ISSN 2042-2695

CENTRE *for* ECONOMIC PERFORMANCE

CEP Discussion Paper No 1204

April 2013

Gender Gaps and the Rise of the Service Economy

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THE LONDON SCHOOL OF ECONOMICS AND POLITICAL SCIENCE

E·S·R·C ECONOMIC & SOCIAL RESEARCH COUNCIL

Abstract
This paper explains the narrowing of gender gaps in wages and market hours in recent decades by the growth of the service economy. We propose a model with three sectors: goods, services and home production. Women have a comparative advantage in the production of services in the market and at home. The growth of the services sector, in turn driven by structural transformation and marketization of home services, acts as a gender-biased demand shift and leads to a rise in women's wages and market hours relative to men. Quantitatively, the model accounts for an important share of the observed rise in women's relative wage and market hours and the fall in men's market hours.

JEL Classifications: E24, J22, J16
Keywords: gender gaps, structural transformation, marketization.

This paper was produced as part of the Centre's Macro Programme. The Centre for Economic Performance is financed by the Economic and Social Research Council.

Acknowledgements
We wish to thank Donghoon Lee, Alessio Moro, Chris Pissarides for helpful discussions, as well as seminar participants at the SED Annual Conference 2012, the 2nd workshop on Structural Change and Macroeconomic Dynamics 2012 and Hong Kong University of Science and Technology for helpful comments. We thank Benjamin Bridgman for making available to us the home production productivity data. Financial support from the ESRC (Grant RES-000-22-4114) is gratefully acknowledged.

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Published by
Centre for Economic Performance
London School of Economics and Political Science
Houghton Street
London WC2A 2AE

1 Introduction

One of the most remarkable changes in labor markets since World War II is the increase in female involvement in the labor market. In the US, the employment rate of prime age 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 large literature on the causes, characteristics and consequences of the increase in female participation to the labor market. There is now a vast literature indicating 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. Also, 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 different, possibly complement, explanation for the observed trends in gender gaps, 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 number of simple facts. First, the sustained rise in female work since the late 1960s in the U.S. has been accompanied by a symmetric fall in male work (Figure 1, panel A), and a rise in the gender wage ratio (Figure 2). 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 sectors producing "goods", and namely the primary sector, manufacturing, construction and utilities (Figure 1, Panels C and D). This pattern is closely linked to the reallocation of labor from goods to service industries (Panel B). Finally, the rise in women's hours in the service sector is accompanied by a strong decline in their hours of home production (see Figure 3), consistent with substantial marketization of home production (Freeman and Schettkat, 2005).[2] Beyond these aggregate trends, our estimates also detect a positive and significant association between the share of services and both women's relative wages and market hours within U.S. states, thus states in which the service share rose faster experienced a faster narrowing in gender gaps.

Motivated by these fact, this paper's objective is to investigate the role of structural transformation and marketization for our understanding of changes in gender gaps in wages and market hours. The interaction between structural transformation, marketization and trends in female work has been largely overlooked in the literature.[3] However there are at least two reasons why

[1] See Goldin (1990) and Goldin (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; Jones, Manuelli and McGrattan (2003) and 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 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. 'Consumerism' appeared when housewifes began to buy goods they had once produced." For evidence on this see Bridgman (2013), who documents the marked rise in the ratio of services purchased relative to home production since the late 1960s.

[3] One notable exception is work by Lee and Wolpin (2009), who estimate an equilibrium labor market model and show that the rise of services is empirical important in understanding changes women's wages and employment.

these can contribute to the rise in female hours of market work. First, service jobs have traditionally been perceived as more appropriate for women since the early 20th century, as they involved safer, cleaner working conditions and shorter working hours than jobs in factories (Goldin, 2006). While these factors may have become less relevant later in the century, other factors have been suggested to imply that women may still retain a comparative advantage in the service sector, like the relatively more intensive use of communication skills than in manufacturing, and the less intensive use of heavy manual skills (Galor and Weil 1996, Rendall 2010). Such comparative advantage is reflected in the initial allocation of women's hours of market work. In 1968, the typical working woman was supplying three quarters of her market time to the service sector, while the typical man was supplying only one half of his market time to it. As structural transformation implies an expansion of the sector in which women have a comparative advantage, this may imply important consequences for the evolution of women's hours of market work.

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 only 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 understand 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 mostly working in the goods sector, and their working hours suffered from the generalized downsizing of this sector.

We propose a model in which both women's relative wages and market hours and the size of services can be driven by uneven productivity growth across sectors. Goods and market services are imperfect substitutes in the consumer's utility function, as they are inherently different commodities, e.g. cars and childcare in nurseries. Market services and home production, however, are close substitutes, as they can encompass very similar commodities such as childcare in nurseries and childcare at home. Male and female labor inputs are imperfect substitutes in all sectors, and females have a comparative advantage in producing services (both at home and in the market). The force driving labor market trends is uneven productivity growth, which is highest in the goods sector, intermediate in market services, and lowest in home production. As goods and market services are poor substitutes, faster 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 productivity growth in the home sector reallocate hours of work from the home to services, resulting in marketization.[4]

We derive two novel results. First, due to women's comparative advantage in services, struc-

The force driving the rise in services in their model is an exogenous shock to the value of home time, while we model changes in the value of home time as endogenously driven by the marketization of home production.

[4] 'Consumerism' (in the terminology of Lebergott, 1993) is thus driven by falling relative price of market services.

tural transformation and marketization together play a role similar to a gender-biased shift in labor demand, driving a rise in women's market hours and wages relative to men. Our model's predictions for both narrowing hours *and* wage gaps is one key novel element in the literature on the rise of female labor market participation. Second, for both men and women, market hours rise with marketization but fall with structural transformation. Thus both processes are necessary to rationalize trends in hours for both genders, and specifically marketization is key to deliver the rise in female market work while structural transformation is key to deliver the fall in male market work.

To quantitatively assess the importance of the mechanisms described, we calibrate our model to the U.S. labor market and then predict the change in the wage ratio and time allocation by gender and sectors implied by uneven productivity growth. Our baseline model predicts the entire rise in the service share and 87% of the rise in female hours in services. It also predicts one-third of the rise in the gender wage ratio and the gender market hours ratio. Finally, it predicts 44% of the rise in female market hours and 11% of the fall in male market hours. The predictions for female work improve if the observed gender-specific trends in human capital are incorporated into the model, and we allow human capital to boost labor productivity in market sectors more than in the household sector.

While our baseline results confirm that structural transformation is an important source of gender-biased demand shifts, this process alone cannot explain the whole observed change in relative wages and the rise in women's market hours relative to men. If we were to introduce an exogenous gender-biased demand shift similar to that calibrated by Heathcote et al (2010), our model could predict 82% of the rise in the wage ratio, the whole rise in women's market hours, and 56% of the fall in men's market hours. This result indicates that other labor demand shifts that are not considered in our model are also important. These should include, most notably, the introduction and progressive enforcement of equal treatment laws, which would simultaneously narrow gender gaps in both wages and hours.

While there are extensive literatures that have independently studied the rise in female labor market participation and the rise of services, respectively, work on the interplay between the two phenomena is scant. Early work by Reid (1934), Fuchs (1968) and Lebergott (1993) has suggested that the two mechanisms could be related, without proposing a unified theoretical framework. Our work is related to Galor and Weil (1996) and Rendall (2010), who illustrate that the rise in female employment may result as a consequence of brain-biased technological progress in a one-sector model in which females have a comparative advantage in the provision of brain (rather than brawn) inputs. In a similar vein, we assume 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 across sectors.

The marketization of home services, which contributes to both the rise of female market work and the share of services, also features in Akbulut (2011) and Rendall (2011). Our main contribution to this strand of literature is that we let the gender wage ratio respond endogenously to sector-specific productivity growth, while this is exogenous in Akbulut (2011) and Rendall (2011), as it is also in most of the macro literature on the rise in female participation (Jones et al., 2003, Greenwood et al., 2004, and Heathcote et al. 2010).

The mechanisms driving the rise in services in our model were first studied by Ngai and Pissarides (2008) and Rogerson (2008), who focus on the dynamics of aggregate market hours and are thus agnostic about diverging trends by gender. Our paper introduces a gender dimension into their framework and argues that this is key to rationalize gender specific trends in hours of work and wages. Finally, motivated by a clear cross-country association between the share of services and female work, a number of papers have taken these ideas to an international perspective (Rogerson, 2005; Rendall, 2011; Olivetti and Petrongolo, 2012) and relate lower female employment rates in Europe to an undersize service sector relative to the U.S.

The paper is organized as follows. The next section describes the data used and documents relevant trends in gender work and the size of services during 1968-2009, both in the aggregate U.S economy and within states.. Section 3 develops a model for a three-sector economy and shows predictions of uneven productivity growth for the gender wage ratio and market hours for each gender. Section 4 proposes a calibration of the main model parameters, and Section 5 illustrated the quantitative predictions of uneven productivity growth for the main variables of interest. Section 6 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. This is the data source that offers the longest span on both labor market participation of various demographic groups and the industry structure. We complement the CPS with data from time use surveys in order to obtain information on hours of home production.

Our working sample obtained from the CPS includes individuals ages 18-65 (both inclusive), who are not in full-time education, retired, or military. Data on annual market hours is obtained from information on usual weekly hours and the number of weeks worked in the year prior to the survey 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. Similarly, usual weekly hours in the previous year are not available for 1968-1975, and thus we use hours worked during the survey week as a proxy for usual weekly hours in the previous year. For individuals who did not work during the survey week we imputed usual weekly hours using the average of current hours for individuals of the same sex in the same year. Both adjustment methods have been previously applied to the March CPS by

Katz and Murphy (1992). Our wage concept is represented by hourly earnings, obtained as wage and salary income in the previous year, divided by annual hours.

Figure 1 shows a number of interesting stylized facts about market work. Panel A plots usual weekly hours by gender, obtained as averages across the whole population, including the nonemployed. Female weekly hours rise steadily from about 16 hours in 1968 to 25 hours in 2000, followed by a slight decline, while male hours were gradually declining throughout the sample period, from about 40 hours in 1968 to 30 hours in 2009. These diverging trend imply a near doubling of the hours ratio[5] from about 0.43 in 1968 to 0.84 in 2009, and a relatively stable average number of hours across genders.

To provide very simple evidence on structural transformation we classify hours of work into two broad sectors, which we define as goods and services. The goods sector includes the primary sector; manufacturing; construction and utilities. The service sector includes all the rest and namely transportation; post and telecommunications; wholesale trade; retail trade; finance, insurance and real estate; professional, business, repair and personal services; entertainment; health; education; welfare and non-profit organizations; public administration. 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 spent by both males and females in the service sector. For women such 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.

Figure 2 (Panel A) shows the evolution of the wage ratio in the aggregate economy, obtained as the exponential of the 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% in 2009. 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 groups), the rise in the gender wage ratio is only slightly attenuated, from 64% in 1968 to 77% in 2009 (see Panel B). Note finally that both the gender wage ratio and its trends are quite similar across market sectors.

One very simple way to summarize the relationship between female work and structural transformation consists in showing how much of the rise in the female share in total hours took place through the expansion of the service sector. We thus decompose the change 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. Having denoted by L_m and L_f the annual hours worked by men and women, respectively, and by L their sum, the change in the

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

Table 1: A Decomposition of Female Hours Share into Within- and Between-Sector Components

	change (×100)	% between sectors
1968-2009	$42.2 - 27.5 = 14.7$	46.8
1968-1980	$34.3 - 27.5 = 6.8$	29.8
1980-1990	$38.8 - 34.3 = 4.4$	38.2
1990-2000	$40.2 - 38.8 = 1.4$	64.7
2000-2009	$42.2 - 40.2 = 2.0$	104.7

Notes. The first column reports changes in the female hours share as on the left-hand side of equation 1. The second column reportes the ratio between the first term on the right-hand side of equation 1 and the left-hand side.

female hours share between time 0 and time t can be expressed as

$$\frac{L_{ft}}{L_t} - \frac{L_{f0}}{L_0} = \sum_j \alpha_{fj}\left(\frac{L_{jt}}{L_t} - \frac{L_{j0}}{L_0}\right) + \sum_j \alpha_j \left(\frac{L_{fjt}}{L_{jt}} - \frac{L_{fj0}}{L_{j0}}\right), \tag{1}$$

where j indexes sectors, L_{fjt} denotes female hours in sector j at time t, $L_{jt} = L_{mjt} + L_{fjt}$ denotes the sectoral hours, and finally $\alpha_{fj} = \left(\frac{L_{fjt}}{L_{jt}} + \frac{L_{fj0}}{L_{j0}}\right)/2$ and $\alpha_j = \left(\frac{L_{jt}}{L_t} + \frac{L_{j0}}{L_0}\right)/2$ 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 sector. The α_{fj} and α_j terms serve as weights on the between- and within industry components, respectively, obtained as averages over the sample period. The results of this decomposition are reported in Table 1, both for the whole sample period and for each decade separately. The first column reports the total change in the female hours share, while the second column reports the proportion of this change that took place between-sectors. The female hours share increased from 27.5% in 1968 to 42.2% in 2009, and nearly one half of this increase took place between sectors, i.e. through the expansion of services. Looking across decades, one can notice a marked deceleration in the rise of the female hours share and an important increase in its between industry component.

