The Rise of Low-Skill Service Employment: the Role of Dual-Income Households*

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Abstract

This paper unveils an important but unexplored channel for the growth of low-skill service employment between 1960 and 2000: the spillover from dual-income households. In particular, we analyze the cross-city association between variation in dual-income households and employment growth in home production substitutes. To address concerns about endogeneity, we use the fact that married working women were extremely concentrated on administrative support occupations, while their birth places were heterogeneously distributed. Our results show that one more dual-income couple creates 0.3 low-skill service jobs in local economies, and the effect mainly comes from the home production service sector.

JEL: E24, J12, J21, R12

Keywords: Dual-income couple; Spillover effect; Low-skilled service worker; Home production substitute; Job polarization

*We would like to thank Matthew Notowidigdo, Vasco Yasenov, seminar and conference participants at Yonsei University, Sogang University, and 2018 Asian and Australasian Society of Labour Economics Conference.

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1 Introduction

Why has low-skill service employment grown over the last several decades? It may be attributed to technology progress (Autor and Dorn, 2013; Buera, Kaboski and Zhao, 2017), the spillover from high-skill consumption (Mazzolari and Ragusa, 2013; Leonardi, 2015), or immigration (Cortés and Tessada, 2011). In this paper, we suggest another potentially important channel for the growth of low-skill service employment: the rise of dual-income households. The dramatic rise in married women's labor supply that occurred over the past decades in the U.S. has led to a greater share of dual-income households.[1] Figure 1 visually shows this change: Between 1960 and 2000, the number of dual-income couples rose fourfold, while the share of dual-income couples relative to the total married couples tripled.[2] Motivated by the fact that both low-skilled service workers and dual-income couples have grown over the past decades, this paper examines whether and the extent to which the growth of low-skill employment depends on the physical proximity of dual-income households (both husband and wife are employed in non-low-skill service sectors).

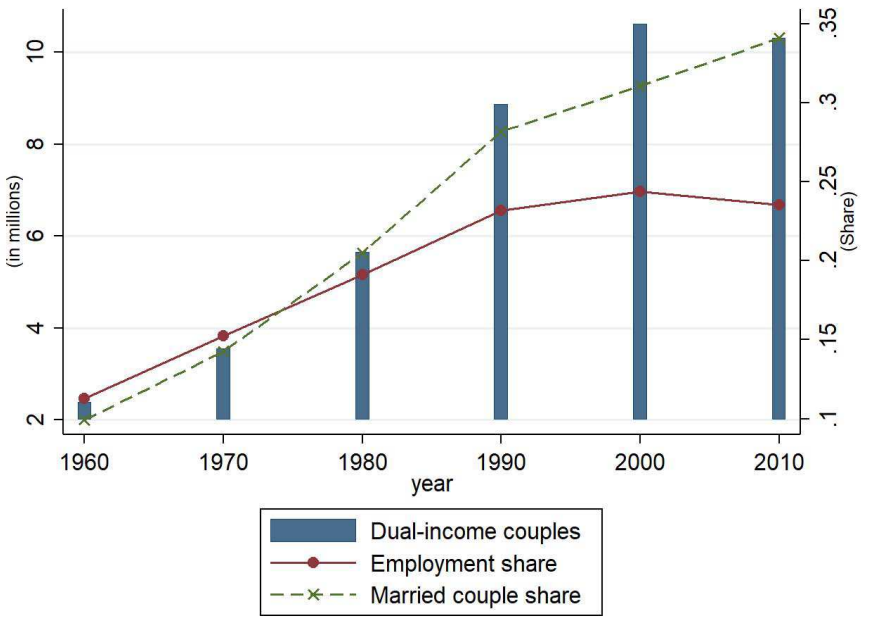
The idea behind our hypothesis is simple. Suppose that there is a female-biased labor market change. Then, more female workers will participate into the labor market, so the number of dual-income households increases. As time endowment is fixed, less time can be devoted to home production, which raises the demand for low-skill and time-intensive services, such as food preparation, cleaning, maintenance, and child care, which can be defined as market substitutes for home production. As a result, the employment in low-skill service sectors increases, and we refer to it as a spillover effect of dual-income households. Time series evidence in the U.S. supports our hypothesis: over the period of 1960 and 2000, the proportion of workers at the bottom of the wage distribution has steadily increased. In particular, service occupations that provide market substitutes for home production have grown more than 190 percent during this period.[3] The positive correlation between dual-earner couples and low-skill employment suggests evidence of consumption spillovers.

[1] According to Blau (1998), most of the rise in female labor force participation between 1970 and 1995 comes from married couples (Table 2).

[2] In addition, there has been a trend of assortative mating, which implies resemblance in some characteristics, such as education and employment between spouses (Behrman and Rosenzweig, 2002; Lefgren and McIntyre, 2006; McCrary and Royer, 2011). In particular, there is considerable within-occupation marital matching (Mansour and McKinnish, 2018).

[3] Buera and Kaboski (2012) show that the share of the service sector in value-added has grown steadily from 60 percent in 1950 to 80 percent in 2000, and provide a theoretical framework for analyzing the role of high-skilled labor in the growth of the service sector.

Figure 1: Trend in Dual-Income Households 1960-2010



Note: Author's calculations from the IPUMS (Ruggles et al., 2010) version of the Decennial Censuses. The employment share is the total number of dual-income workers relative to the total employment. The married couple share is the total number of dual-income couples relative to the total married couples.

We test our hypothesis that the presence of dual-income households creates the demand for low-skill service by utilizing the cross-city association between the decadal change in the share of dual-income households and employment growth in home production substitutes. In doing so, we use the decennial Census data between the period of 1960 and 2000, as women's labor force participation peaked in 2000 and has gradually declined since then.[4] In particular, we estimate the regression model linking the employment growth in home production service sectors to the change in dual-income earners in the same city over the same period. This local labor market analysis is closely related to those of Leonardi (2015), Manning (2004), and Mazzolari and Ragusa (2013), who document the cross-city relationship between high-skilled and low-skilled workers, assuming that service providers have to be located near consumers.

Although some studies have found evidence of the positive cross-city relationship between different types of workers, empirical challenges have made it difficult to identify causality. For instance, unobserved city-specific factors affecting dual-income households might have an independent im-

[4]The main result is robust to extending the sample period to 2010 (see Appendix Table C1).

pact on the supply of low-skilled workers. Reverse causality is another concern: Low-skilled service workers who substitute for home production might induce more married women into the labor market. We address these reverse causality and endogeneity concerns by employing an instrumental variables approach. In particular, we use the fact that women in dual-income households were extremely concentrated on certain occupations (e.g., administrative support) in 1960, while there is a significant heterogeneity in occupations across birth places. Specifically, we use the interaction between the initial (i.e., 1960) concentration and the distribution of dual earners as an instrument for predicting the actual number of dual-income households across cities. This instrument likely satisfies the exclusion restriction because the predicted number of dual-income households is not significantly correlated with the pre-trends in low-skilled service workers. Moreover, our mediation analysis shows that the large part of the effect of administrative support women on home production services is through the increase in dual-income couples.

Our empirical analysis indicates that the spillover effect of dual-income households on low-skill service jobs indeed exists: Between 1960 and 2000, one more dual-income couple created 0.3 to 0.4 low-skill service jobs, and the one percentage point increase in dual-income households was associated with 0.8 to 1.1 percent increases in the wages of low-skilled service workers. More importantly, the positive effect is mainly driven by the home production service sector, such as cleaning, food preparation, maintenance, and child care, a finding consistent with our theory. Our finding is robust to adding control variables, such as low-skilled immigrants, college-educated workers, and the initial routine share, which have been argued as important sources for the rise of service employment.

