Gender Gaps and the Rise of the Service Economy*

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Abstract

This paper investigates the role of the rise of services in the narrowing of gender gaps in hours and wages in recent decades. We document the between-industry component of the rise in female work for the U.S., and propose a model economy with goods, services and home production, in which women have a comparative advantage in producing market and home services. The rise of services, driven by structural transformation and marketization of home production, acts as a gender-biased demand shift raising women's relative wages and market hours. Quantitatively, the model accounts for an important share of the observed trends.

JEL codes: E24, J22, J16.

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1 Introduction

One of the most remarkable changes in labor markets since World War II is the rise in female participation in the workforce. In the US, the employment rate of women has more than doubled from about 35% in 1945 to 77% at the end of the century, and similar trends are detected in the majority of OECD countries. These developments have generated a vast literature on the causes, characteristics and consequences of the rise in women's involvement in the labor market. The existing literature has indicated a number of supply-side explanations for these trends, including human capital investment, medical advances, technological progress in the household, and the availability of child care, and a recent line of research emphasizes the role of social norms regarding women's work in shaping the observed decline in gender inequalities.[1]

In this paper we propose a novel, and complementary, explanation for the observed trends in gender outcomes, based on the secular expansion of the service economy and its role in raising the relative demand for female work. Our emphasis on the evolution of the industry structure is motivated by a few stylized facts. First, the sustained rise in female work since the late 1960s in the U.S. has been accompanied by a fall in male work, and a rise in women's relative wages. In 1968, women's hours were about 37% of men's hours, and their wages were about 64% of male wages. By 2008, these ratios rose to 74% and 78%, respectively. Second, the entire (net) rise in women's hours took place in the broad service sector, while the entire (net) fall in male hours took place in goods-producing sectors, including the primary sector, manufacturing, construction and utilities. This pattern is closely linked to the process of *structural transformation*, and specifically the reallocation of labor from goods to service industries, with an expansion of the services share from 57% in 1968 to 77% in 2008. Finally, the rise in women's hours in the service sector was accompanied by a strong decline in their working hours in the household, from about 38 to 28 hours weekly, consistent with substantial *marketization* of home production.[2]

Motivated by these facts, this paper studies the role of the rise of the services sector, in turn driven by structural transformation and marketization, in the evolution of gender outcomes in hours and wages. The interaction between structural transformation, marketization and female work has been largely overlooked in the literature. However there are clear

[1] See Goldin (1990, 2006) for comprehensive overviews of historical trends and their causes. See (among others) Goldin and Katz (2002) and Albanesi and Olivetti (2009) for the role of medical progress; Greenwood, Seshadri and Yorukoglu (2005) for the role of technological progress in the household; Galor and Weil (1996) and Attanasio, Low and Sanchez-Marcos (2008) for the role of declining fertility. See finally Fernandez (2011, 2013) and references therein for theory and evidence on cultural factors.

[2] See also Freeman and Schettkat (2005) and the discussion in Lebergott (1993, chapter 8) on the link between marketization and consumerism: "... by 1990 [women] increasingly bought the goods and services they had produced in 1900", and Bridgman (2013), documenting the rise in the ratio of services purchased relative to home production since the late 1960s.

reasons why these can contribute to the rise in female market hours. First, the production of services is relatively less intensive in the use of "brawn" skills than the production of goods, and relatively more intensive in the use of "brain" skills. As men are better endowed of brawn skills than women, the historical growth in the service sector has created jobs for which women have a natural comparative advantage (Goldin, 2006, Galor and Weil 1996, Rendall 2010). While the brawn versus brain distinction has become less relevant in recent decades due to the introduction of brawn-saving technologies, women may still retain a comparative advantage in services, related to the more intensive use of communication and interpersonal skills, which cannot be easily automated. The simultaneous presence of producer and consumer in the provision of services makes these skills more valuable in services than goods production, and a few studies have highlighted gender differences in the endowment and use of such traits (Roter et al, 2002, Dickerson and Green, 2004, Borghans et al., 2005, 2008). Women's comparative advantage in services is clearly reflected in the allocation of women's hours of market work. In 1968, the average working woman was supplying three quarters of her market time to the service sector, while the average man was supplying only one half of his market time to it. As structural transformation expands the sector in which women have a comparative advantage, it has potentially important consequences for the evolution of women's hours of market work. Indeed, in a shift-share framework, as much as one third of the rise in female hours took place via the expansion of services, at constant female intensity within each sector.

The second reason is related to women's involvement in household work. In 1965, women spent on average 38 hours per week in home production, while men spent 11 hours. Household work typically includes child care, cleaning, food preparation, and in general activities that have close substitutes in the market service sector. If the expansion of the service sector makes it cheaper to outsource these activities, one should expect a reallocation of women's work from the household to the market. The work allocation of men and women in the late 1960s is thus key to understanding later developments. While women were mostly working in home production and the service sector, and thus their market hours were boosted by both structural transformation and marketization, men were predominantly working in the goods sector, and their working hours mostly bore the burden of de-industrialization.

In our proposed model, market sectors produce commodities (goods and services) that are poor substitutes for each other in consumer preferences, while the home sector produces services that are good substitutes to services produced in the market. Production in each sector involves a combination of male and female work, and females have a comparative advantage in producing services, both in the market and the home. Labor productivity growth is uneven,[3] reducing both the cost of producing goods, relative to services, and the

[3]Uneven labor productivity growth can be driven by uneven TFP growth or different capital intensities across sectors.

cost of producing market services, relative to home services. As goods and services are poor substitutes, faster labor productivity growth in the goods sector reallocates labor from goods to services, resulting in structural transformation. As market and home services are good substitutes, slower labor productivity growth in the home sector reallocates hours of work from the home to market services, resulting in marketization.

The combination of consumer tastes and uneven productivity growth delivers two novel results. First, due to women's comparative advantage in services, structural transformation and marketization jointly raise women's relative market hours and wages. In other words, gender comparative advantages turn a seemingly gender-neutral shock such as the rise in services into a *de facto* gender-biased shock. Second, for both men and women, market hours rise with marketization but fall with structural transformation. Their combination is thus needed to rationalize observed gender trends: marketization is necessary to deliver the rise in female market work while structural transformation is necessary to deliver the fall in male market work.

To quantitatively assess the importance of the mechanisms described, we calibrate our model economy to the U.S. labor market and predict trends in gender outcomes implied by observed productivity growth differences. Our baseline calibration predicts the entire rise in the service share, 20% of the gender convergence in wages, nearly half of the rise in female market hours and 7% of the fall in male market hours. These predictions are solely due to between-sector forces, via structural transformation and marketization, while no within-sector forces are at work. However, we show that introducing within-sector forces such as gender-biased technical change and accumulation of human capital improve the model's predictions for gender-specific trends, leaving sector-specific predictions unchanged.

There exist extensive literatures that have independently studied the rise in female labor market participation and the rise of services, respectively, but work on the interplay between the two phenomena is relatively scant. Early work by Reid (1934), Fuchs (1968) and Lebergott (1993) have suggested links between them, without proposing a unified theoretical framework. One notable exception is work by Lee and Wolpin (2009), who show that the rise in services is empirically important in understanding changes women's wages and employment. The rise in services in their model is driven by an exogenous shock to the value of home time, while marketization of home production endogenously affects the value of home time in our framework.

Our work is also related to Galor and Weil (1996) and Rendall (2010), who illustrate the consequences of brain-biased technological progress for female employment in a one-sector model in which females have a comparative advantage in the provision of brain inputs.[4] In a

[4] Jones, Manuelli and McGrattan (2003) and Heathcote et al. (2010) also consider within-sector demand forces and illustrate the rise in the gender hours ratio stemming, respectively, from a fall in gender discrimination and gender-biased technological progress.

similar vein, we assume that women have a comparative advantage in producing services in a model with two market sectors and home production, in which the rise in female market hours and the share of services are simultaneous outcomes of uneven productivity growth. Marketization of home services, contributing to both the rise of female market work and the services share, also features in Akbulut (2011), Buera et al. (2013) and Rendall (2014). Our main contribution to this strand of literature is to endogenously explain the narrowing of gender gaps in wages. Finally, the interplay between the service share and female outcomes has been recently studied in an international perspective by a few papers that relate lower female employment in Europe to an undersized service sector relative to the U.S. (Rendall, 2014; Olivetti and Petrongolo, 2014; Olivetti, 2014).

The recent literature on structural transformation often classifies the mechanisms that drive the rise in services into income effects and relative price effects.[5] With the first mechanism, income growth shifts the allocation of resources towards services as long as the demand for services is more elastic to income than the demand for goods. With the second mechanism, changes in relative prices alter the resource allocation when the elasticity of substitution between goods and services is not unity. Both channels are at work in our model, as well as in Ngai and Pissarides (2008) and Rogerson (2008). Slower productivity growth in services raises their relative price, in turn raising the expenditure share on services, as services and goods are poor substitutes in consumption. Higher income elasticity of services follows from the assumption that market services are closer substitutes to home services than goods. Under this assumption, the rise in income driven by faster productivity growth in market sectors raises the opportunity cost of home production, in turn stimulating the demand for market services, as these are the closest available substitute to home production.

The paper is organized as follows. The next section documents relevant trends in gender work and the size of services during 1968-2009, combining data from the Current Population Survey and several time use surveys. Section 3 develops a model for a three-sector economy and shows predictions of uneven labor productivity growth for relative wages, market hours and home production hours. Section 4 presents quantitative results, and Section 5 concludes.

2 Data and stylized facts

We show evidence on the evolution of labor market trends by gender and the service share using micro data from the March Current Population Surveys (CPS) for survey years 1968 to 2009. We also obtain information on hours of home production by combining time use surveys for 1965 onwards. The key facts emphasized in this section concern the evolution of

[5]See Herrendorf, Rogerson and Valentinyi (2013b) for a recent survey, and references therein, including Acemoglu and Guerrieri (2008), Baumol (1967), Boppart (2011), Buera and Kobaski (2012), Caselli and Coleman (2001), Kongsamut et al (2001), Ngai and Pissarides (2007) and Rogerson (2008).

market work, wages, and home production.

2.1 Market work

Our CPS sample includes individuals aged 18-65, who are not in full-time education, retired, or in the military. Annual hours worked in the market are constructed as the product of weeks worked in the year prior to the survey year and hours worked in the week prior to the survey week. This hours measure is the only one continuously available since 1968 and comparable across annual surveys. For employed individuals who did not work during the reference week, weekly hours are imputed using the average of current hours for individuals of the same sex in the same year. Until 1975, weeks worked in the previous year are only reported in intervals (0, 1-13, 14-26, 26-39, 40-47, 48-49, 50-52), and to recode weeks worked during 1968-1975 we use within-interval means obtained from later surveys. These adjustment methods have been previously applied to the March CPS by Katz and Murphy (1992) and Heathcote et al. (2010). Our wage concept is represented by hourly earnings, obtained as wage and salary income in the previous year, divided by annual hours. Survey weights are used in all calculations.

Figure 1 shows a evidence on market work. Panel A plots annual hours by gender, obtained as averages across the whole population, including the nonemployed. Female work rises steadily from about 720 annual hours in 1968 to nearly 1200 hours in the 2000s, while male hours gradually decline throughout the sample period, from about 1950 to 1600. These diverging trends imply a doubling of the hours ratio[6], from 0.37 to 0.74, and a fairly stable number of aggregate hours in the economy.

We classify working hours into two broad sectors, which we define as goods and services. The goods sector includes the primary industries, manufacturing, construction and utilities. The service sector includes the rest of the economy. Panel B in Figure 1 plots the proportion of hours in services overall and by gender, and shows an increase of nearly 20 percentage points in the share of market hours worked by both males and females in services. For women, the service share was always substantially higher than for men, and rose from 74% to 91%, while for men it rose from 50% to 68%. Panel C further shows that all of the (net) increase in female hours took place in the service sector, while Panel D shows that all of the (net) fall in male hours took place in the goods sector. In summary, while women were moving - in net terms - from nonemployment into the service sector, men were moving from the goods sector to nonemployment. These trends are also confirmed within broad skill groups, as shown in Figure A1 in Appendix A.

Table 1 provides detailed evidence on hours shares and female intensities for goods and services, and for seventeen finer industries. The 20 percentage points' expansion in the service

[6]Throughout the paper, hours and wage ratios indicate female values divided by male values.

share is bound to raise female employment as the female intensity in services is on average more than double the female intensity in the goods sector. A similar point can be made across more disaggregated industries. The decline in the broad goods sector is disproportionately driven by the fall in manufacturing industries and, to a lesser extent, primary industries. Within the broad service sector, several industries contribute to its expansion (retail, FIRE, business services, personal services, entertainment, health, education, professional services and public administration). The female intensity is generally higher in the expanding service industries than in the declining goods industries. A further stylized fact to note is that the female intensity has risen in every industry.[7] The evidence summarized in Table 1 thus highlights both between- and within-industry components in the rise of female hours.

We quantify between- and within-industry components of trends in female hours by decomposing the growth in the female hours share between 1968 and 2009 into a term reflecting the change in the share of services, and a term reflecting changes in gender intensities within either sector. Using a standard shift-share decomposition, the change in the female hours share between year 0 and year t can be expressed as

$$\Delta l_{ft} = \sum_j \alpha_{fj} \Delta l_{jt} + \sum_j \alpha_j \Delta l_{fjt}, \tag{1}$$

where l_{ft} denotes the share of female hours in the economy in year t, l_{jt} denotes the overall share of hours in sector j, l_{fjt} denotes the share of female hours in sector j, and $\alpha_{fj} = (l_{fjt} + l_{fj0})/2$ and $\alpha_j = (l_{jt} + l_{j0})/2$ are decomposition weights. The first term in equation (1) represents the change in the female hours share that is attributable to structural transformation, while the second term reflects changes in the female intensity within sectors. The results of this decomposition are reported in Table 2. The first row reports the total change in the female hours share, which rises from 29.9% in 1968 to 45.3% in 2009. The second row shows that just above one third of this change was explained by the growth in the share of services, as measured by the first term in equation (1). The third row performs the same decomposition on 17, as opposed to two, industries, and delivers an identical estimate of the role of the between-sector component. This means that, by focusing on our binary decomposition, we do not miss important inter-industry dynamics in the rise in female hours.