While the above decomposition highlights the importance of the sectoral dimension in the aggregate evolution of market hours by gender, below we investigate the association between the rise in services and gender-specific outcomes across US states. To do this we regress (log) hours per person by state and gender on the state-level share of services, controlling for both state and time effects:

$$\frac{L_{gst}}{P_{gst}} = \beta_0 + \beta_1\left(\frac{L_{st\_serv}}{L_{st}}\right) + f_g + \beta_2\left(f_g * \frac{L_{st\_serv}}{L_{st}}\right) + \beta_s + \beta_t + \varepsilon_{gst} \tag{2}$$

where L_{gst} denotes annual hours worked by gender $g = m, f$ in state s and year t, P_{gst} is the corresponding population, $\frac{L_{st\_serv}}{L_{st}}$ is the share of services in state level hours, f_g is a female dummy, and β_s and β_t represent state and year fixed-effects, respectively. While β_1 represents the total effect of services on average hours per person, β_2 picks differences in this effect by gender. A similar expression can be estimated for individual wages:

$$\ln w_{ist} = \gamma_0 + X'_{ist}\delta + \gamma_1 \left(\frac{L_{st\_serv}}{L_{st}} \right) + f_i + \gamma_2 \left(f_i * \frac{L_{st\_serv}}{L_{st}} \right) + \gamma_s + \gamma_t + \varepsilon_{ist} \tag{3}$$

where w_{ist} denotes the hourly wage of individual i in state s at time t, X_{ist} is a vector of human capital characteristics including three education dummies, age and its square and a nonwhite dummy, f_i is a female dummy and γ_s and γ_t represent state and year fixed-effects, respectively. The regression results for specifications (2) and (3) are reported in Table 2. The sample period is now restricted to 1977-2009, which is the longest span over which a consistent classification for state of residence is available in the CPS. Figures reported in column (1) imply that, when the service share rises by 10 percentage points in a state, annual hours decline on average by 112 hours for men, but rise by nearly 50 hours for women $(161.2 - 112)$, and both effects are strongly significant. Moreover, column 2 shows that a 10 percentage point rise in the service share implies a fall in male wages of 6%, but a rise in female wages of nearly 3% $(0.0886 - 0.0599)$. These effects are robust to the introduction of individual controls for the sector of employment, interacted with gender (column 3).

In summary, both the between- and within-sector decomposition of the female hours share and the cross-state regressions for hours and wages clearly indicate that a rise in the service sector significantly improves the labor market prospects of women relative to men.

A further stylized to emphasize here is the change in 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 US surveys: 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 the 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 labor 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 (like meal time or breaks at work). This is the labor supply measure that is most closely comparable to market hours measured in the CPS, although one remaining difference is that usual hours are reported in the CPS but actual hours are reported in the times use surveys. To obtain a measure of home production we add 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 per week for women, and fall from 42 to 33 for men. The trends are very similar to those detected using the CPS in Figure 1A, although levels are slightly higher in time use data than in the CPS. The series for home production also converge across genders,

Table 2: The Impact of the Service Share on Hours Per Person and Wages by Gender

	Dependent variable		
	(1)	(2)	(3)
	hours per person	log wages	log wages
female	-1700^{***}	-0.921^{***}	-0.851^{***}
	(87)	(0.061)	(0.058)
service share	-1120^{***}	-0.599^{***}	-0.454^{***}
	(124)	(0.105)	(0.104)
service share * female	1612^{***}	0.886^{***}	0.801^{***}
	(121)	(0.088)	(0.081)
work in services	–	–	-0.143^{***}
			(0.008)
work in services * female	–	–	0.027^{***}
			(0.006)
human capital controls	yes	yes	yes
state dummies	yes	yes	yes
year dummies	yes	yes	yes
no. observations	3,366	2,003,052	2,003,052
R^2	0.929	0.316	0.320

Notes. Human capital controls include three education dummies (college degree, some college education, high school completed - the excluded category is high school dropout), age and its square, and a non-white dummy. Standard errors are clustered at the state level. Sample: 1977-2009.

and in particular household hours fall from 38 to 28 per week for women, and rise from 11 to 16 for men. Interestingly, there are no major gender differences in total hours of work (see also Burda, Hamermesh, 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.

3 The Model

Our proposed model shows how the processes of structural transformation and marketization can account for the rise in the wage ratio, the rise in female market hours and the fall in male market hours. To highlight the role of each process we develop the model in three steps. First, we introduce structural transformation in a simple two-sector model (goods and services), without home production, and show that structural transformation raises the wage ratio wage when women have a comparative advantage in the service sector. Second, we introduce a home sector producing services that are close substitutes to market services, and illustrate that marketization of home production and structural transformation jointly imply a rise in the wage ratio and in the share of market hours for women, relative to men. To keep these steps simple, we derive results from the planner's optimal resource allocation across sectors. Finally, we lay down the full model economy in decentralized equilibrium, in order to quantitatively access the role of structural transformation and marketization in labor market trends.[6]

3.1 The Role of Structural Transformation

We first consider a simple economy with two sectors, producing goods and services respectively, that are poor substitutes in consumption. The assumed utility function is a CES specification defined over goods (c_1) and services (c_2), with an elasticity of substitution $\varepsilon < 1$:

$$U(c_1, c_2) \equiv \left[\omega c_1^{\frac{\varepsilon-1}{\varepsilon}} + (1-\omega) c_2^{\frac{\varepsilon-1}{\varepsilon}} \right]^{\frac{\varepsilon}{\varepsilon-1}}. \tag{4}$$

Production in each sector $j = 1, 2$ is given by the following linear technology

$$c_j = A_j L_j \tag{5}$$

where productivity growth $\gamma_j \equiv \frac{\dot{A}_j}{A_j}$ is faster in the goods sector, $\gamma_1 > \gamma_2$. Similarly as in Ngai and Pissarides (2007), uneven productivity growth and poor substitutability across sectoral outputs imply structural transformation, by shifting resources from the goods to service sector.

We next introduce a gender dimension in production by modelling the labor input in each sector, L_j, as a CES aggregator of female and male work:

$$L_j = \left[\xi_j L_{fj}^{\frac{\eta-1}{\eta}} + (1-\xi_j) L_{mj}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}} \quad j = 1, 2, \tag{6}$$

where η is the elasticity of substitution between male and female inputs, and $\xi_1 < \xi_2$ is imposed to capture women's comparative advantage in producing services. The model is closed with the corresponding resource constraints for each gender:

$$L_{g1} + L_{g2} = L_g \quad g = f, m. \tag{7}$$

We obtain the equilibrium allocation in this economy solving for the wage ratio $x \equiv \frac{w_f}{w_m}$ and the share of female hours in the goods sector, $\frac{L_{f1}}{L_f}$. We describe the key steps below and leave the details to the Appendix.

First, free mobility of inputs across sectors implies equal marginal rates of technical transformation (MRTS),

$$\frac{\xi_j}{1-\xi_j} \left(\frac{L_{mj}}{L_{fj}} \right)^{1/\eta} = x; \qquad j = 1, 2. \tag{8}$$

Combining equations (7) and (8) for $j = 1, 2$ gives the following allocation of female hours:

$$\frac{L_{f1}}{L_f} = T(x) \equiv \frac{x^{-\eta} \frac{L_m}{L_f} - a_2{}^{\eta}}{a_1^{\eta} - a_2^{\eta}}, \tag{9}$$

[6] To keep exposition as simple as possible, we abstract from capital in production. This implies that our model is essentially static and time subscripts may be everywhere omitted.

where $a_j \equiv \frac{1-\xi_j}{\xi_j}$, $j=1,2$, and $a_1 > a_2$ due to $\xi_1 < \xi_2$.

Free mobility of female labor across sectors also implies equalization of the marginal revenue product of labor. Given the equalization of MRTS in (8), we can derive the allocation of female input across the two sectors as a function of the relative wage

$$\frac{L_{f_1}}{L_{f2}} = R(x) \equiv \left(\frac{\omega}{1-\omega}\right)^{\varepsilon} \left(\frac{A_2}{A_1}\right)^{1-\varepsilon} \left(\frac{\xi_1}{\xi_2}\right)^{\varepsilon} \left(\frac{z_2(x)}{z_1(x)}\right)^{1-\varepsilon/\eta}, \tag{10}$$

where

$$z_j(x) \equiv \frac{L_j}{L_{fj}} = \xi_j^{\frac{\eta}{\eta-1}} \left(1 + a_j^{\eta} x^{\eta-1}\right)^{\frac{\eta}{\eta-1}}, \qquad j=1,2. \tag{11}$$

Together with the resource constraint for female hours, (10) implies

$$\frac{L_{f1}}{L_f} = D(x) \equiv \frac{R(x)}{1+R(x)}. \tag{12}$$

Equilibrium condition (9) is derived independent of the demand, and hence of parameters of the utility function ω and ε. It describes the optimal cross-sector input allocation, given sector-specific technology, and it implies that the equilibrium wage ratio is within the range (x_1, x_2), where $x_j \equiv \frac{1}{a_j}\left(\frac{L_m}{L_f}\right)^{1/\eta}$ is the equilibrium wage ratio in a one-sector economy with sector j only. Equilibrium condition (12) describes optimal output allocation in addition to optimal input allocation. Equations (9) and (12) solve for equilibrium $\frac{L_{f1}}{L_f}$ and x. The other three equilibrium variables (L_{m1}, L_{m2}, L_{f2}) are derived using condition (8) and the resources constraint (7) for $j=1,2$.

The equilibrium can be summarized in the $\left(x, \frac{L_{f1}}{L_f}\right)$ space, where equilibrium $\left(x^*, \frac{L_{f1}^*}{L_f}\right)$ is the intersection of relationships (9) and (12), see Figure 4. While (9) is downward sloping, the slope of (12) depends on ε/η. Given $a_1 > a_2$, we show in the Appendix that (12) is upward sloping for $\eta \leqslant \varepsilon$, or downward sloping for $\eta > \varepsilon$, but flatter than (9), i.e. $D'(x) > T'(x)$. Thus we establish that equilibrium is unique.

Proposition 1 *When goods and services are poor substitutes ($\varepsilon < 1$), faster productivity growth in the goods sector triggers structural transformation, which in turn shifts hours of work from the production of goods to production of services. When women have a comparative advantage in producing services, this raises the wage ratio.*

The proof for Proposition 1 is as follows. From (10), a rise in $\frac{A_1}{A_2}$ leads to a fall in $R(x)$, which shifts down the $D(x)$ curve (12), tracing equilibrium downward along the $T(x)$ curve (9), resulting in higher x and lower $\frac{L_{f1}}{L_f}$. This result has two components. The first component is similar to the finding of Ngai and Pissarides (2007) that, under poor substitutability between goods and services, faster productivity growth in the goods sector shifts resources from the goods sector to the service sector. The second component is novel: since women have a comparative advantage in the service sector, the process of structural transformation acts as an increase in relative demand for female labor, which in turn raises the wage ratio. Note that while the sign of the impact of structural transformation on the wage ratio is independent of the elasticity of substitution between inputs η, its magnitude does indeed depend on η. Finally, it is easily shown that an increase in the relative supply of female hours leads to a fall in the wage ratio as higher L_f/L_m shifts down the $T(x)$ curve (9), resulting in lower x.

The result in Proposition 1 is related to the recent analysis by Heathcote et al (2010), which illustrates in a one-sector model that an exogenous gender-biased shift in labor demand can explain the whole rise in the wage ratio in the US in recent decades, and the bulk of the rise in hours ratio. Using a two-sector model, Proposition 1 shows that structural transformation in the presence of gender comparative advantages can endogenously rationalize such gender-biased demand shifts. To explicitly see the link between our approach and that of Heathcote et al (2010), consider a one-sector model with a CES aggregate production function as in (6), with a technology parameter ξ. The equilibrium wage ratio in such economy is given by

$$\frac{w_f}{w_m} = \frac{\xi}{1-\xi}\left(\frac{L_m}{L_f}\right)^{1/\eta}. \tag{13}$$

Note that this wage ratio falls within the (x_1, x_2) range defined above if ξ falls within the (ξ_1, ξ_2) range. In other words, the equilibrium wage ratio in a two-sector model is related to the equilibrium ratio in a one-sector model by equation (13), with $\xi = \alpha\xi_1 + (1-\alpha)\,\xi_2$, where weights α and $1-\alpha$ are the shares of female hours in sectors 1 and 2, respectively. The advantage of explicitly deriving equilibrium in the two-sector model is that the implied aggregate ξ evolves endogenously with the industry structure. That is, structural transformation raises the implied ξ and the wage ratio, whereas in a one-sector model ξ can only rise exogenously.

In the next subsection we endogenize total market hours for both genders. This has consequences for the full impact of structural transformation on the wage ratio when $\eta < \infty$, and helps rationalize changes in female and male market hours. Specifically, allowing $\eta < \infty$ implies that if structural transformation were to encourage female labor supply, its effect on the wage ratio would be dampened via this general equilibrium channel.[7]

3.2 Structural Transformation and Marketization

This subsection introduces a home sector into the previous two-sector model, in order to account for changes in the allocation of time between the market and the household. Time spent off the market may include both leisure, which directly affects individuals' utility, and home production, which affects utility through services produced in the home. While changes in market hours may in principle imply changes in total working time (via changes in leisure) or changes in the distribution of total working time between the market and the home at constant leisure, time use data reveal that total working time was remarkably similar across genders throughout our sample period. The

[7] Healthcote et al (2010) assume that male and female inputs are perfect substitute ($\eta \to \infty$), so the increase in wage ratio is equal to the exogenous ratio $\xi/(1-\xi)$.

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 evolution of fraction of market hours in total hours differs markedly across genders, rising from 0.34 to 0.45 for women and falling from 0.79 to 0.67 for men. We therefore abstract from leisure decisions and focus on the allocation of total work between the market and the home.

