Gender Gaps
and the Rise of the Service Economy*

L. Rachel Ngai
London School of Economics
and CFM, CEPR.

Barbara Petrongolo
Queen Mary University
and CEP (LSE), CEPR.

January 2017

Abstract

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

JEL codes: E24, J22, J16.

Keywords: gender gaps, structural transformation, marketization.

*We wish to thank Benjamin Bridgman, Berthold Herrendorf, Donghoon Lee, Alessio Moro, Richard Rogerson, Rob Shimer, and especially Alwyn Young and Chris Pissarides for helpful discussions; as well as seminar participants at LSE, NBER Summer Institute 2014, the Conference on Structural Change and Macroeconomics (PSE, 2014), and the Household and Female Labor Supply Conference (Arizona State U, 2015) for constructive comments. We also thank Benjamin Bridgman for sharing data on labor productivity in the home sector. Financial support from the ESRC (Grant RES-000-22-4114) and hospitality from the Institute of Advanced Studies at HKUST are gratefully acknowledged.

1 Introduction

One of the most remarkable changes in labor markets since World War II is the rise in female participation in the workforce. In the U.S., 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 vast literature on the causes, characteristics and consequences of the rise in women's involvement in the labor market. Existing work has indicated a number of supply-side explanations for these trends, including human capital investment, medical advances, technological progress in the household, and the availability of child care, and a recent line of research emphasizes the role of social norms regarding women's work in shaping the observed decline in gender inequalities.[1]

In this paper we propose a novel, and complementary, explanation for the observed trends in gender outcomes, based on the secular expansion of the service economy and its role in raising the relative demand for female work.[2] Our emphasis on the evolution of the industry structure is motivated by a few stylized facts. First, the sustained rise in female work since the late 1960s in the U.S. has been accompanied by a fall in male work, and a rise in women's relative wages. In 1968, women's hours were about 37% of men's hours, and their wages were about 62% of male wages. By 2008, these ratios rose to 73% and 81%, respectively. Second, the entire (net) rise in female hours took place in the broad service sector, while the entire (net) fall in male hours took place in goods-producing sectors, including the primary sector, manufacturing, construction and utilities. This pattern is closely linked to

[1] See Goldin (2006) for a comprehensive overview of historical trends and their causes. See (among others) Goldin and Katz (2002) and Albanesi and Olivetti (2016) for the role of medical progress; Greenwood, Seshadri and Yorukoglu (2005) for the role of technological progress in the household; Galor and Weil (1996) and Attanasio, Low and Sanchez-Marcos (2008) for the role of declining fertility. See Fernandez (2013) and references therein for theory and evidence on cultural factors.

[2] The focus on demand forces is appealing as it has the potential to address gender trends in both quantities and prices. Indeed the rise in female hours at a time of rising female wages "places a strong restriction on theories explaining the increase in female labor force participation" (Aguiar and Hurst, 2007a, p. 982).

the process of *structural transformation*, and specifically the reallocation of labor from goods to service industries, with an expansion of the service share from 56% in 1968 to 75% in 2008. Finally, the rise in women's hours in the service sector was accompanied by a strong decline in their working hours in the household, from about 41 to 31 hours weekly, consistent with substantial *marketization* of home production (Freeman and Schettkat, 2005).[3]

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

First, the production of services is relatively less intensive in the use of "brawn" skills than the production of goods, and relatively more intensive in the use of "brain" skills. As men are better endowed of brawn skills than women, the historical growth in the service sector has created jobs for which women have a natural comparative advantage (Goldin, 2006, Galor and Weil, 1996, Rendall, 2010, Weinberg, 2000, and Fan and Lui, 2003). While the introduction of brawn-saving technologies has to a large extent compensated the female disadvantage in physical tasks, women may still retain a comparative advantage in services, related to the more intensive use of communication and interpersonal skills, which cannot be easily automated. The simultaneous presence of producers and consumers in the provision of services makes these skills relatively more valuable in services, and a few studies have highlighted gender differences in the endowment and use of such traits (Borghans, Bas ter Weel and Weinberg, 2008, 2014). In particular, Borghans, Bas ter Weel and Weinberg (2014) show that the rise in the use of interpersonal tasks accelerated between the late 1970s and the early 1990s, and that women are overrepresented in these tasks, suggesting that women are relatively more endowed

[3] 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", and Bridgman (2013), documenting the rise in the ratio of services purchased relative to home production since the late 1960s.

in those increasingly valuable interpersonal skills. Finally, a recent strand of the experimental literature highlights some gender differences in other social attitudes such as altruism, fairness and caring behavior (Bertrand, 2010; Azmat and Petrongolo, 2014), which may be more highly valued in service jobs, and especially in those that involve assisting or caring for others.

Women's comparative advantage in services is clearly reflected in the allocation of women's hours of market work. In 1968, the average working woman was supplying three quarters of her market time to the service sector, while the average man was supplying only one half of his market time to it. As structural transformation expands the sector in which women are over-represented, it has potentially important consequences for the evolution of women's hours of market work. Indeed, in a shift-share framework, almost one third of the rise in the share of female hours took place via the expansion of services.

The second reason is related to women's involvement in household work. In 1965, women spent on average 41 hours per week in home production, while men only spent 11 hours. Household work includes child care, cleaning, food preparation, and in general activities that have close substitutes in the market service sector. If the expansion of the service sector makes it cheaper to outsource these activities, one should expect a reallocation of women's work from the household to the market. The work allocation of men and women in the late 1960s is thus key to understanding later developments. While women were mostly working in home production and the service sector, and thus their market hours were boosted by the rise in services, men were predominantly working in the goods sector, and their working hours mostly bore the burden of de-industrialization.

In our proposed model, market sectors produce commodities (goods and services) that are poor substitutes for each other in consumer preferences, while the home sector produces services that are good substitutes to services produced in the market. Production in each sector involves a combination of male and female work, and women have a comparative advantage in producing services, both in the market and the home. Labor productivity growth is uneven,[4] reducing both the cost of producing goods, relative to services, and the cost of producing market services, relative to home services. As goods and 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 reallocates hours of work from the home to market services, resulting in marketization.

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

To quantitatively assess the importance of the mechanisms described, we calibrate our model economy to the U.S. labor market and predict trends in gender outcomes. The calibrated marketization and structural transformation forces predict the entire rise in the service share between 1970 and 2006, 20% of the gender convergence in wages, one third of the rise in female market hours and 9% of the fall in male market hours. These predictions are solely due to between-sector forces, while no within-sector forces are at work. Allowing for a within-sector increase in the relative demand for female labor – due for example to the fall in gender discrimination and the evolution of gender norms – improves the model's predictions for gender-specific trends, leaving predictions for the industry structure unchanged. A simple way to summarize the quantitative performance of our model consists in comparing predicted and actual changes in the overall time allocation structure for men

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

and women across market goods, market services, home services and leisure. When between-sector forces alone are at work, the model explains nearly 60% of the variation in the time allocation structure during our sample period, and adding within-sector forces explains a further 30%.

There exist extensive literatures that have independently studied the rise in female labor market participation and the rise of services, respectively, but work on the interplay between the two phenomena is relatively scant. Early work by Reid (1934), Fuchs (1968) and Lebergott (1993) has suggested links between them, without proposing a unified theoretical framework. One notable exception is work by Lee and Wolpin (2006, 2010), who relate the rise in services and female labor market outcomes to shocks to fertility and the value of home time in a labor market equilibrium model.

Our work is related to Galor and Weil (1996) and Rendall (2010), who illustrate the consequences of brain-biased technological progress for female employment in a one-sector model in which females have a comparative advantage in the provision of brain inputs.[5] In a similar vein, we assume that women have a comparative advantage in producing services in a model with two market sectors and home production, in which the rise in female market hours and the share of services are simultaneous outcomes of uneven productivity growth. Marketization of home services, contributing to both the rise of female market work and the services share, also features in Akbulut (2011), Buera, Kaboski and Zhao (2013) and Rendall (2015). Our main contribution to this strand of literature is to endogenously explain the simultaneous narrowing of gender gaps in wages, market hours and home hours. Finally, the interplay between the service share and female outcomes has been recently studied in an international perspective by a few papers that relate lower female employment in Europe to an undersized service sector relative to the U.S. (Rendall, 2015; Olivetti and Petrongolo, 2014, 2016). In particular, Olivetti and Petrongolo (2014) find that the between-industry component of labor demand explains

[5] Heathcote, Storesletten and Violante (2010) and Jones, Manuelli and McGrattan (2015) also consider within-sector demand forces and illustrate the rise in the gender hours ratio stemming, respectively, from gender-biased technological progress and falling gender discrimination.

the bulk of the international variation in the gender-skill structure of labor demand, and Olivetti and Petrongolo (2016) confirm similar qualitative conclusions on a longer time period and a larger set of countries.

The recent literature on structural transformation often classifies the mechanisms that drive the rise in services into income and relative price effects.[6] With the first mechanism, income growth shifts the allocation of resources towards services as long as the demand for services is more elastic to income than the demand for goods. With the second mechanism, changes in relative prices alter the resource allocation when the elasticity of substitution between goods and services is not unity.[7] Both channels are at work in our model. Slower productivity growth in services raises their relative price, in turn raising the expenditure share on services, as services and goods are poor substitutes in consumption. Higher income elasticity of services follows from the assumption that market services are closer substitutes to home services than goods. Under this assumption, the rise in income driven by faster productivity growth in market sectors raises the opportunity cost of home production, in turn stimulating the demand for market services, as these are the closest available substitute to home production.

The paper is organized as follows. Section 2 documents relevant trends in gender work and the size of services during 1968-2008, combining data from the Current Population Survey and several time use surveys. Section 3 develops a model for a three-sector economy and shows predictions of uneven labor productivity growth for relative wages, market hours, home production hours and leisure. Section 4 presents quantitative results and Section 5 concludes.

[6] See Herrendorf et al (2013b) for a recent survey on the mechanisms. See (among others) Baumol (1967), Ngai and Pissarides (2007) and Acemoglu and Guerrieri (2008) for the role of uneven productivity or different capital intensities; Kongsamut, Rebelo and Xie (2001) and Buera and Kaboski (2012) for the role of income effects; and Boppart (2014) for both effects.

[7] See also Dix-Caneiro (2014) for an alternative explanation for the decline in the relative prices of goods due to trade liberalization, and its effects on the skill tructure of employment and wage along the classic mechanims of the Heckscher-Ohlin trade model.

2 Data and stylized facts

This Section presents evidence on the evolution of market work, wages and home production, using micro data from the March Current Population Surveys (CPS) for survey years 1968 to 2008 and time use surveys for 1965-2008.[8]

2.1 Market work

Our CPS sample includes individuals aged 21-65, who are not in full-time education, retired, or in the military. Annual hours worked in the market are constructed as the product of weeks worked in the year prior to the survey year and hours worked in the week prior to the survey week. This hours measure is the only one continuously available since 1968 and comparable across annual surveys. For employed individuals who did not work during the reference week, weekly hours are imputed using the average of current hours for individuals of the same sex in the same year. Until 1975, weeks worked in the previous year are only reported in intervals (0, 1-13, 14-26, 26-39, 40-47, 48-49, 50-52), and to recode weeks worked during 1968-1975 we use within-interval means obtained from later surveys. These adjustment methods have been previously applied to the March CPS by Katz and Murphy (1992) and Heathcote, Storesletten and Violante (2010). Our wage concept is represented by hourly earnings, obtained as wage and salary income in the previous year, divided by annual hours. Survey weights are used in all calculations.

Figure 1 presents evidence on market work. Panel A plots annual hours by gender, obtained as averages across the whole population, including the nonemployed. Female work rises steadily from about 720 annual hours in 1968 to nearly 1200 hours in the 2000s, while male hours gradually decline throughout the sample period, from about 2000 to 1700. These diverging trends imply a doubling of the hours ratio,[9] from about 0.36 to 0.73, with a modest increase in total hours in the economy.

[8] We choose to end our sample period in 2008 to avoid unusual fluctuations in economic activity and the industry structure linked to the onset of the Great Recession.

[9] Throughout the paper, hours and wage ratios indicate female/male ratios.

We classify market hours into two broad sectors, which we define as goods and services. The goods sector includes the primary industries, manufacturing, construction and utilities. The service sector includes the rest of the economy. Panel B in Figure 1 plots the proportion of hours in services overall and by gender, and shows an increase of 19 percentage points in the share of market hours worked by both males and females in services. For women, the service share is substantially higher than for men, and rises from 73% to 88%, while for men it rises from 50% to 65%. Panel C further shows that all of the (net) increase in female hours takes place in the service sector, while Panel D shows that all of the (net) fall in male hours takes place in the goods sector. In summary, while women are moving - in net terms - from nonemployment into the service sector, men are moving from the goods sector to nonemployment. These aggregate trends are also clearly confirmed within broad skill groups, as shown in Figure A1 in the Appendix.

Table 1 provides detailed evidence on the industry composition of total hours and the female intensity within each industry. The 19 percentage points' expansion in the service share is expected to boost female employment as the female intensity in services is much higher than in the goods sector. A similar point can be made across more disaggregated industries. The decline in the broad goods sector is disproportionately driven by the fall in manufacturing industries and, to a lesser extent, primary industries. Within the broad service sector, several industries contribute to its expansion (retail, FIRE, business services, personal services, entertainment, health, education, professional services and public administration). The female intensity is generally higher in expanding service industries than in declining goods industries. A further stylized fact to note is the rise in the female intensity in every industry.[10] The evidence summarized in Table 1 thus highlights both between- and within-industry components in the rise of female hours.

We quantify between- and within-industry components of trends in female

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

hours by decomposing the growth in the female hours share between 1968 and 2008 into a term reflecting the change in the share of services, and a term reflecting changes in gender intensities within either sector. Using a standard shift-share decomposition, the change in the female hours share between year 0 and year t can be expressed as

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

where l_{ft} denotes the share of female hours in the economy in year t, l_{jt} denotes the hours share of sector j, l_{fjt} denotes the share of female hours in sector j, and $\alpha_{fj} = (l_{fjt} + l_{fj0})/2$ and $\alpha_j = (l_{jt} + l_{j0})/2$ are decomposition weights. The first term in equation (1) represents the change in the female hours share that is attributable to changes in sector shares, while the second term reflects changes in the female intensity within sectors. The results of this decomposition are reported in Table 2. The first row reports the total change in the female hours share, which rises from 29% in 1968 to 44.4% in 2008. The second row shows that about 30% of this change was explained by the growth in the share of services, as measured by the first term in equation (1). The third row performs the same decomposition on 17, as opposed to two, industries, and delivers a very similar estimate of the role of the between-sector component. This means that, by focusing on our binary decomposition, we do not miss important between-sector dynamics in the rise in female hours.[11]

We have motivated our focus on the sectoral dimension of gender developments based on gender comparative advantages, via the more intensive use of non-physical tasks and interpersonal skills in the production of services rather than goods. However, tasks are more directly associated to occupations than sectors, and some sectors tend to use female labor more intensively because

[11] Olivetti and Petrongolo (2016) perform a similar analysis on a large panel of OECD countries, and find that variation in the services employment share explains about 60% of the overall variation in the share of female hours across countries since the 1970s. This proportion rises to about 80% when using a 12-fold industry classification, as the finer industries making up the two broad goods/service sectors vary considerably in size across countries.

they use more intensively occupations in which women have a comparative advantage. Thus the rise in female hours should have an important between-occupation component. This is shown in the fourth row of Table 2, based on a 4-fold occupational decomposition.[12] The between-occupation component explains about 24% of the total. This is somewhat smaller than the between-sector component, but still sizeable.

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

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

where k indexes occupations, l_{jkt} is the share of occupation k in industry j, l_{fjkt} is the share of female hours in occupation k and industry j, and $\alpha_{fjk} = (l_{fjkt} + l_{fjk0})/2$ and $\alpha_{jk} = (l_{jkt} + l_{jk0})/2$. The first term in (1) represents the between-industry component, the second term represents the between-occupation component that takes place *within* industries, and the last term represents the component that takes place within industry$\times$occupation cells. The results of this further decomposition are reported in the fifth row of Table 2, and show that only a small share (7.9%) of the growth in the female hours share took place via the expansion of female-friendly occupations within sectors. The bulk of the growth in female-friendly occupations took instead place via the expansion of the service share. We thus focus the rest of the paper on a binary goods/services distinction, as the decomposition results reported in

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

Table 2 suggest that this is a sufficient dimension for understanding relative female outcomes.

