: Oxford University Press, pp. 202–274.

[3] Richard Blundell, Monica Costa Dias, Costas Meghir, and Jonathan Shaw, 2016, "Female labor supply, human capital, and welfare reform," *Econometrica*, Vol. 84, No. 5, September, pp. 1705–1753.

[4] Orazio Attanasio, Hamish Low, and Virginia Sánchez-Marcos, 2008, "Explaining changes in female labor supply in a life-cycle model," *American Economic Review*, Vol. 98, No. 4, September, pp. 1517–1552.

[5] See Attanasio, Low, and Sánchez-Marcos (2008).

[6] Namkee Ahn and Pedro Mira, 2002, "A note on the changing relationship between fertility and female employment rates in developed countries," *Journal of Population Economics*, Vol. 15, No. 4, November, pp. 667–682.

[7] Zvi Eckstein, Michael Keane, and Osnat Lifshitz, 2016, "Sources of change in the life-cycle decisions of American men and women: 1962–2014," University of Oxford, Nuffield College, Economics Group, working paper, No. 2016-W07, June 7.

[8] See Attanasio, Low, and Sánchez-Marcos (2008).

[9] Claudia Olivetti, 2006, "Changes in women's hours of market work: The role of returns to experience," *Review of Economic Dynamics*, Vol. 9, No. 4, October, pp. 557–587.