As above, individuals consume two commodities, goods (c_1) and services (c_2), and the utility function is as in (4). The main new addition here is that services may be produced both in the market and at home, and market and home services are good substitutes, with $\sigma > 1$ denoting the elasticity of substitution between them:

$$c_2 = \left[\psi c_s^{\frac{\sigma-1}{\sigma}} + (1-\psi)\, c_h^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}, \tag{14}$$

where s indexes market-produced services and h indexes home-produced services. Market and home services are produced with identical technologies, except for the productivity index A_j :

$$c_j = y_j = A_j \left[\xi_2 L_{fj}^{\frac{\eta-1}{\eta}} + (1-\xi_2)\, L_{mj}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}} \qquad j = s, h, \tag{15}$$

where we assume the productivity growth in the market is at least as fast as in the home: $\gamma_s \geqslant \gamma_h$. Finally in addition to (7), there is a labor allocation constraint within services:

$$L_{gs} + L_{gh} = L_{g2} \qquad g = f, m. \tag{16}$$

In the simple two-sector model, L_g denotes both total working hours for gender g and labor supply to the market, and it is exogenously set. Once we introduce home production, L_g still denotes total working hours and is fixed, but labor supply to the market is now given by $(L_{g1} + L_{gs})$ and is endogenous.

Below we solve this extended model in two steps. We first solve for the optimal allocation between market and home of a given amount of labour (L_{f2}, L_{m2}) engaged in producing services, and next solve for the optimal allocation of labor across the production of goods and services. The optimal labor allocation between market and home services can be obtained by maximizing (14) with respect to $(L_{fs}, L_{ms}, L_{fh}, L_{mh})$, subject to the resources constraints in (16). Free mobility of inputs between market and home implies equalization of marginal rate of technical transformation. As the respective production functions are identical except for the productivity indexes, this implies

$$\frac{L_{fs}}{L_{ms}} = \frac{L_{fh}}{L_{mh}} = \frac{L_{f2}}{L_{m2}}, \tag{17}$$

where resource constraints (16) are used to derive the second equality.

Free mobility of female labor between the home and the market implies equalization of the value of marginal product of labor in home- and market-produced services. Using the results from the two-sector model with a new notation R_{mh}, the equivalent of equation (10) is

$$\frac{L_{fs}}{L_{fh}} = R_{mh} \equiv \left(\frac{\psi}{1-\psi}\right)^{\sigma} \left(\frac{A_s}{A_h}\right)^{\sigma-1}. \tag{18}$$

This describes the process of marketization: given market and home services are good substitutes with $\sigma > 1$, faster productivity growth in the market service sectors shifts hours from home to the market. A similar implication can be worked out for men.

To derive the allocation between the production of goods and services, we need to obtain a hypothetical production function for the composite services c_2. We show in the Appendix that this is equivalent to (5)-(6) for the two-sector model, with the qualification that the productivity index A_2 depends on A_s and A_h according to:

$$A_2 = \psi^{\frac{\sigma}{\sigma-1}} A_s \left(\frac{R_{mh}}{1+R_{mh}} \right)^{\frac{-1}{\sigma-1}}, \tag{19}$$

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

$$\gamma_2 = \left(\frac{R_{mh}}{1+R_{mh}} \right) \gamma_s + \left(\frac{1}{1+R_{mh}} \right) \gamma_h, \tag{20}$$

It is important to note that productivity growth in composite services (γ_2) is now endogenously determined by the process of marketization.

As one can aggregate market- and home-produced services into a composite service output c_2, , the equilibrium solution $\left(x^*, \frac{L_{f1}^*}{L_f} \right)$ in the extended model still satisfies (9) and (12), with A_2 defined by (19). Given $\gamma_1 > (\gamma_s, \gamma_h)$, (20) implies $\gamma_1 > \gamma_2$ and thus Proposition 1 holds in the extended model. More specifically, Proposition 1 builds on the fact that faster productivity growth in the goods sector decreases the $R(x)$ relationship in (10), which in turn shifts down the equilibrium condition (12) and leads to an increase in the wage ratio. It is important to note that Proposition 1 solely relies on $(1-\varepsilon)(\gamma_1 - \gamma_2) > 0$ and thus it is independent of the marketization process as long as productivity growth is highest in the goods sector.

The actual magnitude of the change in the wage ratio depends on both structural transformation and marketization. To see this, let's define

$$MT \equiv (\gamma_s - \gamma_h)(\sigma - 1) > 0; \qquad ST \equiv (1-\varepsilon)(\gamma_1 - \gamma_s) > 0, \tag{21}$$

where the former denotes the intensity of marketization as discussed in (18) and the latter denotes the intensity of structural transformation across market sectors. Both are a combination of exogenous parameters, and their effects on wages and hours work via the downward shift in $R(x)$ and the shift in R_{mh}. More precisely, let $\frac{\triangle R(x)}{R(x)}$ and $\frac{\triangle R_{mh}}{R_{mh}}$ denote shifts in $R(x)$ and R_{mh}, respectively, due to differences in productivity growth. Using (18) one obtains:

$$\frac{\triangle R_{mh}}{R_{mh}} = MT, \tag{22}$$

and using (10) and (20) one obtains:

$$\frac{-\triangle R(x)}{R(x)} = (1-\varepsilon)(\gamma_1 - \gamma_2) = ST + (1-\varepsilon)\left(\frac{\gamma_s - \gamma_h}{1+R_{mh}} \right), \tag{23}$$

which depends on both ST and MT in a non-trivial way. Proposition 1 states that the intensity of the wage ratio effects depends positively on $\frac{-\triangle R(x)}{R(x)}$. Equation (23) in turn implies that $\frac{-\triangle R(x)}{R(x)}$, depends on four factors. First, it rises with the intensity of structural transformation through lower ε or higher $(\gamma_1 - \gamma_s)$. Second, it falls with σ, due to the positive effect of σ on MT and thus the rise in R_{mh}. Third, it may either rise or fall with $(\gamma_s - \gamma_h)$, as $(\gamma_s - \gamma_h)$ has a direct (positive) effect on $\frac{-\triangle R(x)}{R(x)}$ and an indirect (negative) effect through MT and R_{mh}.

We next turn to the model's prediction for market hours worked by each gender. Let $\mu_g \equiv 1 - \frac{L_{gh}}{L_g}$ denote the fraction of market hours out of total working hours for each gender. Using (10) and (18), for women this ratio is given by

$$\mu_f \equiv 1 - \frac{L_{fh}}{L_f} = 1 - \left(\frac{1}{1+R(x)}\right)\left(\frac{1}{1+R_{mh}}\right). \tag{24}$$

Using the hours ratios obtained in (8) and (17), and the definitions of μ_f and μ_m we obtain

$$\frac{1-\mu_m}{1-\mu_f} = \frac{L_f}{L_m}(a_2 x)^\eta = \frac{R(x)+1}{\left(\frac{a_1}{a_2}\right)^\eta R(x)+1}, \tag{25}$$

where the second equality follows from the equilibrium conditions (9) and (12). 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 $\frac{1-\mu_m}{1-\mu_f}$ results from falling $R(x)$, in turn induced by structural transformation and marketization (see equation (23)).

The fraction of male hours spent in the market can be derived by combining (24) and (25):

$$\mu_m = 1 - \left(\frac{1}{\left(\frac{a_1}{a_2}\right)^\eta R(x)+1}\right)\left(\frac{1}{1+R_{mh}}\right). \tag{26}$$

It follows from (24) and (26) 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. We can now summarize the effects of structural transformation and marketization as follows:

Proposition 2 *For both genders, market hours as a fraction of total working time* (μ_f, μ_m) *fall with structural transformation but rise with marketization.*

While structural transformation and marketization are defined as gender-neutral by (21), women's comparative advantage in services turn them de facto into gender-biased forces, as implied by (24) and (26). In particular, $a_1 > a_2$ implies that 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 μ_f/μ_m.

Proposition 3 *Given women's comparative advantage in services, both the process of structural transformation and the process of marketization lead to a rise in women's market hours as a fraction of total working, relative to men, μ_f/μ_m.*

We finally derive the service share in market hours, s, in Appendix as

$$s = \left[1 + \left(\frac{A_s}{A_1}\right)^{1-\varepsilon} \left(\frac{1+R_{mh}}{R_{mh}}\right)^{\frac{\sigma-\varepsilon}{\sigma-1}} G(x)\right]^{-1}, \tag{27}$$

where

$$G(x) = \left(\frac{\omega}{1-\omega}\right)^{\varepsilon} \left(\frac{\xi_1}{\xi_2}\right)^{\frac{\eta(1-\varepsilon)}{\eta-1}} \left(\frac{1+a_2^{\eta}x^{\eta-1}}{1+a_1^{\eta}x^{\eta-1}}\right)^{\frac{\eta-\varepsilon}{\eta-1}} \left(\frac{1+a_1^{\eta}x^{\eta}}{1+a_2^{\eta}x^{\eta}}\right). \tag{28}$$

Note first that, conditional on x, the service share (27) rises with both structural transformation and marketization, similarly as in Ngai and Pissarides (2008). In our model there are two further, opposing effects via equilibrium x, represented by the last two terms in equation (28).[8] As it will be illustrated in the Quantitative section, the overall effect of these two equilibrium effect is minimal compared to the direct effect from ST and MT.

Proposition 4 *The rise in service hours' share rises with both structural transformation and marketization.*

To summarize, we have shown in this subsection that structural transformation and marketization raise the wage ratio and the fraction of market hours in total working time for women relative to men in Propositions (1) and (3), respectively. As evidence shows that the change in total working hours is similar across genders (see also the iso-work results established by Burda, Hamermesh and Weil, 2013), Proposition 3 also implies a rise in women's market hours relative to men. Proposition 4 establishes that the model predicts a rise in the service employment share. Together, these results are consistent with estimates from cross-state regressions reported in Table (2), that the rise in services is highly correlated with narrowing gender gaps in wages and hours. Proposition 2 shows that a combination of structural transformation and marketization can potentially account for the rise in the wage ratio, the rise in female market hours (especially in the service sector) and the fall in male market hours (especially in the goods sector).

3.3 The Baseline model

Having described the qualitative impact of structural transformation and marketization on wages and hours by gender, our objective here is to embody these processes into a framework that can

[8] Given $a_1 > a_2$, the rising wage ratio raises the relative cost of female hours, which has a detrimental impact on service share. This works through the term $\left(\frac{1+a_1^{\eta}x^{\eta}}{1+a_2^{\eta}x^{\eta}}\right)$ in (28). On the other hand, rising x induces more women to move from the goods to the service sector where they have comparative advantage, thus 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 (28).

be calibrated to the U.S. economy. To do this, we apply one small modification to the model presented in the previous subsection, i.e. we allow women's comparative advantage in services to differ between the household and the market.[9] In particular the production function (15) is replaced by

$$c_j = A_j \left[\xi_j L_{fj}^{\frac{\eta-1}{\eta}} + \left(1-\xi_j\right) L_{mj}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}, \quad j = s, h. \tag{29}$$

This generalization implies that the aggregation across market and home services is not as simple. However, the generalization does not alter the qualitative results summarized in Propositions 1-6. To gain intuition it is useful to derive the decentralized equilibrium of the model. In doing this we will focus on comparing the changes resulting from the generalization in (29).

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 (5) and (6). Profit maximization implies:

$$w_f = p_j A_j \xi_j \left(\frac{L_j}{L_{fj}} \right)^{1/\eta}; \quad w_m = p_j A_j \left(1-\xi_j\right) \left(\frac{L_j}{L_{mj}} \right)^{1/\eta}; \quad j = 1, s. \tag{30}$$

Within each sector the marginal rate of technical substitution between female and male labor equals the wage ratio, thus condition (8) is satisfied under free labor mobility.

Each household consists of a male and a female who jointly maximize a utility function in goods and services as in (4), where c_2 is defined by (14) and can be purchased in the market or produced at home using technology (15). Given wages (w_f, w_m) and prices (p_1, p_s), a representative household chooses a consumption vector (c_1, c_2) and home production vector (L_{mh}, L_{fh}), and supply the rest of their working time to the market. Specifically, the household maximizes the utility function (4), subject to (14), (29) and the household budget constraint:

$$p_1 c_1 + p_2 c_2 = w_m \left(L_m - L_{mh}\right) + w_f \left(L_f - L_{fh}\right). \tag{31}$$

Utility maximization implies that the marginal rate of technical substitution across L_{mh} and L_{fh} equals the wage ratio as in (8); and the marginal rate of substitution across goods and services equal to their relative price. We next define the implicit price of home production similarly as for market production in (30): $p_h \equiv \frac{w_g}{A_h \frac{\partial L_h}{\partial L_{gh}}}$, which implies that equation (11) holds for $j = h$ as well. Using the utility function (14) the relative demand of market to home services is

$$\frac{c_s}{c_h} = \left(\frac{p_h}{p_s} \right)^{\sigma} \left(\frac{\psi}{1-\psi} \right)^{\sigma}, \tag{32}$$

[9] As will be become clearer in the Quantitative section, U.S. data suggests ξ_h is close to ξ_s but slightly bigger.

and the corresponding relative expenditure is given by

$$E_{s,h} \equiv \frac{p_s c_s}{p_h c_h} = \left(\frac{p_h}{p_s}\right)^{\sigma-1} \left(\frac{\psi}{1-\psi}\right)^{\sigma}, \tag{33}$$

stating that, if market and home services are good substitutes $(\sigma > 1)$, a fall in the price of market services relative to home services will induce households to buy more market service relative to home services. This is the process of marketization.