We have motivated our focus on the sectoral dimension of gender developments based on gender comparative advantages, via the more intensive use of non-physical tasks in the production of services rather than goods. However, tasks are more directly associated to occupations than sectors, and some sectors tend to use female labor more intensively because they use more intensively occupations in which women have a comparative advantage. One would thus expect to detect an important between-occupation component in the rise in female hours. This is shown in the fourth row of Table 2, based on a 4-fold occupational

[7] The fall in the female intensity in the post and telecoms industry is an exception, entirely driven by the near disappearance of telephone operators, who were 98% female at the start of our sample period.

decomposition.[8] The between-occupation component explains about 26% of the total. This is somewhat smaller than the between-sector component, but still sizeable.

Between-sector and between-occupation dimensions are clearly not orthogonal. As the distribution of occupations varies systematically across industries, a portion of the between-occupation component may be explained by the expansion of industries in which female-friendly occupations are over-represented. Between-occupation changes that are not captured by changes in the industry structure would by definition be included in the within-industry component of (1). We therefore decompose the within-industry component of (1) into within- and between-occupation components. The full decomposition is

$$\Delta l_{ft} = \sum_j \alpha_{fj} \Delta l_{jt} + \sum_j \alpha_j \left(\sum_k \alpha_{fjk} \Delta l_{jkt} + \sum_k \alpha_{jk} \Delta l_{fjkt} \right), \tag{2}$$

where k indexes occupations, l_{jkt} is the share of occupation k in industry j, l_{fjkt} is the share of female hours in occupation k and industry j, and $\alpha_{fjk} = (l_{fjkt} + l_{fjk0})/2$ and $\alpha_{jk} = (l_{jkt} + l_{jk0})/2$. The first term in (1) represents the between-industry component, the second term represents the between-occupation component that takes place within industries, and the last term represents the component that takes place within industry$\times$occupation cells. The results of this further decomposition are reported in the fifth row of Table 2, and show that only a small share (about 6%) of the growth in the female hours share took place via the expansion of female-friendly occupations within sectors. The bulk of the growth in female-friendly occupations took instead place via the expansion of the service share. We thus focus the rest of the paper on a binary goods/services distinction, as the decomposition results reported in Table 2 suggest that this is a sufficient dimension for understanding relative female outcomes.

2.2 Wages

We turn next to evidence on wages in Figure 2. Panel A shows the evolution of the wage ratio in the aggregate economy, obtained as the exponential of the gender gap in mean log wages, unadjusted for characteristics. Women's hourly wages remained relatively stable at or below 65% of male wages until about 1980, and then started rising up to about 80% at the end of the sample period. The combined increase in female hours and wages raised the female wage bill from 30% to two thirds of the male wage bill. When using hourly wages adjusted for human capital (age and age squared, race and four education levels), the rise in the gender wage ratio is slightly attenuated, from 64% in 1968 to 77% in 2009 (Panel B). While a measure of actual, rather than potential, labor market experience is not available in

[8] This is the broad task-based grouping of occupations suggested by Acemoglu and Autor (2011). Categories are: professional, managerial and technical occupations; clerical and sales occupations; production and operative occupations; service occupations.

the CPS, estimates by Blau and Kahn (2013) on the PSID show that gender differences in actual experience explain about a third of the rise in the wage ratio between 1980 and 1999. Thus there is clear evidence of closing - but still sizeable - gender gaps even after controlling for actual labor market experience. Note finally that the trend in the wage ratio is very similar across market sectors.

2.3 Home production

We finally provide evidence on the distribution of total work between market and home production for each gender. Information on this is gathered from time use data, by linking major time use surveys for the U.S: 1965-1966 America's Use of Time; 1975-1976 Time Use in Economics and Social Accounts; 1985 Americans' Use of Time; 1992-1994 National Human Activity Pattern Survey; and 2003-2009 American Time Use Surveys. These surveys are described in detail in Aguiar and Hurst (2007). As a measure of labor supply to the market we use "core" market work (in the definition of Aguiar and Hurst, 2007), including time worked on main jobs, second jobs and overtime, but excluding time spent commuting to/from work and time spent on ancillary activities, including meal times and breaks. This is the labor supply measure that is most closely comparable to market hours measured in the CPS. However, no information on annual weeks worked is available from the time use surveys, and all work indicators presented are weekly. To obtain a measure of home production we sum hours spent on core household chores (cleaning, preparing meals, shopping, repairing etc.) and hours of child care.

Figure 3 shows trends in market and home hours for men and women since 1965. The series for market work of men and women clearly converge during the sample period: weekly hours worked in the market rise from 19 to 23 for women, and fall from 42 to 33 for men. The trends are very similar to those detected using the CPS in Figure 1A. The series for home production also move closer to each other, as household hours fall from 38 to 28 for women, and rise from 11 to 16 for men. Interestingly, there are no major gender differences in total hours of work (consistent with the iso-work finding of Burda, Hamermesh and Weil, 2013), but of course the market/home divide of total work differs sharply across genders. For women the share of market work in total work rises from one third in 1965 to 45% in 2009, while for men this falls from 80% to two thirds. These trends are also confirmed within two broad skill groups, as shown in Figure A2 in the Appendix, implying that marketization of home production takes place across the skill distribution.

2.4 Summary

The evidence presented above has highlighted a number of stylized facts. First, over the past few decades, market hours have substantially increased for women, but they have declined for men, implying a near dobling of the hours ratio. Second, the share of market hours in services has grown, and about one third of the rise in relative female hours took place via the expansion of services. Third, female relative wages have increased. Fourth, home production hours have risen for men and fallen from women. The model of the next section rationalizes this set of facts by introducing structural transformation and marketization of home production. Structural transformation leads to a rise in the wage ratio and a fall in market hours for both genders. Marketization leads to a rise in market hours for both gender. Due to gender comparative advantages, structural transformation has a stronger impact on male market hours, while marketization has a stronger impact on female home hours. Thus the combination of the two forces has a potential to explain the rise in the gender ratio of market hours, and the fall in the gender ratio of home hours. By contruction, the model can only explain the between-industry component of gender changes, which we have quantified to one third, while it cannot address the within-sector rise in the female intensity. Our approach thus complements previous work on within-sector forces explaining the remaining two thirds of the increase in women's hours, which has focused on a variety of supply-side explanations (see reference list in footnote 1), gender-biased technical change (Heathcote et al., 2010), or antidiscrimination interventions (Goldin, 2006).

3 The Model

Motivated by the facts presented above, this Section presents a model for a multi-sector economy to describe the joint dynamics of male and female market and home hours, as well as the gender wage ratio. It should be emphasized that the proposed framework solely relies on between-sector forces to deliver gender-specific trends. Also, our model does not include leisure decisions, as time use data reveal that total working time was remarkably similar across genders throughout our sample period.[9] Finally, as the evolution of gender time allocation across sectors is qualitatively similar across skills, the model focuses on the time-allocation decisions of representative male and female agents.

The multi-sector economy is modeled in three steps. First, we describe a two-sector market economy, producing goods and services, and show that structural transformation raises the gender wage ratio as long as women have a comparative advantage in services. Second, we introduce a home sector producing services that are close substitutes to market services, and show that marketization of home production and structural transformation jointly imply a rise in the wage ratio and in the share of market hours of women, relative to men. To keep these steps simple, we derive results from the planner's optimal resource

[9] The ratio between female and male total hours is 1.08 in 1965 and it very slightly declines to 1.03 in 2009. On the other hand, the market share of total working time evolves very differently across genders, rising from 0.34 to 0.45 for women and falling from 0.79 to 0.67 for men. The allocation of total work between the market and the home seems therefore the key margin to understand gender trends in market hours.

allocation across sectors. Finally, the decentralized equilibrium is characterized in order to highlight further predictions and quantitatively assess the role of structural transformation and marketization in labor market trends.

3.1 Structural transformation and the wage ratio

Consider an economy with two sectors, producing goods and services respectively, according to the following technology:

$$c_j = A_j L_j, \quad L_j = \left[\xi_j L_{fj}^{\frac{\eta-1}{\eta}} + \left(1-\xi_j\right) L_{mj}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \qquad j = 1, 2, \tag{3}$$

where $j = 1$ denotes goods, and $j = 2$ denotes services, A_j denotes labor productivity, growing at $\dot{A}_j/A_j \equiv \gamma_j$, and L_j denotes labor inputs. The labor input used in each sector is a CES aggregator of male (L_{mj}) and female hours (L_{fj}), where η is the elasticity of substitution between them, and $\xi_1 < \xi_2$ is imposed to capture women's comparative advantage in producing services.

For each gender, the following resource constraint holds:

$$L_{g1} + L_{g2} = L_g \quad g = f, m. \tag{4}$$

Labor is fully mobile across sectors, equalizing marginal rates of technical substitution:

$$\frac{\xi_j}{1-\xi_j}\left(\frac{L_{mj}}{L_{fj}}\right)^{1/\eta} = x; \qquad j = 1, 2, \tag{5}$$

where $x \equiv w_f/w_m$ denotes the gender wage ratio. Combining conditions (4) and (5) for $j = 1, 2$ gives the allocation of female hours:

$$\frac{L_{f1}}{L_f} = T\left(x\right) \equiv \frac{x^{-\eta}\frac{L_m}{L_f} - a_2{}^{\eta}}{a_1^{\eta} - a_2^{\eta}}, \tag{6}$$

where $a_j \equiv (1-\xi_j)/\xi_j$, $j = 1, 2$. Given women's comparative advantage in services (implying $a_1 > a_2$), the equilibrium condition (6) is downward sloping, i.e. $T'(x) < 0$. The intuition is that a higher wage ratio induces substitution away from female labor in all sectors, but substitution is weaker in the sector in which women have a comparative advantage, as implied by (5). Thus a higher wage ratio is associated with a lower share of female hours in the goods sector. As L_{m1}/L_{m_2} is proportional to L_{f1}/L_{f2} due to (5), lower L_{f_1}/L_f implies lower L_{m_1}/L_m and an overall lower share of hours in the goods sector. Finally, note that the equilibrium wage ratio lies within the range (x_1, x_2), where $x_j \equiv \frac{1}{a_j}\left(L_m/L_f\right)^{1/\eta}$ is the equilibrium wage ratio for a one-sector economy with sector j only.

The result $T'(x) < 0$ implies the following Proposition:

Proposition 1 *When women have a comparative advantage in producing services, shocks that raise the service share lead to a higher wage ratio.*

Proposition 1 is solely based on the assumption of gender comparative advantages, and in particular it holds independently of product demand, and the specific process driving structural transformation.

The result in Proposition 1 highlights the importance of considering a two-sector economy. Specifically, gender comparative advantages turn a seemingly gender-neutral shock such as the rise in services into a *de facto* gender-biased shock. To see this more explicitly, consider a one-sector model with a CES production function as in (3), characterized by a technology parameter ξ. The equilibrium wage ratio in this economy is given by

$$x = \frac{\xi}{1-\xi}\left(\frac{L_m}{L_f}\right)^{1/\eta}, \tag{7}$$

and it can only rise following an increase in the relative demand for female labor (ξ) or a fall in its relative supply (L_f/L_m). The rise in aggregate ξ is typically interpreted as a gender-biased demand shift.[10] Note that the equilibrium wage ratio in the one-sector model falls within the (x_1, x_2) range defined above if ξ falls within the (ξ_1, ξ_2) range. Specifically, if the two models imply the same hours allocation, (6) and (7) imply equal equilibrium wage ratios if the following condition is satisfied:

$$\frac{\xi}{1-\xi} = \left[\frac{L_{f1}}{L_f}\left(\frac{1-\xi_1}{\xi_1}\right)^{\eta} + \frac{L_{f2}}{L_f}\left(\frac{1-\xi_2}{\xi_2}\right)^{\eta}\right]^{-1/\eta}. \tag{8}$$

In other words, the ξ parameter in the one-sector can be interpreted as a function of ξ_1 and ξ_2 in the two-sector model, with weights given by the sectoral hours share. The advantage of explicitly deriving equilibrium in a two-sector model is that the implied aggregate ξ evolves endogenously with the industry structure. That is, structural transformation acts as a form of gender-biased demand shift that raises the aggregate ξ, resulting in a higher wage ratio.

3.2 Structural Transformation and Marketization

We next introduce a home sector to account for changes in the allocation of total work between the market and the home. As the home sector affects equilibrium by producing services that are close substitutes to market services, we now fully characterize utility over each sector's output.

Individuals consume goods and a combination of market and home services. The assumed utility function is a nested-CES specification:

$$U(c_1, c_s, c_h) \equiv \left[\omega c_1^{\frac{\varepsilon-1}{\varepsilon}} + (1-\omega)\, c_2^{\frac{\varepsilon-1}{\varepsilon}}\right]^{\frac{\varepsilon}{\varepsilon-1}}; \quad c_2 = \left[\psi c_s^{\frac{\sigma-1}{\sigma}} + (1-\psi)\, c_h^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}, \tag{9}$$

[10] Heathcote et al. (2010) show in a one-sector model that this kind of gender-biased demand shift can explain the bulk of the rise in relative female hours.

where c_1 denotes goods, c_s denotes market services, c_h denotes home services, and c_2 denotes all services combined. Goods and services are poor substitutes ($\varepsilon < 1$), while market and home services are good substitutes ($\sigma > 1$) in the combined service bundle.

