

Gender Gaps and the Rise of the Service Economy*

L. Rachel Ngai Barbara Petrongolo
LSE and CFM Queen Mary University
 and CEP (LSE)

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Abstract

This paper investigates the role of the rise of services in the narrowing of gender gaps in hours and wages in recent decades. We highlight the between-industry component of the rise in female work for the U.S., and propose a model economy with goods, services and home production, in which women have a comparative advantage in producing market and home services. The rise of services, driven by structural transformation and marketization of home production, 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.

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1 Introduction

One of the most remarkable changes in labor markets since World War II is the rise in female participation in the workforce. In the US, the employment rate of 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 64% of male wages. By 2008, these ratios rose to 74% and 78%, respectively. Second, the entire (net) rise in women’s hours took place in the broad service sector, while the entire (net) fall in male hours took place in goods-producing sectors, including the primary sector, manufacturing, construction and utilities. This pattern is closely linked to

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

²The focus on demand forces is appealing in so far 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 57% in 1968 to 77% in 2008. Finally, the rise in women’s hours in the service sector was accompanied by a strong decline in their working hours in the household, from about 38 to 28 hours weekly, consistent with substantial *marketization* of home production (Freeman and Schettkat, 2005).³

Motivated by these facts, this paper studies the role of the rise of 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 and Weinberg, 2000). While the brawn versus brain distinction has become less relevant in recent decades with the introduction of brawn-saving technologies, women may still retain a comparative advantage in services, related to the more intensive use of communication and interpersonal skills, which cannot be easily automated. The simultaneous presence of producer and consumer in the provision of services makes these skills relatively more valuable in services, and a few studies have highlighted gender differences in the endowment and use of such traits (Roter et al, 2002, Dickerson and Green, 2004, Borghans et al., 2005, 2008). In particular, Borghans et al. (2005) show that the rise in the use of interpersonal tasks accelerated between the late 1970s and the early 1990s, and that women are over-represented in these tasks, suggesting that women are relatively more endowed in those

³See 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.

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 have a comparative advantage, it has potentially important consequences for the evolution of women's hours of market work. Indeed, in a shift-share framework, as much as one third of the rise in female hours took place via the expansion of services, at constant female intensity within each sector.

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

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

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

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

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

There exist extensive literatures that have independently studied the rise in female labor market participation and the rise of services, respectively, but

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

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 illustrate that the rise in services and female labor market outcomes are jointly driven by exogenous shocks to relative prices and the value of home time. In our framework, both relative prices and home time are endogenous outcomes of structural transformation and marketization, in turn driven by uneven productivity growth.

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 et al. (2013) and Rendall (2014). 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. In particular, in Rendall's (2014) set-up, female comparative advantages are modeled as an (exogenously) lower wage gap in services than in manufacturing, and some form of job rationing is invoked to rule out the between-industry equalization of gender gaps.⁶ Rendall then quantitatively assesses the impact of exogenously closing gender gaps on female employment and the consequent rise in service. In our set-up, comparative advantages are instead represented by gender-specific technology parameters, and the rise in services endogenously generates wage convergence

⁵Jones et al. (2003) and Heathcote et al. (2010) also consider within-sector demand forces and illustrate the rise in the gender hours ratio stemming, respectively, from a fall in gender discrimination and gender-biased technological progress.

⁶This is also the modelling choice of Fan and Lui (2003), who find that the narrowing of the wage gap in Hong Kong was in large part due to compositional changes in employment, as structural transformation moved women from manufacturing into services. .

via constant comparative advantages. Finally, the interplay between the service share and female outcomes has been recently studied in an international perspective by a few papers that relate lower female employment in Europe to an undersized service sector relative to the U.S. (Rendall, 2014; Olivetti and Petrongolo, 2014; Olivetti, 2014). In particular, Olivetti and Petrongolo (2014) find that the between-industry component of labor demand explains the bulk of the international variation in the gender-skill structure of labor demand, and about one third of the correlation between wage and hours gaps.

The recent literature on structural transformation often classifies the mechanisms that drive the rise in services into income and relative price effects.⁷ With the first mechanism, income growth shifts the allocation of resources towards services as long as the demand for services is more elastic to income than the demand for goods. With the second mechanism, changes in relative prices alter the resource allocation when the elasticity of substitution between goods and services is not unity. Both channels are at work in our model. 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 1968-2009, combining data from the Current Population Survey and several time use surveys. Section 3 develops a model for a three-sector economy and shows predictions of uneven labor productivity growth for relative wages, market hours and home production hours. Section 4 presents quantitative results and Section 5 concludes.