Using the utility function (4) and (14), the relative demand of goods relative to market services is

$$\frac{c_1}{c_s} = \left(\frac{\omega}{1-\omega}\frac{p_s}{p_1}\right)^{\varepsilon} \psi^{\frac{\sigma-\varepsilon}{\sigma-1}} \left[1 + \left(\frac{1-\psi}{\psi}\right)\left(\frac{c_h}{c_s}\right)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma-\varepsilon}{\sigma-1}}. \tag{34}$$

and the relative expenditure is:

$$E_{1,s} = \left(\frac{p_1}{p_s}\right)^{1-\varepsilon} \left(\frac{\omega}{1-\omega}\right)^{\varepsilon} \psi^{\frac{\sigma-\varepsilon}{\sigma-1}} \left[1 + \left(\frac{1-\psi}{\psi}\right)^{\sigma} \left(\frac{p_s}{p_h}\right)^{\sigma-1}\right]^{\frac{\sigma-\varepsilon}{\sigma-1}}. \tag{35}$$

There are two potential sources for the decline in $E_{1,s}$. The first one is marketization, through the fall in relative prices $\frac{p_s}{p_h}$. The second is structural transformation: as goods and services are poor substitutes $(\varepsilon < 1)$, a fall in $\frac{p_1}{p_s}$ induces households to spend less on goods relative to market services.

Finally, we derive female home production hours (L_{fh}) and market hours $(L_f - L_{fh})$ by rewriting the budget constraint (31):

$$L_m w_m + w_f L_f = \sum_{j=1,s,h} p_j c_j = p_h c_h \sum_{j=1,s,h} E_{j,h}. \tag{36}$$

Rearranging, we obtain:

$$\frac{L_{fh}}{L_f} = \frac{I_h(x)}{I(x) \sum_{j=1,s,h} E_{j,h}}, \tag{37}$$

where

$$I_j(x) \equiv \frac{w_f L_{fj}}{p_j y_j} = \xi_j \left[z_j(x)\right]^{1/\eta - 1} \tag{38}$$

is the female wage bill share in sector j and

$$I(x) \equiv \frac{w_f L_f}{w_f L_f + w_m L_m} = \frac{1}{1 + \frac{L_m}{x L_f}} \tag{39}$$

is the female wage bill share in total work. The fraction of female working time supplied to the market is $\mu_f = 1 - \frac{L_{fh}}{L_f}$, which is a function of the wage ratio and relative prices because the relative expenditure is a function of relative prices see eqn 35. Intuitively, equation (37) states that when the expenditure for either market commodity rises relative to home production (i.e. $E_{1,h}$ and $E_{s,h}$ rise), and/or when the female wage bill share in the market more than in the household $(I_h(x)/I(x)$ falls), women shift their working time from the household to the market.

3.3.2 Market Equilibrium

Given the optimal firm and household decisions, we use market clearing to determine relative prices and the wage ratio. Using (30), we can derive relative prices as function of the wage ratio:

$$\frac{p_k}{p_j} = \frac{A_j \xi_j}{A_k \xi_k} \left(\frac{z_j(x)}{z_k(x)} \right)^{1/\eta}; \qquad j, k = 1, s, h. \tag{40}$$

Give relative expenditures in (33) and (35), women's time allocation can be derived from production functions (5) and (29),

$$\frac{L_{fi}}{L_{fj}} = \frac{(L_j/L_{fj})}{(L_i/L_{fi})} \frac{A_j c_i}{A_i c_j}, \qquad i, j = 1, s, h. \tag{41}$$

Using (11) and (40), condition (41) can be rewritten as

$$\frac{L_{fi}}{L_{fj}} = E_{i,j} \frac{\xi_i}{\xi_j} \left(\frac{z_i(x)}{z_j(x)} \right)^{1/\eta - 1} = E_{i,j} \frac{I_i(x)}{I_j(x)}, \qquad i, j = 1, s, h. \tag{42}$$

which is an intuitive condition. That is, female relative time allocation to a sector is determined by the between-sector alloction of expenditure $(E_{i,j})$ and the within sector distribution of the wage bill across genders**.** By substituting (42) into the female time constraint (16), the demand for female home production time is

$$\frac{L_{fh}}{L_f} = \frac{1}{\sum\limits_{j=1,s,h} E_{j,h} \frac{I_j(x)}{I_h(x)}}. \tag{43}$$

We can now solve for the equilibrium gender wage ratio x by equating demand (43) and supply (37), i.e.

$$I(x) \sum_{j=1,s,h} E_{j,h} - \sum_{j=1,s,h} I_j(x) E_{j,h} = 0. \tag{44}$$

Thus the gender wage ratio x, and as a result, female labour supply $\mu_f = 1 - \frac{L_{fh}}{L_f}$, depend on both structural transformation and marketization. Changes that are gender-neutral such as shocks to sector-specific productivity A_j can trigger marketization and structural transformation, which in turn affect female market hours μ_f and the relative wage x. More explicitly, from the expressions for relative prices (40) and relative expenditures (33) and (35), equilibrium (x, μ_f) depends on marketization and structural transformation as defined in (21). This completes the derivation for the decentralized equilibrium. It is important to point out that Propositions 1-4 hold in this more general model for ξ_s close to ξ_h.[10]

[10] The main change is the presence of additional equilibrium effect via the wage ratio x, as the hours ratio in the home sector is a function of x in sccording to (8).

Table 3: Data Targets

	CPS data				ATUS data		
year	$\frac{w_f}{w_m}$	s	s_f	s_m	μ_f	μ_m	$\frac{\mu_f}{\mu_m}$
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

With time use data, the beginning-of-period figure is the average of values recorded in 1965 and 1975.

4 Quantitative Results

Below we quantitatively assess the importance of structural transformation and marketization in accounting for the rise in the wage ratio and female market hours relative to male. We now explain how the model's variables are related to the data and how we calibrate the model.

4.1 Data Targets

Data on the wage ratio are obtained from the CPS, 1968-2009. For each year in the CPS we first regress log wages on a female dummy, age and its square, three education dummies and a nonwhite dummy. We then obtain the wage ratio adjusted for human capital as (the exponential of) the coefficient on the female dummy in wage regressions. Data on the allocation of hours across goods and services within the market are obtained using information on total annual market hours by sector and gender from the CPS, while data on the allocation of hours across the household and the market are obtained from information on usual weekly hours from the ATUS, 1965-2009.

To smooth out short run fluctuations and possibly single-year outliers that are not relevant for model predictions, we use take a five-year average at the beginning and at the end of our sample period, respectively, as targets for our model. All data targets used are summarized in Table 4.

4.2 Calibration

As shown in the model, the intensities of structural transformation and marketization are defined as $ST \equiv (1-\varepsilon)(\gamma_1 - \gamma_s)$ and $MT \equiv (\sigma - 1)(\gamma_s - \gamma_h)$, respectively. While the productivity differential $\gamma_1 - \gamma_s$ is directly measurable, the other three parameters are less straightforward to pin down. 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; McGrattan et al., 1997, 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, Rogerson and Valentinyi (2013) on newly-constructed consumption value-added data. Herrendorf, Rogerson and Valentinyi (2013) argue that if the sectoral production functions are value-added production functions, as it is the case in our model, the arguments of the utility function should be the value added components of final consumption - as opposed to consumption expenditures. Using input-output tables to construct a time-series for consumption value-added, they obtain an estimate for ε of 0.002,[11] which we use as our benchmark value. As regards productivity growth, note that γ_j in our model does not coincide with labor productivity growth, as labor productivity is measured based on total hours worked by both genders combined, while A_j denotes productivity of the composite labor input L_j, as defined in equation (6). In the Appendix we illustrate the mapping of actual labor productivity growth into γ_j using data on gender intensity from the CPS. The implied difference in growth rates is $\gamma_1 - \gamma_s = 1.2\%$. Turning to productivity growth in the home sector, the Bureau of Economic Analysis (BEA) has recently re-caculated U.S. household production using national accounting conventions (see report by Bridgman et al 2012 and references therein). The basic idea consists in estimating value added by imputing income to labor and capital used in home production. Based on this procedure, Bridgman (2013) finds that the average labour productivity growth in home production is 0.5%. During the same period, BEA data reveals that the average labour productivity growth for the service sector is 1.2%, and thus we set $\gamma_s - \gamma_h = 0.7\%$ as our benchmark. We perform sensitivity analysis on $(\sigma, \varepsilon, \gamma_s - \gamma_h)$ in Section 5.4.

The four parameters σ, ε, $\gamma_1 - \gamma_s$ and $\gamma_s - \gamma_h$ help measure directly the intensities of structural transformation and marketization. Given such intensities, the model's predictions for the change in working hours and the wage ratio depends on the gender-related parameters, and namely the time series for the hours ratio $\frac{L_{ft}}{L_{mt}}$, the elasticity of substitution η and the technology parameters (ξ_1, ξ_s, ξ_h).

Changes in $\frac{L_{ft}}{L_{mt}}$ 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 our strategy is to pick the growth rate in $\frac{L_{ft}}{L_{mt}}$ that matches their combined change. During 1968-2009, the population ratio decreased from 1.15 to 1.086 in the CPS, while the hours ratio rose from 1.046 (1965 data) to 1.025 in time use surveys. Together these figures imply that the hours ratio is falling at a rate of 0.18% per year.

As for the elasticity of substitution between male and female labour inputs, η, we draw on both existing estimates and our own estimates on the CPS. Hamermesh (1993) reports evidence on the male-female elasticity of substitution of 2 and 2.3 for the UK and Australia, respectively (Layard, 1983; Lewis, 1985). More recently, Weinberg (2000) obtains an estimate for this parameter for the

[11] They find that the estimate is not statistically significantly different from zero. Our results are almost identical for the case of $\varepsilon = 0.002$ or $\varepsilon = 0$.

US of 2.4, and Acemoglu, Autor and Lyle (2004) obtain a slightly higher estimate of about 3. We also attempt to estimate η using CPS data on hours and wages by gender aggregated at the state level. Our regression equation is

$$\ln \frac{w_{mst}}{w_{fst}} = \beta_0 + \beta_1 \ln \frac{L_{mst}}{L_{fst}} + \beta_2 \frac{h_{mst}}{h_{fst}} + \beta_s + \beta_t + \varepsilon_{st}, \tag{45}$$

where w_{mst} and w_{fst} are average wages by gender in state s and year t, L_{mst} and L_{fst} are the corresponding aggregate hours, h_{mst} and h_{fst} are controls for human capital, and β_s and β_t represent state and time fixed-effects, respectively. Human capital indicators are gender-specific vectors of proportions of college graduates, high-school graduates with some college and high school graduates, and β_2 denotes the vector of associated parameters. Equation (45) is estimated for 1977-2009, as information on state of residence is only available in a consistent form from 1977 onwards. Cells in the regression are weighted by each state's population and standard errors are clustered at the state level. The resulting estimate for β_1 is -0.241 (s.e. 0.057), implying an elasticity of substitution just above 4. In what follows we take 3 as our benchmark value for η, which roughly coincides with the average of existing estimates for the US, and we perform some sensitivity analysis in Section 5.3.

We next describe how we match the six data targets $\left(x_{t^*}, s_{t^*}, s_{ft^*}, s_{mt^*}, \mu_{ft^*}, \mu_{mt^*}\right)$ at any point in time t^*. We show in the Appendix that they are matched by six parameters $\left(\frac{L_{ft^*}}{L_{mt^*}}, \xi_1, \xi_s, \xi_h, \hat{A}_{1,s}, \hat{A}_{s,h}\right)$ where[12]

$$\hat{A}_{s,h} \equiv \left(\frac{A_s}{A_h}\right)\left(\frac{1-\psi}{\psi}\right)^{\frac{\sigma}{1-\sigma}}; \quad \hat{A}_{1,s} \equiv \left(\frac{A_1}{A_s}\right)\left(\frac{1-\omega}{\omega}\right)^{\frac{\varepsilon}{1-\varepsilon}} \psi^{\frac{\frac{\sigma-\varepsilon}{1-\sigma}-\varepsilon}{1-\varepsilon}}. \tag{46}$$

Given the six parameters and the calibrated growth rates, the model delivers predictions for $\left(x_t, s_t, s_{ft}, s_{mt}, \mu_{ft}, \mu_{mt}\right)$ for any period t. While in most cases one would match data targets at the start of the sample period and make predictions forward by feeding in the exogenous dynamic process, we match data targets to 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 perfectly unless labor market discrimination is explicitly taken into account, as the implied parameters levels would be far from the true one even if our model were a good description of the economy except for discrimination. It seems instead more reasonable for a model without gender discrimination to match gender-specific moments in the late 2000s.

Specifically, we match the wage ratio and time allocation by genders across market and the household for the average of 2005-2009. We then feed in the productivity growth differentials to predict the average wage ratio and time allocation during 1968-1972. The exact calibration

[12] Note that the growth of $\hat{A}_{jk}$ are identical as the growth of A_{jk}, which explains why the calibration of γ_{jk} is sufficient for the prediction on future levels of $\hat{A}_{jk}$.