The main contributions of this paper are twofold. First, we provide evidence of an unexplored channel through which dual-income households have an impact on low-skill service jobs. In particular, we find that low-skilled service workers are benefitted from dual-income households because dual earners are more likely to purchase service for home production. This spillover effect of dual-income households is still relevant even when we control for other factors that have been suggested to be important for the growth of service employment in previous literature. Furthermore, our results suggest that the wages of low-skilled service workers have also increased with the rise of dual-income earners, which implies that the finding is driven by the demand side and not by the supply side of service workers. Second, this paper enhances our understandings of job polarization

in the U.S. labor market. Since the mid-1980s, employment in high- and low-skill occupations has increased, whereas job opportunities in middle-skill occupations have declined (see, for example, Acemoglu and Autor (2011)). Our finding indicates that the rapid growth of employment in low-skill occupations, or service occupations, can be understood as a result of spillovers from the change in household structure rather than routine-replacing technological progress, which has a relatively minor impact on non-routine service sectors (Autor, Levy and Murnane, 2003; Goos and Manning, 2007). This study therefore provides a new perspective on the literature on job polarization, particularly emphasizing consumption spillovers in explaining the growth of low-skill service jobs in recent decades.

The remainder of this paper is organized as follows: Section 2 presents a framework that provides theoretical predictions on the relationship between the change in dual-income couples and employment growth in the service sector. Section 3 introduces the data and describes the trend of dual-income households in U.S. cities. We discuss our identification strategy in Section 4 and present the empirical results in Section 5, together with several robustness checks. Section 6 concludes the paper.

2 Theoretical Framework

In this section, we formalize the main idea of our paper with a simple labor market model and then draw some testable implications. Since we are interested in long-run changes, we consider a static model.[5] As we investigate the extent to which an increase in the number of dual-income couples affects jobs in the service sector that can potentially substitute household labor in home production, we need an exogenous change that raises the labor market participation of female workers.[6] To that end, we assume that the wage rate for a female worker, denoted as w_f, exogenously increases to capture female-biased technology change. We also consider an intensive margin of the female worker for the sake of simplicity; an increase in the number of dual-income couples is introduced as an increase in the labor supply of the female worker to the labor market (h_f^M) rather than explicitly modelling the binary decision of the female worker.

[5] One might consider a dynamic model with two different steady states, which is basically equivalent to our analysis.
[6] Hence, we focus on a dual-income couple whose members are male and female workers.

2.1 Couple's Decision Consider the following utility maximization problem of a couple, which is a version of the model introduced by Bar and Leukhina (2011) and Jones, Manuelli and McGrattan (2014):

$$\max \ \lambda_f u\left(c_f^M, c_f^H, 1 - h_f^M - h_f^H\right) + \lambda_m u\left(c_m^M, c_m^H, 1 - h_m^M - h_m^H\right), \tag{1}$$

subject to

$$c_f^M + c_m^M + ps \quad = \quad w_m h_m^M + w_f h_f^M \tag{2}$$

and

$$c_f^H + c_m^H \quad = \quad zG(h_m^H + h_f^H, s), \tag{3}$$

where subscript f (resp. m) refers to a female (resp. male) worker, superscript M (resp. H) refers to a market good (resp. home good), $\lambda_f > 0$ and $\lambda_m > 0$ are constant, and $u(\cdot)$ is a continuous, (at least twice) differentiable, (strictly) increasing, and (strictly) concave function that satisfies Inada conditions. c denotes consumption of a market good. $p > 0$ is the price of service (relative to the market good whose price is normalized to one) that can be used to produce a home good, and $s \geq 0$ denotes the amount of service purchased by the household. $w_m > 0$ (resp. $w_f > 0$) is the hourly wage rate of a male (resp. female) worker. Hence, the first constraint, Equation (2), is the budget constraint of the household, and the second constraint, Equation (3), is the (resource) constraint for a home good. $z > 0$ denotes the productivity of home production. Home production uses two inputs: labor and service purchased at the market. We assume that $G(\cdot)$ is strictly increasing and concave in both inputs (the Inada condition is also assumed to hold). Following the literature, we assume that the female and male labor supply to home production is perfectly substitutable. To pin down a unique equilibrium, we assume that only females work at home (hence $h_m^H = 0$).

2.2 Service sector Note that a couple' decision determines the demand for s, a service good. Here, the service good can substitute for the labor inputs of household members in home production. In other words, other types of services that do not directly substitute household labor in home production are excluded in this model.

We assume that this sector is perfectly competitive both in the goods market and the labor market.

Firm. There is a representative firm that tries to maximize its profit:

$$\max_h pAf(h) - wh, \tag{4}$$

where $A > 0$ is the productivity in the service sector and $w \geq 0$ is the wage rate for low-skilled workers who are employed in the service sector. $f(\cdot)$ is assumed to be continuous, strictly increasing, and strictly concave, and to satisfy the Inada condition. Hence, the labor demand is determined by the usual downward-sloping labor demand equation: $w/p = Af'(h)$.

Worker. Low-skilled workers supply their labor according to the following upward-sloping labor supply equation: $w = Bh^{\psi}$ with $\psi > 0$.[7]

2.3 Main Predictions In this subsection, we derive the predictions of the model that will be tested in Section 4. The details of derivations can be found in Appendix A.

By combining the first-order conditions for the labor supply decision of a female worker and that for a service good, we can obtain

$$w_f = p\frac{G_h}{G_s}, \tag{5}$$

where $G_h \equiv \partial G/\partial h_f^H$ and $G_s \equiv \partial G/\partial s$.

This equation implies that when the wage rate of a female worker increases, there should be an adjustment in labor supply to a home good (a female worker's labor supply to home production) and/or demand for service that can substitute for the female worker's time devoted to home production.

[7] w is the wage rate in terms of the market good. For simplicity of the discussion, one may consider GHH preference to derive this labor supply equation in order to eliminate the income effect for simplicity of the discussion.

In order to draw a clear prediction, we assume a CES production technology for home production and a Cobb-Douglass production function for the service goods-producing firm. Formally,

$$G(h_f^H, s) = \left[\alpha s^{1-\frac{1}{\sigma}} + (1-\alpha)(h_f^H)^{1-\frac{1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}, \tag{6}$$

where $\alpha \in (0,1)$ and $\sigma > 0$ denote the elasticity of substitution between a labor input and a service good, and

$$f(h) = h^{\delta}, \tag{7}$$

where $\delta \in (0,1)$.

Using various equilibrium conditions, we obtain the following equilibrium relationship for hours worked and wage rate in the service sector:

$$\log h \propto \phi + \frac{\sigma}{\psi+1}\log h_f^M + \frac{1}{\psi+1}\log h_f^H + \frac{1-\sigma}{\psi+1}\log p \tag{8}$$

and

$$\log w \propto \log B + \psi\left(\phi + \frac{\sigma}{\psi+1}\log h_f^M + \frac{1}{\psi+1}\log h_f^H + \frac{1-\sigma}{\psi+1}\log p\right). \tag{9}$$

We now draw some testable implications of the model as follows:

Prediction (Spillover effect of a dual-income household)**.** *Suppose that the substitution effect dominates the income effect in a female worker's labor supply decision, and leisure is flexibly adjusted. If there is an exogenous increase in the wage rate of a (married) female worker so that she supplies more labor into the labor market, the following holds:*

1. *The employment (or labor input) of low-skilled workers in the service sector increases.*
2. *The wage rate of low-skilled workers in the service sector increases.*
3. *The above effects become greater as σ, the elasticity of substitution between a labor input and a service good, becomes higher.*

The first two parts of the above prediction are straightforward: both employment (or labor input) and wage rate of low-skilled workers employed in the service sector increase because a dual-income couple increases the demand for a service good that can substitute out their labor input. As the demand curve for the service good shifts out, the service firm's labor demand curve also shifts out, so both of the key variables would become greater. The last part of the prediction is also noteworthy. As the degree of substitutability (σ) becomes greater, the demand for a service good increases more, as it easily substitutes the hours worked supplied by household members. As a result, the impact on the labor market becomes greater as σ becomes higher. For instance, a service good that cannot substitute a labor input, say $\sigma = 0$, is not affected by the rise of dual-income couple.[8]

Extension to Spatial Equilibrium Model. While extension of our benchmark framework to the spatial equilibrium model seems natural, as we exploit variations across cities in the empirical analysis, we only present results from the benchmark model by the following reasons. First, we are interested in service goods, which are normally non-tradable across cities. In addition, low-skilled workers are employed in the production of such goods and their mobility across cities is low compared to that of high-skilled workers (Autor and Dorn (2013)). These two features together imply that predictions of the spatial equilibrium model would be equivalent to those of our model. Consistent with this idea, the effect of inter-city migration of low-skilled workers on our findings is negligible.[9]

3 Data: Dual-Income Households in U.S. Cities

In this section, we describe the data used for our empirical analysis and provide some key aspects of the data.