2.2 Wages

Evidence on wages is presented in Figure 2. Panel A shows the evolution of the wage ratio in the aggregate economy, obtained as the exponential of the gender gap in mean log wages, unadjusted for characteristics. Women's hourly wages remained relatively stable at or below 65% of male wages until about 1980, and then started rising to reach about 80% of male wages at the end of the sample period. The combined increase in female hours and wages raised the female wage bill from 30% to two thirds of the male wage bill. When using hourly wages adjusted for human capital (controlling for age and age squared, ethnicity, and four education levels), the rise in the gender wage ratio is only slightly attenuated, from 64% in 1968 to 78% in 2008 (Panel B). While a measure of actual, rather than potential, labor market experience is not available in the CPS, estimates by Blau and Kahn (2013) on the PSID show that gender differences in actual experience explain about a third of the rise in the wage ratio between 1980 and 1999. Thus there is clear evidence of closing – but still sizeable – gender gaps even after controlling for actual labor market experience. Note finally that the trend in the wage ratio is very similar across market sectors.

2.3 Time use

We show evidence on the distribution of total work between market and home production for each gender, by linking major time use surveys for the U.S. for 1965-2008.[13] As a measure of market hours we use "core" market work, including time worked on main jobs, second jobs and overtime, but excluding time spent commuting to/from work and time spent on ancillary activities,

[13] These are: 1965-1966 America's Use of Time; 1975-1976 Time Use in Economics and Social Accounts; 1985 Americans' Use of Time; 1992-1994 National Human Activity Pattern Survey; and 2003-2008 American Time Use Surveys. These surveys are described in detail in Aguiar and Hurst (2007a).

e.g. meal times and breaks. This is a measure that is most closely comparable to market hours measured in the CPS. However, no information on annual weeks worked is available from the time use surveys, and all work indicators presented are weekly. To obtain a measure of home production we sum hours spent on core household chores (cleaning, preparing meals, shopping, repairing etc.) and hours of child care.

We compute time use series adjusted for changing demographics, i.e. at constant gender, age and education composition. Following Aguiar and Hurst (2007a), we divide our sample into cells defined by two genders, five age groups (21-29, 30-39, 40-49, 50-59, 60-65), and four education groups (less than high school, high school completed, some college or more) and compute average population shares in each of the resulting 40 cells across the sample period. We then compute changes in hours for the whole sample as weighted averages of cell-level changes, using as weights the fixed population shares.

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 24 for women, and fall from 42 to 36 for men. The trends are similar to those detected using the CPS in Figure 1A. The series for home production also move closer to each other, as home hours fall from 38 to 28 for women, and rise from 11 to 16 for men. Interestingly, there are only minor gender differences in the dynamics of total work, which falls slightly for both men and women, keeping the ratio of total work – and therefore leisure – roughly constant.[14]

While gender differences in total work are relatively small and very stable, 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 2008, while for men this falls from 80% to 70%. The allocation of total work between the market and the home seems therefore the key margin to understand gender trends in market hours. All trends considered are also confirmed within two broad skill groups, as shown in Figure A2 in the

[14] This fact - also known as the isowork result - was noted by Aguiar and Hurst (2007a) on the same data, and by Burda, Hamermesh and Weil (2013) in a cross-section of countries

Appendix.

3 The model

The evidence presented has highlighted five main stylized facts, and namely (i) an increase in market hours for women, and a fall for men; (ii) a rise in the service share of market hours; (iii) an increase in female relative wages; (iv) a fall in home production hours for women, and an increase for men; (v) a roughly constant gender ratio of total work.

The multi-sector model presented in this section rationalizes this set of facts by analyzing the process of structural transformation and marketization of home production. The model economy has two market sectors, producing goods and services, respectively, and a home sector, producing home services. Market sectors are perfectly competitive, and populated by identical firms hiring male and female labor. Free labor mobility implies wage equalization across sectors for each gender. Households have identical preferences and choose the allocation of male and female time into market work, home production and leisure, taking market wages and output prices as given. The model is static as there is no capital involved in production, and time subscripts are omitted.

3.1 Firms

Firms in each sector $j = g, s$ produce output using the following technology:

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

where $j = g$ denotes goods, $j = s$ denotes services, A_j denotes labor productivity, growing at $\dot{A}_j / A_j \equiv \gamma_j$, and L_j denotes labor inputs. The labor input used in each sector is a CES combination of male (L_{mj}) and female hours (L_{fj}), where η is the elasticity of substitution between them. We impose $\xi_s > \xi_g$ to capture women's comparative advantage in producing services, and $\gamma_g > \gamma_s$ to represent faster productivity growth in the goods sector relative to service sector.[15]

3.2 Households

Households consists of one man and one woman, whose joint utility depends on consumption of goods (c_g), market services (c_s), home services (c_h) and leisure (L_l):

$$U(c_g, c_s, c_h, L_l) = \ln c + \varphi \ln L_l, \tag{4}$$

where c denotes a bundle of goods and services:

$$c = \left[\omega c_g^{\frac{\varepsilon-1}{\varepsilon}} + (1-\omega) c_z^{\frac{\varepsilon-1}{\varepsilon}}\right]^{\frac{\varepsilon}{\varepsilon-1}}; \quad c_z = \left[\psi c_s^{\frac{\sigma-1}{\sigma}} + (1-\psi) c_h^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} \tag{5}$$

and c_z denotes all services combined. Goods and services are poor substitutes ($\varepsilon < 1$), while market and home services are good substitutes ($\sigma > 1$) in the combined service bundle. Home services are produced with the same technology as market services in (3), except for the level of labor productivity:

$$c_h = A_h \left[\xi_h L_{fh}^{\frac{\eta-1}{\eta}} + (1-\xi_h) L_{mh}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \tag{6}$$

where productivity growth in market services is assumed to be faster than in the home: $\gamma_s > \gamma_h$.

Leisure time L_l is a CES aggregator of male and female leisure:

$$L_l = \left[\xi_l L_{fl}^{\frac{\eta_l-1}{\eta_l}} + (1-\xi_l) L_{ml}^{\frac{\eta_l-1}{\eta_l}}\right]^{\frac{\eta_l}{\eta_l-1}}, \tag{7}$$

where $\eta_l < 1$ is imposed to indicate that male and female leisure are poor substitutes.

Given market wages (w_f, w_m) and market prices (p_g, p_s), a representative household chooses market consumption (c_g, c_s), home production time (L_{mh},

[15] While we are assuming a simple technology directly employing male and female inputs, Appendix A shows that specification (3) delivers equivalent results to one in which output in each sector requires a combination of *tasks*, and men and women are differently endowed of the skills necessary to perform them.

L_{fh}) and leisure time (L_{ml}, L_{fl}) to maximize the utility function (4) subject to (5)-(7) and the household budget constraint:

$$p_g c_g + p_s c_s = w_m \left(L_m - L_{mh} - L_{ml}\right) + w_f \left(L_f - L_{fh} - L_{fl}\right). \qquad (8)$$

3.3 Equilibrium

A competitive equilibrium is defined by market wages (w_f, w_m), market prices (p_g, p_s), consumption (c_g, c_s) and time allocation $\{L_{fj}, L_{mj}\}_{j=g,s,h,l}$ such that:

1. the representative firm maximizes profits, subject to technology (3); and the representative household maximizes utility (4), subject to (5)-(7);

2. given the optimal choices of firms and households, market wages and prices clear the market in each sector and the labor market for each gender:

$$\begin{aligned} c_j &= Y_j, \qquad j = g, s, & (9) \\ L_{ig} + L_{is} &= L_i - L_{ih} - L_{il}, \qquad i = f, m. & (10) \end{aligned}$$

The Subsections that follow highlight the impact of structural transformation and marketization on the equilibrium allocation of time, and their implications for gender gaps in employment and wages and the service share. The full derivation of equilibrium results is provided in Appendix B.

3.4 Structural transformation and the wage ratio

Profit maximization equalizes the marginal rate of technical substitution between female and male labor to the gender wage ratio in each sector, and perfect mobility of labor equalizes the wage ratio across sectors:

$$\frac{L_{mj}}{L_{fj}} = \alpha_j^{-\eta} x^{\eta}, \qquad j = g, s \qquad (11)$$

where $x \equiv w_f/w_m$ and

$$\alpha_j \equiv \frac{\xi_j}{1-\xi_j}.$$

Women's comparative advantage in services is captured by $\alpha_s > \alpha_g$.

Let M_i denote labor supply for each gender, to be determined by households' optimization problem. Labor market clearing implies:

$$L_{ig} + L_{is} = M_i \quad i = f, m. \tag{12}$$

Combining conditions (11) and (12) for $j = g, s$ gives the allocation of female hours:

$$\frac{L_{fs}}{M_f} = \frac{1 - \frac{M_m}{M_f}\alpha_g^\eta x^{-\eta}}{1-(\alpha_g/\alpha_s)^\eta}. \tag{13}$$

Given gender comparative advantages ($\alpha_s > \alpha_g$), the equilibrium condition (13) implies that the allocation of female hours to the service sector is an increasing function of the wage ratio. The intuition is that a higher wage ratio induces substitution away from female labor in all sectors, but substitution is weaker in the sector in which women have a comparative advantage. As L_{mg}/L_{m_s} is proportional to L_{fg}/L_{fs} due to (11), higher L_{fs}/L_f implies higher L_{ms}/L_m and an overall lower share of hours in the goods sector.

Formally, define service employment $s \equiv \frac{L_{ms}+L_{fs}}{L_{mg}+L_{fg}+L_{ms}+L_{fs}}$. Using (11) and (13), service employment is positively related to the wage ratio according to:

$$s = \frac{\left(\frac{x}{\alpha_s}\right)^\eta - \left(\frac{\alpha_g}{\alpha_s}\right)^\eta \left(\frac{M_m}{M_f}\right)}{1-\left(\frac{\alpha_g}{\alpha_s}\right)^\eta} \left[\left(\frac{x}{\alpha_s}\right)^\eta + 1\right] \frac{1}{1+\frac{M_m}{M_f}}. \tag{14}$$

This result can be summarized in the following proposition.

Proposition 1 *When women have a comparative advantage in services, a rise in the service share is associated with a higher wage ratio (at constant relative labor suppy, M_m/M_f).*

Proposition 1, which is derived from profit maximization, is solely based on the assumption of gender comparative advantages, and in particular it holds independently of both product demand and the specific process driving structural transformation.[16]

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

$$x = \frac{\xi}{1-\xi}\left(\frac{M_m}{M_f}\right)^{1/\eta}, \tag{15}$$

and it can only rise following a fall in relative female labor supply (M_f/M_m) or an increase in the female-specific parameter ξ. The rise in ξ is typically interpreted as a gender-biased demand shift (Heathcote, Storesletten and Violante., 2010), driven by a variety of factors: female friendly technological progress (Johnson and Keane, 2007); the evolution of social norms towards women's work and the reduction in gender discrimination in the workplace (Goldin, 2006); or reduced distortions in the allocation of gender talents (Hsieh et al., 2016). Our approach contributes an endogenous between-sector mechanism to existing work to explain the rise in the relative demand for female labor, at constant technology parameters ξ_g and ξ_s.

3.5 Structural transformation and marketization

Utility maximization yields an expression similar to (11) for the home sector, as the marginal rate of technical substitution must equal the gender wage ratio:

$$\frac{L_{mh}}{L_{fh}} = \alpha_h^{-\eta} x^{\eta}, \tag{16}$$

[16] As will be shown below, one outcome of structural transformation is the rise in the relative price of services. Thus Proposition 1 is similar in spirit to the Stolper-Samuelson theorem from international trade theory, predicting that a rise in the relative price of a good leads to higher return to the factor that is used most intensively in the production of the good.

where $\alpha_h \equiv \xi_h/(1-\xi_h)$. Furthermore, the marginal rate of substitution across any two commodities must equal their relative price, thus an implicit price – or the opportunity cost – for home services can be defined as $p_h(\partial c_h/\partial L_{ih}) = w_i$.

Free labor mobility equalizes the value of the marginal product of labor across home and market for each gender. Thus, using production functions (3) and (6), relative prices for any pair of commodities are a function of the wage ratio:

$$\frac{p_k}{p_j} = \frac{A_j}{A_k}\left(\frac{\xi_j}{\xi_k}\right)^{\frac{\eta}{\eta-1}}\left(\frac{I_k(x)}{I_j(x)}\right)^{\frac{1}{\eta-1}}; \qquad j,k = g,s,h, \tag{17}$$

where $I_j(x)$ denotes the female wage bill share in sector j,

$$I_j(x) \equiv \frac{w_f L_{fj}}{w_m L_{mi} + w_f L_{fj}} = \frac{1}{1+\alpha_j^{-\eta}x^{\eta-1}} \tag{18}$$

and the equality follows from (11) and (16).

According to (17), uneven productivity growth ($\gamma_g > \gamma_s > \gamma_h$) acts as a shifter that increases the opportunity cost of home services relative to all market goods and services, and the price of market services relative to goods, for any given level of the wage ratio x.

3.5.1 Labor allocation across market and home services

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

The optimal time allocation between market and home services can be obtained from the corresponding expenditure allocation, $E_{sh} \equiv (p_s c_s)/(p_h c_h)$. Using the utility function (4)-(5) to equalize the marginal rate of substitution of market and home services to their relative prices gives relative expenditure as a function of relative prices:

$$E_{sh} = \left(\frac{p_h}{p_s}\right)^{\sigma-1}\left(\frac{\psi}{1-\psi}\right)^{\sigma}. \tag{19}$$

This results states that a higher opportunity cost of home relative to market services raises the relative expenditure on market services, as the two types of services are good substitutes ($\sigma > 1$). Faster productivity growth in market services thus shifts expenditure from home to market services, by making home services relatively more expensive according to (17). This is the process of marketization and its strength is captured by the "*marketization force*", measured by the interaction between the productivity growth differential between the market and the home and the substitutability in their respective outputs:

$$MF \equiv (\sigma - 1)(\gamma_s - \gamma_h) > 0. \tag{20}$$

To illustrate the impact of marketization on time allocation, the home production function (6) and the market clearing condition (9) can be combined to express the allocation of female hours across home and market services as a function of relative expenditures:

$$\frac{L_{fs}}{L_{fh}} = \frac{I_s(x)}{I_h(x)} E_{sh}. \tag{21}$$

Using (11), the allocation of male hours can be obtained:

$$\frac{L_{ms}}{L_{mh}} = \left(\frac{\alpha_h}{\alpha_s}\right)^{\eta} \frac{L_{fs}}{L_{fh}}. \tag{22}$$

By shifting expenditure from home to market services, marketization also shifts working hours from the home to the market for both women and men, as implied by (21) and (22), respectively.

After substituting (17) and (19) into (21), the equilibrium time allocation between the market and the home can be expressed as a function of sector-specific productivity A_s and A_h, and gender-specific parameters ξ_s and ξ_h:

$$\frac{L_{fs}}{L_{fh}} \equiv R_{sh}(x) = \hat{A}_{sh}^{\sigma-1} \left(\frac{\xi_s}{\xi_h}\right)^{\frac{\eta(\sigma-1)}{\eta-1}} \left(\frac{I_h(x)}{I_s(x)}\right)^{\frac{\sigma-\eta}{\eta-1}}, \tag{23}$$

where

$$\hat{A}_{sh} \equiv \frac{A_s}{A_h} \left(\frac{\psi}{1-\psi} \right)^{\frac{\sigma}{\sigma-1}}. \tag{24}$$

3.5.2 Labor allocation between goods and market services

The optimal time allocation between goods and market services can be obtained from the expenditure allocation, $E_{gs} \equiv (p_g c_g)/(p_s c_s)$, having equalized the marginal rate of substitution between goods and market services to their relative prices:

$$E_{gs} = \left(\frac{p_g}{p_s} \right)^{1-\varepsilon} \left(\frac{\omega}{1-\omega} \right)^{\varepsilon} \psi^{\frac{\sigma(1-\varepsilon)}{\sigma-1}} \left(1 + \frac{1}{E_{sh}} \right)^{\frac{\sigma-\varepsilon}{\sigma-1}}. \tag{25}$$

Two mechanisms induce a decline in the relative goods expenditure. The first is marketization, discussed above, expanding the relative expenditure for market services, E_{sh}. The second is the relative price effect. Faster productivity growth in the goods sector relative to market services raises the relative price of market services, as shown in (17). As goods and market services are poor substitutes $(\varepsilon > 1)$, a rise in the relative price of market services shifts households' expenditure from goods to market services as shown in (25). The strength of this effect is captured by the "*structural transformation force*",[17] measured by the interaction of the productivity growth differential between goods and market services and their poor substitutability in preferences:

$$SF \equiv (1-\varepsilon) \left(\gamma_g - \gamma_s \right) > 0. \tag{26}$$

By combining the production functions (3) and market clearing (9), the allocation of female hours across goods and market services can be expressed as a function of the relative expenditure:

$$\frac{L_{fg}}{L_{fs}} = \frac{I_g(x)}{I_s(x)} E_{gs}. \tag{27}$$

[17] We should admit a slight abuse of terminology here, as the term "structural transformation" is typically referred to the rise in the service employment and value added shares, without reference to the underlying driving forces.