Market and home services are produced with identical technologies, except for the level of labor productivity:

$$c_j = A_j \left[\xi_2 L_{fj}^{\frac{\eta-1}{\eta}} + (1-\xi_2) L_{mj}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}} \qquad j = s, h, \tag{10}$$

where productivity growth in the market is assumed to be at least as fast as in the home: $\gamma_s \geqslant \gamma_h$. In addition to (4), there is a labor allocation constraint within services:

$$L_{gs} + L_{gh} = L_{g2} \qquad g = f, m. \tag{11}$$

Note that L_g still denotes total working hours for each gender and is exogenous, while labor supply to the market is now given by $(L_{g1} + L_{gs})$ and is endogenous.

The equilibrium allocation is characterized in two steps. We first solve for the optimal allocation of service hours between the market and the home, and next solve for the optimal allocation of total hours between the goods and service sectors.

3.2.1 Labor allocation across market and home services

The optimal allocation of labor between market and home services can be obtained by maximizing c_2 in (9) with respect to $(L_{fs}, L_{ms}, L_{fh}, L_{mh})$, subject to the resource constraints in (11). Free labor mobility between the market and the home implies equalization of marginal rates of technical substitution. As the respective production functions are identical, this implies:

$$\frac{L_{fs}}{L_{ms}} = \frac{L_{fh}}{L_{mh}} = \frac{L_{f2}}{L_{m2}}, \tag{12}$$

where resource constraints (11) are used to derive the second equality.

Free mobility also implies equalization of the marginal revenue product of labor, thus:

$$\frac{L_{fs}}{L_{fh}} = R_{mh} \equiv \left(\frac{\psi}{1-\psi} \right)^{\sigma} \left(\frac{A_s}{A_h} \right)^{\sigma-1}. \tag{13}$$

Condition (13) describes the process of marketization: as market and home services are good substitutes ($\sigma > 1$), faster productivity growth in market services shifts female hours from the home to the market. A corresponding condition can be derived for male hours.

Finally, we derive a hypothetical production function for the composite service output c_2, which is equivalent to (3) for the two-sector model, with the qualification that the productivity index A_2 depends on A_s and A_h according to (full derivation in Appendix 6.1.2):

$$A_2 = \psi^{\frac{\sigma}{\sigma-1}} A_s \left(\frac{R_{mh}}{1+R_{mh}} \right)^{-\frac{1}{\sigma-1}}. \tag{14}$$

Its growth is a weighted average of productivity growth in market and home services, with weights given by the share of labor in each sector:

$$\gamma_2 = \frac{R_{mh}}{1+R_{mh}}\gamma_s + \frac{1}{1+R_{mh}}\gamma_h.$$

Thus productivity growth in the composite service output is endogenously determined by the process of marketization. Following the aggregation of market and home services into c_2, the equilibrium wage ratio and hours allocation still satisfies (6), with A_2 defined by (14). The model is closed by equalizing the marginal revenue product of labor across sectors.

3.2.2 Labor allocation across goods and services

To describe the optimal labor allocation between the goods and service sectors, we equalize the marginal revenue product of labor using the production function (3) and the utility function (9). This allows us to express the female hours allocation L_{f1}/L_{f2} as a function of the wage ratio x :

$$\frac{L_{f_1}}{L_{f2}} \equiv R(x) = \left(\frac{\omega}{1-\omega}\right)^{\varepsilon}\left(\frac{A_2}{A_1}\right)^{1-\varepsilon}\left(\frac{\xi_1}{\xi_2}\right)^{\varepsilon}\left(\frac{z_2(x)}{z_1(x)}\right)^{1-\varepsilon/\eta}, \tag{15}$$

where

$$z_j(x) \equiv \frac{L_j}{L_{fj}} = \xi_j^{\frac{\eta}{\eta-1}}\left(1+a_j^{\eta}x^{\eta-1}\right)^{\frac{\eta}{\eta-1}}, \qquad j=1,2. \tag{16}$$

We then impose the resource constraint for female hours (4) into (15) to obtain

$$\frac{L_{f1}}{L_f} = D(x) \equiv \frac{R(x)}{1+R(x)}. \tag{17}$$

Conditions (6) and (17) state the optimal input and output allocations, respectively, and can be solved for equilibrium L_{f1}/L_f and x. Given $a_1 > a_2$, we show in the Appendix 6.1.1 that the slope of (15) has the sign of $\eta - \varepsilon$. Intuitively, the slope of (17) depends on input substitutability (η) relative to output substitutability (ε): input substitutability diverts female labor from goods to services following a rise in the wage ratio, while output substitutability diverts consumption from services to goods, as services use female labor more intensively. Output substitutability thus reduces the demand for female labor in services. Input substitutability dominates, and a rise in the wage ratio is associated with a fall in L_{f1}/L_f, whenever $\eta > \varepsilon$. This is the most realistic case, as typically $\eta > 1$. Thus $D(x)$ is downward-sloping but it is flatter than $T(x)$ due to the presence of offsetting input and output substitutability. As $D'(x) > T'(x)$, equilibrium is unique, as represented by the intersection of (6) and (17) in the $(x, L_{f1}/L_f)$ space in Figure 4.

We next consider shocks to the allocation condition (17). Given (15), $D(x)$ shifts downwards whenever $\gamma_1 > \gamma_2$, i.e. if and only if productivity grows faster in the goods than the (composite) service sector. The shift in $D(x)$ traces equilibrium downward along the $T(x)$ curve (6), resulting in higher x and lower L_{f1}/L_f. Thus the following Proposition can be established:

Proposition 2 *Market services and the wage ratio rise together if and only if* $\gamma_1 > \gamma_2$.

This result has two components. The first component, related to the shift in $D(x)$, is common to the structural transformation literature: faster labor productivity growth in the goods sector shifts resources from the goods to service sectors, due to poor output substitutability. The second component is novel: since women have a comparative advantage in the services sector, uneven labor productivity growth across sectors acts as an increase in relative demand for female labor, which in turn raises the equilibrium wage ratio.

As stated in Proposition 2, uneven labor productivity growth ($\gamma_1 > \gamma_2$) is a necessary condition to simultaneously predict a rise in market services and the wage ratio. Clearly, if productivity growth is balanced across all sectors, $\gamma_1 = \gamma_s = \gamma_h$, the service share and the wage ratio are both unaffected. However, the Proposition still holds in two special cases, $\gamma_1 > \gamma_s = \gamma_h$ and $\gamma_1 = \gamma_s > \gamma_h$. In the first case, faster productivity growth in the goods than service sector, combined with poor output substitutability, shifts labor from goods to services, leading to a higher service share and wage ratio. In the second case, faster productivity growth in market services than home services, combined with good output substitutability, pulls (mostly female) labor out of the household, with a corresponding increase in the market service share and the wage ratio. This mechanism acts like a labor demand shock that raises the wage ratio and female market hours, and reduces female home hours. Clearly, whenever $\gamma_1 > \gamma_s > \gamma_h$, both mechanisms are at work. For the ease of the discussion (though not necessary), we proceed by assuming $\gamma_1 > \gamma_s > \gamma_h$ and define:

$$MF \equiv (\gamma_s - \gamma_h)(\sigma - 1) > 0, \qquad SF \equiv (1 - \varepsilon)(\gamma_1 - \gamma_s) > 0, \tag{18}$$

where MF denotes the driving force of marketization as discussed in (13), and SF denotes the driving force of structural transformation as discussed in (15). Both are combinations of exogenous parameters, and their effects on wages and hours work via the shifts in R_{mh} and $R(x)$. More precisely, let $\triangle R_{mh}/R_{mh}$ and $\triangle R(x)/R(x)$ denote shifts in R_{mh} and $R(x)$, respectively, due to uneven productivity growth. Using (13) one obtains:

$$\frac{\triangle R_{mh}}{R_{mh}} = MF, \tag{19}$$

and using (15) and (14) one obtains:

$$\frac{-\triangle R(x)}{R(x)} = (1 - \varepsilon)(\gamma_1 - \gamma_2) = SF + \frac{1 - \varepsilon}{\sigma - 1}\,\frac{MF}{1 + R_{mh}}. \tag{20}$$

The shift in $\triangle R(x)$ rises with both structural transformation and marketization, and the latter effect is amplified by lower ε, σ, and R_{mh}. Note in particular that ongoing marketization ($MF > 0$) has a progressively weaker impact on $R(x)$ due to the automatic rise in R_{mh} at the denominator.

By combining the above results (13) and (15), we finally obtain the equilibrium service share:

$$s = \left[1 + \left(\frac{A_s}{A_1}\right)^{1-\varepsilon} \left(\frac{1+R_{mh}}{R_{mh}}\right)^{\frac{\sigma-\varepsilon}{\sigma-1}} G(x)\right]^{-1}, \tag{21}$$

where

$$G(x) = \left(\frac{\omega}{1-\omega}\right)^{\varepsilon} \left(\frac{\xi_1}{\xi_2}\right)^{\frac{\eta(1-\varepsilon)}{\eta-1}} \left(\frac{1+a_2^\eta x^{\eta-1}}{1+a_1^\eta x^{\eta-1}}\right)^{\frac{\eta-\varepsilon}{\eta-1}} \frac{1+a_1^\eta x^\eta}{1+a_2^\eta x^\eta}. \tag{22}$$

Conditional on x, the service share (21) rises with both structural transformation and marketization. There are two further, opposing effects via equilibrium x, represented by the last two terms in equation (22), which turn out to be minimal compared to the direct effects from SF and MF.[11]

3.2.3 Gender outcomes

We next turn to the model's prediction for market hours worked by each gender. Let $\mu_g \equiv 1 - L_{gh}/L_g$ denote the share of market hours in total working hours for each gender. Using (15) and (13), for women this ratio is given by

$$\mu_f \equiv 1 - \frac{L_{fh}}{L_f} = 1 - \frac{1}{1+R(x)} \frac{1}{1+R_{mh}}. \tag{23}$$

Combining the hours ratios in (5) and (12) yields

$$\frac{1-\mu_m}{1-\mu_f} = \frac{L_f}{L_m}(a_2 x)^\eta = \frac{R(x)+1}{\left(\frac{a_1}{a_2}\right)^\eta R(x)+1}, \tag{24}$$

where the second equality follows from the equilibrium conditions (6) and (17). The first equality describes the substitution effect between male and female hours in home production, whereby a higher wage ratio discourages relative female hours in home production. The second equality links this effect to the role of structural transformation and marketization. Specifically, if women have a comparative advantage in producing services ($a_1 > a_2$), the rise in female market hours, as reflected in (24), results from structural transformation and marketization according to (20).

[11] Given $a_1 > a_2$, the rising wage ratio raises the relative cost of female hours, which has a negative impact on service share. This works through the term $\frac{1+a_1^\eta x^\eta}{1+a_2^\eta x^\eta}$ in (22). On the other hand, rising x induces more women to move from the goods to the service sector, raising s through the term $\left(\frac{1+a_2^\eta x^{\eta-1}}{1+a_1^\eta x^{\eta-1}}\right)^{\frac{\eta-\varepsilon}{\eta-1}}$ in (22).

The share of market hours for men can be derived using (23) and (24):

$$\mu_m = 1 - \frac{1}{\left(\frac{a_1}{a_2}\right)^{\eta} R(x) + 1} \frac{1}{1 + R_{mh}}. \tag{25}$$

It follows from (23) and (25) that falling $R(x)$ shifts hours of work from the market to the household for both genders, whereas rising R_{mh} shifts hours of work from the household to the market. The effects of structural transformation and marketization are summarized as follows:

Proposition 3 *For both genders, the share of market hours μ_g falls with structural transformation but rises with marketization.*

While structural transformation and marketization are defined as gender-neutral by (18), due to women's comparative advantage in services they have gender-biased effects, as implied by (23) and (25). In particular, the rise in R_{mh} has a stronger effect on μ_f than μ_m, while the fall in $R(x)$ has a stronger effect on μ_m than μ_f. Thus both structural transformation and marketization imply a rise in the gender ratio of the share of market hours.

Proposition 4 *Given women's comparative advantage in services, both structural transformation and marketization lead to a rise in women's market hours share relative to men, μ_f/μ_m.*

As evidence shows that the change in total working time is similar across genders, Proposition 4 also implies a rise in women's market hours relative to men.

3.3 A decentralized economy

The planner solution illustrates the effect of uneven productivity growth on the service share, the wage ratio and the gender ratio in market hours. We next derive the decentralized equilibrium of this economy to gain further insight on how the underlying driving forces work via households' choices. In particular, the decentralized equilibrium shows that uneven productivity growth generates a rise in the service share through both relative price and income effects in households' consumption decisions. The rise in wage ratio, driven by the rise in services, in turn affects the gender hours allocation through households' labor supply decisions.

In doing this, the model of the previous subsection is slightly generalized to allow women's comparative advantage in services to differ between the household and the market. Thus the services production function (10) is replaced by

$$c_j = A_j \left[\xi_j L_{fj}^{\frac{\eta-1}{\eta}} + \left(1 - \xi_j\right) L_{mj}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \quad j = s, h. \tag{26}$$

This generalization allows more flexibility in the derivation of quantitative results.