3.1 Data

For the empirical analysis, we use the Integrated Public Use Microdata Series (IPUMS) version of the U.S. Censuses in 1960, 1970, 1980, 1990, and 2000 to quantify the effect of an increase in dual-income households on low-skilled service workers. The data provide various individual-level information, including occupations, wages, and geographic locations of residence. Using this

[8] It can indirectly affect the labor market for the service good through changes in $\log h_f^H$, but the magnitude of the effect should be much smaller.

[9] Results are available upon request.

information, we construct city-level measures, such as the growth of dual-income households.

Throughout our analysis, we restrict our sample to workers aged between 25 and 54, and we exclude workers in group quarters or in schools. We define dual-income households as households in which both husband and wife work at least 50 weeks per year in non-low-skill service sectors. Although the Census records the detailed titles of workers' occupations, the classification system has been redefined in every decennial Census. To consistently follow the low-skill service occupations for the period between 1960 and 2000, we use the occupational classifications of Autor and Dorn (2013) and define low-skill service occupations as service occupations in their classifications. For example, these service occupations include housekeepers, janitors, and child care workers.

The geographical unit of analysis is the metropolitan statistical area (MSA) of residence.[10] The MSA is a region consisting of a large urban core together with surrounding communities that have a high degree of economic and social integration with the urban core, and it has been widely used to analyze local effects. We determine 105 MSAs that are consistently identified across different Census samples.

3.2 Summary statistics

We begin with providing some descriptive statistics on dual-income households. As is evident from Figure 1, the number of dual-income households has remarkably grown over the sample period. Since 1960, the number of dual-income couples has increased by about 8 million, resulting in approximately 10 million or 24 percent of the total employment in 2000. This increase has been significant at least until 2000. To analyze the economic impact of this dramatic increase, we focus on the period between 1960 and 2000.

While the increase has been national, dual-income households are unevenly distributed across cities in the U.S. Table 1 shows the lists of top 10 and bottom 10 MSAs according to the share of dual-income earners out of the total employment. There is a significant variation across local areas. For instance, in York, PA, almost 25 percent of the employment is dual-income earners, whereas in El Paso, TX, less than 10 percent are dual-income families. It also shows that the within-state variation is quite large. For example, a comparison of Albany and New York in New York state shows that the difference between the two areas is 8.8 percentage points. We exploit this significant variation to estimate the local impact of dual-income households on low-skill service sectors, which

[10] Throughout the article, we interchangeably refer to MSAs as cities.

will be discussed further in the next section.

Table 1: Geographic Distribution of Dual-Income Households in 2000

Top 10		Bottom 10	
Metro Area	Dual-income share	Metro Area	Dual-income share
York, PA	24.9%	San Francisco, CA	14.0%
Madison, WI	24.7%	New York, NY	13.0%
Des Moines, IA	24.7%	San Diego, CA	12.9%
Minneapolis, MN	23.8%	Stockton, CA	12.7%
Lancaster, PA	23.0%	Riverside, CA	12.1%
Reading, PA	22.9%	Fresno, CA	10.9%
Fort Wayne, IN	22.6%	Los Angeles, CA	10.4%
Harrisburg, PA	22.4%	Miami, FL	10.3%
Omaha, NE/IA	22.2%	Flint, MI	9.9%
Albany, NY	21.8%	El Paso, TX	9.7%

Note: Author's calculation from the Census 2000 5% sample. Dual-income couples mean that both husband and wife are employed in non-low-skill service sectors.

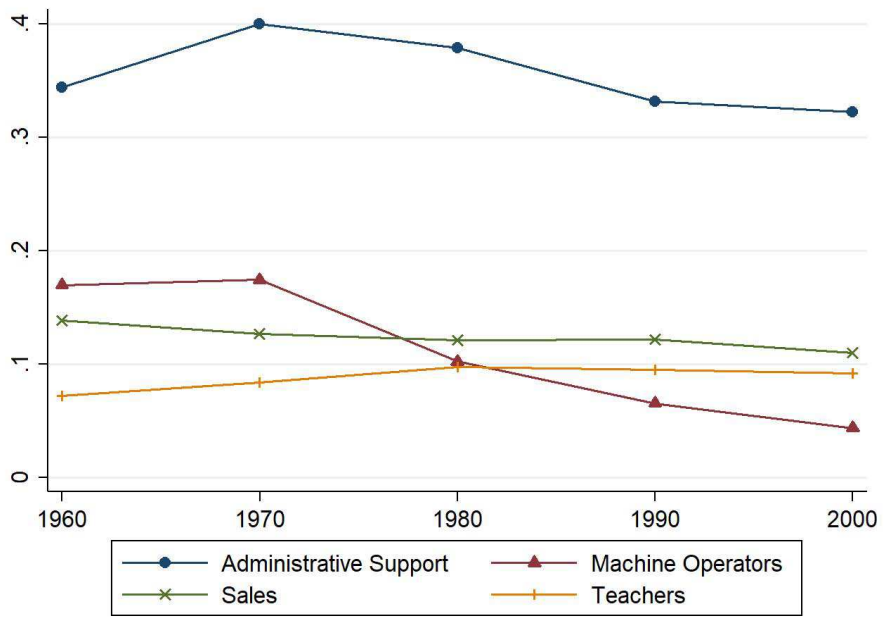
Table 2 describes another interesting aspect of dual-income earners by comparing the occupational distributions of men and women. Among dual-income earners, women's jobs were extremely concentrated on administrative support occupations in 1960, whereas the distribution of men across occupations was relatively even. Furthermore, the fraction of women in administrative support jobs is surprisingly stable over the period between 1960 and 2000 (Figure 2). This means that local economies with many women who worked in administrative jobs in 1960 have experienced a significant growth of dual-income households because of the increasing labor force participation of women. Based on this historical pattern, we construct predicted changes in dual-income households within cities, which we describe in detail in Section 4.

Table 2: Distribution of Dual-Income Workers across Occupations in 1960

Rank	Men		Women	
1	Machine Operators, Assemblers	14.3%	Administrative Support	34.4%
2	Executive, Administrative	12.7%	Machine Operators, Assemblers	17.0%
3	Transportation and Material Moving	11.1%	Sales	13.8%
4	Sales	8.6%	Teachers	7.2%
5	Precision Production	8.3%	Professional Specialty	6.9%
6	Administrative Support	8.0%	Precision Production	5.0%
7	Mechanics and Repairers	7.4%	Executive, Administrative	4.1%
8	Professional Specialty	6.4%	Other Agricultural and Related	1.9%
9	Construction Trades	5.3%	Technicians and Related Support	1.5%
10	Farm Operators and Managers	4.2%	Transportation and Material Moving	1.0%

Note: Author's calculation from the Census 1960 5% sample. The occupational classification follows that of Autor and Dorn (2013). Dual-income couples mean that both husband and wife are employed in non-low-skill service sectors.