Using (11) gives the corresponding allocation of male hours:

$$\frac{L_{mg}}{L_{ms}} = \left(\frac{\alpha_s}{\alpha_g}\right)^{\eta} \frac{L_{fg}}{L_{fs}}. \tag{28}$$

By shifting expenditure from goods to market services, structural transformation shifts market hours of men and women from the goods to service sector, as shown in (27) and (28).

Substituting (17) and (25) into (27) gives the time allocation as a function of sector-specific productivities A_g, A_s and A_h, and gender-specific parameters ξ_s and ξ_h:

$$\frac{L_{fg}}{L_{fs}} \equiv R_{gs}(x) = \left(\frac{I_g(x)}{I_s(x)}\right)^{\frac{\eta-\varepsilon}{\eta-1}} \hat{A}_{gs}^{1-\varepsilon} \left(\frac{\xi_s}{\xi_g}\right)^{\frac{\eta(1-\varepsilon)}{\eta-1}} \left(1 + \frac{I_s(x)}{R_{sh}(x) I_h(x)}\right)^{\frac{\sigma-\varepsilon}{\sigma-1}}, \tag{29}$$

where

$$\hat{A}_{gs} \equiv \frac{A_s}{A_g} \left(\frac{\omega}{1-\omega}\right)^{\frac{\varepsilon}{1-\varepsilon}} \psi^{\frac{\sigma}{\sigma-1}}. \tag{30}$$

The service share of employment in the market can be derived from (11):

$$s = \frac{1}{1 + R_{gs}(x) \frac{I_s(x)}{I_g(x)}}, \tag{31}$$

and it rises with both marketization and structural transformation, as summarized in the following Proposition:

Proposition 2 *Marketization and structural transformation expand the service share.*

The intuition for Proposition 2 follows directly from the forces behind relative expenditure, E_{gs}. Faster productivity growth in the goods sector ($\gamma_g > \gamma_s$) makes market services relatively more expensive. As goods and services are poor substitutes ($\varepsilon < 1$), the change in relative prices shifts expenditure and working hours towards market services, expanding the service share. Furthermore, faster productivity growth in the market relative to the home ($\gamma_s > \gamma_h$)

raises the opportunity cost of home production, leading households to substitute home production for market services, as these are closer substitute for home production than goods ($\sigma > \varepsilon$).

These two channels are related to relative price and income effects often emphasized in the structural transformation literature (Herrendorf, Rogerson and Valentinyi, 2013b). In our framework, income effects are generated by nested CES preferences (5), in which the presence of home services implies non-homothetic utility in goods and market services. Marketization thus provides a channel whereby the income elasticity of demand is higher for market services than for goods.[18]

Taken together, Propositions 1 and 2 state that marketization and structural transformation raise both the service share and the wage ratio. The prediction about the service share is common to the structural transformation literature. The second prediction is novel: since women have a comparative advantage in producing services, uneven labor productivity growth acts as an increase in relative demand for female labor, which in turn raises the equilibrium wage ratio.

Uneven labor productivity growth is a necessary condition to deliver a simultaneous increase in both market services and the wage ratio. Clearly, if productivity growth is balanced across all sectors, $\gamma_g = \gamma_s = \gamma_h$, the service share and the wage ratio are unaffected. However, these results still hold in two special cases, $\gamma_g > \gamma_s = \gamma_h$ and $\gamma_g = \gamma_s > \gamma_h$. In the first case, only structural transformation is present, and faster productivity growth in the goods sector, combined with poor substitutability between goods and market services, shifts labor from goods to services, leading to a higher service share and wage ratio. In the second case, only marketization is present, and faster productivity growth in market than home services, combined with their good substitutability, pulls labor out of the household, with a corresponding increase

[18] The link between the income elasticity of services and home production is first noted by Kongsamut, Rebelo and Xie (2001), who adopt a non-homothetic utility function defined over c_g and $(c_s + \bar{c})$, where $\bar{c}$ is an exogenous constant that "can be viewed as representing home production of services". See Moro, Moslehi and Tanaka (2017) for recent work on this.

in the market service share and the wage ratio. Whenever $\gamma_g > \gamma_s > \gamma_h$ both mechanisms are at work.

3.6 Market hours by gender

Marketization and structural transformation have opposing effects on market hours. While marketization drives hours out of the home sector – thereby increasing market hours for both genders – structural transformation shifts hours from goods into services, in turn reducing market hours for both genders, as part of services are produced in the home. Their combination has the potential to rationalize observed gender trends: marketization is needed to deliver the rise in female market work while structural transformation is needed to deliver the fall in male market work.

While the effect of structural transformation and marketization on the level of market hours for each gender depends on leisure choices, it is possible to learn about how they affect relative labor supply M_f/M_m through the allocation of market hours. Using (27), the share of female market hours in services is

$$\frac{L_{fs}}{M_f} = \frac{1}{1 + R_{gs}(x)}.$$

Setting this equal to (13) delivers:

$$\frac{M_f}{M_m} = \left(\frac{\alpha_g}{x}\right)^{\eta} \left[1 - \frac{1 - \left(\frac{\alpha_g}{\alpha_s}\right)^{\eta}}{1 + R_{gs}(x)}\right]^{-1}. \tag{32}$$

Recall from (29) that $R_{gs}(x)$ falls with both marketization and structural transformation forces as defined in (20) and (26), with a consequent increase in relative labor supply, M_f/M_m, which in equilibrium equals the gender ratio of market hours. This result is summarized in the following proposition:

Proposition 3 *When women have a comparative advantage in producing services, marketization and structural transformation raise the ratio of female to male market hours.*

3.7 Work and leisure

Utility maximization yields an expression similar to (11) for leisure choice:

$$\frac{L_{ml}}{L_{fl}} = \alpha_l^{-\eta_l} x^{\eta_l}. \tag{33}$$

Comparing (33) to the corresponding condition (16) for home hours, the following result follows:

Proposition 4 *When the wage ratio increases, relative female hours in home production fall more than in leisure time if and only if $\eta > \eta_l$.*

In particular, the gender ratio of leisure time is independent of the wage ratio for $\eta_l = 0$. As a corollary, the gender ratio of total work is also approximately constant for small enough η_l. The intuition for Proposition 4 is that, if male and female leisure hours are complements ($\eta_l < 1$), while their home production hours are substitutes ($\eta > 1$), a higher opportunity cost of staying out of the market (x) mostly substitutes male to female inputs in home production, while leaving them roughly unchanged in leisure time, as spouses enjoy spending leisure together.

3.8 Summary of qualitative results

Our three-sector model establishes four qualitative results. First a rise in the service share is associated to a higher gender wage ratio whenever women have a comparative advantage in producing services (Proposition 1). Second, uneven productivity growth raises the share of services (Proposition 2), thereby raising the wage ratio. Third, given women's comparative advantage in services, structural transformation and marketization unambiguously raises female market hours relative to men (Proposition 3). Fourth, given poor substitutability of spousal leisure time, the increase in female market hours mostly translates into a decline in female home production hours, keeping the ratio of total work roughly unchanged (Proposition 4). These four results rationalize the main stylized facts presented in Section 2.

4 Quantitative analysis

We quantitatively assess the importance of structural transformation and marketization in accounting for observed changes in time allocation and the rise in the wage ratio in the U.S. since the late 1960s.

In doing this, we enrich the model of Section 3 to allow for changes in technology parameters ξ_g and ξ_s. Our model has introduced a novel mechanism whereby the demand for female labor increases, *at given* ξ_g and ξ_s, following changes in the industry structure. However, gender-specific forces have also been at work, raising the demand for female labor within sectors (see Heathcote Storesletten and Violante, 2010, and references therein), and we incorporate these in our model by allowing ξ_g and ξ_s to evolve over time as follows:

$$\xi_{j0} = \pi_j \chi_j; \quad \xi_{jT} = \chi_j; \quad j = g, s, \tag{34}$$

where subscripts 0 and T denote the start and end of our sample period, respectively, χ_j is a technology parameter capturing female comparative advantage in market sector j, and $\pi_j \leq 1$ captures factors (social norms or discrimination) that lower women's perceived marginal product of labor relative to men at time 0.[19] Using (11), π_j can be interpreted as a wedge that lowers the gender wage ratio at time 0 relative to the marginal rate of technical substitution:

$$\frac{w_{f0}}{w_{m0}} = \left(\frac{\pi_j \chi_j}{1 - \pi_j \chi_j}\right)^{\eta} \frac{L_{mj0}}{L_{fj0}}; \quad j = g, s. \tag{35}$$

The increase in ξ_j, via the introduction of the wedge parameter π_j, drives an increase in female hours within each market sector, that could not be explained by between-sector mechanisms of marketization and structural transformation. In fact, between-sector forces alone would produce a fall, rather than an increase, in within-sector female intensity, via the rise in the wage

[19]Equation (34) implicitly assumes $\pi_{jT} = 1$ by the end of our sample period. If we were to allow for $\pi_{jT} < 1$, what matters for time allocation would be $\pi_{jT}\chi_j$. As the focus of the paper is on changes in wage and market hours, the assumption $\pi_{jT} = 1$ is just a normalization.

ratio, as shown in (11). Changes in ξ_j thus help our model fit evidence on both between- and within-sector changes in female hours.

4.1 Data targets

Model outcomes are related to changes in relevant data moments between the start and the end of the sample period. We aim to account for changes in the aggregate service share, s, and its gender components (s_m and s_f), the wage ratio x, and shares of market hours (M_i/L_i) and total work ($\kappa_i \equiv 1 - L_{il}/L_i$) for each gender. The service shares are obtained from the CPS, using the sample selection criteria and the goods/service classification described in Subsection 2.1, and are adjusted for changing demographics as we did for time use data in Subsection 2.3. The adjusted wage ratio, x, is also obtained from the CPS, as plotted in Panel B of Figure 2. Market hours and home hours are obtained from time use data as described in Subsection 2.3. To obtain the share of total work, we adopt Aguiar and Hurst (2007a) narrow leisure measure, which includes the time individuals spend socializing, in passive and active leisure, volunteering, in pet care, and gardening.

Data on s, s_i, M_i/L_i, and κ_i can be combined to characterize the full time allocation across four activities (goods, market services, home services or leisure) for each gender:

$$\frac{L_{ij}}{L_i} = \begin{cases} \frac{M_i}{L_i}(1 - s_i) & \text{for } j = g, \\ \frac{M_i}{L_i} s_i & \text{for } j = s, \\ \kappa_i - \frac{M_i}{L_i} & \text{for } j = h, \\ 1 - \kappa_i & \text{for } j = l, \end{cases} \qquad i = m, f.$$

Data on s, s_i, M_i/L_i, κ_i and L_{ij}/L_i for the start and the end of our sample period are shown in Table 3 as 5-year averages for 1968-1972 and 2004-2008, respectively. This is to smooth out short-run fluctuations that are not relevant for model predictions, and possibly single-year outliers. For simplicity we will refer to the start of the sample period 1968-1972 as "1970", and to the end of the sample period 2004-2008 as "2006".

4.2 Baseline parameters

We calibrate baseline parameters to match the time allocation and wage ratio in 1970, and then feed in the measured marketization and structural transformation forces to predict their change until 2006. The parameters needed to match the data at baseline include the elasticity parameters (σ, ε, η and η_l), the relative time endowment L_m/L_f, the leisure preference parameter φ, the sector-specific productivity parameters ($\gamma_s - \gamma_h$, $\gamma_g - \gamma_s$), the gender-specific parameters (χ_g, χ_s, ξ_h and ξ_l), the wedge parameters (π_g, π_s), and ($\hat{A}_{sh0}$, $\hat{A}_{gs0}$) defined in (24) and (30).

The calibration procedure is described below, and step-by-step details are given in Appendix C. In a nutshell, σ, ε, $\gamma_s - \gamma_h$ and $\gamma_g - \gamma_s$ (measuring marketization and structural transformation) are model-free, i.e. pinned down by existing estimates of relevant magnitudes. The remaining twelve parameters are calibrated to match the initial time allocation across the four activities for each gender (8 data targets) and the responsiveness of the gender hours ratio in such activities to changes in the wage ratio (4 data targets).

4.2.1 Marketization and structural transformation parameters

The driving forces of marketization and structural transformation are defined, respectively, as $MF \equiv (\sigma - 1)(\gamma_s - \gamma_h)$ and $SF \equiv (1 - \varepsilon)\left(\gamma_g - \gamma_s\right)$. To obtain a value for σ, we borrow from existing estimates of the elasticity of substitution between home and market consumption, discussed in detail by Aguiar, Hurst and Karabarbounis (2012) and Rogerson and Wallenius (2016). The most common approach to estimate such elasticity has used micro data on consumer expenditure and home production hours (see e.g. Rupert, Rogerson and Wright, 1995; Aguiar and Hurst, 2007b). More recently, Gelber and Mitchell (2012) obtain an estimate of the elasticity of substitution between home and market goods from the observed hours response to tax changes. Estimates obtained typically range between 1.5 and 2.5. We use as our benchmark the mid-range value of this interval, $\sigma = 2$, which is also close to the average of existing point estimates. Appendix D provides some sensitivity analysis for σ.

As for the elasticity of substitution between goods and services, recent findings in Herrendorf, Rogerson and Valentinyi (2013a) on newly-constructed consumption value-added data and relative prices suggest very values of ε. They argue that, if technology is specified as a value-added production function, as is the case in our model, the arguments of the utility function should also be the value added components of final consumption – as opposed to final consumption expenditures. They identify ε using the equilibrium condition equating the marginal rate of substitution between (value-added consumption in) goods and services to relative prices, and obtain an estimate of 0.002, which we use as our benchmark value. Moro, Moslehi and Tanaka (2017) extend the framework of Herrendorf, Rogerson and Valentinyi (2013a) to allow for home production and also find an estimate for ε that is not significantly different from zero. In Appendix D we provide some sensitivity analysis for ε.

Labor productivity growth in market sectors is obtained from the Bureau of Economic Analysis (BEA) database, delivering real labor productivity growth in the goods and services sectors of 2.49% and 1.25% respectively, thus $\gamma_g - \gamma_s = 1.24\%$. To obtain a measure of labor productivity growth in the home sector, we follow recent BEA calculations of U.S. household production using national accounting conventions (see Bridgman et al, 2012, and references therein). The BEA approach consists in estimating home nominal value added by imputing income to labor and capital used in home production, and deflating this using the price index for the private household sector. Specifically, Bridgman (2013) obtains productivity in the home sector as:

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

where w_h denotes the wage of private household employees; L_h denotes hours worked in the household sector; K_{jh} denotes the capital inputs used (consumer durables, residential capital, government infrastructure used for home production), with associated returns and depreciation rates r_j and δ_j, respectively; and P_h is the price index for the sector "private households with employed persons". This includes both the wage of private sector employees and imputed rental services provided by owner-occupied housing. The average growth in A_h during our sample period is 0.45%. Thus we set $\gamma_s - \gamma_h = 0.80\%$ as our baseline.

Later work has suggested slight variations on the measurement of home productivity growth. Bridgman, Duernecker and Herrendorf (2016) construct explicit price indexes for expenditure on close market substitutes to household consumption, instead of using the price index the for private household sector, and excludes residential capital from home capital. These variations deliver estimates in home productivity growth in the range 0.12%-0.45% during our sample period. Lower values for γ_h would deliver a stronger marketization force than in the benchmark case $\gamma_h = 0.45\%$. Appendix C will show the effects of a stronger marketization force, MF, by varying σ, which has qualitatively similar effects to reducing γ_h.

4.2.2 Calibrated parameters

The relative time endowment, L_m/L_f, is set to match the service share, noting that this can be expressed as:

$$s = \frac{s_m \frac{M_m}{L_m}\frac{L_m}{L_f} + s_f \frac{M_f}{L_f}}{\frac{M_m}{L_m}\frac{L_m}{L_f} + \frac{M_f}{L_f}}.$$

The implied L_m/L_f for 1970 is 1.03.