Table 4: Baseline Parameters

Parameters	Values	Targets
$\gamma_1 - \gamma_s$	1.2%	labor productivity growth in goods and services, adjusted for gender intensity
$\gamma_s - \gamma_h$	0.7%	Bridgman (2013) on home productivity and BEA on service productivity
σ	2.3	max. estimate for elasticity of subst. between all market goods and home production
ε	0.002	elasticity of substitution across goods and services, Herrendorf et. al. (2013)
η	3	avg. of our estimates and other estimates on elasticity of subst. across gender
γ_{L_f/L_m}	-0.18%	CPS data on population and time use data on total work across genders
$\frac{L_{ft^*}}{L_{mt^*}}$	1.19	match s given (s_f, s_m, μ_f, μ_m)
ξ_1	0.332	match relative wage x and relative hours ratio $\frac{L_{f,1,t^*}}{L_{m,1,t^*}} = \left(\frac{1-s_f}{1-s_m}\right)\left(\frac{\mu_f}{\mu_m}\right)\frac{L_{ft^*}}{L_{mt^*}}$
ξ_s	0.443	match relative wage x and relative hours ratio $\frac{L_{f,s,t^*}}{L_{m,s,t^*}} = \left(\frac{s_f}{s_m}\right)\left(\frac{\mu_f}{\mu_m}\right)\frac{L_{ft^*}}{L_{mt^*}}$
ξ_h	0.495	match relative wage x and relative hours ratio $\frac{L_{f,h,t^*}}{L_{m,h,t^*}} = \left(\frac{1-\mu_f}{1-\mu_m}\right)\frac{L_{ft^*}}{L_{mt^*}}$
$\hat{A}_{s,h}$	1.02	match female's time allocation across market and home $\frac{L_{f,s,t^*}}{L_{f,2h,t^*}} = \frac{\mu_f s_f}{1-\mu_f}$
$\hat{A}_{1,s}$	10.8	match female's time allocation across goods and services $\frac{L_{f,1,t^*}}{L_{f,s,t^*}} = \frac{1-s_f}{s_f}$

procedure for the six level parameters is described in the Appendix. In summary, given the gender specific time allocation (s_f, s_m, μ_f, μ_m), in order to match the service hours share s we need the aggregate hours ratio $\frac{L_{ft^*}}{L_{mt^*}}$. The implied $\frac{L_{ft^*}}{L_{mt^*}}$ for the 2005-2009 is 1.19, which is very close to the number we would obtain on the CPS and time use data directly, 1.12. One would not expect these two figures to coincide if actual labor market outcomes are affected by potentially important elements not present in our model, such as discrimination against women or barriers to mobility across sectors, but the fact that the two figures are very close suggests that a model without discrimination or mobility barriers does a relatively good job at capturing the hours ratio for the period 2005-2009. We then set ξ_j to match the within-sector hours ratio according to (8). Finally, together with the allocation of hours across sectors, we pin down $\left(\hat{A}_{s,h}, \hat{A}_{s,h}\right)_{t^*}$. Baseline parameters are summarized in Table 4

5 Quantitative Results

5.1 Baseline Results

Table 5 reports our baseline results. Using the baseline parameters (row 1), our model perfectly replicates the rise in services. The service share rises from 0.58 to 0.75 in the data, and the model replicates this rise almost exactly.[13] Using a similar framework without a gender dimension, Ngai

[13] The percentage explained for any variable x_t are computed as $\left(\frac{x_1^{\text{model}} - x_0^{\text{model}}}{x_1^{\text{data}} - x_0^{\text{data}}}\right)$ where period 0 is 1968-72 and period 1 is 2005-2009. Given we matched period 1, $x_1^{\text{model}} = x_1^{\text{data}}$.

and Pissarides (2008) explain about 73% of the rise in services. As it will become clear in the Sensitivity Analysis Section 5.4, the improvement here is due to stronger structural transformation than in Ngai and Pissarides (through lower ε than in their calibration) and stronger marketization (through higher $\gamma_s - \gamma_h$). By introducing a gender dimension, the main value-added of our framework consists in providing predictions for the wage ratio as well as the separate dynamics of male and female hours, as illustrated below.

The model replicates quite well time allocation for women but not as well for men. Let's consider time allocation across market sectors first. In the data, 75% of women's market hours and 51% of men's market hours are initially spent in the service sector, rising to 88% and 65%, respectively by the end of the sample period. The model explains about 87% of the rise in service hours for women but overpredicts the rise for men. We turn next to allocation between the market and the home sector. In the data, the average woman allocates 36% of her total working hours to the market in the late 1960s, rising to 45% by the late 2000s, while for men the corresponding fraction falls from 78% to 68%. The model explains 44% of the rise for women but only 11% of the fall in men. In relative term, the model accounts for one third of the observed rise in the ratio of the market hours share for women, relative to men. Finally, in the data the wage ratio rises from 0.64 to 0.77, and our model accounts for about one third of this rise.

There are three major driving forces for the change in the share of services, the wage ratio, and male and female market hours and their ratio. First, there are two demand forces stemming from structural transformation and marketization in the presence of women's comparative advantages in producing services, whose effects are summarized in Propositions 1-4. Furthermore, there is a supply shock, and namely the fall in the total hours ratio L_f/L_m by about 0.18% per year. To understand the relative contribution of these three forces, we conduct three counter-factual experiments, muting each force in turn. The results are shown in rows 2-4 of Table 5.

In row 2 we set $\gamma_1 - \gamma_s = 0$, thus shutting down the structural transformation channel, 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 (39%, 30% and 59%, respectively). This is in line with proposition 4. More importantly, the intensity of structural transformation is quantitatively relevant for the rise in the wage ratio, and in particular it contributes to more than a half of its predicted increase, confirming Proposition 1. Finally, structural transformation is key to account for the fall in male market hours as a fraction of total hours, as without it the model would actually predicts a rise in the male market hours share. The results also confirms the dampening effect of structural transformation on the rise of female market hours as a share of total hours, as the model's prediction for the female hours share now improves by 20%. These results are in line with Proposition 2.

In row 3 we set $\gamma_s - \gamma_h = 0$, which is equivalent to shutting down the marketization channel. This exercise shows that marketization is essential for the rise in female market hours, and a model without it would in fact predict a fall in female market hours (according to Proposition

4), as structural transformation alone would move resources from the goods sector to the service sectors, including the home. Comparing rows 1 and 3 also illustrates the dampening effect of marketization on the fall of male market hours - consistent with Proposition 2. In its absence the model can predict only half of the fall in men's market hours.

Finally, comparing rows 2 and 3 with row 1 confirms both Proposition 3 and 4. First, marketization has a stronger effect on female market hours than male market hours, while the opposite happens for structural transformation - thus they both contribute to the rise in μ_f/μ_m (consistent with Proposition **3**). Quantitatively, marketization contributes about 80 percent of the predicted rise in μ_f/μ_m whereas ST contributes the remaining 20 percent. Second, both structural transformation and marketization are quantitatively important in accounting for the rise in service employment share (consistent with Proposition 4), contributing to about 60% and 40% of the predicted rise, respectively.

Finally, by keeping $\frac{L_{ft}}{L_{mt}}$ constant in row 4, it can be shown that slight fall in the gender ratio of total working time mostly affects the wage ratio, and namely our model can account for 20% of the rise in the wage ratio absent this labor supply shock. However this does not affect in any discernible way other model predictions.

5.2 More on gender-biased demand shifts

Our model is novel insofar it allows the wage ratio, female market hours and male market hours to be endogenously determined by the evolving industry structure. As we discussed in the Model Section, structural transformation endogenously leads to a gender-biased labor demand shift, which is modeled as exogenous by Heathcote et al. (2010) and drives the entire rise in the wage ratio and the bulk of the rise in female market hours in their framework. Specifically, Heathcote et al (2010) consider the case $\eta \longrightarrow \infty$ and assume that $\xi/(1-\xi)$ in (13) grows exogenously so as to match the observed rise in the wage ratio. This is in turn interpreted as a gender-biased demand shift. In our multi-sector model we do not assume exogenous changes in $\xi_j^{'}$s but instead calibrate the $\xi_j^{'}$s to match the within-sector hours ratios during the late 2000s. The calibrated values are $\xi_1 = 0.33$ and $\xi_s = 0.44$, reflecting women's comparative advantages in services, and the aggregate ξ in the economy endogenously rises as labor reallocates from the goods to service sector. Quantitatively, though, this proposed mechanism is not strong enough to produce a substantial rise in aggregate ξ, explaining why we fail to explain a large portion of the evolution in gender-specific outcomes $\left(w_f/w_m, \mu_f, \mu_m, \mu_f/\mu_m\right)$.

To investigate how much of the gender-biased demand shifts in Heathcote et al (2010) may be attributed to structural transformation, we allow for exogenous growth in $\xi_j's$ at the same rate as in Heathcote et al. (2010). In their framework, exogenous growth in $\xi/(1-\xi)$ needs to match the observed rise in the wage ratio at 0.5% per year, implying a 0.5% growth rate in $\xi/(1-\xi)$ when $\eta \longrightarrow \infty$. This shock accounts for three quarters of the increase in relative female hours in their model.

In table 6, row 2, we let $\xi_1/(1-\xi_1)$ and $\xi_s/(1-\xi_s)$ grow at 0.5% per year, thereby explaining the whole rise in female market hours and 82% of the rise in the wage ratio.[14] The model's predictions also improve for men's market hours, now accounting for 56% of the observed fall. Finally the model can accounts for the whole **rise** in relative female hours. Comparing rows 1 and 2 reveals that structural transformation captures an important part of gender-biased demand shifts – it accounts for about 42% of the predicted increase in the wage ratio (34.4/81.6) and 36% of the predicted increase in women's relative market hours.

However, there may be other important factors that are observational equivalent to a rise in (ξ_1, ξ_s) in the current version of the model, most notably the rise in women's human capital levels relative to men. This change may be easily incorporated in our model, as the next section will illustrate.[15]

5.3 Role of Human capital

To allow for an exogenous rise in women's human capital levels relative to men's we replace raw (hours) labor inputs by efficiency units of labour $h_{gj}L_{gj}$, where h_{gj} denotes the efficiency units of one hour of labor for gender g in sector j. The composite labor expression (6) becomes

$$L_j = \left[\xi_j \left(h_{fj}L_{fj}\right)^{\frac{\eta-1}{\eta}} + \left(1-\xi_j\right)\left(h_{mj}L_{mj}\right)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}} \qquad j = 1, s, h \tag{47}$$

where the efficiency of human capital is assumed constant across market sectors $h_{g1} = h_{gs} = h_g$ for each gender g, but may differ in the household. As it will become clear later, the quantitative results are markedly different whether h_{gh} is lower than or equal to h_g. Each gender is paid a wage w_g in the market, which includes the return to their human capital.

The derivation of the extended model follows similar steps as in the baseline model, with two adjustments. First, equation (11) is now replaced by

$$\frac{L_j}{h_{fj}L_{fj}} = z_j(x) = \xi_j^{\frac{\eta}{\eta-1}}\left(1 + b_j^{\eta}x^{\eta-1}\right)^{\frac{\eta}{\eta-1}} \qquad j = 1, s, h. \tag{48}$$

In other words a_j is replaced by

$$b_j = \left(\frac{1-\xi_j}{\xi_j}\right)\left(\frac{h_{mj}}{h_{fj}}\right)^{\frac{\eta-1}{\eta}} = a_j\left(\frac{h_{mj}}{h_{fj}}\right)^{\frac{\eta-1}{\eta}} \qquad j = 1, s, h. \tag{49}$$

Second, the relatives price between market and home services in (40) is now

$$\frac{p_i}{p_j} = \frac{A_j\xi_j h_{f_j}}{A_i\xi_i h_{f_i}}\left(\frac{z_j(x)}{z_i(x)}\right)^{1/\eta}; \qquad i, j = s, h. \tag{50}$$

[14] The reason we cannot explain the whole rise in the wage ratio is that we assume finite η.

[15] Other potential factors include the decline in labor marker discrimination against women or changes in attitudes towards working women in both the labor and marriage markets (see Fernandez, 2013). Modelling these types of gender-biased shifts is outside the scope of our paper.

As the efficiency units of one hour of work are rising for women relative to men, the market parameter b_1 and b_s are falling over time. This has a qualitatively similar impact to allowing ξ_1 and ξ_s to grow in a model without human capital. In other words, the rise in women's human capital would have effects that go in the same direction as the effects of structural transformation.

It is clear from expressions (49) and (50) that whether or not human capital is productive in the household has key implications. If human capital is not useful at home, $h_{mh} = h_{fh} = 1$, then home production b_h is equal to a_h, which is a constant, thus market parameters b_1 and b_s are falling relative to b_h. Moreover, the extent of marketization in (33) now depends on $(\sigma - 1)\left(\gamma_s - \gamma_h + \gamma_{h_f}\right)$, as shown in the expression for the relative price (50), where γ_{h_f} denotes the growth in women's human capital.[16] Therefore women's accumulation of human capital delivers more intensive marketization, in turn implying a higher rise in female market hours and the service share, and a smaller rise in the wage ratio.

To assess the quantitative impact of human capital accumulation, we introduce it into our model by simply matching the growth in h_m and h_f to the gender-specific evolution of human capital observed in the data. Specifically, we estimate wage equations on the CPS for 1968-2009, including a female dummy, age and its square, a race dummy, education dummies and year dummies. The schooling categories are: high school dropout ($drop$), high school completed (hs), some college (sc), and college completed (cc). We the use the coefficients on the education dummies to construct the human capital index h_{gt} for each gender in each year as

$$h_{gt} = (x_{drop,gt} + \exp(\beta_{hs})x_{hs,gt} + \exp(\beta_{sc})x_{sc,gt} + \exp(\beta_{cc})x_{cc,gt}),$$

where the $x's$ 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).

Using these indices, we find that the gender ratio in human capital has risen from 0.98 to 1.02 during 1968-2009, with an average growth of 0.11% per year. We use these numbers to calibrate h_f/h_m. When human capital is equally productive in the market and home production, i.e. $h_{gh} = h_g$, the driving forces of labor market changes are still $(\gamma_1 - \gamma_s)$ and $(\gamma_s - \gamma_h)$, as in the baseline model. However, when human capital is not productive at home ($h_{fh} = h_{mh} = 1$), as previously explained, the relevant driving forces are $(\gamma_1 - \gamma_s)$ and $\left(\gamma_s - \gamma_h + \gamma_{h_f}\right)$, where γ_{h_f} is estimated to be 0.49% per year. Finally, note that the wage ratio x in the model with human capital is calibrated to unadjusted wage ratio, which increases from 0.63 in 1968 to 0.81 in 2009.