Figure 2: Share of Wives' Job among Dual-Income Earners



Note: Author's calculations from the IPUMS (Ruggles et al. (2010)) version of the Decennial Censuses. The occupational classification follows that of Autor and Dorn (2013).

4 Empirical Strategy

In order to empirically validate the predictions introduced in Section 2, this section introduces our empirical strategy to identify the causal effect of the presence of dual-income households on the rise of low-skill service jobs. In other words, we examine whether dual-income couples crowd in low-skilled service workers in local economies.

We first consider an ideal case in which workers are randomly assigned to each city. Under such a random assignment, the causal estimate can be obtained with the following specification:

$$S_{ct} = \alpha + \beta D_{ct} + \varepsilon_{ct}, \tag{10}$$

where S_{ct} and D_{ct} represent an MSA (c)'s number of low-skilled service workers and dual-income couples, respectively, in a particular year (t). In this case, β indicates the number of jobs created as a result of the one more dual-income household in a locality.

Unfortunately, however, the above empirical specification is not appropriate to obtain consistent

estimates because workers select into the local labor markets, and other unobservable factors that affect the distribution of low-skilled workers confound the estimates. We therefore utilize a more demanding specification that partially accounts for the factors that vary within MSAs as follows:

$$\frac{\Delta S_{ct}}{L_{ct-1}} = \alpha + \beta \frac{\Delta D_{ct}}{L_{ct-1}} + \Theta X_c + \gamma_t + \epsilon_{ct}. \tag{11}$$

The dependent variable captures the variation in low-skill service jobs, taking the first difference ($\Delta S_{ct} = S_{ct} - S_{ct-1}$) and dividing it by the total population in the initial year (L_{ct-1}). Dual-income households are transformed in the same manner. First differencing effectively removes the influence of fixed local characteristics. Standardizing by the total population in the initial year prevents the inherent specification bias from scale effects (Peri and Sparber, 2011). As the outcome and key explanatory variable are simple transformations of the number of workers, the key coefficient β can be interpreted in the number of workers. If $\beta > 0$, each dual-income couple increases the number of low-skilled service workers. If $\beta < 0$, then dual-income couples crowd out low-skill service jobs. Lastly, $\beta = 0$ means that there is no linear relationship between the two variables of interest. We also include time-period dummies (γ_t) to account for changes in national conditions. The term X_c is a vector of other MSA-specific controls, and ϵ_{ct} is a zero-mean idiosyncratic error term. The analysis estimates the spillover effects for four periods: 1960-1970, 1970-1980, 1980-1990, and 1990-2000. Using time differences over these four decades allows us to add additional location fixed effects occasionally, removing region-specific pre-trends.

While our specification controls for a wide array of potential confounding factors, time-varying city-specific shocks remain a concern. In order to correct these issues, we develop an instrumental variable to predict actual changes in dual-income households, which is discussed in the next subsection.

4.1 Instruments and Controls

In order to develop an instrumental variable that is independent of time-varying unobservable confounders, we exploit the uneven concentration of dual-income women in administrative support occupations in 1960 and the growth of dual-income households, which is documented in Section 3.2. Furthermore, as couple formation may depend on the couple's

network, we consider the origins (birth places) of couples to increase the power of the instrument.[11] Specifically, we predict the number of dual-income households in MSA c for each year t as follows:

$$\widehat{D_{ct}} = \sum_b D_t^b \cdot \frac{A_{c,1960}^b}{A_{1960}^b}, \tag{12}$$

where the first term D_t^b is the total number of dual-income households from a wife's birth place b for year t. We distribute this D_t^b by using the second term, the share of administrative support women for each birth place ($A_{c,1960}^b/A_{1960}^b$), as weight. The weight part for each birth place b is obtained by calculating the number of administrative support (married) women in MSA c in year 1960.[12] We multiply these two terms and sum across birth places to yield the predicted number of dual-income households of MSA c for each year t. This formation indicates that we essentially use the variation that comes from the predetermined distribution of administrative support women (by birth place) in 1960.

Recall that Equation (11) specifies dual-income households in the first difference standardized by the total local population. Hence, the instruments are formed similarly by taking the first difference in predicted numbers, and then it is divided by the predicted total local population in the initial period.[13]

$$\frac{\widehat{\Delta D_{ct}}}{\widehat{L_{ct-1}}} = \frac{\widehat{D_{ct}} - \widehat{D_{ct-1}}}{\widehat{L_{ct-1}}}. \tag{13}$$

With this instrument, our first-stage regression takes the following form:

$$\frac{\Delta D_{ct}}{L_{ct-1}} = \mu + \phi \frac{\widehat{\Delta D_{ct}}}{\widehat{L_{ct-1}}} + \Gamma X_c + \delta_t + u_{ct}. \tag{14}$$

The coefficient, ϕ, represents the actual increase in dual-income households as a result of the predicted increase in dual earners, and the power of this coefficient is the key for our causal in-

[11] The birth place indicates the U.S. state or the foreign country where the person was born. According to Table B1 in Appendix B, while the average share of dual-income women out of the total number of women in 2000 is about 21 percent, there is significant variation in the share of dual-income women across birth places.

[12] Foreign-borns are collapsed into one category to overcome the curse of dimensionality.

[13] In order to avoid endogenous changes in the local population at the MSA level, we also predict the local population by augmenting population by birth place and age group in 1960 by the corresponding growth rate in the total national population of each group. Specifically, $\widehat{L_{ct-1}^x} = L_{c,1960}^x \times (L_t^x / L_{1960}^x)$, where x is the birth place by age group (aged 25 to 40 and aged 41 to 54), and, thus, $\widehat{L_{ct-1}} = \sum_x \widehat{L_{ct-1}^x}$.

terpretation. In large part, the validity of our identification is based on the assumption that the predetermined distribution of administrative support women (for each birth place of women) across cities in 1960–after controlling for other city characteristics–affects the local supply of dual-income earners but is independent of other confounding shocks that influence the growth of low-skilled service workers. Our empirical choices aim to reduce this risk of correlation between the instrument and unobserved city-specific factors.

Table 3: First-Stage Regressions

	(1) Basic	(2) Control: Demographic controls	(3) Control: Share routine & college edu.	(4) Control: MSA fixed effects
Predicted value	0.632***	0.636***	0.657***	1.108***
	(0.124)	(0.111)	(0.123)	(0.197)
Bartik	0.087**	0.098**	0.100**	-0.027
	(0.036)	(0.040)	(0.043)	(0.046)
Share routine in 1960			0.042	
			(0.033)	
Share college in 1960			-0.040	
			(0.074)	
1st stage F	26.03	32.74	28.59	31.51
Period FE	Yes	Yes	Yes	Yes
MSA FE				Yes
Observations	420	420	420	420
R-squared	0.317	0.351	0.352	0.609

Note: The dependent variable is the decade change in dual-income couples. The explanatory variable is the predicted change in dual-income couples. Dual-income couples mean that both husband and wife are employed in non-low-skill service sectors. The units of observations are MSAs. Standard errors in parentheses are heteroskedasticity robust and clustered by MSAs. All regressions are weighted by population aged 25 to 54 in 1960. ***p< 0.01, **p< 0.05, *p< 0.1

Table 3 shows the estimated first-stage results based on Equation (14). The first column shows the basic specification that controls for the log of the lagged population (L_{ct-1}), period effects (δ_t), and the well-known Bartik index (Bartik, 1991). This Bartik index captures industry-driven employment growth and is constructed in the following way:

$$BIV_{ct} = \sum_s \eta_{sc,1960} \Delta E_{st}, \tag{15}$$

where $\eta_{sc,1960}$ denotes the share of total city employment in each industry s in 1960 and ΔE_{st} is the log change over the decade for each industry. We include theses variables in all subsequent specifications. In column 2, we add local characteristics, including the shares of Hispanic, young (aged 25 to 40), and female population in 1960 as control variables. In column 3, we control for two important factors known to affect growth in service sectors. The share of routine workers is included to control for possible differences in technology adoption across cities, following Autor and Dorn (2013).[14] We also include the share of college graduates to control for the local multiplier effects of highly educated workers as a result of the demand for local services generated by the increase in total earnings (Moretti and Thulin, 2013; Mazzolari and Ragusa, 2013).[15] Lastly, in column 4, we also include additional location fixed effects (γ_c) to control for unobserved characteristics that grow linearly within MSAs. Hence, the identification of the key parameter relies on changes in dual-income households within the local economy. Controlling for the additional location fixed effects relieves some concerns regarding our instrument. Specifically, the location fixed effects absorb any potential confounders in the initial year, such as the shares of routine and college-educated workers. It also addresses concerns that this type of instrument may conflate short-run and long-run impacts of shocks (Jaeger, Ruist and Stuhler, 2018).