⁷See Herrendorf et al. (2013b) for a recent survey, and references therein, including Acemoglu and Guerrieri (2008), Baumol (1967), Boppart (2011), Buera and Kaboski (2012), Caselli and Coleman (2001), Kongsamut et al (2001), Ngai and Pissarides (2007) and Rogerson (2008).

2 Data and stylized facts

This Section presents data 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 2009 and time use surveys for 1965 onwards.

2.1 Market work

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

Figure 1 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 1950 to 1600. These diverging trends imply a doubling of the hours ratio,⁸ from 0.37 to 0.74, and a fairly stable number of aggregate hours in the economy.

We classify market hours into two broad sectors, which we define as goods and services. The goods sector includes the primary industries, manufacturing,

⁸Throughout the paper, hours and wage ratios indicate female/male ratios.

construction and utilities. The service sector includes the rest of the economy. Panel B in Figure 1 plots the proportion of hours in services overall and by gender, and shows an increase of nearly 20 percentage points in the share of market hours worked by both males and females in services. For women, the service share is substantially higher than for men, and rises from 74% to 91%, while for men it rises from 50% to 68%. 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 Appendix A.

Table 1 provides detailed evidence on hours shares and female intensities for goods and services, and for seventeen finer industries. The 20 percentage points' expansion in the service share is expected to boost female employment as the female intensity in services is on average 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 female intensity in every industry.⁹ The evidence summarized in Table 1 thus highlights both between- and within-industry components in the rise of female hours.

We next quantify between- and within-industry components of trends in female hours by decomposing the growth in the female hours share between 1968 and 2009 into a term reflecting the change in the share of services, and

⁹The 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.

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

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

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

We have motivated our focus on the sectoral dimension of gender developments based on gender comparative advantages, via the more intensive use of non-physical tasks 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 they use more intensively occupations in which women have a comparative advantage. One would thus expect to detect an important between-occupation component in the rise in female hours. This is shown in the fourth row of Table 2, based on a 4-fold occupational decomposition.¹⁰ The between-occupation

¹⁰This is the broad task-based grouping of occupations suggested by Acemoglu and Autor (2011). Categories are: professional, managerial and technical occupations; clerical and sales

component explains about 26% of the total. This is somewhat smaller than the between-sector component, but still sizeable.

Between-sector and between-occupation dimensions are clearly not orthogonal. As the distribution of occupations varies systematically across industries, a portion of the between-occupation component may be explained by the expansion of industries in which female-friendly occupations are over-represented. Between-occupation changes that are not captured by changes in the industry structure is 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

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

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

occupations; production and operative occupations; service occupations.

2.2 Wages

Evidence on wages is provided in Figure 2. Panel A shows the evolution of the wage ratio in the aggregate economy, obtained as the exponential of the gender gap in mean log wages, unadjusted for characteristics. Women’s hourly wages remained relatively stable at or below 65% of male wages until about 1980, and then started rising up to about 80% at the end of the sample period. The combined increase in female hours and wages raised the female wage bill from 30% to two thirds of the male wage bill. When using hourly wages adjusted for human capital (controlling for age and age squared, race, and four education levels), the rise in the gender wage ratio is only slightly attenuated, from 64% in 1968 to 77% in 2009 (Panel B). While a measure of actual, rather than potential, labor market experience is not available in the CPS, estimates by Blau and Kahn (2013) on the PSID show that gender differences in actual experience explain about a third of the rise in the wage ratio between 1980 and 1999. Thus there is clear evidence of closing - but still sizeable - gender gaps even after controlling for actual labor market experience. Note finally that the trend in the wage ratio is very similar across market sectors.

2.3 Home production

We finally provide evidence on the distribution of total work between market and home production for each gender, by linking major time use surveys for the U.S for 1965-2009.¹¹ As a measure of labor supply to the market we use “core” market work (in the definition of Aguiar and Hurst, 2007a), including time worked on main jobs, second jobs and overtime, but excluding time spent commuting to/from work and time spent on ancillary activities, including meal times and breaks. This is the labor supply measure that is most closely comparable to market hours measured in the CPS. However, no information on annual weeks worked is available from the time use surveys,

¹¹These 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 2003-2009 American Time Use Surveys. These surveys are described in detail in Aguiar and Hurst (2007a).

and all work indicators presented are weekly. To obtain a measure of home production we sum hours spent on core household chores (cleaning, preparing meals, shopping, repairing etc.) and hours of child care.