Row (3) and (4) of Table 6 report the quantitative results for each case, respectively. The main changes in the quantitative results happen when human capital is only useful in the market (row (4)). Two forces are at work here. First, the rise in h_f/h_m at 0.11% 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 row (2), in which a_1 and a_s are falling exogenously at 0.5% per year. Second, the rise in women's

[16] Similarily, the extent of marketization for men's hours depends on $(\sigma - 1)\left(\gamma_{2m} - \gamma_{2h} + \gamma_{h_m}\right)$, where γ_{h_m} denotes the growth in men's human capital.

relative human capital strengthens marketization, thereby reinforcing the model's prediction for μ_f and μ_f/μ_m. Together, comparing row (4) and row (1), these two forces double the model's predictions on μ_f and μ_f/μ_m. On the other hand, this worsens the model's prediction for the fall in men's market hours.

5.4 Sensitivity Analysis

We finally perform some sensitivity analysis on parameters $\varepsilon, \sigma, \gamma_s - \gamma_h$ and η. The results are reported in Table 7.

In our baseline we set $\eta = 3$, but in row 2 we allow for a higher elasticity $\eta = 10$. Comparing rows 1 and 2 shows that all baseline predictions remained virtually unchanged, except the model now can only account for 11% of the rise in the wage ratio. The reason is that with higher η, one now needs a smaller female comparative advantage in services to match wage and hours ratios, according to equation (8). In particular the implied (ξ_1, ξ_s, ξ_h) values become (0.40, 0.44, 0.45), and ξ_1 and ξ_s are too close for structural transformation to have a significant effect on the wage ratio.

The next four rows let the strength of marketization and structural transformation vary, according to alternative levels of $(\varepsilon, \sigma, \gamma_s - \gamma_h)$. The results are reported in rows (3)-(6) and show that our baseline predictions on the relative gender outcomes x and μ_f/μ_m are robust, while the prediction on the fall in μ_m is not robust to higher elasticity of substitution between market and home services.

Given that our utility structure is similar to that of Ngai and Pissarides (2008), we use their benchmark value of $\varepsilon = 0.1$, which implies a reduction in the intensity of structural transformation. Comparing row (3) to row (1), predictions improve slightly for the male's service share s_f and female market hours μ_f, but slightly worsen in most other dimensions, consistent with Propositions 1-4.

Next, we consider $\sigma = 3$, which is above the upper bound of 2.3 found for the elasticity of substitution across home services and all market commodities, and implies an increase in the marketization force. Comparing rows (1) and (4), the prediction for female market hours μ_f almost double, the prediction for the female service share s_f improves slightly, while the predictions for s and s_m deteriorate slightly. But the major difference is the predicted rise - as opposed to a fall - in male market hours μ_m. Male maret hours are now predicted to rise the strong marketization force is sufficient to attract even men to the market service sector. Despite this, the model explains 15 extra percentage points of the rise in μ_f/μ_m. Finally, the wage ratio is predicted to rise slightly less than in the baseline case. Again all these results are qualitatively consistent with Propositions 1-4.

We next lower the productivity growth differential between market and home services $\gamma_s - \gamma_h$. Our baseline calibration uses the estimate of home productivity growth obtained by Bridgman (2013). The same paper also notes, however, that the estimate for γ_h rises slightly if an alternative price deflator is used. Thus we next set $\gamma_s - \gamma_h = 0.4\%$, which is also the value used by Ngai and Pissarides (2008), and consistent with zero TFP growth in the home sector.[17] 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.

Finally, to corroborate our previous discussion on the equilibrium effects of a higher wage ratio on the service share in Section 3.2, we adopt Ngai and Pissarides (2008) calibration, by setting $\varepsilon = 0.1$ and $\gamma_s - \gamma_h = 0.4\%$ simultaneously. Results reported in row (6) show that the model now predicts 72% of the rise in the service share, which is nearly identical to 73% prediction of Ngai and Pissarides (2008), thus confirming that the equilibrium effect of x on s is small. As already stated, the main value-added of our framework is its set of predictions in the gender dimension, and our baseline results together with various sensitivity checks show that the model performs quite well in this aspect.

6 Conclusion

The narrowing of gender gaps in wages and market hours and the reallocation of labor from manufacturing into services are two of the most remarkable stylized facts of the post-war period. Motivated by these facts, we model an economy three sectors: goods, services and home, in which women have a comparative advantage in the production of services, both in the market and at home. Productivity growth is faster in market sectors than in home production, and, within the market, it is faster in manufacturing than in services. Both developments are women-friendly because women are both more likely to work in market services and are the main providers of home services. Marketization frees women's time from the home and structural transformation creates the jobs that the women can do in the market.

When calibrated to the U.S. economy, our model does a very good job in predicting the evolution of both the overall service share, and the involvement of each gender in producing services. The model also explains one-third of the narrowing gender gaps in wages and market hours.

[17] As shown by Bridgman (2013), and used in our baseline, $\gamma_s - \gamma_h$ can be higher than the difference in the correspinding TFP growth rates if, for example, market services are more capital intensive than home services, as falling relative price of capital will raise $\gamma_s - \gamma_h$. On the other hand, it is also possible for $\gamma_s - \gamma_h$ to fall short of the difference in TFP growth if biased technological progress reduces the relative price of household durables (Greenwood et al. 2004), thus benefiting the home sector relativel more.

7 Appendix

7.1 The Model

7.1.1 Deriving equilibrium conditions (9) and (12)

From equation (8), L_{mj} can be expressed as function of L_{fj} :

$$L_{mj} = (a_j x)^{\eta} L_{fj}$$

Substituting into the resource constraint (7) for $g = m$ gives

$$(a_1 x)^{\eta} L_{f1} + (a_2 x)^{\eta} L_{f2} = L_m$$

Together with the resource constraint (7) for $g = f$ we obtain (9). Using the utility function (4) and production function (5), equalization of VMPL for L_{f1} and L_{f2}:

$$\frac{\omega}{1-\omega}\left(\frac{y_2}{y_1}\right)^{1/\varepsilon} = \frac{\xi_2 A_2}{\xi_1 A_1}\left(\frac{L_2/L_{f2}}{L_1/L_{f1}}\right)^{1/\eta}$$

rewrite as

$$\frac{\omega}{1-\omega}\left(\frac{A_2 L_{f2}}{A_1 L_{f1}}\right)^{1/\varepsilon} = \frac{\xi_2 A_2}{\xi_1 A_1}\left(\frac{L_2/L_{f2}}{L_1/L_{f1}}\right)^{1/\eta - 1/\varepsilon}$$

solving for

$$\frac{L_{f_1}}{L_{f2}} = \left(\frac{\omega}{1-\omega}\right)^{\varepsilon}\left(\frac{A_2}{A_1}\right)^{1-\varepsilon}\left(\frac{\xi_1}{\xi_2}\right)^{\varepsilon}\left(\frac{L_2/L_{f2}}{L_1/L_{f1}}\right)^{1-\varepsilon/\eta} \tag{51}$$

obtain (10) by definition (11). Finally use the resource constraint for female to derive (12).

7.1.2 Unique 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 $\frac{L_{f1}}{F} \in [0, 1]$. Using the first equilibrium condition (9), it requires $a_1{}^{\eta} \leqslant x^{-\eta}\frac{L_m}{L_f} \leqslant a_2{}^{\eta}$, result follows. ■

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

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

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

Proof. From (9), $T'(.) < 0$. From (12)

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

Given $a_1 > a_2$, if $\eta \leqslant \varepsilon$, $D'(.) > 0$. If $\eta > \varepsilon$, then $D'(.) < 0$. From (9) and (12)

$$T'(x) = \frac{-\eta x^{-\eta-1}}{a_1 - a_2}\left(\frac{L_m}{L_f}\right); \qquad D'(x) = \frac{R'(x)}{[1 + R(x)]^2};$$

where using (10)

$$\frac{R'(x)}{R(x)} = \frac{(\eta - \varepsilon)(a_2 - a_1)x^{\eta-2}}{(1 + a_2 x^{\eta-1})(1 + a_1 x^{\eta-1})} < 0$$

Using $T'(.)$, $D'(.)$, and definition of x^*, at any $x = x^*$

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

the second term is negative, and the term in the bracket is

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

Given $a_1 > a_2$, $T'(x) - D'(x) < 0$ for any $x = x^*$. ■

Proposition 8 *Equilibrium x^* is unique.*

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

7.1.3 Aggregation across market and home

Rewrite the production function (15) 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

$$\frac{c_s}{c_h} = \frac{A_s}{A_h}\left(\frac{L_{fs}}{L_{fh}}\right) = \left(\frac{\psi A_s}{(1 - \psi)A_h}\right)^{\sigma} \tag{52}$$

where the last equality follows from (18). Substituting into (14),

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

using definition of R_{mh} in (18),

$$c_2 = c_s \left[\psi \left(\frac{1+R_{mh}}{R_{mh}} \right) \right]^{\frac{\sigma}{\sigma-1}}. \tag{53}$$

Finally, using (15), (17) and (18)

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

substitute into (53), the productivity index for the hypothetical production of c_2 is

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

results for γ_2 follows from taking time derivative and using definition of R_{mh} in (18).

7.2 Calibration and Computation

7.2.1 Baseline Model

Here we give details on (1) how we match the levels of $(s, s_f, s_m, \mu_f, \mu_m)$ for the average of 2005-2009 and (2) how productivity growth differences γ_{jk} between sector j and sector k is computed.

Matching 2005-2009 The time allocation by each gender $g = m, f$ are

$$\frac{L_{gj}}{L_g} = \left\{ \begin{array}{ll} \mu_g (1-s_g) & j=1 \\ \mu_g s_g & j=s \\ 1-\mu_g & j=h \end{array} \right\}, \tag{54}$$

which are uniquely pinned down by the data on (s_f, s_m, μ_f, μ_m). The gender hours ratios in the production function are

$$\frac{L_{fj}}{L_{mj}} = \left\{ \begin{array}{ll} \frac{1-s_f}{1-s_m} \left(\frac{\mu_f}{\mu_m} \right) \left(\frac{L_f}{L_m} \right) & j=1 \\ \frac{s_f}{s_m} \left(\frac{\mu_f}{\mu_m} \right) \left(\frac{L_f}{L_m} \right) & j=1 \\ \left(\frac{1-\mu_f}{1-\mu_m} \right) \left(\frac{L_f}{L_m} \right) & j=1 \end{array} \right\}, \tag{55}$$

which depends on the level of $\frac{L_f}{L_m}$ which can be set to match the service employment share:

$$s = \frac{L_{ms} + L_{fs}}{L_{m1} + L_{f1} + L_{ms} + L_{fs}} \tag{56}$$

rewrite it as

$$\frac{1}{s}=1+\frac{\left(\frac{L_{m1}}{L_m}\right)\left(\frac{L_f}{L_{fs}}\right)\left(\frac{L_m}{L_f}\right)+\frac{L_{f1}}{L_{fs}}}{\left(\frac{L_{ms}}{L_m}\right)\left(\frac{L_f}{L_{fs}}\right)\left(\frac{L_m}{L_f}\right)+1}. \tag{57}$$

Using (54) and (55), we can derive

$$\frac{L_f}{L_m}=\frac{\left(\frac{1-s_m}{s_m}\right)-\left(\frac{1-s}{s}\right)}{\left(\frac{1-s}{s}\right)-\left(\frac{1-s_f}{s_f}\right)}\left(\frac{\mu_m s_m}{s_f\mu_f}\right). \tag{58}$$

Thus given data on $\left(s_f, s_m, \mu_f, \mu_m\right)$, $\frac{L_f}{L_m}$ in 2005-2009 is set to match s in the data, which in turns determine the hours ratio (55) in the model.

Given data on relative wage x and hours ratio, we compute ξ_j from equilibrium equation (8). Finally, we match the time allocation in (54) by setting the levels of relative productivity $A_{jk}\equiv\frac{A_j}{A_k}$ and preference parameters (ω,ψ). Given data on time allocation $\left(L_{fj}, L_{mj}\right)_{j=1,s,h}$ and gender wage ratio $\left(x=\frac{w_f}{w_m}\right)$, we can compute

$$I_j\equiv\frac{w_f L_{fj}}{p_j c_j}=\frac{L_{fj}}{L_{fj}+\frac{w_m}{w_f}L_{mj}}.$$

and across sector j and sector k

$$E_{jk}=\frac{L_{fj}}{L_{fk}}\frac{p_j c_j}{w_f L_{fj}}\frac{w_f L_{fk}}{p_k c_k}=\frac{L_{fj}}{L_{fk}}\frac{I_k}{I_j}.$$

Using computed ξ_j from equilibrium equation (8) and the data, we derive

$$z_j(x)=\frac{L_j}{L_{fj}}=\left(\xi_j+\left(1-\xi_j\right)\left(\frac{L_{mj}}{L_{fj}}\right)^{\frac{\eta-1}{\eta}}\right)^{\frac{\eta}{\eta-1}}, \tag{59}$$

which give values for

$$\frac{A_k p_k}{A_j p_j}=\frac{\xi_j\left(z_j(x)\right)^{1/\eta}}{\xi_k\left(z_k(x)\right)^{1/\eta}}. \tag{60}$$

From marketization (33), we can write

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

so together with (60), we can compute an effective relative productivity in 2009

$$\hat{A}_{s,h}\equiv\left(\frac{A_s}{A_h}\right)\left(\frac{1-\psi}{\psi}\right)^{\frac{\sigma}{1-\sigma}}=\left(\frac{A_s p_s}{A_h p_h}\right)\left(\frac{1}{E_{s,h}}\right)^{\frac{1}{1-\sigma}}. \tag{61}$$

Similarly from structure transformation (35), we can write

$$E_{1,s} = \left(\frac{\omega}{1-\omega}\right)^{\varepsilon} \psi^{\frac{\sigma-\varepsilon}{\sigma-1}} \left(\frac{p_s}{p_1}\right)^{1-\varepsilon} M$$

where

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

so together with (60), we can compute

$$\hat{A}_{1,s} \equiv \left(\frac{A_1}{A_s}\right) \left(\frac{1-\omega}{\omega}\right)^{\frac{\varepsilon}{1-\varepsilon}} \psi^{\frac{\frac{\sigma-\varepsilon}{1-\sigma}-\varepsilon}{1-\varepsilon}} = \frac{A_1 p_1}{A_s p_s} \left(\frac{M}{E_{1,s}}\right)^{\frac{1}{1-\varepsilon}}. \tag{62}$$

The growth rate of $\hat{A}_{jk}$ is simply $\gamma_{jk} \equiv \gamma_j - \gamma_k$.