3.3.1 Firms and Households

Both market sectors are perfectly competitive. Taking wages (w_f, w_m) and prices (p_1, p_s) as given, firms in sector $j = 1, s$ choose (L_{mj}, L_{fj}) to maximize profits, subject to technologies in (3). Profit maximization implies:

$$w_f = p_j A_j \xi_j \left(\frac{L_j}{L_{fj}}\right)^{1/\eta}; \quad w_m = p_j A_j \left(1 - \xi_j\right) \left(\frac{L_j}{L_{mj}}\right)^{1/\eta}; \quad j = 1, s. \tag{27}$$

Under free labor mobility, the equalization of the marginal rate of technical substitution (5) still holds. Combined with (16), this implies that relative prices are a function of the wage ratio:

$$\frac{p_k}{p_j} = \frac{A_j \xi_j}{A_k \xi_k} \left(\frac{z_j(x)}{z_k(x)}\right)^{1/\eta}; \qquad j, k = 1, s. \tag{28}$$

Each household consists of a male and a female, with a joint utility function (9). Given wages (w_f, w_m) and prices (p_1, p_s), a representative household chooses a consumption vector (c_1, c_s, c_h) and home production vector (L_{mh}, L_{fh}), and supply the remaining working time to the market. Specifically, the household maximizes the utility function (9) subject (26) and the household budget constraint:

$$p_1 c_1 + p_2 c_2 = w_m (L_m - L_{mh}) + w_f (L_f - L_{fh}). \tag{29}$$

Utility maximization implies that (5) holds for the home sector, $j = h$; and that the marginal rate of substitution across any two commodities must equal their relative price. Perfect labor mobility between the household and the market implies that (27) holds for $j = h$, thus an implicit price for home services can be defined as $p_h \equiv \frac{w_g}{A_h\left(\partial L_h / \partial L_{gh}\right)}, \quad g = f, m$, and condition (28) also holds for $j = h$.

Using the utility function (9), the relative demand for market services is

$$\frac{c_s}{c_h} = \left(\frac{p_h}{p_s}\right)^{\sigma} \left(\frac{\psi}{1-\psi}\right)^{\sigma},$$

and the corresponding relative expenditure is given by

$$E_{sh} \equiv \frac{p_s c_s}{p_h c_h} = \left(\frac{p_h}{p_s}\right)^{\sigma-1} \left(\frac{\psi}{1-\psi}\right)^{\sigma}. \tag{30}$$

As market and home services are good substitutes $(\sigma > 1)$, a fall in the price of market services shifts households' expenditure from home to market services. Thus the process of marketization can be viewed as an outcome of both household's consumption and labor supply decisions.

Using utility functions (9), the relative demand of goods to market services is

$$\frac{c_1}{c_s} = \left(\frac{\omega}{1-\omega} \frac{p_s}{p_1}\right)^{\varepsilon} \psi^{\frac{\sigma-\varepsilon}{\sigma-1}} \left[1 + \frac{1-\psi}{\psi} \left(\frac{c_h}{c_s}\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma-\varepsilon}{\sigma-1}}.$$

and the relative expenditure is:

$$E_{1s} = \left(\frac{p_1}{p_s}\right)^{1-\varepsilon} \left(\frac{\omega}{1-\omega}\right)^{\varepsilon} \psi^{\frac{\sigma-\varepsilon}{\sigma-1}} \left[1 + \left(\frac{1-\psi}{\psi}\right)^{\sigma} \left(\frac{p_s}{p_h}\right)^{\sigma-1}\right]^{\frac{\sigma-\varepsilon}{\sigma-1}}. \tag{31}$$

As relative prices are a function of the wage ratio, the relative expenditure is also a function of the wage ratio. As derived in (28) for $j = 1, s, h$, uneven labor productivity growth implies a rising relative price of market services to goods, p_s/p_1, and a rising cost of home production relative to market services, p_h/p_s. Both imply a fall in the relative expenditure E_{1s} according to (31).

Two mechanisms induce the decline in E_{1s}. The first is a relative price effect: as goods and services are poor substitutes $(\varepsilon < 1)$, a rise in the relative price of services reduces expenditure on goods relative to market services. The second is an income effect, via marketization: higher wage income raises the opportunity cost of home production p_h, which leads to substitute home production for market services, as these are closer substitute for home production than goods $(\sigma > \varepsilon)$. This income effect is driven by the nested CES utility function (9), in which the presence of home services implies non-homothetic utility in goods and market services. Marketization thus provides a channel whereby the income elasticity of demand is higher for market services than for goods.[12]

Finally, using the budget constraint (29), the supply of female home production hours can be derived as a function of the relative expenditures:

$$\frac{L_{fh}}{L_f} = \frac{I_h(x)}{I(x) \sum_{j=1,s,h} E_{jh}}, \tag{32}$$

where $I_j(x)$ denotes the female wage bill share in sector j and $I(x)$ denotes the female wage bill share in total work:

$$I_j(x) \equiv \frac{w_f L_{fj}}{p_j y_j} = \xi_j \left[z_j(x)\right]^{1/\eta - 1}; \quad I(x) \equiv \frac{w_f L_f}{w_f L_f + w_m L_m}.$$

As relative expenditures are functions of the wage ratio as in (30) and (31), the fraction of female hours supplied to the market $\mu_f \equiv 1 - L_{fh}/L_f$ is also a function of the wage ratio. Intuitively, (32) states that when the expenditure for either market commodity rises relative to home production, and/or when the female wage bill share in the market rises more than in the household, women reallocate their working time from the household to the market.

[12] The link between the income elasticity of services and home production is first noted by Kongsamut, Rebelo and Xie (2001), who use a non-homothetic utility function defined over c_1 and $(c_s + \bar{c})$, where $\bar{c}$ is an exogenous constant. They state on p.7 that $\bar{c}$ "can be viewed as representing home production of services", but they do not provide an explicit model for its determination.

3.3.2 Market Equilibrium

Given the optimal firm and household decisions, the wage ratio is derived from goods and labor market clearing conditions. Goods market clearing implies that women's time allocation can be expressed as functions of relative expenditures

$$\frac{L_{fi}}{L_{fj}} = E_{ij}\frac{\xi_i}{\xi_j}\left(\frac{z_i(x)}{z_j(x)}\right)^{1/\eta - 1} = E_{ij}\frac{I_i(x)}{I_j(x)}, \qquad i, j = 1, s, h, \tag{33}$$

which states that the sectoral allocation of hours is determined by the between-sector allocation of expenditure and the within-sector gender wage bill shares. By substituting (33) into the female time constraint (11), the demand for female home production time is given by

$$\frac{L_{fh}}{L_f} = \frac{1}{\sum_{j=1,s,h} E_{jh}\frac{I_j(x)}{I_h(x)}}, \tag{34}$$

and is a function of the wage ratio. Together with the supply condition in (32), labor market clearing implies that the equilibrium wage ratio x satisfies:

$$I(x)\sum_{j=1,s,h} E_{jh} - \sum_{j=1,s,h} I_j(x)\,E_{jh} = 0. \tag{35}$$

Thus the gender wage ratio x, and, as a result, female labor supply μ_f, depend on relative expenditures, in turn reflecting gender neutral shocks. It is important to point out that Propositions 1-4 hold in this more general model for ξ_s close to ξ_h.[13]

4 Quantitative Results

Below we quantitatively assess the importance of structural transformation and marketization in accounting for the rise in the wage ratio and changes in time allocation. The model's outcomes are related to the data in the following way. The hours allocation across market sectors is obtained from the CPS, and is represented by series plotted in Panel B of Figure 1. We aim to account for the rise in the service share for the aggregate economy, s, as well as for each gender separately (s_f and s_m). The wage ratio x is obtained from the CPS, and is adjusted for characteristics, as in Panel B of Figure 2. The hours allocation between the market and the home is obtained from time use data, and from series plotted in Figure 3 we calculate μ_f and μ_m. Changes in these variables are shown in Table 3. To smooth out short-run fluctuations that are not relevant for model predictions, and possibly single-year outliers, we focus on 5-year averages at the beginning and at the end of the sample period.

[13] The main change is the presence of additional equilibrium effect via the wage ratio x, as equation 12 does not hold for $\xi_s \neq \xi_h$.

While in most calibration exercises one would match data targets at the start of the sample period and make predictions forward by feeding in an exogenous driving force, we match data targets at the end of the sample period and make predictions backward. The reason for this choice is that our model abstracts from an important factor identified in the literature for the rise in the wage ratio, and namely the decline in labor market discrimination against women (see, among others, Goldin, 2006). It would be thus unreasonable to force our model to match gender moments for the late 1960s, as the implied parameters would be far from the true ones even if our model were a good description of the economy except for gender discrimination. It seems instead more reasonable for a model without gender discrimination to match gender-specific moments in the late 2000s. Thus we match the wage ratio and time allocation for 2005-2009, and then feed in the measured SF and MF to predict the average wage ratio and time allocation in 1968-1972.

4.1 Baseline parameters

The driving forces of structural transformation and marketization are defined as $SF \equiv (1-\varepsilon)(\gamma_1 - \gamma_s)$ and $MF \equiv (\sigma - 1)(\gamma_s - \gamma_h)$, respectively. Existing work suggests an elasticity of substitution between market goods and services on one side and home production on the other side in the range of 1.5 to 2.3 (see Rupert et al., 1995, and Chang and Schorfheide, 2003). As σ denotes the elasticity of substitution between market services and home production, it should be as least as large as the elasticity of substitution between any market good and home production. Thus we use the upper bound of existing estimates $\sigma = 2.3$ as a benchmark. Ngai and Pissarides (2008) review previous work on the elasticity of substitution between goods and services and suggest $(0, 0.3)$ as a plausible range for ε. Relatively low values for ε are also consistent with the recent findings in Herrendorf et al. (2013a) on newly-constructed consumption value-added data. Herrendorf et al. (2013a) argue that, if the sectoral production functions are value-added production functions, as in our model, the arguments of the utility function should be the value added components of final consumption - as opposed to final consumption expenditures. Using input-output tables to construct time-series for consumption value-added, they obtain an estimate for ε of 0.002, which we use as our benchmark value. This estimate is not significantly different from zero and our results are unchanged by setting $\varepsilon = 0$.

Labor productivity growth in market sectors is obtained from Bureau of Economic Analysis (BEA) data, delivering real labor productivity growth in the goods and services sectors of 2.47% and 1.24% respectively, and we approximate their difference to $\gamma_1 - \gamma_s = 1.2\%$.[14]

[14] Strictly speaking γ_j does not coincide with labor productivity growth, as A_j denotes the productivity of the composite labor input L_j defined in equation (3). But one can map labor productivity into A_j using data on gender intensities and ξ_j, which can be obtained from (5). Using this approach we obtain a productivity growth difference between goods and services of 1.12%. The drawback of this approach is to factor in changes

To obtain a measure of labor productivity growth in the home sector, we follow recent BEA calculations of U.S. household production using national accounting conventions (see Bridgman et al., 2012, and references therein). The BEA approach consists in estimating home nominal value added by imputing income to labor and capital used in home production, and deflating this using the price index for the private household sector. During our sample period, this procedure yields an estimate of average labor productivity growth in home production of 0.5% (Bridgman, 2013).[15] Thus we set $\gamma_s - \gamma_h = 0.7\%$ as our benchmark. We perform sensitivity analysis with respect to $(\sigma, \varepsilon, \gamma_s - \gamma_h)$ in Section 5.4.

Given SF and MF, the model's predictions for the dynamics of hours allocation and the wage ratio depend on the elasticity of substitution η and the comparative advantages ξ_1, ξ_s and ξ_h. To choose a value for η, we draw on existing estimates by Weinberg (2000), who obtains an estimate for η for the US of 2.4, and Acemoglu, Autor and Lyle (2004), who obtain estimates ranging between 2.5 and 4. In what follows we set the baseline value of η at 3, which roughly coincides with the average of existing estimates, and we allow for higher η in the sensitivity analysis of Section 5.4.

Finally, setting 2005-2009 as the baseline period, denoted by t^*, six parameters are chosen to match the predicted values for $\left(x_{t^*}, s_{t^*}, s_{ft^*}, s_{mt^*}, \mu_{ft^*}, \mu_{mt^*}\right)$ in the data at baseline: the gender-specific technology parameters ξ_1, ξ_s and ξ_h, the gender ratio of total hours, L_{ft^*}/L_{mt^*}, and (a transformation of) relative productivity $\hat{A}_{1st^*}$ and $\hat{A}_{sht^*}$, defined as:[16]

$$\hat{A}_{sht^*} \equiv \frac{A_{st^*}}{A_{ht^*}} \left(\frac{1-\psi}{\psi}\right)^{\frac{\sigma}{1-\sigma}}; \quad \hat{A}_{1st^*} \equiv \frac{A_{1t^*}}{A_{st^*}} \left(\frac{1-\omega}{\omega}\right)^{\frac{\varepsilon}{1-\varepsilon}} \psi^{\frac{\frac{\sigma-\varepsilon}{1-\sigma}-\varepsilon}{1-\varepsilon}}. \tag{36}$$

The value of L_{ft^*}/L_{mt^*} needs to be consistent with both the hours allocation between the home and the market (obtained from time use surveys) and the share of services in the market economy (obtained from the CPS), and thus it is pinned down by μ_{ft^*}, μ_{mt^*}, s_{t^*}, s_{ft^*}, and s_{mt^*}. The implied L_{ft^*}/L_{mt^*} for the 2005-2009 is 1.19, which is close to the number obtained by directly adding market and home hours from the CPS and time use surveys,

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in ξ_j, in turn driving changes in gender intensities within sectors, from which our baseline calibration would abstract. As this approach and labor productivity data yield very similar values for differences in productivity growth, we simply use labor productivity data.

[15] Bridgeman (2013) obtains productivity in the home sector as:

$$A_h = \frac{w_h L_h + \sum_j (r_j + \delta_j) K_{jh}}{P_h L_h},$$

where w_h denotes the wage of private household employees; L_h denotes hours worked in the household sector; K_{jh} denotes the capital inputs used (consumer durables, residential capital, government infrastructure used for home production), with assiciated returns and depreciation rates r_j and δ_j, respectively; and P_h is the price index for the sector "private households with employed persons". This includes both the wage of private sector employees and imputed rental services provided by owner-occupied housing. The average growth in A_h during our sample period is 0.51%, which we approximate to 0.5%.