The estimated coefficients across four columns indicate that the imputed change in dual-income households correctly predicts the actual change in dual-income households. For example, in column 3, the 1 percentage point increase in the predicted value leads to approximately a 0.66 percentage point increase in dual-income households. The power of the instrument, represented by the F-statistic that is about 30, is strong enough to avoid the weak instrument bias. Notably, even with additional MSA fixed effects, in column 4, this specification still leaves the instrument with significant explanatory power and thus adds to the validity of our instrument (Goldsmith-Pinkham, Sorkin and Swift, 2018).

[14] Routine occupations are defined as the upper 25 pecentile occupations in the distribution based on the routine task intensity.

[15] The specific definitions of these two are available in the Appendix B.

5 Estimated Effects on Low-skilled Service Workers

5.1 Benchmark Results

We estimate Equation (11) to identify the impact of dual-income households on low-skill service sectors in the same city. Our main outcome variable is the growth of low-skill service employment, as well as the growth of average weekly wages. For two-stage least-squares (2SLS) regressions, we use the imputed change in dual-income couples in Equation (13) as an instrument for the actual change. The basic specification controls for the log of the lagged population (L_{ct-1}), period effects (δ_t), and the Bartik index. We add other control variables gradually in subsequent specifications. Standard errors are clustered at the MSA level. The results are reported in Table 4.[16]

Panel A of Table 4 summarizes the benchmark results by reporting the estimated coefficients of interest (β) in Equation (11). The OLS results reported in the first three columns indicate that one additional increase in dual-income households, which is equivalent to a two-worker increase, is associated with about a 0.7-worker increase in the low-skill service sector. In columns 4–6, the estimates from the 2SLS specifications are reported. Column 4 is the basic specification. Column 5 controls for local characteristics, including the shares of routine workers, the college educated, Hispanic, female, and aged 25 to 40. Lastly, column 6 controls for additional MSA fixed effects instead of fixed local characteristics in 1960. The 2SLS estimates are, in general, smaller than the OLS estimates and range between 0.29 and 0.39: one additional increase in dual-income households leads to about a 0.3-worker increase in the low-skill service sector. Therefore, it is reasonable to argue that unobservable period-specific shocks have affected the changes in dual-income households and low-skilled service workers in the same way, resulting in an upward bias in the OLS specifications.

To examine how large these estimates are, we use the back-of-the-envelope calculations to determine how much of the increase in low-skill service jobs can be attributed to the rise of dual-income couples. The 2SLS estimates indicate that 10 more dual-income couples (20 workers) create approximately 3 low-skill service jobs in local economies. As the number of dual-income couples has increased by approximately 8.2 million during the period 1960–2000, the increase in low-skill

[16] In Appendix Table C1, we extend our analysis to the period between 1960 and 2010. The results are similar to Table 4.

Table 4: Effects on Low-Skilled Service Workers: Employment and Wages

	(1)	(2)	(3)	(4)	(5)	(6)
		OLS			**2SLS**	
	Basic	Control: Share routine & college edu.	Control: MSA fixed effects	Basic	Control: Share routine & college edu.	Control: MSA fixed effects
Panel A: Employment						
Dual income	0.651***	0.699***	0.679***	0.331**	0.288**	0.387***
	(0.045)	(0.041)	(0.054)	(0.139)	(0.140)	(0.103)
Bartik	0.112***	0.099***	0.088***	0.151***	0.138***	0.063**
	(0.029)	(0.023)	(0.033)	(0.035)	(0.035)	(0.030)
Share routine in 1960		0.036			0.047*	
		(0.022)			(0.026)	
Share college in 1960		-0.101***			-0.067	
		(0.035)			(0.049)	
Panel B: Wages						
Dual income	0.229***	0.167**	0.182*	0.849***	1.153***	1.033***
	(0.073)	(0.067)	(0.095)	(0.248)	(0.271)	(0.255)
Bartik	-0.023	-0.017	-0.083	-0.099	-0.112	-0.008
	(0.042)	(0.051)	(0.088)	(0.063)	(0.069)	(0.078)
Share routine in 1960		0.064*			0.037	
		(0.036)			(0.058)	
Share college in 1960		-0.067			-0.149	
		(0.061)			(0.093)	
1st stage F				26.03	28.59	31.51
Period FE	Yes	Yes	Yes	Yes	Yes	Yes
MSA FE			Yes			Yes
Observations	420	420	420	420	420	420

Note: The explanatory variable is the change in dual-income couples. Dual-income couples mean that both husband and wife are employed in non-low-skill service sectors. The units of observations are MSAs. Standard errors in parentheses are heteroskedasticity robust and clustered by MSAs. All regressions are weighted by population aged 25 to 54 in 1960.
***p< 0.01, **p< 0.05, *p< 0.1

service jobs as a result of dual-income earners is about 2.4 million, which comprises 40 percent of the total 6 million increase in low-skilled service workers.

In panel B of Table 4, we examine the impact on the growth of average wages of low-skilled service workers to further verify if the increase in dual-income households creates a demand for local services. The positive and statistically significant estimates confirm this hypothesis. Each column uses the same specification in panel A of Table 4. For the OLS results, the one percentage point increase in dual-income households is associated with about a 0.2 percent increase in the wages of low-skilled service workers. Contrary to the results in employment growth, the estimates for wage growth in the 2SLS specifications range between 0.8 and 1.2 and are larger than the estimates from the OLS. This is not surprising because the estimates from the OLS capture unobservable factors that increase the supply of low-skilled workers, making the OLS estimates for wage growth underestimated. Overall, the results reported in Table 4 suggest that an increase in dual-income households expands the local low-skill service sectors because of the increased demand for local services.

We finally comment regarding the two important control variables, the initial share of routine workers and that of the college graduates. First, as argued by Autor and Dorn (2013), cities that have historically specialized in routine task-intensive industries could have experienced a more pronounced job polarization, so the low-skill service jobs here could have expanded more than those in cities that have not historically specialized in routine task-intensive industries. The coefficient on the share of routine workers is positive and significant, thus confirming the previous findings of Autor and Dorn (2013). Second, another important channel that has been emphasized was the spillover effect from high-skilled workers on low-skill service markets (Mazzolari and Ragusa, 2013). While we need to control for the change in college graduates, the initial share of college graduates would be sufficient to capture this education spillover channel. Even after these channels are controlled for, reassuringly, the estimated coefficients on dual-income families are robust. We will further examine other hypotheses that might drive our results in subsection 5.5.

5.2 Results by Sub-occupations

One interesting prediction of our model is that the substitutability of labor and service goods is positively related to the spillover effect. Hence, another interesting exercise would be to examine which occupations within low-skilled service sectors are

greatly affected by an increase in dual-income households. Namely, if dual-income households are likely to demand services that substitute home production, services such as cleaning or child care should benefit the most. Table 5 tests this hypothesis by separately estimating the effects of dual-income earners on sub-occupations of low-skill service sectors.

