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The effect of household appliances on female labor force participation: Evidence from microdata ☆

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ABSTRACT

We estimate the effect of household appliance ownership on the labor force participation rate of married women using micro-level data from the 1960 and 1970 U.S. Censuses. In order to identify the causal effect of home appliance ownership on married women's labor force participation rates, our empirical strategy exploits both time-series and cross-sectional variation in these two variables. To control for endogeneity, we instrument a married woman's ownership of an appliance by the average ownership rate for that appliance among single women living in the same U.S. state. Single women's labor force participation rates did not increase between 1960 and 1970. We find evidence in support of the hypothesis that the diffusion of household appliances contributed to the increase in married women's labor force participation rates during the 1960's.

1. Introduction

In the last few decades women's labor force participation rates have increased dramatically, especially for married women. In 1950, about 25% of married women participated in the workforce; by 2000, nearly 60% of married women participated. An extensive literature has investigated the possible causes of this increase.[1] Greenwood et al. (2005) [from now on GSY] argue that the diffusion of home appliances such as washing machines, freezers, etc. played an important role in "liberating" women from housework and in propelling them into the workforce. According to GSY, the adoption of time-saving technologies occurred because of a surge in the rate of technological progress in the home durable goods sector. Consequently, the quality-adjusted relative price of home appliances declined. Building on Becker (1965) and Gronau (1977), GSY develop a dynamic equilibrium model in which a household jointly determines female labor force participation and home appliance purchases. GSY calibrate a version of their model and show that the observed decline in the relative price of home appliances can explain about 50% of the increase in married women's labor force participation rates between 1900 and 1980.

Despite the intuitive appeal of GSY's story and the quantitative results of their model, there is little independent empirical evidence in favor of their hypothesis. Moreover, from a theoretical perspective, improvements in the productivity of home durable goods could lead married women to increase rather than decrease their time allocated to housework. The sign of this effect depends on the elasticity of substitution between home and market goods in the household's utility function (Jones et al., 2003).

The goal of this paper is to empirically test GSY's hypothesis using micro-level data on female labor force participation and household appliance ownership. The data comes from the 1960 and 1970 U.S. Census of the Population. In only those years, households were asked to provide information on their ownership of some home appliances (freezers, washers, and dryers) in addition to the standard demographic variables. Women's labor force participation rates and households' ownership of appliances both increased significantly

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[1] In addition to the "liberation hypothesis" discussed in this paper, other explanations for the increase in women's labor force participation include: 1. A reduction in fertility (Angrist and Evans, 1998) 2. The diffusion of the oral contraceptive (Goldin and Katz, 2002; Bailey, 2006; Wong, 2008) which reduced the pregnancy-related uncertainty faced by young women enrolling in professional programs. 3. The indirect effect of WWII on men's attitudes toward working women (Fernandez et al., 2004) 4. The reduction in the gender wage gap (Smith and Ward, 1985; Jones et al., 2003; Gayle and Golan, 2006). Albanesi and Olivetti (2007) develop a variant of the "liberation hypothesis", emphasizing the role of medical advances and the introduction of infant formula as catalysts that enabled married women to increase their participation in the workforce. Goldin (1990) provides a detailed historical account of women's experience in the labor market.

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during the 1960's. The labor force participation rate for white married women increased by 10 percentage points, and the fraction of households with all three of the appliances mentioned above increased from 11 to 28% (see Table 1).

In order to identify the causal effect of home appliance ownership on married women's labor force participation rates, our empirical strategy exploits time-series and cross-sectional variation in these two variables. Ordinary least squares (OLS) will not, in general, provide consistent estimates of the causal effect of appliance ownership on women's labor force participation because of the endogeneity of home appliance ownership. Instead, we employ an instrumental variable (IV) strategy by using the state-level ownership rate of an appliance among *single* women as an instrument for a *married* woman's ownership of that appliance.

We assume that the observed temporal and cross-sectional variation in single women's ownership of home appliances is driven by the (unobserved) appliance costs rather than by changes in women's labor force participation rates. Two key observations corroborate this assumption. First, differently from married women, the labor force participation rate of single women did not change appreciably from 1960 to 1970 (see Table 2). Second, the instruments based on single women's appliance ownership rates at the state level do not explain differential changes in *single* women's labor force participation rates across states and over time.

Table 1
Summary statistics for married women aged 18–55.