[16] Note that the growth rate for $\hat{A}_{jk,t}$ is equal to $\left(\gamma_j - \gamma_k\right)$ for $j, k = 1, 2, h$. Thus data on $(\gamma_1, \gamma_s, \gamma_h)$ are sufficient to predict trends in $\hat{A}_{jk}$.

respectively (1.12). These two figures would differ whenever actual hours are also affected by important factors not present in the model, such as discrimination against women or barriers to mobility across sectors. Thus obtaining similar figures suggests that a simple model without discrimination or mobility barriers does a relatively good job at capturing the gender ratio in total hours for 2005-2009. Given L_{ft^*}/L_{mt^*} and x_{t^*}, condition (5) can be solved for ξ_j, $j = 1, s, h$, and conditions (28), (30) and (31) can be solved for $\hat{A}_{1st^*}$ and $\hat{A}_{sht^*}$. Appendix 6.2.1 shows detailed steps by which the six data targets $\left(x_{t^*}, s_{t^*}, s_{ft^*}, s_{mt^*}, \mu_{ft^*}, \mu_{mt^*}\right)$ can be matched by the six parameters $\left(L_{ft^*}/L_{mt^*}, \xi_1, \xi_s, \xi_h, \hat{A}_{1st^*}, \hat{A}_{sht^*}\right)$.

Given these six parameters and the measured SF and MF, the model delivers predictions for $\left(x_t, s_t, s_{ft}, s_{mt}, \mu_{ft}, \mu_{mt}\right)$ at each point in time t. Baseline parameters are summarized as follows:

Parameters	Values	Data or Targets
$\gamma_1 - \gamma_s$	1.2%	BEA data.
$\gamma_s - \gamma_h$	0.7%	BEA data for services and Bridgeman (2013) for home sector.
σ	2.3	Chang and Schorfheide (2003).
ε	0.002	Herrendorf et. al. (2013b).
η	3	Weinberg (2000), Acemoglu, Autor and Lyle (2004).
L_{ft^*}/L_{mt^*}	1.19	match s_{t^*} given $(s_{ft^*}, s_{mt^*}, \mu_{ft^*}, \mu_{mt^*})$
ξ_1	0.332	match x_{t^*} and $\frac{L_{f1t^*}}{L_{m1t^*}} = \frac{1-s_{ft^*}}{1-s_{mt^*}} \frac{\mu_{ft^*}}{\mu_{mt^*}} \frac{L_{ft^*}}{L_{mt^*}}$
ξ_s	0.443	match x_{t^*} and $\frac{L_{fst^*}}{L_{mst^*}} = \frac{s_{ft^*}}{s_{mt^*}} \frac{\mu_{ft^*}}{\mu_{mt^*}} \frac{L_{ft^*}}{L_{mt^*}}$
ξ_h	0.495	match x_{t^*} and $\frac{L_{fht^*}}{L_{mht^*}} = \frac{1-\mu_{ft^*}}{1-\mu_{mt^*}} \frac{L_{ft^*}}{L_{mt^*}}$
$\hat{A}_{sht^*}$	1.02	match $\frac{L_{fst^*}}{L_{fht^*}} = \frac{\mu_{ft^*} s_{ft^*}}{1-\mu_{ft^*}}$
$\hat{A}_{1st^*}$	10.8	match $\frac{L_{f1t^*}}{L_{fst^*}} = \frac{1-s_{ft^*}}{s_{ft^*}}$

4.2 Baseline Results

Table 4 reports our quantitative results. The top two rows in the Table show data targets, and Panels A-C report results based on alternative parameter combinations. Simulations in Panel A are based on the baseline parameter values described above. Column 1 shows that our model almost exactly replicates the rise in the overall service share from 58% to 75% of market hours. Columns 2 and 3 show predictions on the service share for each gender separately: the model explains the bulk of the rise in service hours for women (83%) but overpredicts service hours for men (141%).

The next three columns concern time allocation between the market and the home. The average woman allocates 36% of her working hours to the market in the late 1960s, and

45% in the late 2000s, while the corresponding ratio for men falls from 78% to 68%. The model explains 47% of the rise in market hours for women (column 4), 7% of the fall for men (column 5), and 36% of the rise in the gender ratio of market hours (column 6). To relate sectoral gender outcomes to the shift-share analysis of Section 2, we obtain predictions for the ratio in female share of total market hours, $\mu_f L_f/(\mu_f L_f + \mu_m L_m)$. The model predicts an increase in this ratio from 0.429 to 0.444, which is equivalent to about 19% of its actual change. The shift-share analysis of Section 2 has shown that 34% of the rise in the female hours share was driven by the rise in services. The model thus predicts about 55% (19/34) of the between-sector component of the rise in female hours.

Finally, the wage ratio rises from 0.64 to 0.77, and the model accounts for 20% of the observed wage convergence (column 7). To put this figure into perspective, it may be noted that our model's contribution is quantitatively similar to the contribution of the rise in women's human capital (as proxied by education, potential experience and ethnicity, see notes to Figure 2), as including basic human capital controls explains about 23% of wage convergence over the sample period.[17]

As both structural transformation and marketization drive our baseline results, in Panels B and C we conduct counterfactual experiments to assess each force in turn. In Panel B we shut the structural transformation channel, by setting $\gamma_1 = \gamma_s$. The only active force is marketization and, as one would expect, the model now explains a much lower portion of the rise in services, both overall and for women and men separately (38%, 28% and 54%, respectively). This also mutes the predicted rise in the wage ratio (column 7), in line with Proposition 1. Note further that a model without structural transformation improves model predictions for female market hours (column 4), as structural transformation shifts resources from the goods to the service sector, including the home. By contrast, structural transformation is key to account for the fall in market hours for men (column 5), as a model without structural transformation would actually predicts a rise, rather than a fall, in male market hours. In the absence of structural transformation, men are only subject to marketization, shifting their working hours from the home to the market.

In Panel C we shut the marketization channel, by setting $\gamma_s = \gamma_h$. As in Panel B, the model predicts a smaller rise in services (columns 1-3). Column 4 next shows that marketization is essential to attract female hours to the market, as without marketization female market hours would fall as a consequence of structural transformation, while column 5 shows that removing marketization improves the predictions for male market hours, which now fall more than in the baseline case. Finally, column 7 shows that marketization alone has a small negative effect on wage ratio. This is due to the fact that, according to our

[17] During the sample period the raw wage ratio rises by about 17 percentage points $(80.5 - 63.2)$, while the adjusted wage ratio rises by about 13 percentage points $(77.5 - 64.1$, as reported in Table 5). Thus basic human capital controls explain about 23% of wage convergence.

calibration, $\xi_h > \xi_s$, i.e. women have stronger comparative advantages in home than market services. Thus marketization shifts female hours to the branch of services in which women have a smaller comparative advantage.

The comparison of Panels B and C clearly confirms Propositions 3 and 4. Market hours for both genders fall with structural transformation and rise with marketization. But, due to gender comparative advantages, marketization has a stronger effect on female market hours, while structural transformation has a stronger effect on male market hours, and they both contribute to the rise in μ_f/μ_m. Quantitatively, MF contributes about 80% of the predicted rise in μ_f/μ_m whereas SF contributes the remaining 20%. Also note that both structural transformation and marketization are quantitatively important in accounting for the rise in services, contributing about 55% and 39% of the predicted rise, respectively (whereby the rest would be accounted for by their interaction).

4.3 Gender-specific shocks

We next compare baseline results to the outcomes of gender-specific, within-sector shocks.[18] These are (1) labor supply shocks, represented by changes in the total hours ratio, L_f/L_m, (2) gender-biased technological progress, represented by a rise in ξ_1 and ξ_s; and (3) gender-biased accumulation of human capital. The results are presented in Table 5, in which Panel A reports baseline results for reference.

4.3.1 Gender shifts in total hours

Changes in L_{ft}/L_{mt} can be driven by both changes in the gender mix in the population and changes in the gender-specific time allocation between work (market and home) and other activities (leisure, sleep and personal care). Our model is silent about either force, and we pick the growth rate in L_{ft}/L_{mt} that matches their combined effect. During the sample period, the population ratio falls from 1.143 to 1.088 in the CPS, while the hours ratio rises from 1.046 (average of 1965 and 1975) to 1.025 in time use surveys. Together, these figures imply a fall of 0.18% per year in the hours ratio.

Panel B in Table 5 shows the effects of a fall in L_{ft}/L_{mt}. The model can now account for 34.4% of the rise in the wage ratio, due to the slight fall in female hours. This effect corresponds to an upward shift in the $T(x)$ curve in Figure 4, resulting in higher x. Labor supply shocks do not affect in any discernible way other model predictions. In particular, as labor supply shocks are sector-neutral, they have little effect on the allocation of labor across the three sectors.

[18] Note that the between-sector forces considered predict a fall in the female intensity within each sector, following the rise in relative wages. However, female intensity has risen slightly in the goods sector, and markedly in the service sector (see Table 1). Gender-specific shocks may thus revert model predictions for within-sector female intensities.

4.3.2 Gender-biased technical change

Structural transformation induces a gender-biased labor demand shift by raising relative labor demand in the sector in which women have a comparative advantage. The aggregate ξ thus rises endogenously via a change in the composition of employment at constant ξ_1 and ξ_s, as explicitly shown in equation (8). The strength of this mechanism depends on the difference $\xi_s - \xi_1$. In our calibration exercise, in which ξ_1 and ξ_s are pinned down by within-sector gender intensities, $\xi_s = 0.44$ and $\xi_1 = 0.33$, in turn predicting an increase in the wage ratio equal to about one fifth of its actual rise.

We next allow for an exogenous rise in both ξ_1 and ξ_s as in Heathcote et al. (2010). Specifically, Heathcote et al. (2010) assume perfect substitutability of male and female hours in production ($\eta \rightarrow \infty$), implying $x = \xi / (1 - \xi)$. Growth in $\xi / (1 - \xi)$ is in turn set to match the observed rise in the wage ratio at 0.5% per year, and in their calibrated model this accounts for three quarters of the increase in relative female hours.

Borrowing from Heathcote et al. (2010), we let $\xi_1 / (1 - \xi_1)$ and $\xi_s / (1 - \xi_s)$ grow at 0.5% per year. The simulation results are reported in Panel C of Table 5. The model now predicts more than the whole rise in female market hours, the whole increase in the gender ratio in market hours, and 68% of the rise in the wage ratio.[19] The comparison of Panels A and B reveals that structural transformation and marketization capture an important portion of gender-biased demand shifts, and namely 30% of the predicted increase in the wage ratio (20/68) and 36% of the predicted increase in the gender ratio of market hours.

4.3.3 Human capital

While the previous exercise is agnostic as to the cause of the rise in within-sector female intensities, we next consider a measurable shock leading to a similar outcome, and namely the rise in women's relative human capital investment. This change may be easily incorporated in our model by replacing raw labor inputs by efficiency units of labor, $h_{gj} L_{gj}$, where h_{gj} denotes the efficiency units of one hour of work for gender g in sector j. The composite labor input in sector j is now given by:

$$L_j = \left[\xi_j \left(h_{fj} L_{fj} \right)^{\frac{\eta-1}{\eta}} + \left(1 - \xi_j \right) \left(h_{mj} L_{mj} \right)^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}, \quad j = 1, s, h,$$

where human capital efficiency is assumed to be constant across market sectors for each gender, $h_{g1} = h_{gs} = h_g$, but may be lower in the household. The market wage w_g now includes the return to human capital.

The introduction of human capital affects equilibrium via changes in relative prices and

[19] The reason we cannot explain the whole rise in the wage ratio is that we assume $\eta = 3$ whereas Heathcote et al. (2010) assume $\eta \longrightarrow \infty$.

wages. To see this, profit maximization implies:

$$w_f = p_j A_j h_{f_j} \xi_j \left(\frac{L_j}{h_{fj} L_{fj}}\right)^{1/\eta}; \quad w_m = p_j A_j h_{mj} \left(1 - \xi_j\right) \left(\frac{L_j}{h_{mj} L_{mj}}\right)^{1/\eta}; \quad j = 1, s,$$

where

$$\frac{L_j}{h_{fj} L_{fj}} = \xi_j^{\frac{\eta}{\eta-1}} \left(1 + b_j^{\eta} x^{\eta-1}\right)^{\frac{\eta}{\eta-1}} \qquad j = 1, s, h$$

and the relevant measure of gender comparative advantages is now

$$b_j = \frac{1-\xi_j}{\xi_j} \left(\frac{h_{mj}}{h_{fj}}\right)^{\frac{\eta-1}{\eta}} = a_j \left(\frac{h_{mj}}{h_{fj}}\right)^{\frac{\eta-1}{\eta}} \qquad j = 1, s, h. \tag{37}$$

Whether or not human capital is productive in the household has key implications. If human capital is equally useful in the market and at home, b_1, b_s and b_h are all falling at the same rate, according to (37), as women are accumulating human capital faster than men. If human capital is not productive at home ($h_{mh} = h_{fh} = 1$), b_h stays constant (with $b_h = a_h$), and b_1 and b_s are falling relative to b_h. This mechanism gives both genders an additional incentive to work in the market, and it is stronger for women than for men. The fall in b_1 and b_s has qualitatively similar impacts to rising ξ_1 and ξ_s in a model without human capital.