Table 5: Effects on Low-Skilled Service Workers: by Sub–Occupations

Dependent Variable:	(1) Home Production Service	(2) Other Service Jobs	(3) Cleaning Service	(4) Food Preparation	(5) Maintenance & Janitors	(6) Child Care
Dual income	0.518***	-0.202*	0.175***	0.195***	0.083***	0.064***
	(0.088)	(0.119)	(0.040)	(0.042)	(0.029)	(0.018)
Bartik	0.041**	0.116***	-0.030***	0.023**	0.043***	0.005
	(0.020)	(0.033)	(0.011)	(0.010)	(0.008)	(0.003)
Share routine in 1960	0.025	0.033*	0.007	0.019**	0.001	-0.001
	(0.016)	(0.020)	(0.007)	(0.007)	(0.006)	(0.002)
Share college in 1960	-0.060**	-0.023	0.009	-0.040***	-0.032***	0.004
	(0.027)	(0.038)	(0.010)	(0.013)	(0.012)	(0.004)
1st stage F	28.59	28.59	28.59	28.59	28.59	29.34
Period FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	420	420	420	420	420	401
R-squared	0.660		0.511	0.620	0.611	0.534

Note: The explanatory variable is the change in dual-income couples. Dual-income couples mean that both husband and wife are employed in non-low-skill service sectors. The units of observations are MSAs. Standard errors in parentheses are heteroskedasticity robust and clustered by MSAs. All regressions are weighted by population aged 25 to 54 in 1960.
***p< 0.01, **p< 0.05, *p< 0.1

In columns 1 and 2, we first broadly divide low-skill service sectors into home production service and other services. Interestingly, while the presence of dual-income households significantly increases the employment of home production service workers, it lowers the employment of other service workers, although the magnitude is smaller. This may suggest that some low-skilled workers switch their jobs to home production service sectors from the other service sectors.

In columns 3 to 6 of Table 5, we further estimate the effects on sub-occupations of home production services, including cleaning, food preparation, maintenance and janitors, and child

care. The effects of these occupations are highly significant. For example, one additional dual-income couple leads to approximately a 0.17-worker increase in cleaning service and a 0.19-worker increase in food preparation service. Therefore, our results are consistent with the predictions from our model. It is also important to note that other factors, the share of routine workers or that of college graduates in 1960, do not seem to have more significant impacts on the employment of home production service, suggesting that the dual-income channel is more relevant for the growth of low-skill employment.

5.3 Falsification Tests

The identifying assumption for using our instrument is that the predetermined variation in administrative support women in 1960 across cities, conditioning on fixed effects and other shocks, is independent of unobservable local factors that affect low-skill service employment. As it is not possible to directly test this identifying assumption, we instead present suggestive evidence by examining the correlations between the pre-trends of our outcome variables and our instrument. If our instrument is credible, we expect to see weak correlations between the instrument and the pre-trends. To be specific, similar to Equation (14), we regress changes in low-skilled service workers between 1950 and 1960 on the instrument, and we observe if the instrument predicts the pre-trends. By doing so, we test whether dual-income couples select into local areas with a large supply of low-skill services.

Table 6 describes the results from the falsification tests that regress the pre-trends of four outcome variables of main interest on our instrument. Columns 1 and 2 examine the pre-trends of employment and wages of low-skill service sectors, and columns 3 and 4 run for the employment of sub-occupations. Reassuringly, although the correlations are not exactly zeroes, they are at least not statistically significant, so our estimates should not be significantly biased by the pre-trends. Furthermore, when we estimate Equation (11) using our instrument, we include the additional location fixed effects (γ_c) to absorb the pre-trends of the outcomes in order to relieve concerns regarding pre-trends.

5.4 Mediation Analysis

Our identifying assumption is that the predicted change in dual-income couples affects the change in low-skilled workers only through the actual change in dual-income couples. In other words, if there are any direct effects of the instrument on low-skill service employment, our estimates would be biased.

Table 6: Falsification Tests

Dependent Variable:	(1) Low-skill Service Employment 1950–60	(2) Low-skill Service Wages 1950–60	(3) Home Production Employment 1950–60	(4) Other Service Employment 1950–60
Predicted value	0.520	0.360	0.411	0.175
	(0.460)	(0.444)	(0.287)	(0.215)
Bartik	0.081	0.231	0.039	0.056
	(0.120)	(0.163)	(0.086)	(0.048)
Share routine in 1960	0.083	0.077	0.048	0.036
	(0.108)	(0.105)	(0.069)	(0.052)
Share college in 1960	-0.149	-0.141	-0.085	-0.091
	(0.142)	(0.173)	(0.079)	(0.072)
Observations	105	105	105	105
R-squared	0.370	0.034	0.374	0.261

Note: The explanatory variable is the predicted change in dual-income couples between 1960 and 1970. The dependent variable is a change in low-skilled workers between 1950 and 1960. The units of observations are MSAs. Standard errors in parentheses are heteroskedasticity robust and clustered by states. All regressions are weighted by population aged 25 to 54 in 1960.
***p< 0.01, **p< 0.05, *p< 0.1

Although this assumption is not directly testable, we complement our analysis by examining the extent to which pre-existing variation in administrative support occupations affects employment of home production services via dual-income households. If the increase in dual-income couples is an important pathway for the instrumental variable's influence, including the instrument in the reduced-form regression should reduce the significance of the coefficient on the instrument.

In column 1 of Table 7, we first run a reduced-form regrssion by regressing the change in employment of home production services on the predicted increase in dual-income couples. As expected, this relationship is statistically significant. However, in column 2, once we additionally include the actual increase in dual-income households, the coefficient on the predicted value indeed becomes weaker and insignificant. These results suggest that the large part of the effect of administrative support women on employment of home production services is transmitted by dual-income households. This is essentially the Sobel-Goodman mediation test.[17]

Furthermore, in column 3 of Table 7, we control for the direct effect of administrative support women in 1960 on the employment growth of low-skilled service workers by including the imputed increase in home production service from the distribution of administrative support women. Specifically, using the distribution of administrative support women in 1960 as weight, we directly impute an increase in low-skilled service workers (instead of an increase in dual-income workers). The detailed procedure for this imputed shock is included in Appendix B. Notably, the effect of dual-income couples on service employment remains significant. Overall, it is unlikely that the direct effects of administrative support women confound our estimates.

5.5 Robustness Checks

While we use plausibly exogenous variation in dual-income households driven by the predetermined distribution of administrative support women in 1960 and control for a rich set of local characteristics and fixed effects, there may still be other shocks to local economies that might drive our results. In this subsection, we discuss other potential channels that may confound our estimates and present the robustness of our estimates. As our main conclusion is that dual-income earners expand local services that substitute home production, we display the estimates on the employment growth of home production services for the sake of simplicity.

There are three potential time-varying local shocks that might bias our estimates. The first

[17] We are grateful to Matthew Notowidigdo for suggesting this exercise.