Variables	All	1960	1970
Outcome variables			
Participation rate	0.410	0.327	0.427
	(0.492)	(0.469)	(0.495)
Employment rate	0.391	0.311	0.407
	(0.488)	(0.463)	(0.491)
Share working full-time (35+ hours/week)	0.253	0.214	0.261
	(0.435)	(0.410)	(0.439)
Share at work year-round (48+ weeks in prior year)	0.238	0.181	0.250
	(0.426)	(0.385)	(0.433)
Hours worked per week (conditional on working)	34.1 (10.5)	34.9 (10.6)	34.0 (10.5)
Endogenous regressors of interest			
Washer present in the household	0.854	0.871	0.851
	(0.353)	(0.335)	(0.356)
Dryer present in the household	0.565	0.293	0.618
	(0.496)	(0.455)	(0.486)
Freezer present in the household	0.351	0.254	0.370
	(0.477)	(0.435)	(0.483)
All 3 appliances present in the household	0.251	0.109	0.278
	(0.434)	(0.312)	(0.448)
Covariates			
Age	36.8 (10.2)	36.9 (9.7)	36.8 (10.3)
Number of children under age 5	0.44 (0.73)	0.55 (0.84)	0.41 (0.70)
Number of children over age 5	1.43 (1.48)	1.31 (1.35)	1.45 (1.51)
Potential experience (years)	19.1 (10.7)	19.7 (10.2)	19.0 (10.8)
Share with 0–11 years of schooling	0.324	0.432	0.303
	(0.468)	(0.495)	(0.460)
Share with 12 years of schooling	0.467	0.398	0.480
	(0.499)	(0.489)	(0.500)
Share with 13–15 years of schooling	0.124	0.109	0.127
	(0.329)	(0.312)	(0.333)
Share with 16 or more years of schooling	0.085	0.061	0.090
	(0.279)	(0.239)	(0.286)
Household income (minus own earnings)	10,706	8674	11,100
	(8050)	(6459)	(8266)
Instruments			
Share of single women in state owning a washer	0.581	0.586	0.580
	(0.077)	(0.102)	(0.071)
Share of single women in state owning a dryer	0.285	0.100	0.321
	(0.115)	(0.070)	(0.084)
Share of single women in state owning a freezer	0.147	0.084	0.159
	(0.062)	(0.041)	(0.057)
Share of single women in state owning /all three appliances	0.084	0.026	0.095
	(0.044)	(0.025)	(0.038)
Number of observations	322,312	52,373	269,939

Notes: Entries are means with standard deviations reported in parentheses. The data are from the Census IPUMS for 1960 and 1970 (State Form 1), with the sample restricted to white, U.S.-born, married women of prime working age (18 to 55 years old), with state information, and working husbands. Dollar amounts are in 1970 dollars.

Table 2
Change in married women labor force participation and appliance ownership by quartiles of household income distribution and woman's education.

	Variables	Change from 1960 to 1970	1960	1970
Income				
Quartile one	Participation rate	0.108	0.371	0.479
	Own all 3 appliances	0.118	0.058	0.176
Quartile two	Participation rate	0.111	0.357	0.468
	Own all 3 appliances	0.169	0.076	0.245
Quartile three	Participation rate	0.084	0.322	0.406
	Own all 3 appliances	0.198	0.110	0.308
Quartile four	Participation rate	0.097	0.256	0.353
	Own all 3 appliances	0.191	0.195	0.386
Education				
HS dropout	Participation rate	0.078	0.305	0.383
	Own all 3 appliances	0.157	0.071	0.228
HS degree	Participation rate	0.101	0.333	0.434
	Own all 3 appliances	0.170	0.124	0.294
Some college	Participation rate	0.086	0.350	0.436
	Own all 3 appliances	0.155	0.158	0.313
College graduate	Participation rate	0.120	0.403	0.522
	Own all 3 appliances	0.124	0.192	0.316

Notes: Entries are means. The data are from the Census IPUMS for 1960 and 1970 (State Form 1), with the sample restricted to white, U.S.-born, married women of prime working age (18 to 55 years old), with state information, and working husbands. The income quartiles represent family income excluding the woman's labor income. Education is the married woman's highest education attainment.

Our estimates, based on the identification strategy described above, provide strong empirical support for GSY's hypothesis. According to our results, the diffusion of home appliances in the decade between 1960 and 1970 contributed to the increase in married women's labor force participation rates.

As far as we know, this paper is the first to use microdata on appliance ownership and female labor force participation to provide evidence on GSY's hypothesis. There is related work in both economics and sociology. In the economics literature, Cavalcanti and Tavares (2008) use country-level panel data for OECD countries for the period 1975–1999 to show the existence of a statistically significant relationship between the relative price of home appliances and female labor force participation rates across countries. Dinkelman (2008) considers the employment effects of household electrification in rural South Africa in the late 1990's. She uses a community's land gradient as an instrument for its treatment status and finds a positive effect of electrification on female employment. Cardia (2008) regresses county-level changes in female labor force participation rates between 1940 and 1950 on county-level adoption rates of bathtubs and refrigerators using data from the U.S. Census. She finds a positive association between the adoption of indoor plumbing facilities and female labor force participation rates.[2] In addition to adopting a different identification strategy relative to these papers, our approach is based on microdata, and allows us to control at the individual level for the standard determinants of female labor force participation, such as experience, household income, a woman's education, etc.

Sociologists have also studied the relationship between home technology and women's allocation of time to housework, sometimes reaching different conclusions than GSY. For example, Cowan (1983)

[2] Cortes and Tessada (2007) focus on increased immigration, as opposed to declining prices of home appliances, as a determinant of female labor supply. They observe that immigrants' labor often substitutes for female labor in home production (e.g. child care and housekeeping services) and find evidence that immigration affects the labor supply of high-skill native women.