We proceed by simply matching the growth in h_m and h_f to the gender-specific evolution of human capital observed in the data. To this purpose, we use the coefficients on the education dummies from wage equations (see notes to Figure 2) to construct the human capital index h_{gt} for each gender in each year as

$$h_{gt} = \exp(\beta^{HS} h_{gt}^{HS} + \beta^{SC} h_{gt}^{SC} + \beta^{CC} h_{gt}^{CC}),$$

where the $h's$ are shares of the gender-specific population in each schooling category, and the $\beta's$ are the associated coefficients from the wage regression (dropouts being the excluded category). During 1968-2009, the implied human capital index grows at 0.49% per year for females and at 0.38% for males. The steps for the calibration of this extended model are described in Appendix **??**.

Panels D1 and D2 of Table 5 report quantitative results. The wage ratio x is now calibrated to the unadjusted wage ratio, which increases from 0.63 to 0.81. If human capital is useful in all sectors (panle D1), the rise in relative female human capital simply drives, unsurprisingly, a larger increase in the unadjusted wage ratio, but is roughly neutral with respect to all other outcomes. The case in which human capital is only useful in the market (Panel D2) delivers deeper insight. Two forces are at work here. First, the rise in h_f/h_m implies a fall in b_1 and b_s at 0.1% relative to b_h, with similar effects to the gender-biased shift in labor demand represented in Panel C, in which a_1 and a_s are falling exogenously at 0.5% per year. Second, the rise in women's relative human capital implies stronger marketization for women than for men, thereby reinforcing the model's prediction for μ_f and μ_f/μ_m. Comparing Panels A and D2, these two forces double the model's predictions on μ_f and μ_f/μ_m. On the other hand, the introduction of human capital worsens the model's prediction for the fall in male market hours, as marketization rises for men too - albeit less than for women.

4.4 Sensitivity Analysis

We next perform some sensitivity analysis on parameters $\varepsilon, \sigma, \gamma_s - \gamma_h$ and η. The results are reported in Table 6. In Panel B we allow for a higher elasticity of substitution between male and female labor, $\eta = 10$. All baseline predictions remained virtually unchanged, except the model now can only account for 6% of the rise in the wage ratio, as higher gender substitutability reduces the implied female comparative advantage in services, according to (5). In particular the resulting (ξ_1, ξ_s, ξ_h) values are (0.40, 0.44, 0.45), and ξ_1 and ξ_s are too close to each other for structural transformation to have a sizeable impact on the wage ratio.

In the rest of the Table we let the strength of marketization and structural transformation vary, according to alternative levels of ε, σ and $\gamma_s - \gamma_h$. Given that our utility structure is similar to that of Ngai and Pissarides (2008), in Panel B we use their benchmark value of $\varepsilon = 0.1$, which implies a reduction in the intensity of structural transformation. Model predictions improve slightly for the male service share s_m and female market hours μ_f, but slightly worsen in most other dimensions, consistent with Propositions 1-4.

We next let $\sigma = 3$ in Panel C. This implies stronger marketization, and a doubling in the predicted change in female market hours μ_f, accompanied by a rise - as opposed to a fall - in male market hours μ_m. Stronger marketization now dominates structural transformation, and as a result even men work more in the market. Despite this, the model explains 15 extra percentage points of the rise in μ_f/μ_m.

We next consider an alternative value for the productivity growth differential between market and home services $\gamma_s - \gamma_h = 0.4\%$, which is the value used by Ngai and Pissarides (2008). This delivers an improvement in the male service share and male market hours (s_m, μ_m), due to weaker marketization. But clearly the predictions for $(s, s_f, \mu_f, \mu_f/\mu_m)$ deteriorate.

5 Conclusion

The rise in female participation to the workforce is one of the main labor market changes of the post-war period, and has been reflected in a large and growing body of work on the factors underlying such change. The bulk of the existing literature has emphasized gender-specific factors such as human capital accumulation, medical advances, gender-biased technical change, cultural change, and antidiscrimination interventions, which imply a rise in the female intensity across the whole industry structure. This paper complements existing work by proposing a gender-neutral mechanism that boosts female employment and wages by expanding the sector of the economy in which women have a comparative advantage.

In our proposed model, marketization and structural transformation, in turn driven by changes in relative prices of sectoral output, jointly act as a demand shock, generating a simultaneous increase in both women's relative wages and market hours. While the source of both forces is gender neutral, their combination has female friendly outcomes. Marketization draws women's time into the market and structural transformation creates the jobs that women are better suited for in the market. These outcomes are consistent with evidence on gender convergence in wages, market work, and household work. When calibrated to the U.S. economy, our model adequately predicts the rise in services and it explains about a half of the rise in women's market hours and 20% of the rise in the wage ratio.

6 Appendix

6.1 The Model

6.1.1 Uniqueness of equilibrium

Lemma 5 *Any equilibrium wage ratio* $x^* \in [x_1, x_2]$, *where* $x_j \equiv \frac{1}{a_j}\left(\frac{L_m}{L_f}\right)^{1/\eta}$, $j = 1, 2$.

Proof. Any equilibrium x^* must imply $L_{f1}/L_f \in [0,1]$. Using the equilibrium condition (6), it requires $a_1{}^\eta \leqslant x^{-\eta} L_m/L_f \leqslant a_2{}^\eta$, and the result follows. ■

Lemma 6 *For any* $x \in [x_1, x_2]$, $T(x_1) > D(x) > T(x_2)$, *thus equilibrium* x^* *exists.*

Proof. Note $T(x_1) = 1$ and $T(x_2) = 0$, but for any $x \in [x_1, x_2], 0 < D(x) < 1$, and the result follows. ■

Lemma 7 *For any equilibrium* x^*, $D'(x^*) > T'(x^*)$.

Proof. From (6):

$$T'(x) = -\frac{\eta x^{-\eta-1}}{a_1 - a_2}\left(\frac{L_m}{L_f}\right) < 0$$

From (17):

$$D'(x) = \frac{R'(x)}{[1 + R(x)]^2}; \quad \frac{R'(x)}{R(x)} = -\frac{(\eta - \varepsilon)(a_1 - a_2)x^{\eta-2}}{(1 + a_2 x^{\eta-1})(1 + a_1 x^{\eta-1})}$$

and $D'(x) \gtreqless 0$ for $\eta \lesseqgtr \varepsilon$. Together they imply:

$$\begin{aligned} D'(x) - T'(x) &= -\frac{R(x)}{[1 + R(x)]^2}\frac{R'(x)}{R(x)} + \frac{\eta x^{-\eta-1}}{a_1 - a_2}\left(\frac{L_m}{L_f}\right) \\ = \quad & \frac{x^{-\eta-1}}{a_1 - a_2}\left(\frac{L_m}{L_f}\right)\left[\eta + \frac{xR'(x)}{R(x)[1 + R(x)]}\right] - \frac{a_2}{a_1 - a_2}\frac{R'(x)}{R(x)[1 + R(x)]}. \end{aligned} \tag{38}$$

The second term in (38) is positive, and the term in square bracket is:

$$\begin{aligned} & \eta + \frac{xR'(x)}{R(x)[1 + R(x)]} \\ = \quad & \frac{\eta}{1 + R(x)}\left(\frac{2a_2 x^{\eta-1} + 1 + a_2 x^{\eta-1} a_1 x^{\eta-1}}{(1 + a_2 x^{\eta-1})(1 + a_1 x^{\eta-1})} + R(x)\right) + \frac{\varepsilon(a_1 - a_2)x^{\eta-1}}{(1 + a_2 x^{\eta-1})(1 + a_1 x^{\eta-1})[1 + R(x)]} > 0 \end{aligned}$$

for any $x = x^*$. ■

Proposition 8 *Equilibrium* x^* *is unique.*

Proof. For any $x \in [x_1, x_2]$, $T'(.) < 0$. If $\eta \leqslant \varepsilon$, $D'(.) \geqslant 0$, and x^* is unique. If $\eta > \varepsilon$, $D'(.) < 0$. There in an odd number of equilibria, and at least one of them must imply $T'(x^*) > D'(x^*)$, which contradicts Lemma 7. ■

6.1.2 Aggregation across market and home

The production function (10) can be rewritten as

$$c_j = A_j L_{f_j} \left[\xi_2 + (1-\xi_2) \left(\frac{L_{mj}}{L_{fj}} \right)^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}} \qquad j = s, h,$$

which implies

$$\frac{c_s}{c_h} = \frac{A_s}{A_h} \frac{L_{fs}}{L_{fh}} = \left(\frac{\psi A_s}{(1-\psi) A_h} \right)^{\sigma},$$

where the second equality follows from (13). Substituting into (9) and using (13) yields

$$c_2 = c_s \left[\psi + (1-\psi) \left(\frac{\psi A_s}{(1-\psi) A_h} \right)^{1-\sigma} \right]^{\frac{\sigma}{\sigma-1}} = c_s \left(\psi \frac{1+R_{mh}}{R_{mh}} \right)^{\frac{\sigma}{\sigma-1}}. \tag{39}$$

Combining (10), (12) and (13) yields:

$$c_s = A_s \left[\xi_2 \left(\frac{R_{mh}}{1+R_{mh}} L_{f2} \right)^{\frac{\eta-1}{\eta}} + (1-\xi_2) \left(\frac{R_{mh}}{1+R_{mh}} L_{m2} \right)^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}},$$

which can be substituted into (39) to obtain A_2 :

$$A_2 = A_s \frac{R_{mh}}{1+R_{mh}} \left(\psi \frac{1+R_{mh}}{R_{mh}} \right)^{\frac{\sigma}{\sigma-1}} = A_s \psi^{\frac{\sigma}{\sigma-1}} \left(\frac{R_{mh}}{1+R_{mh}} \right)^{\frac{-1}{\sigma-1}}. \tag{40}$$

The results for γ_2 follow from taking the time derivative of (40) and using (13).

6.2 Calibration and Computation

6.2.1 Baseline Parameters

Below we give detailed steps to match $(s_f, s_m, \mu_f, \mu_m, s, x)$ in 2005-09. Data on the time allocation by gender (s_f, s_m, μ_f, μ_m) correspond to the model's variables L_{gj}/L_g for $g = m, f$:

$$\frac{L_{gj}}{L_g} = \left\{ \begin{array}{ll} \mu_g (1-s_g) & \text{for } j = 1 \\ \mu_g s_g & \text{for } j = s \\ 1-\mu_g & \text{for } j = h \end{array} \right\}. \tag{41}$$

The ratio L_f/L_m is set to match the observed service share s as follows. By definition, $s = \frac{L_{ms}+L_{fs}}{L_{m1}+L_{f1}+L_{ms}+L_{fs}}$, which can be rewritten as

$$\frac{1}{s} = 1 + \frac{\frac{L_{m1}}{L_m} \frac{L_f}{L_{fs}} \frac{L_m}{L_f} + \frac{L_{f1}}{L_{fs}}}{\frac{L_{ms}}{L_m} \frac{L_f}{L_{fs}} \frac{L_m}{L_f} + 1}.$$

Using (41) yields

$$\frac{L_f}{L_m} = \frac{\frac{1-s_m}{s_m} - \frac{1-s}{s}}{\frac{1-s}{s} - \frac{1-s_f}{s_f}} \frac{\mu_m s_m}{s_f \mu_f}. \tag{42}$$

Using the observed wage ratio x and hours ratio L_{fi}/L_{mi},[20] we obtain ξ_j from equilibrium condition (5).

Finally, the (transformed) relative productivities $\hat{A}_{1,s}$ and $\hat{A}_{s,h}$, defined in (36), are pinned down by data on time allocation $(L_{fj}, L_{mj})_{j=1,s,h}$ and the wage ratio x. We first compute the female wage bill shares and relative expenditures across sectors:

$$I_j \equiv \frac{w_f L_{fj}}{p_j c_j} = \frac{L_{fj}}{L_{fj} + \frac{w_m}{w_f} L_{mj}}; \quad E_{jk} = \frac{L_{fj}}{L_{fk}} \frac{p_j c_j}{w_f L_{fj}} \frac{w_f L_{fk}}{p_k c_k} = \frac{L_{fj}}{L_{fk}} \frac{I_k}{I_j}.$$

Using the obtained ξ_j and data on (L_{fj}, L_{mj}), we obtain

$$z_j(x) = \frac{L_j}{L_{fj}} = \left(\xi_j + (1-\xi_j) \left(\frac{L_{mj}}{L_{fj}} \right)^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}}. \tag{43}$$

Combining (43) and (28) gives:

$$\frac{A_k p_k}{A_j p_j} = \frac{\xi_j (z_j(x))^{1/\eta}}{\xi_k (z_k(x))^{1/\eta}}. \tag{44}$$

The marketization equation (30) implies

$$E_{s,h} = \left(\frac{p_s}{p_h} \right)^{1-\sigma} \left(\frac{\psi}{1-\psi} \right)^{\sigma} = \left(\frac{A_s p_s}{A_h p_h} \right)^{1-\sigma} \left(\frac{A_h}{A_s} \right)^{1-\sigma} \left(\frac{\psi}{1-\psi} \right)^{\sigma},$$

which, together with (44), solves for $\hat{A}_{s,h}$. Similarly the structural transformation equation (31) implies

$$E_{1,s} = \left(\frac{\omega}{1-\omega} \right)^{\varepsilon} \psi^{\frac{\sigma-\varepsilon}{\sigma-1}} \left(\frac{p_s}{p_1} \right)^{1-\varepsilon} M; \quad M \equiv \left[1 + \left(\frac{1-\psi}{\psi} \right)^{\sigma} \left(\frac{p_s}{p_h} \right)^{\sigma-1} \right]^{\frac{\sigma-\varepsilon}{\sigma-1}} = \left(1 + \frac{1}{E_{s,h}} \right)^{\frac{\sigma-\varepsilon}{\sigma-1}},$$

which, together with (44), solves for $\hat{A}_{1,s}$. Note that the growth rate of $\hat{A}_{jk}$ is simply $\gamma_j - \gamma_k$ for any sector $j = 1, s, h$.