Matching productivity growth Finally we describe how we obtain $(\gamma_1 - \gamma_s)$. Using data from Burea of Economic Analysis, we compute the real labour productivity growth in service and non-service sector, $\frac{\dot{B}}{B}$, where

$$Y_j = B_j \left(L_{fj} + L_{mj}\right); \tag{63}$$

where Y_j is the real value-added of sector j and L_{gj} is the hours of work by gender $g = m, f$. Using BEA data, B_j is simply real value-added per hour. We find $\gamma_{B1} = 2.47\%$ and $\gamma_{B2} = 1.24\%$, so the difference across the two sectors is 1.22%. To link γ_{Bj} to γ_j in the model, rewrite (63) as

$$Y_j = L_j B_j \frac{(L_{fj} + L_{mj})}{L_j};$$

where L_j is the CES form of male and female labour hours as in the model (**??**), so we have

$$A_j = B_j \left(\frac{L_{fj} + L_{mj}}{L_j}\right)$$

We can rewrite it as

$$A_j = B_j \left[\frac{L_{fj} + L_{mj}}{L_{fj}}\right] \left(\frac{L_{fj}}{L_j}\right),$$

where we can obtain the first two terms directly from the data and the last term from the model, where $\frac{L_j}{L_{fj}}$ is derived in before in (59).

To summarize, the growth rate we are interested is

$$\frac{\dot{A}_j}{A_j} = \frac{\dot{B}_j}{B_j} - \frac{\dot{I}_{fj}}{j_{fj}} + \frac{\dot{z}_j}{z_j}, \tag{64}$$

where from (59)

$$\frac{\dot{z}_j}{z_j} = -\frac{\left(1-\xi_j\right)\left(\frac{L_{mj}}{L_{fj}}\right)^{\frac{\eta}{\eta-1}}}{\xi_j + \left(1-\xi_j\right)\left(\frac{L_{mj}}{L_{fj}}\right)^{\frac{\eta}{\eta-1}}} \left(\frac{\dot{\overline{L_{mj}/L_{fj}}}}{L_{mj}/L_{fj}}\right)$$

where $I_{fj} \equiv \frac{L_{fj}}{L_{fj}+L_{mj}}$ is the intensity of female hours in sector j.

Together with the average $\frac{\dot{B}_j}{B_j}$from 1968-2009 from BEA, we can calibrate $\frac{\dot{A}_j}{A_j}$ using CPS data 1968-2009 related to gender, i.e. the hours ratio across gender $\frac{\dot{L_{mj}/L_{fj}}}{L_{mj}/L_{fj}}$. We obtain $(\gamma_1 - \gamma_s) = 1.17\%$, which is very close to the difference in the real productivity growth.

The computation algorithm is as follow: given $(\gamma_1 - \gamma_s) = 1.2\%$ and $(\gamma_s - \gamma_h) = 0.4\%$, we have the time series for $\hat{A}_{jkt}$, which allows us to solve for E_{jkt} and I_{jt}. Together with $\frac{L_f}{L_m}$, we can derive the gender wage ratio $\left(\frac{w_f}{w_m}(t)\right)$ from (44) and female labour supply using (37).

7.2.2 Extended model with human capital

The calibration is exactly the same as before with the presence of the term h_{mj}/h_{fj} starting from equation (59)

$$\frac{L_j}{h_{f_j} L_{fj}} = \left(\xi_j + (1-\xi_j)\left(\frac{h_{mj}L_{mj}}{h_{fj}L_{fj}}\right)^{\frac{\eta-1}{\eta}}\right)^{\frac{\eta}{\eta-1}}, \tag{65}$$

which give values for

$$\frac{A_k h_{fk} p_k}{A_j h_{fj} p_j} = \frac{\xi_j (z_j(x))^{1/\eta}}{\xi_k (z_k(x))^{1/\eta}}. \tag{66}$$

The relative expenditure $E_{s,h}$ is modified to

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

so the effective relative productivity

$$\hat{A}_{s,h} \equiv \left(\frac{A_s h_{fs}}{A_h h_{fh}}\right)\left(\frac{1-\psi}{\psi}\right)^{\frac{\sigma}{1-\sigma}} = \left(\frac{A_s p_s h_{fs}}{A_h p_h h_{fh}}\right)\left(\frac{1}{E_{s,h}}\right)^{\frac{1}{1-\sigma}}. \tag{67}$$

which has a growth rate $\gamma_s - \gamma_h + \gamma_{h_f}$ if human capital is not useful at home.

The growth rate γ_1 and γ_s are in principle different from the values calibrated for the baseline model because of the presence of human capital. As before, we rewrite

$$A_j = \frac{B_j}{h_f}\left[\frac{L_{fj}+L_{mj}}{L_{fj}}\right]\left(\frac{h_{fj}L_{fj}}{L_j}\right),$$

where we can obtain the first two terms directly from the data and the last term from the model, where $\frac{L_j}{h_{fj}L_{fj}}$ is derived in (65). With some algebra we have

$$\frac{\dot{A}_j}{A_j} = \frac{\dot{B}_j}{B_j} - \frac{\dot{h}_f}{h_f} - \frac{\dot{I}_{fj}}{I_{fj}} + \frac{(1-\xi_j)\left(\frac{h_f L_{fj}}{h_m L_{mj}}\right)^{\frac{\eta}{1-\eta}}}{\xi_j + (1-\xi_j)\left(\frac{h_f L_{fj}}{h_m L_{mj}}\right)^{\frac{\eta}{1-\eta}}}\left(\frac{\dot{h_f/h_m}}{h_f/h_m} + \frac{\dot{L_{fj}/L_{mj}}}{L_{fj}/L_{mj}}\right),$$

or as

$$
\begin{aligned}
\frac{\dot{A}_j}{A_j} &= \frac{\dot{B}_j}{B_j} - \left(\frac{\xi_j}{\xi_j + (1-\xi_j)\left(\frac{h_f L_{fj}}{h_m L_{mj}}\right)^{\frac{\eta}{1-\eta}}} \frac{\dot{h}_f}{h_f} + \frac{(1-\xi_j)\left(\frac{h_f L_{fj}}{h_m L_{mj}}\right)^{\frac{\eta}{1-\eta}}}{\xi_j + (1-\xi_j)\left(\frac{h_f L_{fj}}{h_m L_{mj}}\right)^{\frac{\eta}{1-\eta}}} \frac{\dot{h}_m}{h_m} \right) \\
&\quad - \frac{\dot{I}_{fj}}{I_{fj}} + \frac{(1-\xi_j)\left(\frac{h_f L_{fj}}{h_m L_{mj}}\right)^{\frac{\eta}{1-\eta}}}{\xi_j + (1-\xi_j)\left(\frac{h_f L_{fj}}{h_m L_{mj}}\right)^{\frac{\eta}{1-\eta}}} \frac{\dot{\overline{L_{fj}/L_{mj}}}}{L_{fj}/L_{mj}},
\end{aligned}
$$

In addition to the information for the baseline model, we also use CPS data for the growth rate of human capital for each gender $\left(\frac{\dot{h}_f}{h_f}, \frac{\dot{h}_m}{h_m}\right)$. We obtain $\gamma_1 - \gamma_s = 1.20\%$ which is very close to the numbers we found for the baseline model. This is not surprising given the our measure of growth in human capital are very small.

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Table 5: Baseline Results

			share of services	women's hours: services/ total market	men's hours services/ total market	women's hours: market/ total	men's hours: market/ total	women's/ men's: market/ total	wage ratio adjusted
	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
Baseline	model	1968-72	0.583	0.766	0.444	0.413	0.693	0.596	0.729
	% explained		99.5%	87.2%	145.7%	44.3%	10.9%	35.6%	34.4%
No structural transformation	model	1968-72	0.685	0.842	0.564	0.390	0.639	0.610	0.759
$\gamma_1 - \gamma_s = 0$	% explained		38.6%	30.4%	58.7%	67.1%	-48.1%	29.2%	11.3%
No marketization	model	1968-72	0.658	0.819	0.524	0.480	0.728	0.659	0.729
$\gamma_s - \gamma_h = 0$	% explained		54.6%	47.5%	87.7%	-19.4%	48.4%	6.3%	34.4%
No relative supply change:	model	1968-72	0.583	0.771	0.450	0.411	0.689	0.596	0.748
L_f/L_m is constant	% explained		99.1%	83.4%	140.6%	46.5%	6.6%	35.5%	20.1%

Table 6: Other Gender-Biased Shocks

			share of services	women's hours: services/ total market	men's hours services/ total market	women's hours: market/ total	men's hours: market/ total	women's/ men's: market/ total	wage ratio adjusted	wage ratio raw
	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
Baseline	model	1968-72	0.583	0.766	0.444	0.413	0.693	0.596	0.729	
	% explained		99.5%	87.2%	145.7%	44.3%	10.9%	35.6%	34.4%	
Exogenous gender-biased demand shift	model	1968-72	0.583	0.783	0.468	0.335	0.735	0.456	0.666	
$\xi_i/(1-\xi i)$ grows at 0.5%, i=1,s	% explained		99.0%	74.5%	128.3%	119.1%	55.9%	100.8%	81.6%	
Case (A): Human capital is useful everywhere	model	1968-72	0.586	0.769	0.447	0.412	0.691	0.596		0.738
	% explained		97.5%	85.1%	142.8%	45.6%	8.5%	35.6%		38.8%
Case (B): Human capital useful only in the market	model	1968-72	0.530	0.728	0.395	0.367	0.684	0.537		0.746
	% explained		130.5%	115.5%	180.6%	88.4%	0.8%	63.1%		34.0%

Table 7: Sensitivity Analysis

			share of services	women's hours: services/ total market	men's hours services/ total market	women's hours: market/ total	men's hours: market/ total	women's/ men's: market/ total	wage ratio adjusted
	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
Baseline	model	1968-72	0.583	0.766	0.444	0.413	0.693	0.596	0.729
	% explained		99.5%	87.2%	145.7%	44.3%	10.9%	35.6%	34.4%
Higher elasticity of substitution, male and female	model	1968-72	0.585	0.767	0.445	0.417	0.696	0.599	0.760
$\eta = 10$	% explained		98.3%	86.2%	144.3%	41.2%	13.4%	34.3%	10.7%
Higher elasticity of substitution, goods&services	model	1968-72	0.597	0.778	0.460	0.410	0.685	0.597	0.733
$\varepsilon=0.1$	% explained		91.0%	78.5%	133.9%	48.0%	2.3%	35.0%	30.9%
Higher elasticity of substitution, home&market services	model	1968-72	0.554	0.745	0.416	0.375	0.667	0.563	0.734
$\sigma=3$	% explained		116.7%	102.7%	165.4%	81.0%	-18.2%	51.1%	30.6%
Lower productivity growth diffeernce, home&market services	model	1968-72	0.617	0.791	0.479	0.441	0.707	0.623	0.729
$\gamma_s-\gamma_h = 0.4\%$	% explained		79.1%	68.5%	119.8%	18.2%	25.7%	23.0%	34.1%
Ngai-Pissarides (2008): home&market services	model	1968-72	0.630	0.800	0.494	0.438	0.701	0.624	0.733
$\varepsilon=0.1$, $\gamma s-\gamma h = 0.4\%$	% explained		71.6%	61.3%	109.2%	21.1%	18.8%	22.4%	31.1%