Using equilibrium condition (16) and (33), the elasticity parameters η and η_l are set to match the observed response in (log) gender hours ratios at home and in market services, respectively, to changes in the (log) wage ratio. The implied values are $\eta = 2.27$ and $\eta_l = 0.19$, respectively. As expected, $\eta > 1$ reflects substitutability of male and female inputs in production (see also estimates for the US by Weinberg, 2000, and Acemoglu, Autor and Lyle, 2004), and $\eta_l < 1$ reflects complementarity of male and female leisure time (see Goux, Maurin and Petrongolo, 2014). The low value of η_l is unsurprising, given the relative stability of the gender ratio of total market time.

Given η and η_l, the gender-specific parameters ξ_h and ξ_l are pinned down by conditions (16) and (33), evaluated in 1970, giving $\xi_h = 0.50$ and $\xi_l = 0.29$. The wedge parameters π_g and π_s are set to match the observed response in gender hours ratios in goods and services, respectively, to changes in the wage ratio, according to condition (11) and definition (34). This gives $\pi_g = 0.84$ and $\pi_s = 0.80$, and thus fairly similar wedges between the marginal rate of technical substitution and the wage ratio in the two market sectors in 1970. Given π_g and π_s, the gender-specific parameters χ_g and χ_s are set to match the 1970's hours ratios in goods and services, respectively. This gives $\chi_g = 0.29$ and $\chi_s = 0.43$. Women's comparative advantage is thus highest in the home sector ($\xi_h = 0.50$), intermediate in market services ($\chi_s = 0.43$), and lowest in goods ($\chi_g = 0.29$).

The three remaining parameters $\hat{A}_{sh0}$, $\hat{A}_{gs0}$ and φ are calibrated to match the 1970's time allocation across home and services in (23), across goods and services in (29), and across leisure and goods.[20] Note that, given the 1970 data targets and the calibrated values for $\hat{A}_{sh0}$ and $\hat{A}_{gs0}$, separate values for (ψ, ω) and productivity levels of (A_{g0}, A_{s0}, A_{h0}) are not needed to work out predictions for the time allocation and the wage ratio.

The determination of baseline parameters is summarized as follows:

[20] This is derived in Appendix B:

$$\frac{L_{fl}}{L_{fg}} = \varphi \frac{I_l(x)}{I_g(x)} \left[1 + \left[\hat{A}_{gs} \left(\frac{\xi_g}{\xi_s} \right)^{\frac{\eta}{\eta-1}} \left(\frac{I_s(x)}{I_g(x)} \right)^{\frac{1}{\eta-1}} \left(1 + \frac{1}{E_{sh}} \right)^{\frac{\sigma}{1-\sigma}} E_{gs} \right]^{\frac{1-\varepsilon}{\varepsilon}} \right],$$

where E_{sh} and E_{gs} are functions of the time allocation in (21) and (27).

Parameters	Values	Data or Targets
Model free parameters		
$\gamma_g - \gamma_s$	1.2%	BEA data.
$\gamma_s - \gamma_h$	0.8%	BEA data for services and Bridgman (2013) for home sector.
σ	2.0	Various estimates in Aguiar, Hurst and Karabarbounis (2012).
ε	0.002	Herrendorf, Rogerson and Valentinyi (2013a).
Calibrated parameters		
L_m/L_f	1.03	match service share in 1970 given $s_f, s_m, M_f/L_f, M_m/L_m, \kappa_f, \kappa_m$.
$\eta, \eta_l,$	2.27, 0.19	match response in hours ratio (home&leisure) to changes in wage ratio
ξ_h, ξ_l	0.50, 0.29	match wage ratio and hours ratio (home&leisure) in 1970
π_g, π_s	0.84,0.80	match response in hours ratio (goods&services) to changes in wage ratio
χ_g, χ_s	0.29,0.43	match gender wage ratio and hour ratio (goods&services) in 1970
$\hat{A}_{sh0}$	0.95	match relative hours across services and home in 1970
$\hat{A}_{gs0}$	5.35	match relative hours across goods and services in 1970
φ	0.60	match relative hours across leisure and goods in 1970

4.3 Results

Our baseline quantitative exercise takes on board both between-sector forces of marketization and structural transformation, and within-sector forces represented by the reduction in the wedge between the marginal rate of technical substitution and the wage ratio, via the rise in π_g and π_s. To assess the sole contribution of between-sector forces, in a later exercise we shut down within-sector forces by fixing $\pi_g = \pi_s = 1$.

Table 4 reports the quantitative results of model calibrations for the service share, the wage ratio, market hours and total work. The two top rows report their levels in 1970 and 2006, respectively, the third row reports their percentage change, and rows denoted A-D report predicted changes from model calibrations. Calibration A uses baseline parameters described in subsections

4.2.1 and 4.2.2, and it shows that our model almost exactly replicates the 25% rise in the service share observed in the data (column 1) and the 24% increase in the wage ratio (column 2), and slightly overpredicts the 51% increase in the market hours ratio (column 5). However, model performance for each gender separately is weaker, by overpredicting and underpredicting, respectively, the rise in female market hours and the decline in male market hours (columns 3 and 4). Finally, the model does a relatively good job at replicating a relatively stable ratio of total work, which rises by only 3% during the sample period (column 6). This is due to poor substitutability of spousal leisure, which constrains the reallocation of total work across genders.

Calibration B assesses the merit of between-sector forces of marketization and structural transformation, having shut down within-sector forces by setting $\pi_g = \pi_s = 1$. The prediction on the service share is spot on, indicating that the key forces in the model can account for the rise in services. The fall in the female wage-productivity wedges (i.e. the rise in π_g and π_s) would induce a further rise in the service share by pulling women into the market – and especially so in the sector in which they have a comparative advantage – but quantitatively this effect is tiny, as shown by comparison of predictions in column 1 of rows A and B. Between-sector forces predict a nearly 5% increase in the wage ratio (column 2), translating into a 3 percentage points' increase from 0.63 to 0.66, against an actual increase up to 0.78. Thus between-sector forces predict one fifth of the observed rise in the wage ratio, i.e. (0.66-0.63)/(0.78-0.63). To put this figure into perspective, the calibrated contribution of marketization and structural transformation to the rise in relative female wages is quantitatively similar to the contribution of the rise in women's human capital (as proxied by education, potential experience and ethnicity, see notes to Figure 2), as including basic human capital controls explains about 20% of wage convergence over the sample period.[21] Similarly, between-sector forces predict a nearly 11% rise in relative market hours, equivalent to roughly one fifth of the

[21] Between 1968-72 and 2004-08, the raw wage ratio rises by about 18 percentage points $(0.80-0.62)$, while the adjusted wage ratio rises by about 15 percentage points $(0.78-0.63)$. Thus basic human capital controls explain 20% of wage convergence.

actual increase. The shift-share analysis of Subsection 2.1 suggests that 30% of the rise in female hours is enabled by the expansion of services[22], and the model proposed thus explains two thirds of such between-sector component. As above, the model implies near stability in the gender ratio of total work.

Model predictions for the full time allocation across four activities and two genders are represented graphically in Figure 4. Each panel plots combinations between actual percentage changes during 1970-2006 (horizontal axis) and predicted percentage changes (vertical axis) for each of the eight outcomes, together with the 45 degree line for reference. Panel A plots prediction based on calibration A, encompassing within- and between-sector forces. The full model provides a very good fit overall of changes in the structure of time allocation of men and women, as summarized by an R^2 of 0.90 from a regression of predicted on actual changes.[23] Despite the very good fit overall, the model does a better job at matching changes in hours in the goods sector and the home, than in market services and leisure. In particular, the model predicts a slight reduction in leisure for women, from 37% to 36% of total hours, while this rose from 37% to 38% - though magnitudes involved are too small to be at all meaningful. Panel B plots predictions based on calibration B, which isolates the role of between-sector forces. The overall model fit falls to 0.57, and in particular the shift of female and male hours out of and into the home, respectively, are underpredicted. A further, within-sector, increase in the relative demand for female labor is thus necessary to accurately reproduce the decline of female home hours and the rise in male home hours.

Calibrations C and D in Table 4 decompose between-sector forces into marketization and structural transformation separately. In row C we shut down the structural transformation channel by imposing balanced productivity growth in market sectors ($\gamma_g = \gamma_s$), and in row D we shut down the marketization channel by imposing balanced productivity growth across all services ($\gamma_s = \gamma_h$). In both cases we impose $\pi_g = \pi_s = 1$. Our results show that struc-

[22]This result is also confirmed on the series adjusted for changing demographics.

[23]Note that none of these outcomes are targeted directly. Two baseline parameters (η and η_l) are set to match the elaticity in the gender hours with respect to the wage ratio, which is itself predicted by marketization and structural transformation.

tural transformation is necessary to deliver a decline in male hours (comparing column 4 in rows C and B) and marketization is necessary to increase female hours (comparing column 3 in rows D and B). The comparison of results from calibrations C and D confirms Propositions 3. Market hours for both genders fall with structural transformation and rise with marketization. But, due to gender comparative advantages, marketization has a stronger effect on female market hours, while structural transformation has a stronger effect on male market hours, and they both contribute to the rise in the market hours ratio.

As expected, each force contributes to the rise in services (11% and 16.7% increase, respectively), in line with Proposition 2. The rise in services is in turn associated to a rise in the wage ratio, in line with Proposition 1. However, structural transformation is the key driver of relative wages, explaining a 5.1% rise in the wage ratio, as opposed to 0.2% for marketization. Note that structural transformation alone would predict a higher rise in the wage ratio than both forces together (5.1% versus 4.7%), due to the strong impact of marketization on gender relative market hours (8.3%).

5 Conclusions

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

Due to gender comparative advantages in production, marketization of home production and structural transformation, in turn driven by differential productivity growth across sectors, jointly act as a gender-biased labor demand force, generating a simultaneous increase in both women's relative wages and market hours. While the source of both forces is gender neutral, their combination has female friendly outcomes. Marketization draws women's time into the market and structural transformation creates the jobs that women are better suited for in the market. These outcomes are consistent with evidence on gender convergence in wages, market work, and household work. When calibrated to the U.S. economy, inter-sector forces adequately predict the rise in services, and explain about one fifth of the narrowing wage gap and nearly 60% of changes in the time allocation of men and women.

References

[1] Acemoglu, Daron, David Autor and David Lyle. 2004. "Women, War, and Wages: The Effect of Female Labor Supply on the Wage Structure at Mid-century". *Journal of Political Economy* 112: 497–551.

[2] Acemoglu, Daron, and David Autor. 2011. "Skills, Tasks and Technologies: Implications for Employment and Earnings". In O. Ashenfelter and D. Card, eds., *Handbook of Labor Economics*, Volume 4B. Amsterdam: Elsevier, North Holland, 1043–1171.

[3] Acemoglu, Daron and Veronica Guerrieri. 2008. "Capital Deepening and Non–Balanced Economic Growth," *Journal of Political Economy* 116: 467–498.

[4] Albanesi, Stefania and Claudia Olivetti. 2016. "Gender Roles and Medical Progress." *Journal of Political Economy* 124: 650–695.

[5] Attanasio, Orazio, Hamish Low and Virginia Sanchez-Marcos. 2008. "Explaining Changes in Female Labor Supply in a Life-Cycle Model." *American Economic Review* 98: 1517–1542.

[6] Aguiar, Mark and Erik Hurst. 2007a. "Measuring Trends in Leisure: The Allocation of Time Over Five Decades". *Quarterly Journal of Economics* 122: 969–1006.

[7] Aguiar, Mark and Erik Hurst. 2007b. "Lifecycle Prices and Production". *American Economic Review* 97: 1533–1559.

[8] Aguiar, Mark, Erik Hurst, and Loukas Karabarbounis. 2012. "Recent Developments in the Economics of Time Use." *Annual Review of Economics* 4: 373–397.

[9] Akbulut, Rahsan. 2011, "Sectoral Changes and the Increase in Women's Labor Force Participation" *Macroeconomic Dynamics* 15: 240–264.

[10] Azmat, Ghazala and Barbara Petrongolo. 2014. "Gender and the Labor Market: What Have We Learned from Field and Lab Experiments?" *Labour Economics* 30: 32–40.

[11] Baumol, William 1967. "Macroeconomics of Unbalanced Growth: The Anatomy of Urban Crisis." *American Economic Review* 57: 415–26.

[12] Bertrand, Marianne. 2011. "New Perspectivs on Gender." In O. Ashenfelter and D. Card (eds.) *Handbook of Labor Economics*, vol. 4B: 1545–1592. Amsterdam: Elsevier

[13] Blau, Francine and David Kahn. 2013. "The Feasibility and Importance of Adding Measures of Actual Experience to Cross-Sectional data Collection". *Journal of Labor Economics* 31: S17–S58.

[14] Boppart, Timo. 2014. "Structural Change and the Kaldor Facts in a Growth Model with Relative Price Effects and non-Gorman Preferences." *Econometrica* 82: 2167–2196.

[15] Borghans, Lex, Bas ter Weel, and Bruce Weinberg. 2008. "Interpersonal Styles and Labor Market Outcomes." *Journal of Human Resources* 43: 815–858.

[16] Borghans, Lex, Bas ter Weel, and Bruce Weinberg. 2014. "People Skills and the Labor-market Outcomes of Underrepresented Groups." *Industrial and Labor Relations Review* 67: 287–334.

[17] Bridgman, Benjamin, Andrew Dugan, Mikhael Lal, Matthew Osborne and Shaunda Villones. 2012. "Accounting for Household Production in National Accounts, 1965-2010", *Survey of Current Business* 92: 23–36.

[18] Bridgman, Benjamin. 2013. "Home Productivity", Working Paper 0091, Bureau of Economic Analysis.

[19] Bridgman, Benjamin, Georg Duernecker and Berthold Herrendorf. 2016. "Structural Transformation, Marketization, and Household Production around theWorld". Mimeo, University of Arizona.

[20] Buera, Francisco and Joseph Kaboski. 2012. "The Rise of the Service Economy." *American Economic Review* 102: 2540–2569.

[21] Buera, Francisco, Joseph Kaboski, and Min Qiang Zhao. 2013. "The Rise of Services: the Role of Skills, Scale, and Female Labor Supply." NBER working paper No. 19372.

[22] Burda, Michael, Daniel Hamermesh and Phillipe Weil. 2013. "Total Work and Gender: Facts and Possible Explanations." *Journal of Population Economics* 26: 239–261.

[23] Dix-Carneiro, Rafael. 2014. "Trade Liberalization and labor Market Dynamics." *Econometrica* 82: 825–885.

[24] Fan, Chengze Simon and Hon-Kwong Lui. 2003. "Structural change and the narrowing gender gap in wages: Theory and evidence from Hong Kong". *Labour Economics* 10: 609–626.

[25] Fernández, Raquel. 2013. "Cultural Change as Learning: The Evolution of Female Labor Force Participation over a Century", *American Economic Review* 103: 472–500.

[26] Freeman, Richard and Ronald Schettkat. 2005. "Marketization of Household Production and the EU-US Gap in Work", *Economic Policy* 41: 5–39.

[27] Fuchs, Victor. 1968. *The Service Economy,* New York: Columbia University Press.

[28] Galor, Oded and David Weil. 1996. "The Gender Gap, Fertility, and Growth." *American Economic Review* 86: 374–87.

[29] Gelber, Alexander and Joshua W. Mitchell. 2012. "Taxes and Time Allocation: Evidence from Single Women and Men." *Review of Economic Studies* 79: 863–897.

[30] Goldin, Claudia. 2006. "The Quiet Revolution That Transformed Women's Employment, Education, and Family". *American Economic Review, Papers and Proceedings* 96: 1–21.

[31] Goldin, Claudia and Lawrence Katz. 2002. "The Power of the Pill: Oral Contraceptives and Women's Career and Marriage Decisions". *Journal of Political Economy* 100: 730–770.

[32] Greenwood, Jeremy, Ananth Seshadri and Mehmet Yorukoglu. 2005. "Engines of Liberation". *Review of Economic Studies* 72: 109–133.

[33] Goux, Dominique, Eric Maurin and Barbara Petrongolo. 2014. "Wortime Regulations and Spousal Labor Supply." *American Economic Review* 104: 252–276.

[34] Heathcote, Jonathan, Kjetil Storesletten and Gianluca Violante. 2010. "The Macroeconomic Implications of Rising Wage Inequality in the United States". *Journal of Political Economy* 118: 681–722.

[35] Herrendorf, Berthold, Richard Rogerson, and Ákos Valentinyi. 2013a."Two Perspectives On Preferences and Structural Transformation." *American Economic Review* 103: 2752–2789.

[36] Herrendorf, Berthold, Richard Rogerson, and Ákos Valentinyi. 2013b. "Growth and Structural Transformation". In P. Aghion and S. Durlauf (eds.) *Handbook of Economic Growth.* Amsterdam: Elsevier, North Holland, 855–941.