[20] Note that the gender hours ratio in each of the three sectors is related to (s_f, s_m, μ_f, μ_m) and the obtained level of L_f/L_m according to:

$$\frac{L_{fj}}{L_{mj}} = \left\{ \begin{array}{ll} \frac{1-s_f}{1-s_m} \frac{\mu_f}{\mu_m} \frac{L_f}{L_m} & \text{for } j = 1 \\ \frac{s_f}{s_m} \frac{\mu_f}{\mu_m} \frac{L_f}{L_m} & \text{for } j = s \\ \frac{1-\mu_f}{1-\mu_m} \frac{L_f}{L_m} & \text{for } j = h \end{array} \right\}.$$

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Table 1
Descriptive statistics on 17 industries, 1968-2009.

	(1) 1968	(2) 2009	(3) Change	(4) 1968	(5) 2009	(6) Change
Primary sector	6.2	3.2	-3.0	10.0	17.1	7.1
Construction	5.8	6.8	1.0	4.7	10.1	5.4
Manufacturing	29.6	11.6	-18.0	23.7	28.2	4.5
Utilities	1.7	1.4	-0.3	9.6	17.3	7.7
All goods	*43.3*	*23.0*	*-20.3*	*18.7*	*20.7*	*2.0*
Transportation	4.3	3.5	-0.8	9.2	20.2	11.0
Post and Telecoms	1.3	0.9	-0.4	48.4	36.9	-11.5
Wholesale trade	3.7	3.0	-0.7	16.1	26.2	10.1
Retail trade	14.2	15.3	1.1	36.3	46.3	10.0
FIRE	4.8	7.1	2.3	41.3	55.2	13.9
Business and repair services	3.1	8.6	5.5	18.9	36.3	17.4
Personal services	4.1	2.7	-1.4	64.6	71.3	6.7
Entertainment	0.9	2.2	1.3	24.7	40.3	15.6
Health	4.8	10.7	5.9	65.8	77.5	11.7
Education	7.1	10.8	3.7	57.3	70.7	13.4
Professional services	1.1	3.3	2.2	25.7	42.0	16.3
Welfare and no-profit	1.3	2.8	1.5	38.8	65.1	26.3
Public administration	6.1	6.3	0.2	26.8	43.9	17.1
All services	*56.7*	*77.0*	*20.3*	*38.5*	*52.7*	*14.2*

Notes. Figures reported are shares of annual hours (×100). The primary sector includes agriculture, forestry, fishing, mining and extraction. Source: CPS.

Table 2
Alternative decompositions of the rise in the female hours share

1	Total change (×100)	45.3 – 29.9 = 15.4
2	Between sector, % of total change (goods/services)	34.0
3	Between sector, % of total change (17 categories)	34.0
4	Between occupation, % of total change (4 categories)	26.1
5	Between occupation, % of within-sector component (4 occupations, 2 sectors)	6.4

Notes. Row 1 corresponds to the left-hand side of equation (1) in the text. Percentages in rows 2-4 are obtained as ratios between the first term on the right-hand side of equation (1) and the left-hand side. The percentage in row 5 is obtained as the ratio between the second term on the right-hand side in equation (2) and the left-hand side.

Table 3
Data Targets

Time	x	s	s_f	s_m	μ_f	μ_m	μ_f/μ_m
1968-72	0.64	0.58	0.75	0.51	0.36	0.78	0.46
2005-09	0.77	0.75	0.88	0.65	0.46	0.68	0.67
Source	CPS				Time use surveys		

Table 4: Baseline results

			Service share (Total) s	Service share (Women) s_f	Service share (Men) s_m	Market hours (Women) μ_f	Market hours (Men) μ_m	Market hours (Women/ Men) μ_f/μ_m	Wage ratio (adjusted) x
			1	2	3	4	5	6	7
	data	2005-09	0.751	0.882	0.646	0.460	0.683	0.672	0.775
	data	1968-72	0.582	0.749	0.507	0.355	0.776	0.458	0.641
A: Baseline	model	1968-72	0.583	0.771	0.450	0.411	0.689	0.596	0.748
Structural transformation and marketization	% explained		99	83	141	46	7	36	20
B: Marketization only	model	1968-72	0.686	0.845	0.571	0.388	0.636	0.610	0.779
$\gamma_1 - \gamma_s = 0$	% explained		38	28	54	69	-52	29	-3
C: Structural transformation only	model	1968-72	0.659	0.823	0.531	0.478	0.725	0.659	0.748
$\gamma_s - \gamma_h = 0$	% explained		54	45	83	-18	45	6	20

Notes. All parameter values are baseline values, unless otherwise indicated. The % explained are obtained as $100 \times \frac{z_t - z_{t-1}}{z_t - \hat{z}_{t-1}}$, where z denotes the target variable, t denotes 2005-09, $t-1$ denotes 1968-72, and a superscript hat indicates model (backward) predictions.

Table 5: Gender-specific shocks

			Service share (Total) s	Service share (Women) s_f	Service share (Men) s_m	Market hours (Women) μ_f	Market hours (Men) μ_m	Market hours (Women/ Men) μ_f/μ_m	Wage ratio (adjusted) x	Wage ratio (raw)
			1	2	3	4	5	6	7	8
	data	2005-09	0.751	0.882	0.646	0.460	0.683	0.672	0.775	0.805
	data	1968-72	0.582	0.749	0.507	0.355	0.776	0.458	0.641	0.632
A: Baseline	model	1968-72	0.583	0.771	0.450	0.411	0.689	0.596	0.748	
	% explained		99	83	141	46	7	36	20	
B: Relative supply shifts	model	1968-72	0.583	0.766	0.444	0.413	0.693	0.596	0.729	
L_f/L_m falls at 0.18% per year	% explained		100	87	146	44	11	36	34	
C: Gender-biased demand shift	model	1968-72	0.585	0.788	0.475	0.333	0.731	0.455	0.684	
$\xi_i/(1-\xi_i)$ grows at 0.5% per year, $i = 1, s$.	% explained		98	71	123	122	51	101	68	
D1: Human capital accumulation	model	1968-72	0.587	0.774	0.454	0.410	0.687	0.596		0.757
Human capital useful in all sectors	% explained		97	81	138	48	4	36		28
D2: Human capital accumulation	model	1968-72	0.531	0.734	0.402	0.365	0.679	0.537		0.766
Human capital only useful in the market	% explained		130	111	175	91	-4	63		23

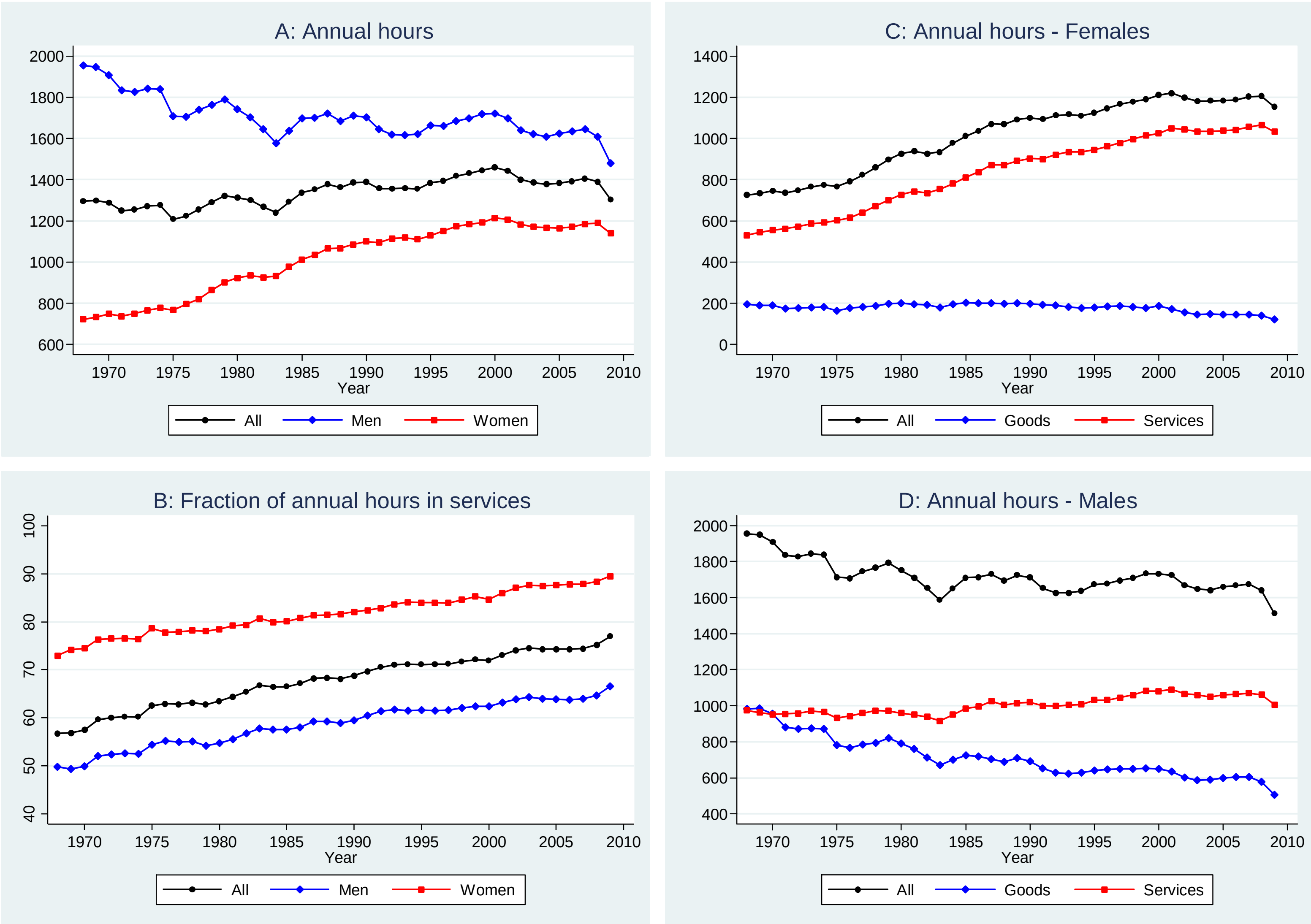
See notes to Table 4.

Table 6: Sensitivity analysis

			Service share (Total) s	Service share (Women) s_f	Service share (Men) s_m	Market hours (Women) μ_f	Market hours (Men) μ_m	Market hours (Women/ Men) μ_f/μ_m	Wage ratio (adjusted) x
			1	2	3	4	5	6	7
	data	2005-09	0.751	0.882	0.646	0.460	0.683	0.672	0.775
	data	1968-72	0.582	0.749	0.507	0.355	0.776	0.458	0.641
A: Baseline	model	1968-72	0.583	0.771	0.450	0.411	0.689	0.596	0.748
	% explained		99	83	141	46	7	36	20
B: Higher elasticity of substitution, male vs female	model	1968-72	0.585	0.772	0.452	0.413	0.691	0.598	0.766
$\eta = 10$	% explained		98	83	140	45	8	35	6
C: Higher elasticity of substitution, goods vs services	model	1968-72	0.598	0.782	0.467	0.407	0.682	0.598	0.752
$\varepsilon = 0.1$	% explained		91	75	129	50	-2	35	17
D: Higher elasticity of substitution, home vs market services	model	1968-72	0.555	0.751	0.424	0.373	0.663	0.564	0.753
$\sigma = 3$	% explained		116	98	160	83	-22	51	16
E: Lower productivity growth difference, home vs market services	model	1968-72	0.618	0.796	0.486	0.439	0.704	0.623	0.748
$\gamma_s - \gamma_h = 0.4\%$	% explained		79	65	115	20	22	23	20

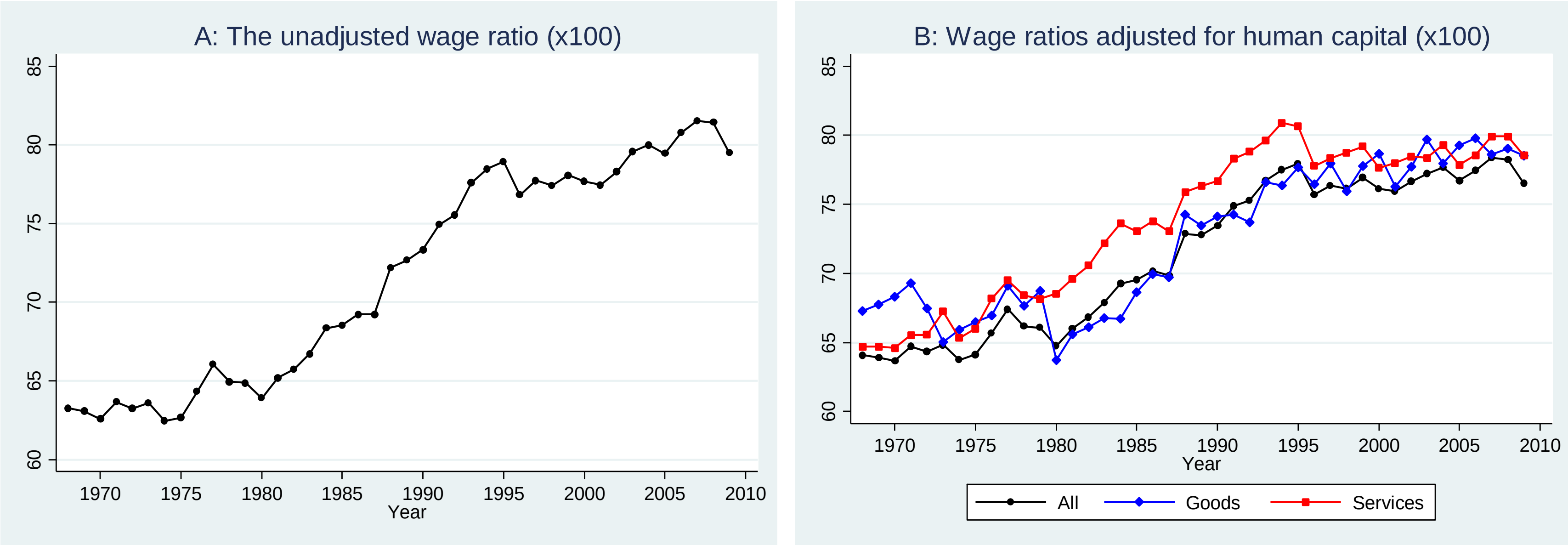
See notes to Table 4.