Table 7: Mediation Analysis

Dependent Variable:	(1) Home Production	(2) Home Production	(3) Home Production
Dual income		0.489***	0.437***
		(0.033)	(0.069)
Predicted value	0.340***	0.019	
	(0.078)	(0.063)	
Imputed service			0.122*
			(0.070)
Bartik	0.093***	0.044**	0.055***
	(0.027)	(0.017)	(0.019)
Share routine in 1960	0.047**	0.027*	0.030*
	(0.021)	(0.016)	(0.016)
Share college in 1960	-0.081	-0.061**	-0.071**
	(0.051)	(0.029)	(0.031)
1st stage F	-	-	62.45
Observations	420	420	420
R-squared	0.228	0.661	0.659

Note: The dependent variable is the change in employment of home production service sectors. Dual-income couples mean that both husband and wife are employed in non-low-skill service sectors. The units of observations are MSAs. Standard errors in parentheses are heteroskedasticity robust and clustered by states. All regressions are weighted by population aged 25 to 54 in 1960.
***p< 0.01, **p< 0.05, *p< 0.1

concern is that our instrument could be highly correlated with the inflow of low-skilled immigrants. Between 1960 and 2000, significant numbers of foreign-born workers arrived in the U.S., and many of them worked in low-skill service sectors. For example, while immigrants in 1960 were less than 10 million, they were more than 30 million in 2000, accounting for 11 percent of the total population (Census of Population, 1960 to 2000). If some of administrative support women are foreign-born, our instrument will capture the impacts of immigrants and bias our estimates. The second concern is regarding the spillover effect from high-skilled workers (Mazzolari and Ragusa, 2013), although we control for the initial share of college graduates in Table 4. The third concern is that an increase in non-dual-income female workers could be correlated with the growth of dual-income couples. As we have shown in our theoretical model, the exogenous shock comes from the increase in labor market participation of women, including non-dual-income female workers. Furthermore, single mothers might also spend less time in home production for similar reasons that dual-income couples have less time to devote for home production. Therefore, our estimates may mix the effects from the increase in non-dual-income women.

Since directly controlling for these shocks would introduce endogeneity problems, we impute each shock (the growth of immigrants, the wage bill of top wage earners, and non-dual-income female workers) and include them as control variables in columns 1 to 3 of Table 8. For simplicity of analysis, we only report results from IV regression. To be specific, we control for the well-known immigrant enclave instrument (Altonji and Card, 1991; Card, 2001), the occupation-driven growth of the wage bill of top wage earners (Mazzolari and Ragusa, 2013), and the predicted growth of single female workers based on administrative women across areas in 1960 (similar to the way that we construct our instrument for dual-income earners). The detailed procedure for these imputed shocks is included in Appendix B.

In columns 1 to 3, the growth of dual-income earners strongly increases the employment of home production sectors, and the magnitudes of the coefficients are comparable to that of column 1 in Table 5. The first-stage powers are also reasonably strong. In column 4, we run a regression with a full set of controls that include all the imputed shocks and the direct effects from our instrument. Even with this rich set of controls and other shocks, dual-income households significantly increase home production service employment: one additional dual-income couple increases home production workers by approximately 0.46.

Table 8: Robustness Checks

	(1) Control: Δlow-skilled immigrants	(2) Control: Δtop wage bill share	(3) Control: Δfemale employment	(4) Control: full controls	(5) Non-power couples only
Dual income	0.514***	0.516***	0.468***	0.461***	0.606***
	(0.089)	(0.085)	(0.079)	(0.068)	(0.110)
Bartik	0.038*	0.042**	0.046**	0.052***	0.048**
	(0.020)	(0.020)	(0.019)	(0.019)	(0.021)
Share routine in 1960	0.023	0.023	0.026*	0.026	0.030**
	(0.016)	(0.017)	(0.016)	(0.017)	(0.015)
Share college in 1960	-0.059**	-0.064**	-0.066**	-0.071**	0.005
	(0.027)	(0.027)	(0.029)	(0.029)	(0.026)
1st stage F	27.33	28.92	33.96	50.96	23.84
Observations	420	420	420	420	420
R-squared	0.663	0.660	0.661	0.666	0.650

Note: The dependent variable is the change in employment of home production service sectors. The explanatory variable is the change in dual-income couples. Dual-income couples mean that both husband and wife are employed in non-low-skill service sectors. The units of observations are MSAs. Standard errors in parentheses are heteroskedasticity robust and clustered by states. All regressions are weighted by population aged 25 to 54 in 1960. ***p< 0.01, **p< 0.05, *p< 0.1

Finally, in column 6, we test the robustness of our results by further considering heterogeneity within dual-income households. Column 6 considers the skill of dual-income couples by excluding power couples (both husband and wife are college educated) in our explanatoy variable because Costa and Kahn (2000) and Compton and Pollak (2007) document that college-educated couples are increasingly located in large metropolitan areas. Notably, the estimate is strongly significant, showing the robustness of our results.

5.6 Heterogeneious Effects of Dual-income Couples

Dual-income couples with different characteristics may have heterogeneous effects on local low-skill service employment. For example, if some couples spend more time in market work, they would have even lesser time to devote for home production. On the contrary, if a dual-income family has children, the amount of needed home goods might be greater, requiring either more services from the market or home production participation. In this subsection, we investigate heterogeneity within dual-income couples by focusing on full-time dual-income couples (both husband and wife work for more than 40 hours per week) and dual-income couples with at least one child. If the spillover mechanism works, an increase in these families should have greater effects on low-skilled service employment, compared with an increase in other types of dual-income couples.

Table 9 shows these heterogeneous effects of dual-income couples. Column 1 examines the effect of full-time dual-income couples. Column 2 is for dual-income households with at least a child. The estimates are 0.61 and 0.65, respectively, and are slightly greater than the estimates in Table 5.[18] Therefore, these results confirm that time constraints in households play a crucial role in home production.

In columns 3 to 6 of Table 9, we further estimate the heterogeneous effects on sub-occupations of home production services, similar to Table 5, to check whether greater effects are found for each sub-occupation. As is expected, compared with the estimates in Table 5, the estimated effects are slightly greater. Overall, the results are consistent with our hypothesis.

[18]The estimate of column 1 in Table 9 is very similar to that of column 6 in Table 8. This is because full-time dual-income households and non-power couples are highly correlated.

Table 9: Heterogeneity across Dual-income Couples

	(1) Full-time couples only	(2) Couples with kids only	(3) Outcome: cleaning service	(4) Outcome: food preparation	(5) Outcome: maintenance & janitors	(6) Outcome: child care
Dual income (full-time)	0.605***		0.205***	0.228***	0.097***	0.075***
	(0.099)		(0.043)	(0.049)	(0.034)	(0.021)
Dual income (with kids)		0.652***	0.221***	0.246***	0.105***	0.080***
		(0.140)	(0.059)	(0.059)	(0.040)	(0.024)
Observations	420	420	420	420	420	401

Note: The dependent variable is the change in employment of home production services. The explanatory variable is the change in dual-income couples. Dual-income couples mean that both husband and wife are employed in non-low-skill service sectors. The units of observations are MSAs. Standard errors in parentheses are heteroskedasticity robust and clustered by states. All regressions are weighted by population aged 25 to 54 in 1960. ***p< 0.01, **p< 0.05, *p< 0.1

6 Conclusion

The structure of employment in the U.S. has changed dramatically over the past decades. One of the most prevalent aspects of this change is the rising female labor supply and hence the emergence of dual-income households. This study investigates whether the presence of dual-income households creates a demand for low-skill services between 1960 and 2000. Dual-income couples are more likely to buy low-skilled, time-intensive, services that free them from home production tasks. In particular, we study the cross-city association between the variation in dual-income households and employment growth in home production substitutes. Endogeneity concerns are addressed by exploiting the concentration of women in dual-income households on administrative support occupations in 1960 and the uneven distribution of dual earners across birth places. The results show that employment in the low-skill service sectors that substitute for home production has increased between 1960 and 2000 with the increase in a city's dual-income households, suggesting further evidence of consumption spillover. That is, the changes in household structure, which are driven by the rising female labor supply and dual earners' opportunity costs of home production, could increase the demand for low-skill services. This paper particularly contributes to the existing literature on job polarization by helping to shed light on the rapid growth of employment in service

sectors. Rather than focusing on technological progress, which has been cited as the main reason for job polarization, we explore a new channel, consumption spillover from dual-income households, to explain the growth of low-skill service jobs in recent decades.

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A Appendix. Derivation of Predictions

Let q^M (resp. q^H) denote the Lagrangian multiplier attached to the budget constraint (resp. constraint for home good). Using the first-order conditions for the labor supply decision of the female worker (FOCs with respect to h_f^M and h_f^H), we can obtain

$$zG_h = \frac{q^M}{q^H} w_f, \tag{16}$$

where $G_h \equiv \partial G / \partial h_f^H$.