[37] Hsieh, Chang-Tai, Erik Hurst, Chad Jones and Pete Klenow. 2016. "The Allocation of Talent and U.S. Economic Growth". Mimeo, Chicago Booth.

[38] Jones, Larry, Rodolfo Manuelli, Ellen McGrattan. 2015. "Why Are Married Women Working So Much?" *Journal of Demographic Economics* 81: 75–114.

[39] Kongsamut, Piyabha, Sergio Rebelo, and Danyang Xie. 2001. "Beyond Balanced Growth," *Review of Economic Studies* 68: 869–882.

[40] Lebergott, Stanley. 1993. *Pursuing Happiness.* Princeton Univ. Press, Princeton, NJ.

[41] Lee, Donghoon and Ken Wolpin. 2006. "Intersectoral labor mobility and the growth of the service sector". *Econometrica* 74: 1–46.

[42] Lee, Donghoon and Ken Wolpin. 2010. "Accounting for Wage and Employment Changes in the U.S. from 1968-2000: A Dynamic Model of Labor Market Equilibrium". *Journal of Econometrics* 156: 68–85.

[43] Katz Lawrence and Kevin Murphy. 1992. "Changes in Relative Wages, 1963-1987: Supply and Demand Factors". *Quarterly Journal of Economics* 107: 35–78.

[44] Moro, Alessio, Solmaz Moslehi and Satonshi Tanaka. 2017. "Does Home Production Drive Structural Transformation?" Forthcoming in *American Economic Journal: Macroeconomics.*

[45] Ngai, L. Rachel and Christopher Pissarides. 2007. "Structural Change in a Multi-sector Model of Growth". *American Economic Review* 97: 429–443.

[46] Ngai, L. Rachel and Christopher Pissarides. 2008. "Trends in Hours and Economic Growth". *Review of Economic Dynamics* 11: 239–256.

[47] Olivetti, Claudia and Barbara Petrongolo. 2014. "Gender Gaps Across Countries and Skills: Supply, Demand and the Industry Structure". *Review of Economic Dynamics* 17: 842–859

[48] Olivetti, Claudia and Barbara Petrongolo. 2016. "The Gender Gap in Industrialized Countries." *Annual Review of Economics* 8: 405–434.

[49] Rendall, Michelle. 2010. "Brain versus Brawn: The Realization of Women's Comparative Advantage." Mimeo, University of Zurich.

[50] Rendall, Michelle. 2015. "Female Market Work, Tax Regimes, and the Rise of the Service Sector." Mimeo, University of Zurich.

[51] Reid, Margaret. 1934. *Economics of Household Production.* Wiley, New York.

[52] Rogerson, Richard and Johanna Wallenius. 2016. "Retirement, Home Production and Labor Supply Elasticities", *Journal of Monetary Economics* 78: 23–34.

[53] Rupert, Peter, Richard Rogerson and Rendall Wright, 1995. "Estimating Substitution Elasticities in Household Production Models". *Economic Theory* 6: 179–193.

[54] Weinberg, Bruce 2000. "Computer Use and the Demand for Female Workers". *Industrial and Labor Relations Review* 53: 290–308.

Table 1
Descriptive statistics on 17 industries, 1968-2008.

	Sector share			Female intensity		
	(1) 1968	(2) 2008	(3) Change	(4) 1968	(5) 2008	(6) Change
Primary sector	6.2	3.3	-3.0	10.2	17.1	7.0
Construction	6.0	7.6	1.7	4.5	9.0	4.6
Manufacturing	29.7	12.7	-17.0	23.1	29.3	6.2
Utilities	1.7	1.3	-0.4	8.1	20.9	12.8
All goods	43.6	25.0	-18.6	18.1	21.1	3.0
Transportation	4.4	3.8	-0.6	8.4	21.6	13.2
Post and Telecoms	1.2	0.9	-0.3	44.1	36.4	-7.6
Wholesale trade	3.8	3.0	-0.8	15.4	28.4	13.0
Retail trade	13.6	14.0	0.4	36.2	45.1	9.0
FIRE	4.6	7.2	2.6	36.9	54.6	17.7
Business and repair services	3.1	8.4	5.3	18.3	37.3	19.0
Personal services	4.1	2.8	-1.3	64.4	69.0	4.7
Entertainment	0.9	2.1	1.2	24.7	40.8	16.1
Health	4.8	10.2	5.4	64.7	76.0	11.3
Education	7.2	10.4	3.1	56.8	70.5	13.7
Professional services	1.1	3.2	2.2	23.7	41.9	18.2
Welfare and no-profit	1.4	2.7	1.4	36.8	64.2	27.3
Public administration	6.2	6.4	0.1	25.1	43.4	18.3
All services	56.4	75.0	18.6	37.4	52.1	14.8

Notes. Columns 1 and 2 report the share of sector hours in total annual hours (×100) in 1968 and 2008, respectively, and column 3 reports their change. Columns 4 and 5 report the share of female hours in each sector (×100) in 1968 and 2008, respectively, and column 6 reports their change. The primary sector includes agriculture, forestry, fishing, mining and extraction. Source: CPS.

Table 2
Alternative decompositions of the rise in the female hours share, 1968-2008.

1	Total change (×100)	44.4 – 29.0 = 15.4
2	Between sector, % of total change (goods/services)	30.4
3	Between sector, % of total change (17 categories)	28.6
4	Between occupation, % of total change (4 categories)	24.1
5	Between occupation, % of within-sector component (4 occupations, 2 sectors)	7.9

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

Table 3
Data Targets

	Estimates of model targets							
	Service share	Service share (women)	Service share (men)	Wage ratio	Market hours (women)	Market hours (men)	Total work (women)	Total work (men)
Time	s	s_f	s_m	x	M_f/L_f	M_m/L_m	κ_f	κ_m
1968-1972	0.59	0.76	0.51	0.63	0.23	0.48	0.64	0.62
2004-2008	0.74	0.87	0.63	0.78	0.29	0.40	0.62	0.59
Source	Current Population Survey				Time Use Surveys			

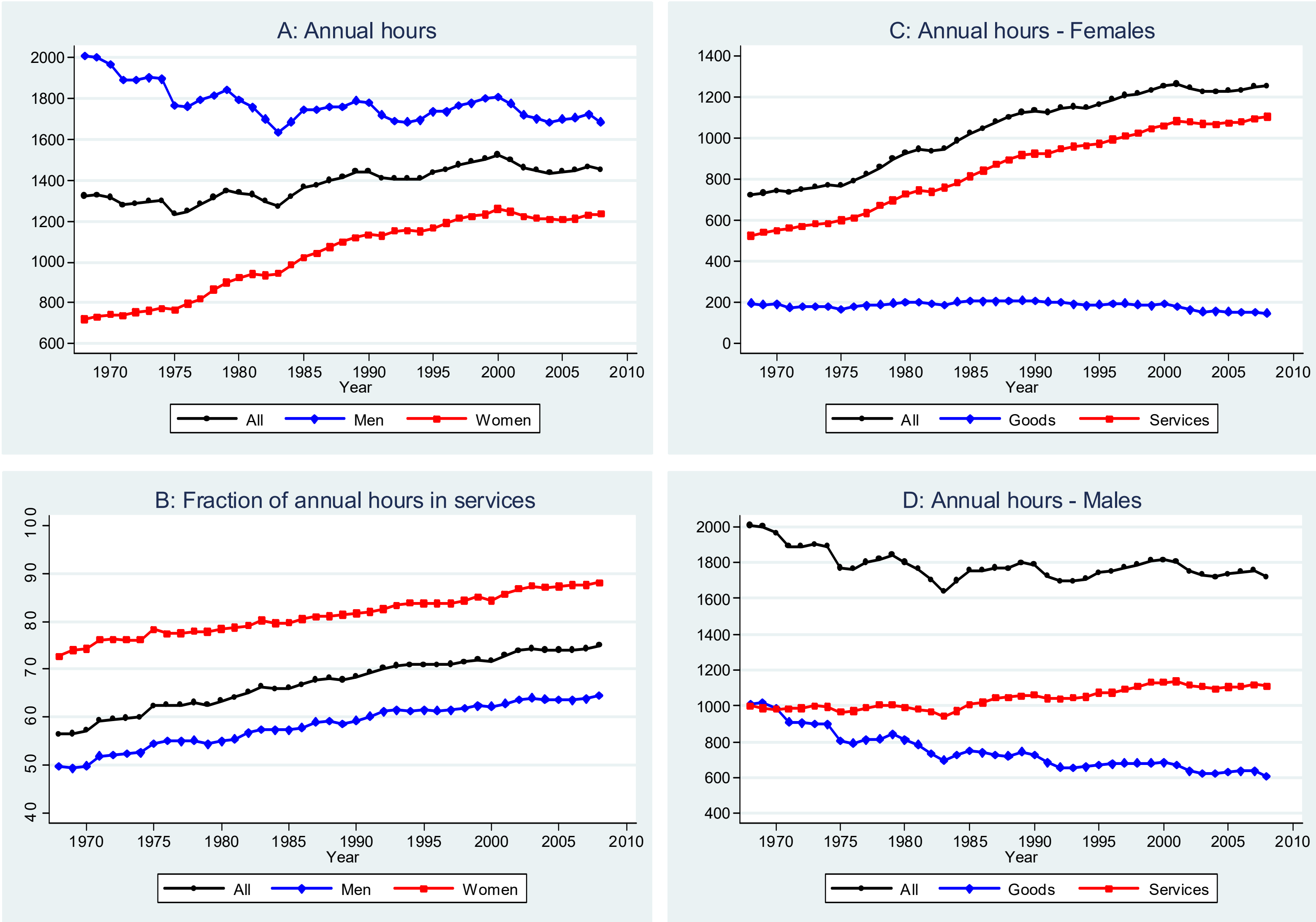
	Complete time allocation							
	Women				Men			
	goods	Services	home	leisure	goods	services	home	leisure
Time	L_{f1}/L_f	L_{fs}/L_f	L_{fh}/L_f	L_{fl}/L_f	L_{m1}/L_m	L_{ms}/L_m	L_{mh}/L_m	L_{ml}/L_m
1968-1972	0.05	0.17	0.41	0.37	0.23	0.24	0.14	0.38
2004-2008	0.04	0.25	0.34	0.38	0.15	0.25	0.18	0.41
Source	Current Population Survey and Time Use Surveys							

Table 4
Quantitative results

	Service share s	Wage ratio x	Female market hours M_f/L_f	Male market hours M_m/L_m	Market hours ratio $\frac{M_f/L_f}{M_m/L_m}$	Total work ratio κ_f/κ_m
	1	2	3	4	5	6
1970 data	0.59	0.63	0.23	0.48	0.47	1.03
2006 data	0.74	0.78	0.29	0.40	0.71	1.06
	Percentage change 1970-2006					
Data	25.4	23.8	26.9	-15.8	50.6	3.0
A. Model – baseline	27.3	22.7	44.9	-8.0	57.6	2.3
B. Model – Between-sector forces only ($\pi_g = \pi_s = 1$)	26.1	4.7	9.0	-1.4	10.6	0.5
C. Model – Marketization only ($\pi_g = \pi_s = 1$ and $\gamma_g = \gamma_s$)	11.0	0.2	12.4	3.8	8.3	0.0
D. Model – Structural transformation only ($\pi_g = \pi_s = 1$ and $\gamma_s = \gamma_h$)	16.7	5.1	-4.3	-6.6	2.4	0.6

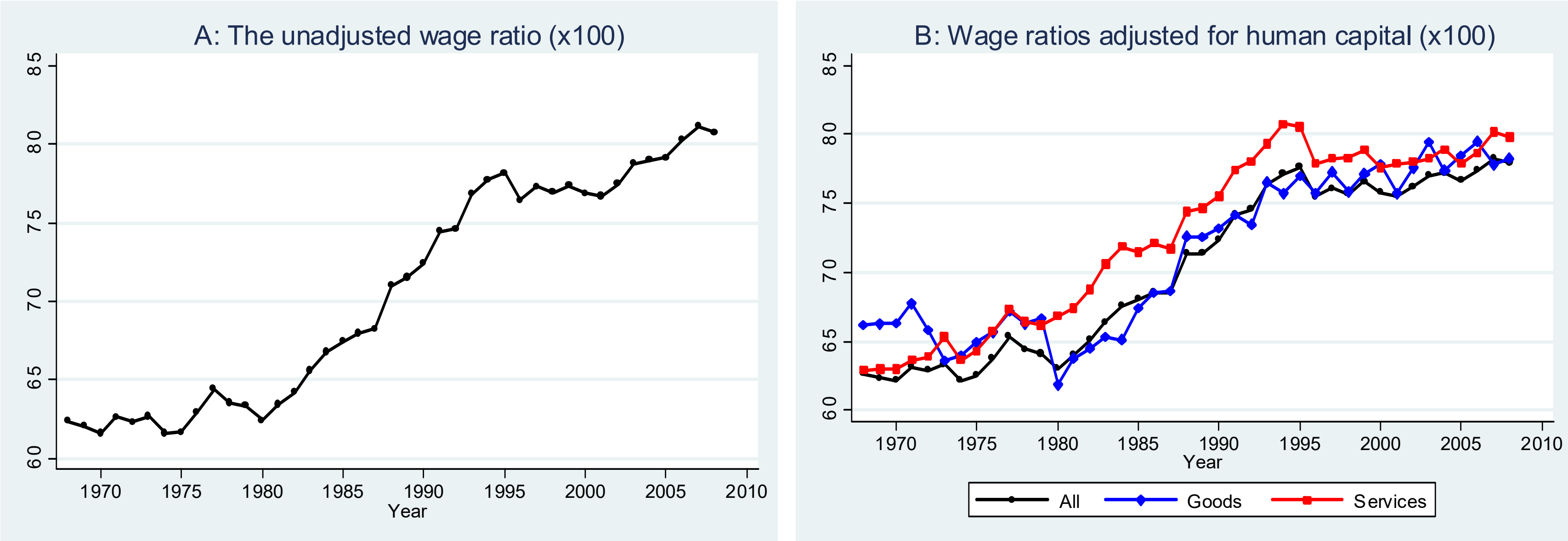
Notes. 1970 refers to the 1968-1972 average. 2006 refers to the 2004-2008 average. All parameters used are baseline values reported in Subsection 4.2, unless indicated in brackets.

Figure 1
Trends in market hours, by gender.



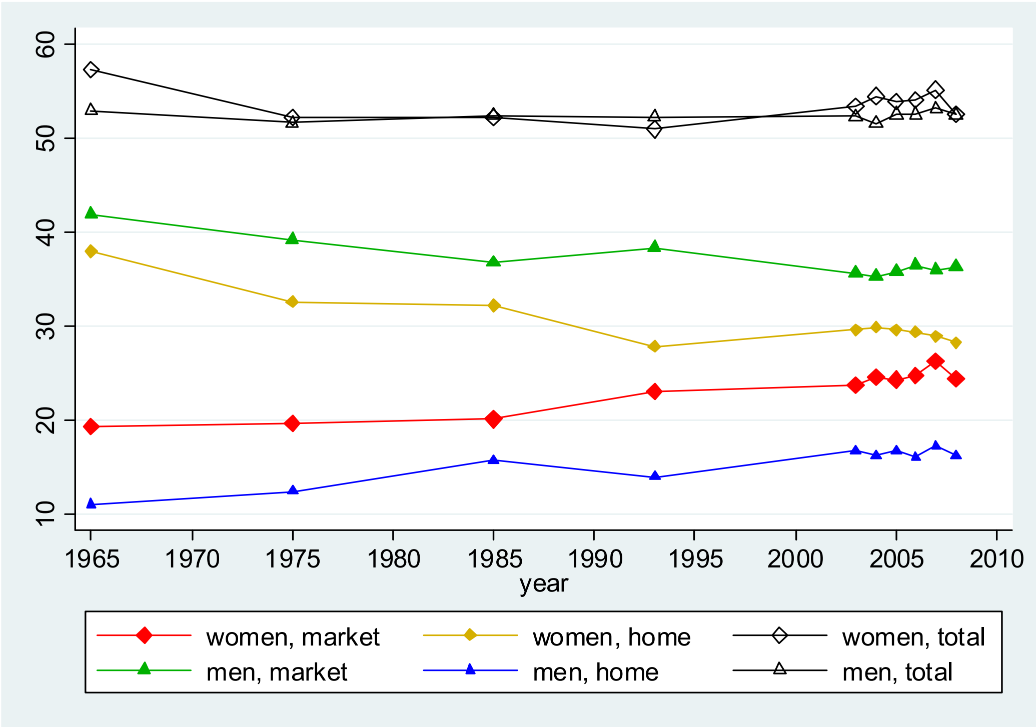
Notes. See Table 1 for definition of the service sector. Sample: men and women aged 21-65. Source: CPS: 1968-2008.