Figure 1
Trends in market hours, by gender.



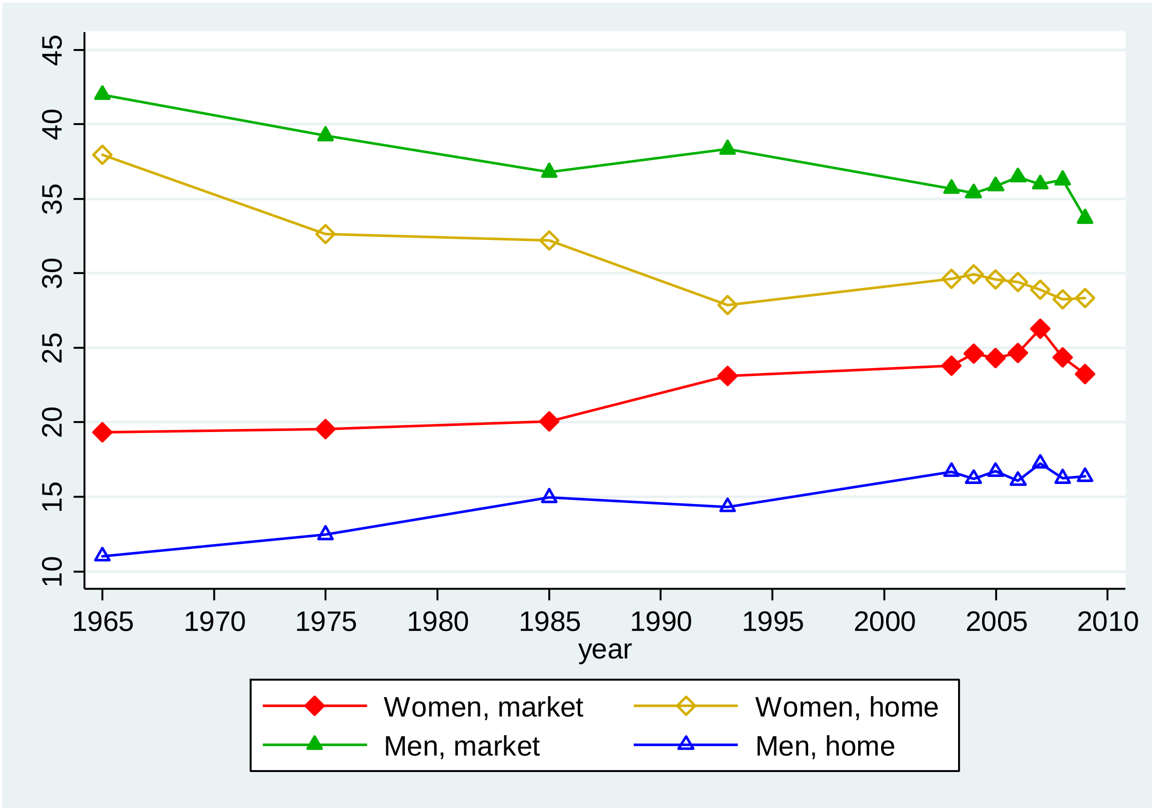
Notes. See Table 1 for definition of the service sector. Source: CPS: 1968-2009.

Figure 2
The gender wage ratio



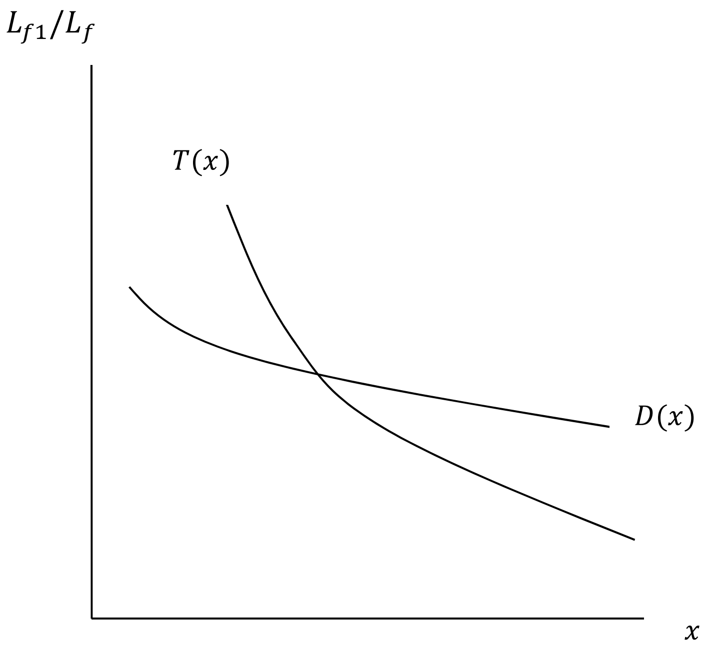
Notes. In panel A the wage ratio is obtained as (the exp of) the coefficient on the female dummy from yearly log wage regressions that only control for gender. In panel B the wage ratio is obtained from corresponding regressions that also control for age, age squared, education (4 categories) and ethnicity (one non-white dummy). Source: CPS: 1968-2009.

Figure 3
Trends in market work and home production
(usual weekly hours)



Notes. Market work includes includes time spent working in the market sector on main jobs, second jobs, and overtime, including any time spent working at home, but excluding commuting time. Home production hours include: time spent on meal preparation and cleanup, doing laundry, ironing, dusting, vacuuming, indoor and outdoor cleaning, design, maintenance, vehicle repair, gardening, and pet care; time spent obtaining goods and services; child care. Source: 1965-1966 America's Use of Time; 1975-1976 Time Use in Economics and Social Accounts; 1985 Americans' Use of Time; 1992-1994 National Human Activity Pattern Survey; 2003-2009 American Time Use Surveys.

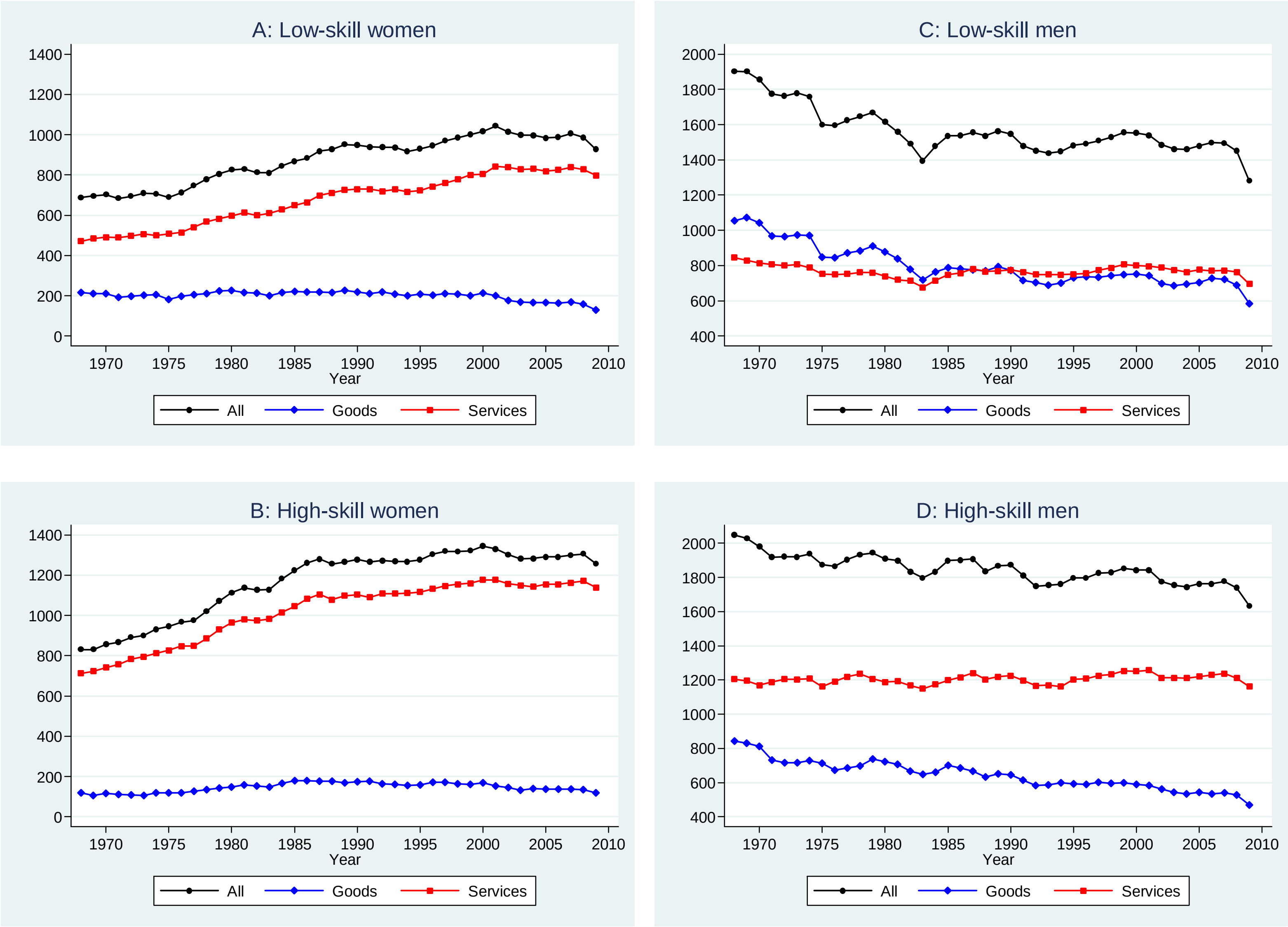
Figure 4
The equilibrium wage ratio



The $T(x)$ and $D(x)$ relationships represent conditions (6) and (17), respectively, for $\eta > \varepsilon$.

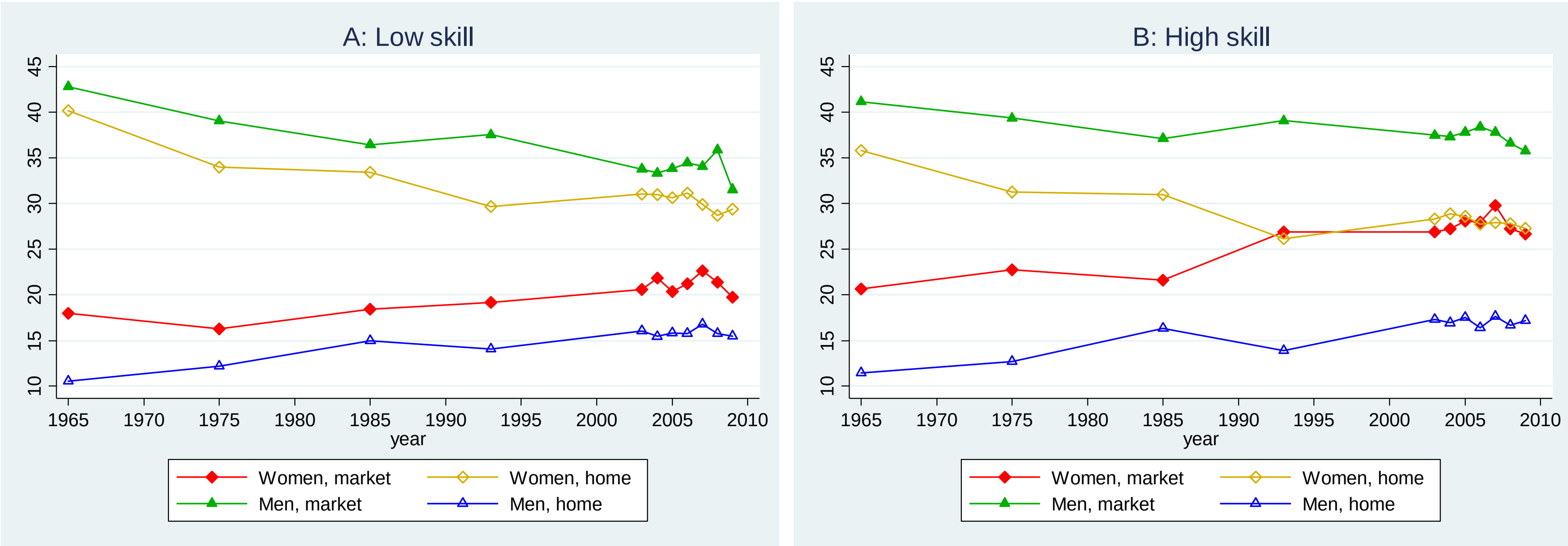
Appendix Tables and Figures

Figure A1. Trends in market hours, by skill



Notes. The low-skilled include high-school dropouts and high-school graduates. The high-skilled include those with some college, or college completed. Source: CPS: 1968-2009.

Figure A2
Trends in market work and home production, by skill.
(usual weekly hours)



Notes. The low-skilled include high-school dropouts and high-school graduates. The high-skilled include those with some college, or college completed. See notes to Figure 3 for definitions of market and home hours and source.