The first-order condition with respect to s is given by

$$pq^M = zG_s q^H, \tag{17}$$

where $G_s \equiv \partial G / \partial s$.

Using the CES function, we can rewrite Equation (5) as follows:

$$w_f = \frac{1-\alpha}{\alpha} p \left(\frac{s}{h_f^H} \right)^{\frac{1}{\sigma}}. \tag{18}$$

Taking logs to the both sides and rearranging the terms, we obtain

$$\log s = -\sigma \ln \frac{1-\alpha}{\alpha} - \sigma \log p + \sigma \log w_f + \log h_f^H. \tag{19}$$

Hence, the above equation is the demand function for the service good.

We further assume that the production function of the firm that produces the service good takes the usual Cobb-Douglass form:

$$f(h) = h^\delta, \tag{20}$$

where $\delta \in (0, 1)$.

Since the labor market equilibrium condition is $pAf'(h) \equiv pA\delta h^{\delta-1} = Bh^\psi$ and $s = Af(h)$ as the service good market clearing condition, we can obtain the following equilibrium condition in log:

$$\log s = (\psi + 1)\log h - \log p - \log \frac{\delta}{B}. \tag{21}$$

Combining the demand and supply equations (Equations (19) and (21)), we obtain the following equation:

$$\log h = \phi + \frac{\sigma}{\psi + 1}\log w_f + \frac{1}{\psi + 1}\log h_f^H + \frac{1-\sigma}{\psi + 1}\log p, \tag{22}$$

where $\phi \equiv (-\sigma \log \frac{1-\alpha}{\alpha} + \log \frac{\delta}{B})/(\psi + 1)$.

Hence, the above equation provides a prediction that a labor input in the service good sector (h) is increasing in the wage of the female worker (w_f).

Let us further consider the first-order conditions of the couple with respect to c_f^M and h_f^H:

$$w_f = \frac{u_{c_f^M}}{u_{l_f}} \equiv MRS_{c_f^M, l_f}. \tag{23}$$

Under the assumption that the income effect is dominated by the substitution effect, $w_f \propto h_f^M$. Hence, we can rewrite Equation (22) as

$$\log h \propto \phi + \frac{\sigma}{\psi + 1}\log h_f^M + \frac{1}{\psi + 1}\log h_f^H + \frac{1-\sigma}{\psi + 1}\log p. \tag{24}$$

Notice that $h_f^H = 1 - h_f^M - l_f$, so it also responds to changes in w_f. One can show that $\partial l_f / \partial h_f^M < \sigma h_f^H / h_f^M - 1$ is the sufficient condition for $\log h$ to increase with respect to $\log h_f^M$. As $\partial l_f / \partial h_f^M$ is negative in the usual case, this implies that the prediction requires leisure to decline sufficiently.

The labor supply equation of the service sector ($w = Bh^\psi$) implies

$$\log w \propto \log B + \psi \left(\phi + \frac{\sigma}{\psi + 1}\log h_f^M + \frac{1}{\psi + 1}\log h_f^H + \frac{1-\sigma}{\psi + 1}\log p \right). \tag{25}$$

B Appendix. Data Appendix

Table B1: Share of dual-income couples across birth places in 2000

Birth Place	Share dual-income
Iowa	28.1%
South Dakota	28.0%
Minnesota	27.4%
Nebraska	27.4%
North Dakota	26.8%
Wisconsin	26.8%
Kansas	25.1%
Vermont	24.8%
New Hampshire	23.7%
Maine	23.5%
...	...
...	...
District of Columbia	17.9%
New Mexico	17.7%
Alabama	17.7%
South Carolina	17.5%
California	17.0%
Louisiana	16.6%
Alaska	16.1%
Arizona	15.9%
Mississipi	15.1%
Foreign-born	12.1%

Note: The share of dual-income women out of the total number of women in 2010.

B.1 The growth of immigrants

To construct the predicted growth of immigrants, we first calculate the imputed number of immigrants for MSA c in year t in the following way:

$$\widehat{I_{ct}} = \sum_o I_t^o \cdot \frac{I_{c,1960}^o}{I_{1960}^o}, \tag{26}$$

where the first term I_t^o is the total number of immigrants from country of origin o for year t and $(I_{c,1960}^o / I_{1960}^o)$ is the share of foreign-borns in MSA c in year 1960 for each country of origin o. The countries of origins are collapsed into 12 categories. Then, we take the first difference in these numbers and divide them by the total local population in the initial period (L_{ct-1}).

B.2 The change in the wage bill of top wage earners Our measure of the change in the wage bill of top wage earners follows Mazzolari and Ragusa (2013). Specifically,

$$\overline{\Delta WB_{ct}^{90}} = \sum_j \lambda_{c,1960}^j \cdot \Delta w_{jt}, \tag{27}$$

where $\lambda_{c,1960}^j$ is the share of wage earners in the top decile of the MSA wage distribution in 1960 employed in occupation j and Δw_{jt} is the change over decade t in the log wages of workers in that same occupation j. Occupations are defined on the basis of 18 occupation cells.

B.3 The growth of non-dual-income female workers To construct the predicted growth of non-dual-income female workers, we first impute the number of those female workers for MSA c in year t in the following way:

$$\widehat{F_{ct}} = \sum_b F_t^b \cdot \frac{A_{c,1960}^b}{A_{1960}^b}, \tag{28}$$

where the first term F_t^b is the total number of non-dual-income female workers from birth place b for year t and $(A_{c,1960}^b/A_{1960}^b)$ is the share of administrative support women (not married) in MSA c in year 1960 for each birth place b. Then, we take the first difference in these numbers and divide them by the total local population in the initial period (L_{ct-1}).

B.4 Direct effects of administrative support women in 1960 To control for the direct effects of our instrument on low-skilled service workers, we first predict the growth of low-skilled service workers by using the same share of administrative support women (married) in MSA c in year 1960 for each birth place b.

$$\widehat{S_{ct}} = \sum_b S_t^b \cdot \frac{A_{c,1960}^b}{A_{1960}^b}, \tag{29}$$

where the first term S_t^b is the total number of low-skilled service workers from birth place b for year t and $(A_{c,1960}^b/A_{1960}^b)$ is the share of administrative support women (married) in MSA c for each birth place b. Then, we take the first difference in these numbers and divide them by the total local population in the initial period (L_{ct-1}).

C Appendix. Analysis for the period 1960 – 2010

Table C1: Effects on Low-Skilled Service Workers: Employment and Wages, 1960–2010

	(1)	(2)	(3)	(4)	(5)	(6)
		OLS			**2SLS**	
	Basic	Control: Share routine & college edu.	Control: MSA fixed effects	Basic	Control: Share routine & college edu.	Control: MSA fixed effects
Panel A: Employment						
Dual income	0.655***	0.681***	0.633***	0.393***	0.347**	0.388***
	(0.043)	(0.040)	(0.051)	(0.148)	(0.151)	(0.134)
Panel B: Wages						
Dual income	0.230***	0.199***	0.218***	0.804***	1.123***	1.139***
	(0.064)	(0.061)	(0.076)	(0.261)	(0.283)	(0.271)
1st stage F				24.42	25.97	31.36
Period FE	Yes	Yes	Yes	Yes	Yes	Yes
MSA FE			Yes			Yes
Observations	525	525	525	525	525	525

Note: The explanatory variable is the change in dual-income couples. Dual-income couples mean that both husband and wife are employed in non-low-skill service sectors. The units of observations are MSAs. Standard errors in parentheses are heteroskedasticity robust and clustered by MSAs. All regressions are weighted by population aged 25 to 54 in 1960.
***p< 0.01, **p< 0.05, *p< 0.1