Figure 2
The gender wage ratio



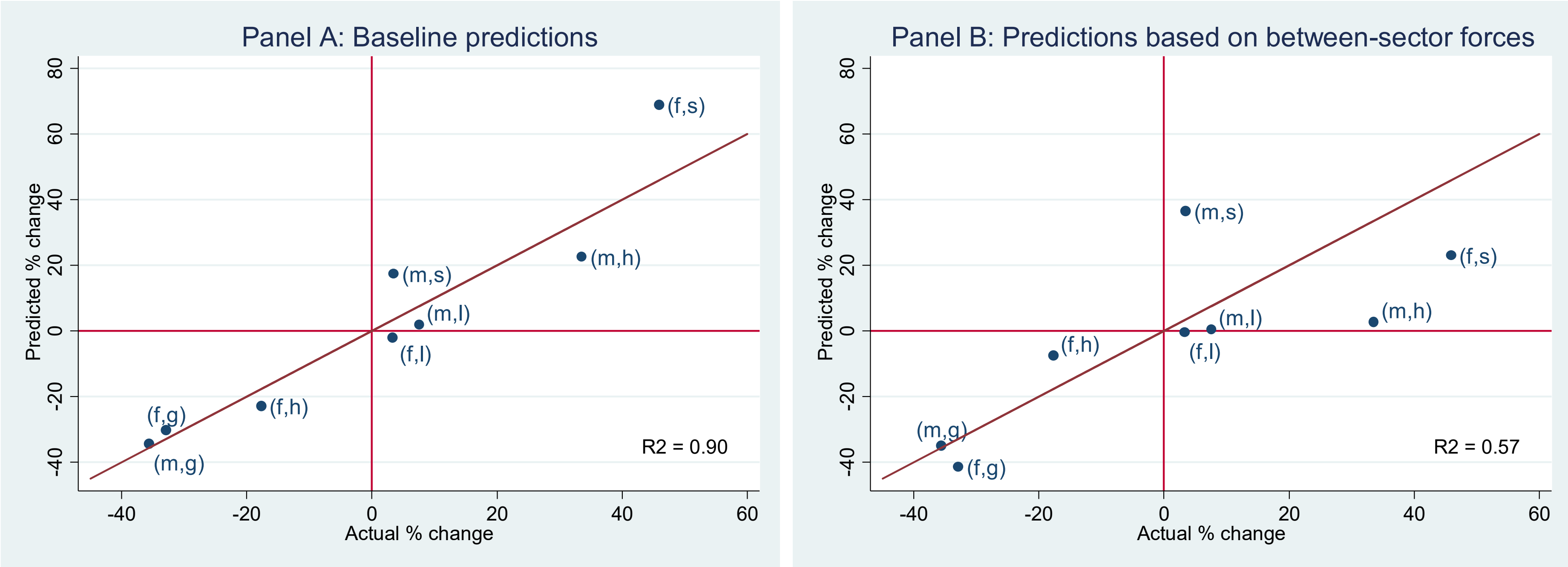
Notes. In panel A the wage ratio is obtained as (the exp of) the coefficient on a female dummy from yearly log wage regressions that only control for gender. In panel B the wage ratio is obtained from corresponding regressions that also control for age, age squared, education (4 categories) and ethnicity (one non-white dummy). Sample: men and women aged 21-65. Source: CPS: 1968-2008.

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



Notes. Market work includes time spent working in the market sector on main jobs, second jobs, and overtime, including any time spent working at home, but excluding commuting time. Home production hours include: time spent on meal preparation and cleanup, doing laundry, ironing, dusting, vacuuming, indoor and outdoor cleaning, design, maintenance, vehicle repair, gardening, and pet care; time spent obtaining goods and services; child care. Sample: men and women aged 21-65. Source: 1965-1966 America's Use of Time; 1975-1976 Time Use in Economics and Social Accounts; 1985 Americans' Use of Time; 1992-1994 National Human Activity Pattern Survey; 2003-2008 American Time Use Surveys. All series are adjusted for changing demographics following Aguiar and Hurst (2007a).

Figure 4
Model predictions for men's and women's time allocation across goods, market services home services and leisure



Notes. Each point in the scatter plot represents the combination of actual and predicted changes in time allocation. In Panels A and B, predicted changes are obtained using calibrations A and B, respectively, in Table 4. The (i, j) label used for each point refers to gender $i = m, f$ and sector $j = g$ (good), s (market services), h (home), l (leisure).

Appendices

A A multisector model with tasks

Our model technology combines male and female inputs to produce output in each sector. This Appendix provides microfoundations for the assumed technology, showing that our production function specification delivers equivalent results to one in which output in each sector requires a combination of tasks, and men and women are differently endowed of the skills necessary to perform them.

Assume for simplicity that there are only two sectors in the economy, goods and services, denoted by $j = g, s$, respectively, whose output is produced combining mental and physical tasks, according to the following technology:

$$Y_j = A_j \left[\delta_j H_j^{\frac{\lambda-1}{\lambda}} + (1-\delta_j) P_j^{\frac{\lambda-1}{\lambda}} \right]^{\frac{\lambda}{\lambda-1}},$$

where H_j and P_j represent hours of mental and physical tasks, respectively, in sector j, λ is the elasticity of substitution between them, and δ_j is a technology parameter representing the relative weight of mental inputs in sector j. We impose $\delta_s > \delta_g$ to capture the relatively heavier use of physical tasks in goods than service production.

Mental and physical inputs are each described by CES aggregators of male and female work:

$$\begin{aligned} H_j &= \left[\beta_{Hj} L_{fHj}^{\frac{\eta-1}{\eta}} + \left(1-\beta_{Hj}\right) L_{mHj}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}} \\ P_j &= \left[\beta_{Pj} L_{fPj}^{\frac{\eta-1}{\eta}} + \left(1-\beta_{Pj}\right) L_{mPj}^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}, \end{aligned}$$

where L_{iHj} and L_{iPj} represent gender inputs in either task and β_{Hj} and β_{Pj} represent female comparative advantages. We impose $\beta_{Hj} > \beta_{Pj}$ to capture female comparative advantages in mental tasks.

The first order condition for female wages in mental tasks is

$$w_{fHj} = \delta_j Y_j^{\frac{1}{\lambda}} H_j^{-\frac{1}{\lambda}} \beta_{Hj} H_j^{\frac{1}{\eta}} L_{fHj}^{-\frac{1}{\eta}},$$

which can be rearranged as

$$L_{fHj}^{\frac{1}{\eta}} = \frac{\delta_j Y_j^{\frac{1}{\lambda}} H_j^{\frac{1}{\eta}-\frac{1}{\lambda}} \beta_{Hj}}{w_{fHj}} = \frac{z_{Hj}\beta_{Hj}}{w_{fH}},$$

where $z_{Hj} \equiv \delta_j Y_j^{\frac{1}{\lambda}} H_j^{\frac{1}{\eta}-\frac{1}{\lambda}}$ and inter-sector labor mobility is imposed, thus $w_{fH} = w_{fHj}$, $j = g, s$.

Total female hours in mental tasks are given by:

$$L_{fH} \equiv L_{fHg} + L_{fHs} = \frac{z_{Hg}^{\eta}\beta_{Hg}^{\eta} + z_{Hs}^{\eta}\beta_{Hs}^{\eta}}{w_{fH}^{\eta}},$$

and similarly for physical tasks:

$$L_{fP} \equiv L_{fPg} + L_{fPs} = \frac{z_{Pg}^{\eta}\beta_{Pg}^{\eta} + z_{Ps}^{\eta}\beta_{Ps}^{\eta}}{w_{fP}^{\eta}}.$$

Total female hours in the economy are thus given by

$$L_f \equiv L_{fH} + L_{fP} = \frac{z_{Hg}^{\eta}\beta_{Hg}^{\eta} + z_{Hs}^{\eta}\beta_{Hs}^{\eta} + z_{Pg}^{\eta}\beta_{Pg}^{\eta} + z_{Ps}^{\eta}\beta_{Ps}^{\eta}}{w_f^{\eta}}, \tag{36}$$

where inter-task labor mobility is imposed, with $w_{fH} = w_{fP} = w_f$.

Using expression (36) and a similar expression for total male hours the gender wage gap can be derived:

$$x = \left(\frac{z_{Hg}^{\eta}\beta_{Hg}^{\eta} + z_{Hs}^{\eta}\beta_{Hs}^{\eta} + z_{Pg}^{\eta}\beta_{Pg}^{\eta} + z_{Ps}^{\eta}\beta_{Ps}^{\eta}}{z_{Hg}^{\eta}(1-\beta_{Hg})^{\eta} + z_{Hs}^{\eta}(1-\beta_{Hs})^{\eta} + z_{Pg}^{\eta}(1-\beta_{Pg})^{\eta} + z_{Ps}^{\eta}(1-\beta_{Ps})^{\eta}} \right)^{1/\eta} \left(\frac{L_m}{L_f} \right)^{1/\eta}. \tag{37}$$

This expression has clear similarities with result (11) for the gender wage gap in the main model, having expressed women's comparative advantages (ξ) as a combination of their comparative advantages in mental and physical tasks in both sectors (β^{η}_{Hj} and β^{η}_{Pj}), with weights that depend on the use of such tasks in each sector (z^{η}_{Hj} and z^{η}_{Pj}).

To highlight the link between the share of services and the demand for women, consider the $z^{\eta}_{Hs}\beta^{\eta}_{Hs}$ term at the numerator of (37), which is in turn equal to $\delta_s Y_s^{\frac{1}{\lambda}} H_s^{\frac{1}{\eta}-\frac{1}{\lambda}} \beta^{\eta}_{Hs}$. Given the assumptions made, a rise in services (Y_s) raises the wage ratio via the combination of the heavier use of mental tasks in services (δ_s) and female comparative advantages in mental tasks (β_{Hs}).

B Deriving the competitive equilibrium

B.1 Firms

Taking wages (w_f, w_m) and prices (p_g, p_s) as given, the representative firm in sector $j = g, s$ chooses $\{L_{f_j}, L_{mj}\}$ to maximize profit

$$\pi_j = p_j Y_j - w_f L_{fj} - w_m L_{mj},$$

subject to technology:

$$Y_j = A_j L_j, \quad L_j = \left[\xi_j L_{fj}^{\frac{\eta-1}{\eta}} + \left(1-\xi_j\right) L_{mj}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \quad j = g, s. \tag{38}$$

The first order conditions for wages are

$$w_f = p_j A_j \xi_j \left(\frac{L_j}{L_{fj}}\right)^{1/\eta}; \quad w_m = p_j A_j \left(1-\xi_j\right)\left(\frac{L_j}{L_{mj}}\right)^{1/\eta}. \tag{39}$$

Free mobility of labor implies equal marginal rates of technical substitution across sectors:

$$\frac{L_{mj}}{L_{fj}} = \alpha_j^{-\eta} x^{\eta}, \tag{40}$$

which is equation (11) in the main text, with $x \equiv w_f/w_m$ and $\alpha_j \equiv \xi_j/(1-\xi_j)$. Having denoted by $I_j(x)$ the female wage bill share in sector j, the following expression can be derived:

$$I_j(x) \equiv \frac{w_f L_{fj}}{w_m L_{mj} + w_f L_{fj}} = \frac{1}{1 + \alpha_j^{-\eta} x^{\eta - 1}}, \tag{41}$$

which is the equation (18) in the main text. Using the production function (38) gives:

$$\frac{L_j}{L_{fj}} = \xi_j^{\frac{\eta}{\eta-1}} \left(1 + \alpha_j^{-\eta} x^{\eta-1}\right)^{\frac{\eta}{\eta-1}} = \left(\frac{\xi_j}{I_j(x)}\right)^{\frac{\eta}{\eta-1}}. \tag{42}$$

Combining (42) and (39) implies

$$w_f = p_j A_j \xi_j^{\frac{\eta}{\eta-1}} \left(I_j(x)\right)^{\frac{1}{1-\eta}}. \tag{43}$$

Equalizing the value of the marginal product of labor across sectors for each gender implies:

$$\frac{p_s}{p_g} = \frac{A_g}{A_s} \left(\frac{\xi_g}{\xi_s}\right)^{\frac{\eta}{\eta-1}} \left(\frac{I_s(x)}{I_g(x)}\right)^{\frac{1}{\eta-1}}, \tag{44}$$

which is equation (17) in the main text.

Let M_i denote labor supply for each gender (which will be determined by the household optimization problem). Labor market clearing for each gender implies:

$$L_{ig} + L_{is} = M_i \quad i = f, m. \tag{45}$$

Combining (45) and (40) for $j = g, s$ gives the allocation of female hours:

$$\frac{L_{fs}}{M_f} = \frac{1 - \alpha_g^{\eta} \frac{M_m}{M_f} x^{-\eta}}{1 - (\alpha_g / \alpha_s)^{\eta}}, \tag{46}$$

which is the equation (13) in the main text.

B.2 Households

The representative household chooses $(c_g, c_s, L_{fh}, L_{mh}, L_{fl}, L_{ml})$ to maximize

$$U(c_g, c_s, c_h, L_l) = \ln c + \varphi \ln L_l \tag{47}$$

subject to

$$c=\left[\omega c_g^{\frac{\varepsilon-1}{\varepsilon}}+(1-\omega)\,c_z^{\frac{\varepsilon-1}{\varepsilon}}\right]^{\frac{\varepsilon}{\varepsilon-1}};\quad c_z=\left[\psi c_s^{\frac{\sigma-1}{\sigma}}+(1-\psi)\,c_h^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}} \tag{48}$$

$$c_h=A_h\left[\xi_h L_{fh}^{\frac{\eta-1}{\eta}}+(1-\xi_h)\,L_{mh}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}, \tag{49}$$

$$L_l=\left[\xi_l L_{fl}^{\frac{\eta_l-1}{\eta_l}}+(1-\xi_l)\,L_{ml}^{\frac{\eta_l-1}{\eta_l}}\right]^{\frac{\eta_l}{\eta_l-1}}, \tag{50}$$

$$p_g c_g+p_s c_s=w_m\left(L_m-L_{mh}-L_{ml}\right)+w_f\left(L_f-L_{fh}-L_{fl}\right). \tag{51}$$

Let λ be the Langrangian multiplier on the budget constraint (51). The first order conditions of the household optimization problem are

$$(c_g)\ :\ \frac{\partial U}{\partial c_g}=\lambda p_g \tag{52}$$

$$(c_s)\ :\ \frac{\partial U}{\partial c_s}=\lambda p_s \tag{53}$$

$$(L_{fh})\ :\ \frac{\partial U}{\partial c_h}\frac{\partial c_h}{\partial L_{fh}}=\lambda w_f \tag{54}$$

$$(L_{mh})\ :\ \frac{\partial U}{\partial c_h}\frac{\partial c_h}{\partial L_{mh}}=\lambda w_m \tag{55}$$

$$(L_{fl})\ :\ \frac{\partial U}{\partial L_l}\frac{\partial L_l}{\partial L_{fl}}=\lambda w_f \tag{56}$$

$$(L_{ml})\ :\ \frac{\partial U}{\partial L_l}\frac{\partial L_l}{\partial L_{ml}}=\lambda w_m. \tag{57}$$

B.2.1 Home production

The first order conditions for L_{fh} and L_{mh} imply that the marginal rate of technical substitution must equal the wage ratio:

$$\frac{L_{mh}}{L_{fh}}=\alpha_h^{-\eta}x^{\eta}, \tag{58}$$

where $\alpha_h \equiv \xi_h/(1-\xi_h)$. Let $I_h(x)$ denote the implicit female wage bill share in the home sector:

$$I_h(x) \equiv \frac{w_f L_{fh}}{w_m L_{mh} + w_f L_{fh}} = \frac{1}{1+\alpha_h^{-\eta} x^{\eta-1}}. \tag{59}$$

Using production function (49) gives:

$$\frac{L_h}{L_{fh}} = \xi_h^{\frac{\eta}{\eta-1}} \left(1+\alpha_h^{-\eta} x^{\eta-1}\right)^{\frac{\eta}{\eta-1}} = \left(\frac{\xi_h}{I_h(x)}\right)^{\frac{\eta}{\eta-1}}. \tag{60}$$

The implicit price index for home output p_h is defined using the first order conditions for L_{fh} and L_{mh}:

$$p_h \equiv \frac{w_i}{\partial c_h / \partial L_{gh}}; \qquad i = m, f. \tag{61}$$

Using (39), (49) and (60) gives

$$\frac{p_h}{p_s} = \frac{A_s}{A_h}\left(\frac{\xi_s}{\xi_h}\right)^{\frac{\eta}{\eta-1}} \left(\frac{I_h(x)}{I_s(x)}\right)^{\frac{1}{\eta-1}}, \tag{62}$$

which is equation (17) in the main text.