Figure 1:
Trends in (Market) Working Hours and Wages by Gender

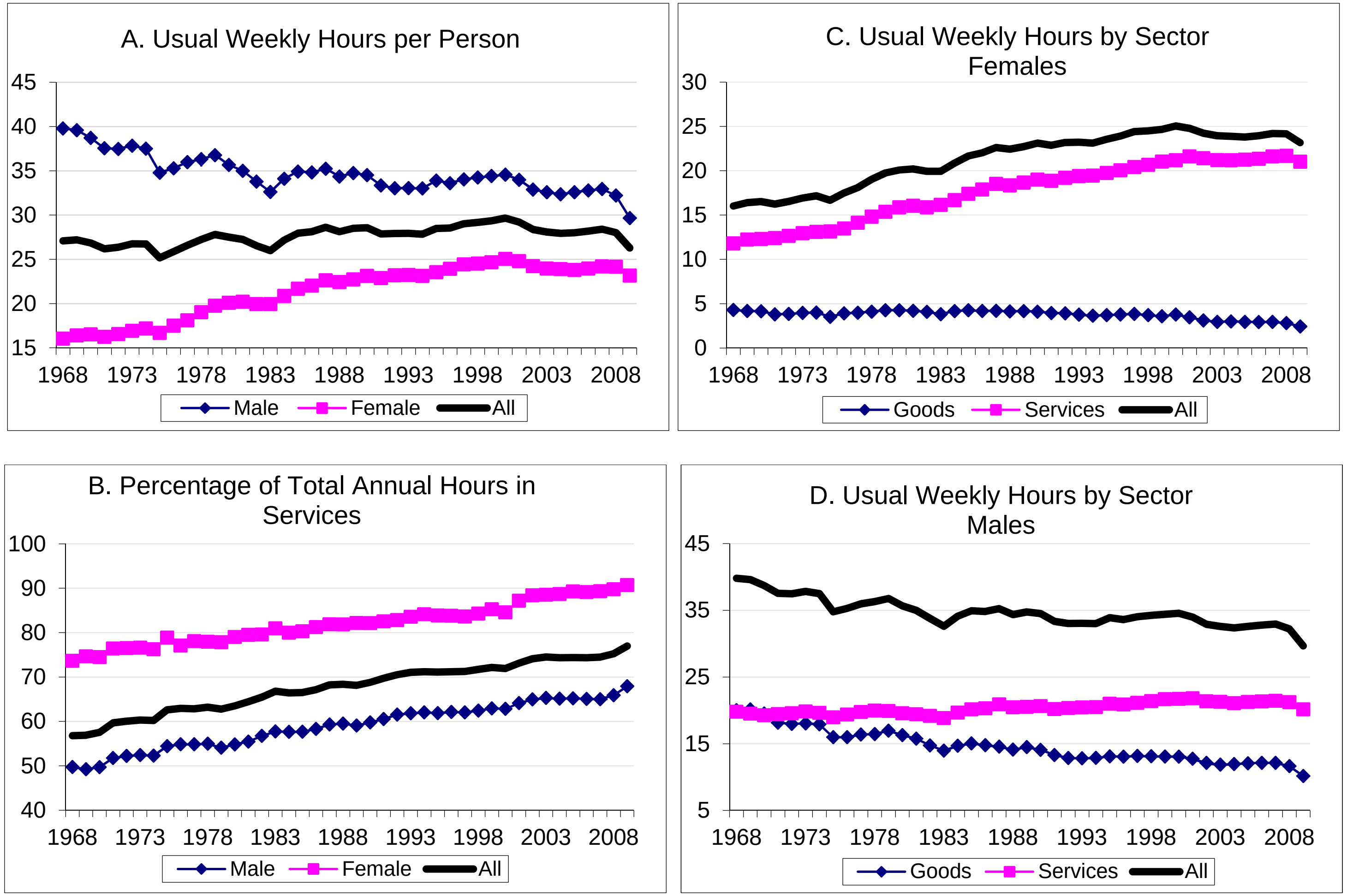
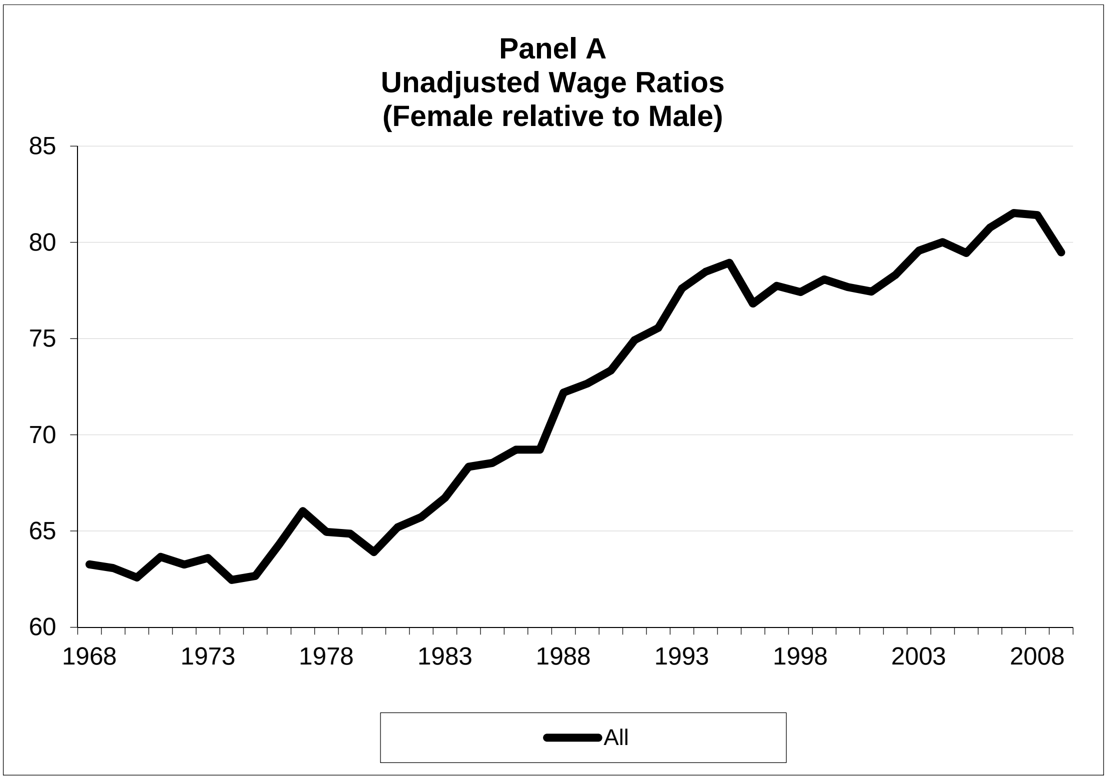


Figure 2:
Trends in Gender Wage Ratios by Sector



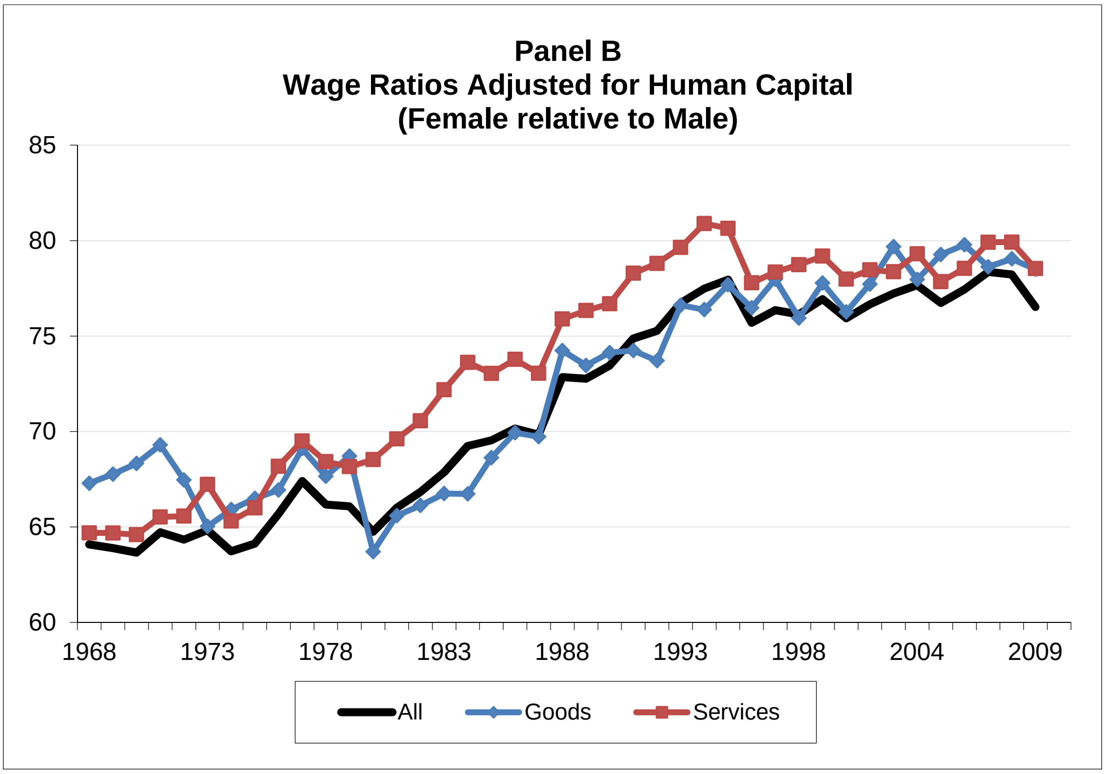


Figure 3
Trends in market work and home production by gender

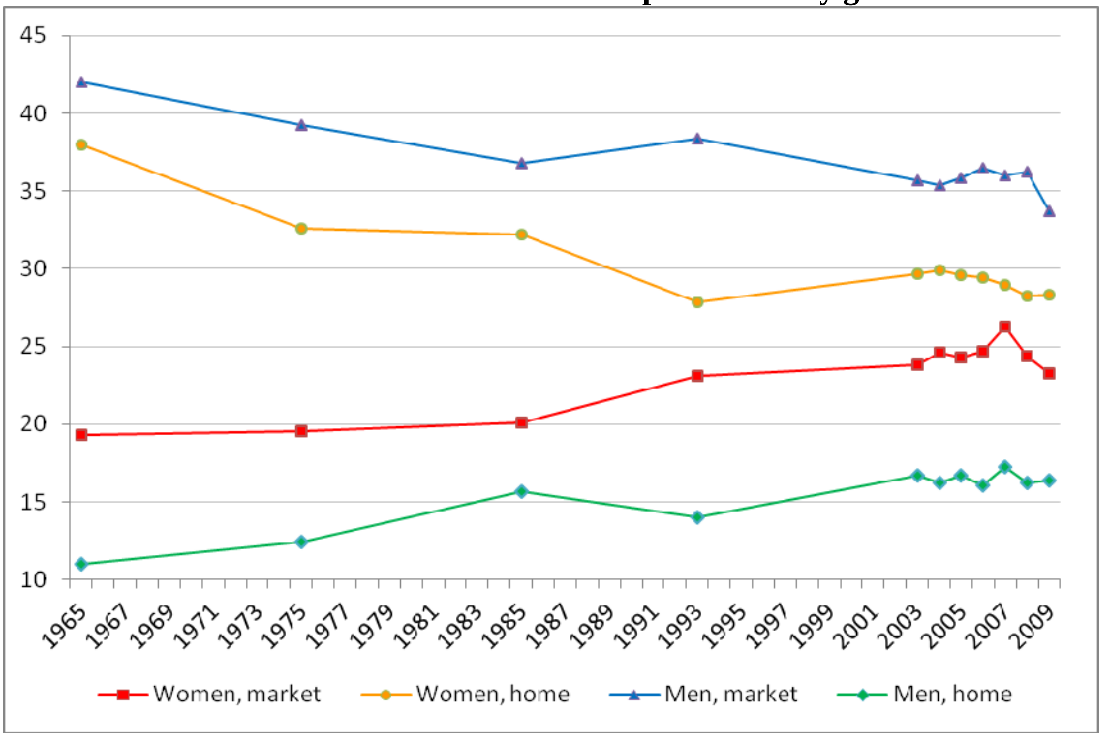
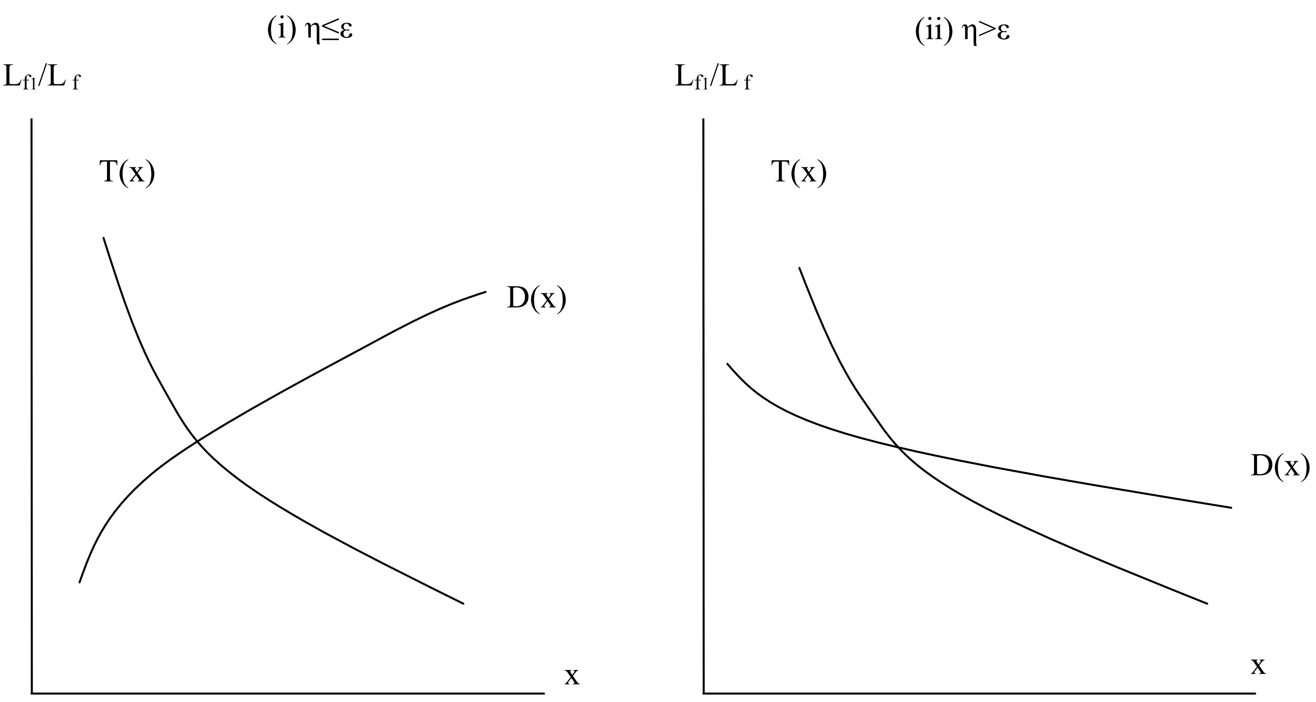


Figure 4
Equilibrium wage ratio $x=w_f/w_m$



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