Equating the marginal rate of substitution across market and home services to their relative prices using first order conditions (53) and (54), the utility functions (48) and the definition of p_h, (61), implies the relative demand function:

$$\frac{c_s}{c_h} = \left(\frac{\psi}{1-\psi}\right)^{\sigma} \left(\frac{p_h}{p_s}\right)^{\sigma}. \tag{63}$$

Rearranging (63) gives relative expenditure E_{sh}:

$$E_{sh} \equiv \frac{p_s c_s}{p_h c_h} = \left(\frac{p_h}{p_s}\right)^{\sigma-1} \left(\frac{\psi}{1-\psi}\right)^{\sigma}, \tag{64}$$

which is equation (19) in the main text. Using the relative prices (62), the relative expenditure can be expressed as function of x :

$$E_{sh} = \hat{A}_{sh}^{\sigma-1} \left[\left(\frac{\xi_s}{\xi_h} \right)^{\frac{\eta}{\eta-1}} \left(\frac{I_h(x)}{I_s(x)} \right)^{\frac{1}{\eta-1}} \right]^{\sigma-1}, \tag{65}$$

where

$$\hat{A}_{sh} \equiv \left(\frac{A_s}{A_h} \right) \left(\frac{\psi}{1-\psi} \right)^{\frac{\sigma}{\sigma-1}} \tag{66}$$

is growing at rate $\gamma_s - \gamma_h$.

It is convenient to derive an expression for c_z/c_s for developing the rest of the model. Substituting (63) into (48) gives:

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

Finally using (64) gives:

$$\frac{c_z}{c_s} = \psi^{\frac{\sigma}{\sigma-1}} \left(1 + \frac{1}{E_{sh}} \right)^{\frac{\sigma}{\sigma-1}}. \tag{67}$$

B.2.2 Expenditure on market goods and services

Equating the marginal rate of substitution across goods and market services to their relative prices using the first order conditions (52) and (53) and utility functions (48) gives:

$$\frac{\omega}{\psi(1-\omega)} \left(\frac{c_z}{c_g} \right)^{\frac{1}{\varepsilon}} \left(\frac{c_s}{c_z} \right)^{\frac{1}{\sigma}} = \frac{p_g}{p_s}$$

and, rearranging:

$$\frac{c_g}{c_s} = \left(\frac{\omega}{\psi(1-\omega)} \left(\frac{p_s}{p_g} \right) \right)^{\varepsilon} \left(\frac{c_z}{c_s} \right)^{\frac{\sigma-\varepsilon}{\sigma}}.$$

Substituting c_z/c_s using (67) gives:

$$\frac{c_g}{c_s} = \left(\frac{\omega}{\psi(1-\omega)}\right)^{\varepsilon} \left(\frac{p_s}{p_g}\right)^{\varepsilon} \left(\psi^{\frac{\sigma}{\sigma-1}} \left(1+\frac{1}{E_{sh}}\right)^{\frac{\sigma}{\sigma-1}}\right)^{\frac{\sigma-\varepsilon}{\sigma}},$$

which can be simplified to

$$\frac{c_g}{c_s} = \left[\left(\frac{\omega}{1-\omega}\right) \frac{p_s}{p_g}\right]^{\varepsilon} \psi^{\frac{\sigma(1-\varepsilon)}{\sigma-1}} \left(1+\frac{1}{E_{sh}}\right)^{\frac{\sigma-\varepsilon}{\sigma-1}}. \tag{68}$$

Thus relative expenditure E_{gs} can be obtained:

$$E_{gs} \equiv \frac{p_g c_g}{p_s c_s} = \left(\frac{p_g}{p_s}\right)^{1-\varepsilon} \left(\frac{\omega}{1-\omega}\right)^{\varepsilon} \psi^{\frac{\sigma(1-\varepsilon)}{\sigma-1}} \left(1+\frac{1}{E_{sh}}\right)^{\frac{\sigma-\varepsilon}{\sigma-1}}. \tag{69}$$

This is equation (25) in the main text. Using relative prices in (44), the relative expenditure can be expressed as function of x :

$$E_{gs} = \hat{A}_{gs}^{\varepsilon-1} \left(\left(\frac{\xi_s}{\xi_g}\right)^{\frac{\eta}{\eta-1}} \left(\frac{I_g(x)}{I_s(x)}\right)^{\frac{1}{\eta-1}}\right)^{1-\varepsilon} \left(1+\frac{1}{E_{sh}}\right)^{\frac{\sigma-\varepsilon}{\sigma-1}}, \tag{70}$$

where

$$\hat{A}_{gs} \equiv \frac{A_g}{A_s} \left(\frac{1-\omega}{\omega}\right)^{\frac{\varepsilon}{1-\varepsilon}} \psi^{\frac{\sigma}{1-\sigma}} \tag{71}$$

is growing at rate $\gamma_g - \gamma_s$.

B.2.3 Leisure

The first order conditions for L_{fl} and L_{ml} imply that the marginal rate of technical substitution must equal the wage ratio:

$$\frac{L_{ml}}{L_{fl}} = \alpha_l^{-\eta_l} x^{\eta_l}, \tag{72}$$

where $\alpha_l \equiv \xi_l/(1-\xi_l)$. Let's denote by $I_l(x)$ the implicit female wage bill share for leisure:

$$I_l(x) \equiv \frac{w_f L_{fh}}{w_m L_{mh} + w_f L_{fh}} = \frac{1}{1+\alpha_l^{-\eta_l} x^{\eta_l - 1}}. \tag{73}$$

Using the leisure aggregator (50) gives:

$$\frac{L_l}{L_{fl}} = \xi_l^{\frac{\eta_l}{\eta_l - 1}} \left(1+\alpha_l^{-\eta_l} x^{\eta_l - 1}\right)^{\frac{\eta_l}{\eta_l - 1}} = \left(\frac{\xi_l}{I_l(x)}\right)^{\frac{\eta_l}{\eta_l - 1}}. \tag{74}$$

The implicit price index for leisure p_l is defined using the first order conditions for L_{fl} and L_{ml}:

$$p_l \equiv \frac{w_i}{\partial L_l / \partial L_{gl}}; \qquad i = m, f. \tag{75}$$

Using (39), (49) and (60) gives

$$\frac{p_l}{p_g} = \frac{A_g}{A_l} \left(\frac{\xi_l}{\xi_g}\right)^{\frac{\eta}{\eta-1}} \left(\frac{I_g(x)}{I_l(x)}\right)^{\frac{1}{\eta-1}}. \tag{76}$$

Equating the marginal rate of substitution across goods and leisure to their relative prices using the first order conditions (52) and (56) and the utility functions (48) and (50) gives:

$$\frac{\omega}{\varphi} \frac{L_l}{c} \left(\frac{c}{c_g}\right)^{\frac{1}{\varepsilon}} = \frac{p_1}{p_l}. \tag{77}$$

Thus relative expenditure E_{lg} is given by:

$$E_{lg} \equiv \frac{p_l c_l}{p_g c_g} = \frac{\varphi}{\omega} \left(\frac{c}{c_g}\right)^{\frac{\varepsilon - 1}{\varepsilon}}. \tag{78}$$

Using (48):

$$\frac{\varphi}{\omega} \left(\frac{c}{c_g}\right)^{\frac{\varepsilon-1}{\varepsilon}} = \varphi \left(1 + \frac{1-\omega}{\omega} \left(\frac{c_z}{c_g}\right)^{\frac{\varepsilon-1}{\varepsilon}}\right).$$

Using (67) and (68):

$$\begin{aligned}\left(\frac{c_z}{c_s}\right)\left(\frac{c_s}{c_g}\right) &= \psi^{\frac{\sigma}{\sigma-1}}\left(1+\frac{1}{E_{sh}}\right)^{\frac{\sigma}{\sigma-1}}\left(\frac{\omega}{1-\omega}\frac{p_s}{p_g}\right)^{-\varepsilon}\psi^{\frac{\sigma(\varepsilon-1)}{\sigma-1}}\left(1+\frac{1}{E_{sh}}\right)^{\frac{\varepsilon-\sigma}{\sigma-1}} \\ &= \psi^{\frac{\sigma\varepsilon}{\sigma-1}}\left(1+\frac{1}{E_{sh}}\right)^{\frac{\varepsilon}{\sigma-1}}\left(\frac{\omega}{1-\omega}\frac{p_s}{p_g}\right)^{-\varepsilon}.\end{aligned}$$

Substituting this into (78) gives:

$$E_{lg} = \varphi\left[1+\left(\frac{1-\omega}{\omega}\right)^{\varepsilon}\psi^{\frac{\sigma(\varepsilon-1)}{\sigma-1}}\left(1+\frac{1}{E_{sh}}\right)^{\frac{\varepsilon-1}{\sigma-1}}\left(\frac{p_s}{p_g}\right)^{1-\varepsilon}\right]. \tag{79}$$

Substituting relative prices using (44) gives:

$$E_{lg} = \varphi\left[1+\left(\frac{1-\omega}{\omega}\right)^{\varepsilon}\psi^{\frac{\sigma(\varepsilon-1)}{\sigma-1}}\left(1+\frac{1}{E_{sh}}\right)^{\frac{\varepsilon-1}{\sigma-1}}\left(\frac{A_g}{A_s}\left(\frac{\xi_g}{\xi_s}\right)^{\frac{\eta}{\eta-1}}\left(\frac{I_s(x)}{I_g(x)}\right)^{\frac{1}{\eta-1}}\right)^{1-\varepsilon}\right],$$

which can be simplified to obtain:

$$E_{lg} = \varphi\left[1+\left[\hat{A}_{gs}\left(\frac{\xi_g}{\xi_s}\right)^{\frac{\eta}{\eta-1}}\left(\frac{I_s(x)}{I_g(x)}\right)^{\frac{1}{\eta-1}}\left(1+\frac{1}{E_{sh}}\right)^{\frac{1}{1-\sigma}}\right]^{1-\varepsilon}\right]. \tag{80}$$

B.2.4 Household's optimal decision

Given the definition of implicit prices p_h and p_l, the budget constraint (51) can be rewritten as

$$\sum_{j=g,s,h} p_j c_j + p_l L_l = w_m L_m + w_f L_f.$$

Dividing through by $p_l c_l$ gives:

$$\sum_{j=g,s,h,l}\frac{p_j c_j}{p_l c_l} = \frac{w_m L_m + w_f L_f}{p_l c_l},$$

and, rearranging:

$$\frac{p_l c_l}{w_m L_m + w_f L_f} = \frac{1}{\sum\limits_{j=g,s,h,l} E_{jl}(x)}; \qquad E_{jl}(x) \equiv \frac{p_j c_j}{p_l c_l},$$

where $E_{jl}(x)$ is a function of x given (65), (70) and (80). The share of female leisure time can be derived as a function of relative expenditures, and thus a function of the wage ratio x :

$$\frac{L_{fl}}{L_f} = \frac{I_l(x)}{I(x) \sum\limits_{j=g,s,h,l} E_{jl}(x)}, \tag{81}$$

where $I(x)$ is the implicit female wage bill share in total wage income:

$$I(x) \equiv \frac{w_f L_f}{w_f L_f + w_m L_m}. \tag{82}$$

B.3 Market clearing

The market clearing conditions for the labor and commodity markets are, respectively:

$$c_j = Y_j, \qquad j = g, s \tag{83}$$

$$L_{ig} + L_{is} = L_i - L_{ih} - L_{il}, \qquad i = f, m. \tag{84}$$

Using market clearing conditions and the production functions, relative expenditures in (64), (69) and (79) can be rewritten as:

$$E_{kj}(x) = \frac{p_k c_k}{p_j c_j} = \frac{p_k A_k L_k}{p_j A_j L_j}.$$

Using relative prices (44), (62) and (76) gives:

$$E_{kj}(x) = \left(\frac{\xi_j^{\eta_j}}{I_j(x)}\right)^{\frac{1}{\eta_j - 1}} \left(\frac{\xi_k^{\eta_k}}{I_k(x)}\right)^{\frac{1}{1-\eta_k}} \left(\frac{L_k/L_{fk}}{L_j/L_{fj}}\right) \left(\frac{L_{fk}}{L_{fj}}\right).$$

Using L_j/L_{fj} derived in (42), (60) and (74), to obtain:

$$\frac{L_{fk}}{L_{fj}} = \frac{I_k(x)}{I_j(x)} E_{kj}(x), \qquad k,j = g,s,h,l. \tag{85}$$

This gives equation (21) and (27) in the main text. Substituting it into the female time constraint (84), a second condition for female leisure time is given by

$$\frac{L_{fl}}{L_f} = \frac{1}{\sum\limits_{j=g,s,h,l} E_{jl}(x) \frac{I_j(x)}{I_l(x)}}, \tag{86}$$

which is also a function of the wage ratio. Together with the condition in (81), the equilibrium wage ratio x satisfies:

$$I(x) \sum_{j=g,s,h,l} E_{jl}(x) - \sum_{j=g,s,h,l} I_j(x) E_{jl}(x) = 0. \tag{87}$$

Thus the gender wage ratio x depends on relative expenditures in (65), (70) and (80), which respond to gender-neutral shifts due to the effects of uneven productivity growth through the terms $\hat{A}_{gs}$ and $\hat{A}_{sh}$.

B.4 Time allocation

B.4.1 Time allocation across market and home services

Substituting the relative expenditure (65) into (85) gives:

$$\frac{L_{fs}}{L_{fh}} = \left(\frac{I_s(x)}{I_h(x)}\right) \hat{A}_{sh}^{\sigma-1} \left(\left(\frac{\xi_s}{\xi_h}\right)^{\frac{\eta}{\eta-1}} \left(\frac{I_h(x)}{I_s(x)}\right)^{\frac{1}{\eta-1}}\right)^{\sigma-1},$$

which simplifies to:

$$\frac{L_{fs}}{L_{fh}} = R_{sh}(x) \equiv \hat{A}_{sh}^{\sigma-1} \left(\frac{\xi_s}{\xi_h}\right)^{\frac{\eta(\sigma-1)}{\eta-1}} \left(\frac{I_h(x)}{I_s(x)}\right)^{\frac{\sigma-\eta}{\eta-1}}. \tag{88}$$

This is equation (23) in the main text.

B.4.2 Time allocation across goods and market services

Substituting the relative expenditure (70) into (85) gives:

$$\frac{L_{fg}}{L_{fs}} = \left(\frac{I_g(x)}{I_s(x)}\right) \hat{A}_{gs}^{\varepsilon-1} \left(\left(\frac{\xi_s}{\xi_g}\right)^{\frac{\eta}{\eta-1}} \left(\frac{I_g(x)}{I_s(x)}\right)^{\frac{1}{\eta-1}}\right)^{1-\varepsilon} \left(1+\frac{1}{E_{sh}}\right)^{\frac{\sigma-\varepsilon}{\sigma-1}}.$$

Substituting E_{sh} using (85) and (88) gives:

$$\frac{L_{fg}}{L_{fs}} = R_{gs}(x) \equiv \hat{A}_{gs}^{\varepsilon-1} \left(\frac{I_g(x)}{I_s(x)}\right)^{\frac{\eta-\varepsilon}{\eta-1}} \cdot \left(\frac{\xi_s}{\xi_g}\right)^{\frac{\eta(1-\varepsilon)}{\eta-1}} \left(1+\frac{I_s(x)}{R_{sh}(x)\, I_h(x)}\right)^{\frac{\sigma-\varepsilon}{\sigma-1}}. \tag{89}$$

B.4.3 Service employment share

By definition, the service employment share is $s = (L_{ms} + L_{fs})/(L_{ms} + L_{fs} + L_{mg} + L_{fg})$. Thus:

$$s^{-1} = 1 + \frac{L_{f_g}}{L_{fs}} \frac{\frac{L_{mg}}{L_{fg}} + 1}{\frac{L_{ms}}{L_{fs}} + 1} = 1 + \frac{L_{f_g}}{L_{fs}} \frac{I_s(x)}{I_g(x)}.$$

Substituting this into (40) gives

$$s^{-1} = 1 + \frac{L_{f_g}}{L_{fs}} \frac{I_s(x)}{I_g(x)} \Longrightarrow s = \frac{1}{1 + R_{gs}(x)\, \frac{I_s(x)}{I_g(x)}}, \tag{90}$$

which is equation (31) in the main text.

B.4.4 Leisure

Substituting (80) in (85) gives:

$$\frac{L_{fl}}{L_{f1}} = \varphi \frac{I_l(x)}{I_g(x)} \left[1 + \left[\hat{A}_{gs} \left(\frac{\xi_g}{\xi_s}\right)^{\frac{\eta}{\eta-1}} \left(\frac{I_s(x)}{I_g(x)}\right)^{\frac{1}{\eta-1}} \left(1+\frac{1}{E_{sh}}\right)^{\frac{\sigma}{1-\sigma}} E_{1s}\right]^{\frac{1-\varepsilon}{\varepsilon}}\right]. \tag{91}$$

C Calibration

Sixteen parameters are required to determine the wage ratio and the time allocation by gender in the model. The paper has explained in detailed how the time use data and the CPS data are combined to obtain the data targets $\{L_{fj}/L_f;\ L_{mj}/L_m\}_{j=1,s,h,l}$ and how $\left\{\gamma_s - \gamma_h,\ \gamma_g - \gamma_s,\ \sigma,\ \varepsilon,\ L_m/L_f\right\}$ are calibrated. This section describes the step-by-step procedure of obtaining the remaining eleven parameters $\left\{\eta_l, \eta, \xi_h, \xi_l, \pi_1, \pi_s, \chi_g, \chi_s, \hat{A}_{sh0}, \hat{A}_{gs0}, \varphi\right\}$ sequentially.

(a) Elasticity of substitution in leisure aggregator (η_l).

As (72) needs to hold at any point in time, η_l is set to match the response in the (log) leisure hours ratio to the change in the wage ratio:

$$\eta_l = \frac{\ln \frac{L_{mlT}}{L_{flT}} - \ln \frac{L_{ml0}}{L_{fl0}}}{\ln x_T - \ln x_0}, \tag{92}$$

where subscripts 0 and T denote the start and end of our sample period, respectively

(b) Elasticity of substitution in the production function (η).

As (58) needs to hold at any point in time, η is set to match the response in the (log) home hours ratio to the change in the wage ratio:

$$\eta = \frac{\ln \frac{L_{mhT}}{L_{fhT}} - \ln \frac{L_{mh0}}{L_{fh0}}}{\ln x_T - \ln x_0}. \tag{93}$$

(c) Gender-specific parameters ξ_h and ξ_l

Given L_{mh0}/L_{fh0}, L_{ml0}/L_{fl0} and x_0, ξ_h and ξ_l are obtained from (58) and (72) respectively:

$$\frac{\xi_h}{1-\xi_h} = x_0 \left(\frac{L_{mh0}}{L_{fh0}}\right)^{\frac{-1}{\eta}}; \quad \frac{\xi_l}{1-\xi_l} = x_0 \left(\frac{L_{ml0}}{L_{fl0}}\right)^{-\frac{1}{\eta_l}}. \tag{94}$$

(d) Wedge parameters π_g and π_s

Using definition (34) and condition (40), π_g and π_s are set to match the response in the hours ratio in goods and services, respectively, to the change in the wage ratio:

$$\pi_j = \frac{x_0 \left(\frac{L_{mj0}}{L_{fj0}}\right)^{-\frac{1}{\eta}}}{1 + x_0 \left(\frac{L_{mj0}}{L_{fj0}}\right)^{-\frac{1}{\eta}}} \frac{1 + x_T \left(\frac{L_{mjT}}{L_{fjT}}\right)^{-\frac{1}{\eta}}}{x_T \left(\frac{L_{mjT}}{L_{fjT}}\right)^{-\frac{1}{\eta}}}, \quad j = g, s. \tag{95}$$

(e) Gender-specific parameters χ_1 and χ_s

Using (34) and (40), χ_g and χ_s are set to match the initial hours ratio in goods and services:

$$\chi_j = \frac{1}{\pi_j} \frac{x_0 \left(\frac{L_{mj0}}{L_{fj0}}\right)^{-\frac{1}{\eta}}}{1 + x_0 \left(\frac{L_{mj0}}{L_{fj0}}\right)^{-\frac{1}{\eta}}}, \quad j = g, s. \tag{96}$$

(f) Combinations of productivity parameters, $\hat{A}_{sh0}$ and $\hat{A}_{gs0}$

From (88):

$$\hat{A}_{sh0} = \left(\frac{\xi_h}{\xi_{s0}}\right)^{\frac{\eta}{\eta-1}} \left(\frac{I_{s0}(x)}{I_{h0}(x)}\right)^{\frac{1}{\eta-1}} \left[\frac{L_{fs0}}{L_{fh0}} \frac{I_{h0}(x)}{I_{s0}(x)}\right]^{\frac{1}{\sigma-1}}. \tag{97}$$

From (89):

$$\hat{A}_{gs0} = \left(\frac{\xi_{s0}}{\xi_{g0}}\right)^{\frac{\eta}{\eta-1}} \left(\frac{I_{g0}(x)}{I_{s0}(x)}\right)^{\frac{1}{\eta-1}} \left[\frac{L_{fs0}}{L_{fg0}} \frac{I_{g0}(x)}{I_{s0}(x)} \left(1 + \frac{1}{E_{sh0}(x)}\right)^{\frac{\sigma-\varepsilon}{\sigma-1}}\right]^{\frac{1}{1-\varepsilon}}. \tag{98}$$

where $E_{sh0}(x) = (L_{fs0}/L_{fh0})(I_{h0}(x)/I_{s0}(x))$ from (85).

(g) Leisure parameter in utility function (φ)

Using (91):

$$\varphi = \frac{\frac{L_{fl0}}{L_{fg0}} \frac{I_{g0}(x)}{I_{l0}(x)}}{1 + \left[\hat{A}_{gs} \left(\frac{\xi_{g0}}{\xi_{s0}}\right)^{\frac{\eta}{\eta-1}} \left(\frac{I_{s0}(x)}{I_{g0}(x)}\right)^{\frac{1}{\eta-1}} \left(1 + \frac{1}{E_{sh0}(x)}\right)^{\frac{\sigma}{1-\sigma}} E_{gs0}(x)\right]^{1-\varepsilon}}, \tag{99}$$

where $E_{gs0}(x) = (L_{fg0}/L_{fs0})(I_{s0}(x)/I_{g0}(x))$ from (85).

D Sensitivity Analysis

We perform some sensitivity analysis on parameters σ and ε, which affect the strength of marketization and structural transformation forces, respectively. The results are shown in Table A1, which reports for reference in row A our previous calibration of between-sector forces (row B of Table 4). As the main contribution of our calibrations is to highlight the quantitative impact of between-sector forces, we show sensitivity analysis with respect to this benchmark. In rows B-D we consider lower and upper bounds for σ, respectively, near the extremes of the range of variation of empirical estimates found in the literature, and a higher value for ε.[24] In row B we consider weaker marketization than in the baseline case ($\sigma = 1.5$), implying lower market hours for both genders than in row A (in which $\sigma = 2$). The model thus does a better job at predicting the fall in men's market hours, but performs worse on women's hours. The model also predicts a slightly stronger rise in the wage ratio, thanks to reduced labour supply of women relative to men. In row C we consider instead stronger marketization ($\sigma = 2.5$), and as expected changes in model predictions are reversed. The calibration in row D weakens structural transformation by setting $\varepsilon = 0.1$, leaving the marketization force unchanged. Model predictions slightly worsen in all dimensions, but quantitatively they stay very close to the baseline simulation.

[24] Clearly ε could not be reduced further from the baseline calibration, in which we set $\varepsilon = 0.002$.

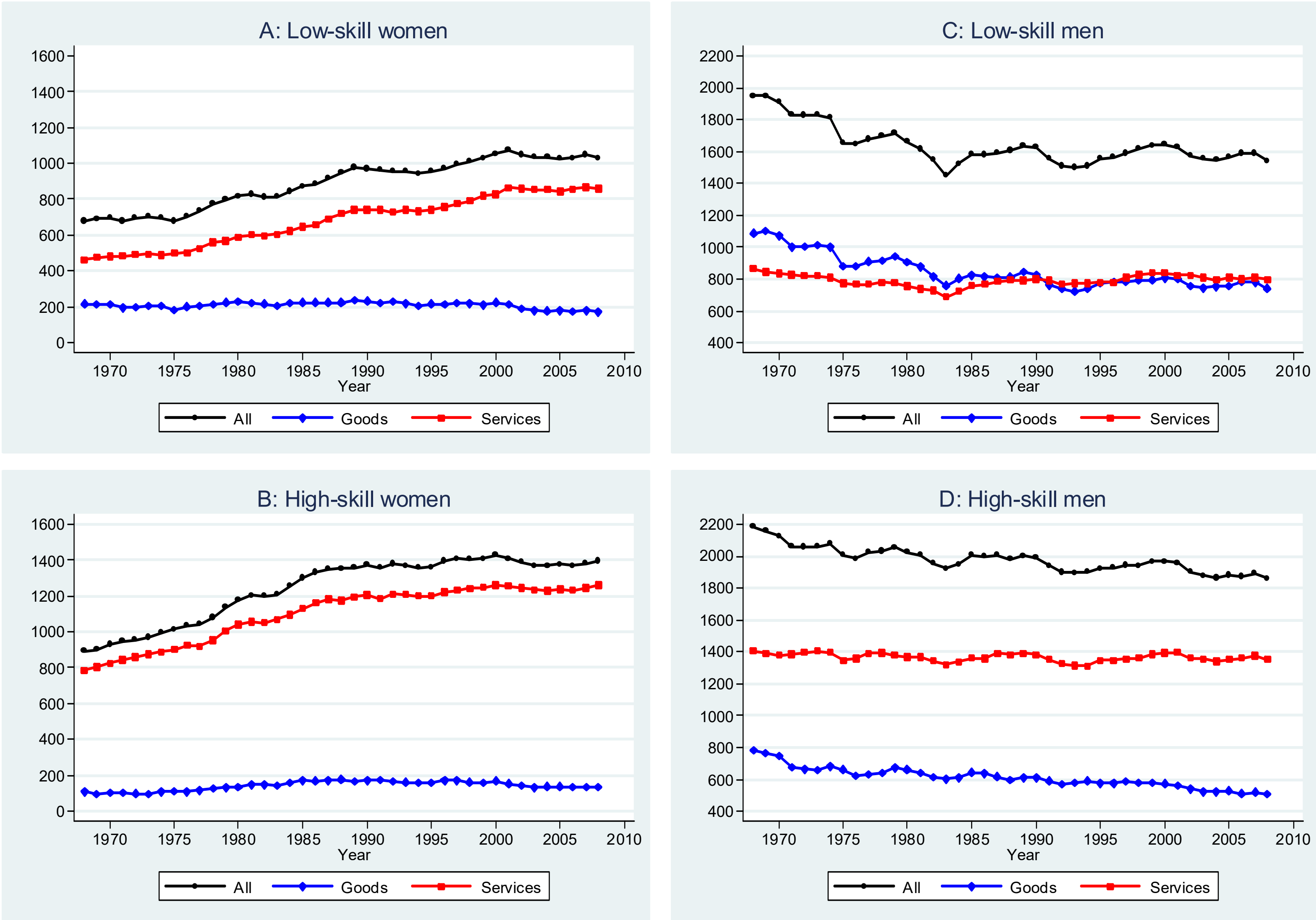
Appendix Tables and Figures

Table A1
Sensitivity analysis on between-sector forces

	Service share s	Wage ratio x	Female market hours M_f/L_f	Male market hours M_m/L_m	Market hours ratio $\frac{M_f/L_f}{M_m/L_m}$	Total work ratio κ_f/κ_m
	1	2	3	4	5	6
1970 data	0.59	0.63	0.23	0.48	0.47	1.03
2006 data	0.74	0.78	0.29	0.40	0.71	1.06
			Percentage change 1970-2006			
Data	25.4	23.8	26.9	-15.8	50.6	3.0
A. Model – Between-sector forces only ($\pi_g = \pi_s = 1$)	26.1	4.7	9.0	-1.4	10.6	0.5
B. Model – Weaker marketization ($\pi_g = \pi_s = 1$ and $\sigma = 1.5$)	24.2	5.7	1.5	-5.1	7.0	0.6
C. Model – Stronger marketization ($\pi_g = \pi_s = 1$ and $\sigma = 2.5$)	27.6	3.8	16.5	2.1	14.0	0.4
D. Model – Weaker structural transformation ($\pi_g = \pi_s = 1$ and $\varepsilon = 0.1$)	24.2	4.2	9.4	-0.8	10.3	0.5

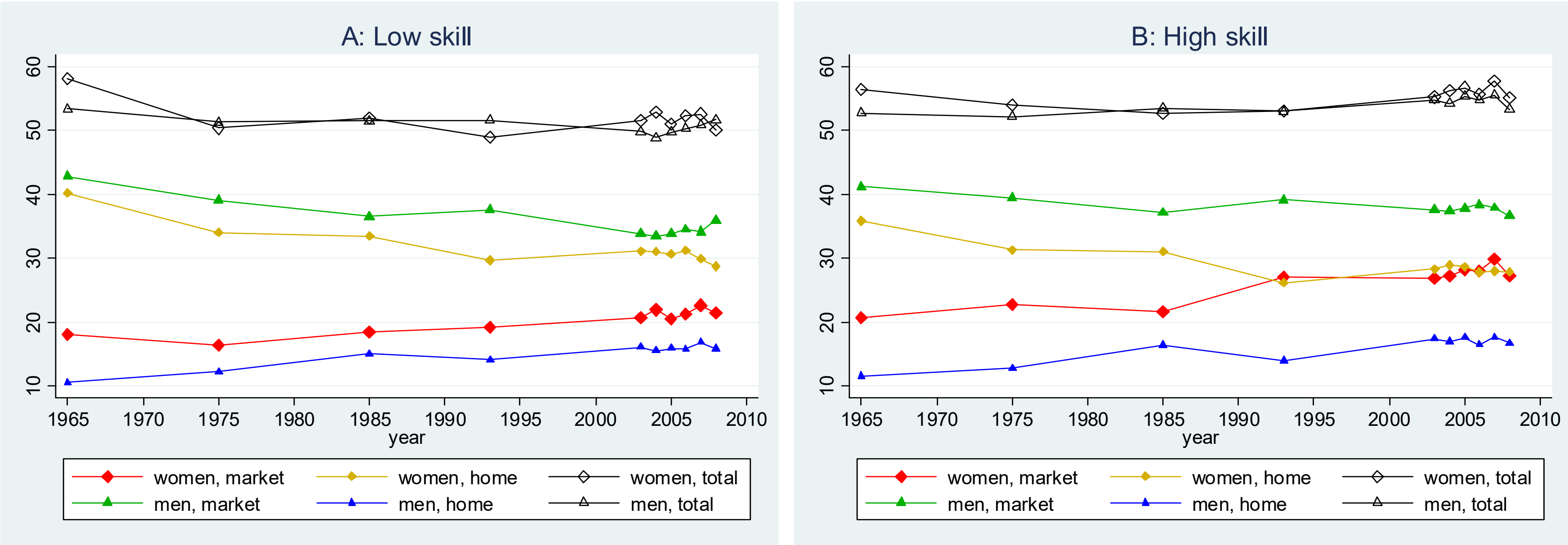
Notes. 1970 refers to the 1968-1972 average. 2006 refers to the 2004-2008 average. All parameters used are baseline values reported in Subsection 4.2, unless indicated in brackets.

Figure A1. Trends in market hours, by skill



Notes. The low-skilled include high-school dropouts and high-school graduates. The high-skilled include those with some college, or college completed. See Table 1 for definition of the service sector. Sample: men and women aged 21-65. Source: CPS: 1968-2008.

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



Notes. The low-skilled include high-school dropouts and high-school graduates. The high-skilled include those with some college, or college completed. Market work includes time spent working in the market sector on main jobs, second jobs, and overtime, including any time spent working at home, but excluding commuting time. Home production hours include: time spent on meal preparation and cleanup, doing laundry, ironing, dusting, vacuuming, indoor and outdoor cleaning, design, maintenance, vehicle repair, gardening, and pet care; time spent obtaining goods and services; child care. Sample: men and women aged 21-65. Source: 1965-1966 America's Use of Time; 1975-1976 Time Use in Economics and Social Accounts; 1985 Americans' Use of Time; 1992-1994 National Human Activity Pattern Survey; 2003-2008 American Time Use Surveys. All series are adjusted for changing demographics following the method of Aguiar and Hurst (2007a).