Figure 3 shows trends in market and home hours for men and women since 1965. The series for market work of men and women clearly converge during the sample period: weekly hours worked in the market rise from 19 to 23 for women, and fall from 42 to 33 for men. The trends are very similar to those detected using the CPS in Figure 1A. The series for home production also move closer to each other, as household hours fall from 38 to 28 for women, and rise from 11 to 16 for men. Interestingly, as first noted by Aguiar and Hurst (2007a) on the same data, and by Burda et al. ((2013) in a cross-section of countries, there are no major gender differences in the dynamics of total work, but the market/home divide of total work differs sharply across genders. For women the share of market work in total work rises from one third in 1965 to 45% in 2009, while for men this falls from 80% to two thirds (see also Aguiar and Hurst 2007a and Ramey and Francis, 2009, for a discussion of these trends throughout the 20th century). All trends considered are also confirmed within two broad skill groups, as shown in Figure A2 in the Appendix.

3 The model

The evidence presented above has highlighted four main stylized facts, namely: (i) an increase in market hours for women, and a fall for men; (ii) a rise in the market share of services, with about one third of the rise in relative female hours taking place between sectors; (iii) an increase in female relative wages; (iv) a fall in home production hours for women, and an increase for men.

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. Structural transformation leads to a rise in the wage ratio and a fall in market hours for both genders. Marketization leads to a rise in market hours for both genders. Due to gender comparative advantages, structural transformation has a stronger impact on male market hours, while

marketization has a stronger impact on female home hours. Thus the combination of the two forces can potentially account for the rise in the gender ratio of market hours, and the fall in the gender ratio of home hours.

It should be emphasized that the proposed framework solely relies on between-sector forces to deliver gender-specific trends. By construction, the model can only explain the between-industry component of gender changes, which we have quantified to one third, while it cannot address the within-sector rise in the female intensity. Our approach thus complements previous work on within-sector forces explaining the remaining two thirds of the increase in women's hours, which has focused on a variety of supply-side explanations (see reference list in footnote 1), gender-biased technical change (Heathcote et al., 2010), antidiscrimination interventions (Goldin, 2006), or frictions distorting the job allocation of gender talents (Hsieh et al., 2013).¹²

Also, our model does not include leisure decisions, as time use data reveal that the gender ratio in total working time was remarkably stable throughout our sample period.¹³ Finally, as the evolution of gender time allocation across sectors is qualitatively similar across skills, the model focuses on the time-allocation decisions of a representative household.

The multi-sector economy is modeled in two steps. First, we describe a two-sector economy, producing goods and services, and show that structural transformation raises the gender wage ratio as long as women have a comparative advantage in services. Such comparative advantage stems from the more intensive use of brawn skills in the goods sector, and the more intensive use of interpersonal skills in the service sector, under the assumption that women are relatively less endowed with the former and relatively more endowed with the latter. Second, we introduce a home sector producing services that are close substitutes to market services, and show that marketization of home produc-

¹²Additional explanations for narrowing gender gaps in wages hinge on changes in female workforce composition (see Mulligan and Rubinstein, 2008).

¹³The ratio between female and male total hours is 1.08 in 1965 and it very slightly declines to 1.03 in 2009. On the other hand, the market share of total working time evolves very differently across genders, rising from 0.34 to 0.45 for women and falling from 0.79 to 0.67 for men. The allocation of total work between the market and the home seems therefore the key margin to understand gender trends in market hours.

tion and structural transformation jointly imply a rise in the wage ratio and in the share of market hours of women, relative to men.

Since there are no distortions, the equilibrium allocation will be characterized in the Section by solving the social planner's problem. The full derivation of the decentralized equilibrium for the representative firm and the representative household, is provided in Appendix 6.2.

3.1 Structural transformation and the wage ratio

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

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

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

For each gender, the following resource constraint holds:

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

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

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

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

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

where $a_j \equiv (1 - \xi_j)/\xi_j$, $j = 1, 2$. Given women's comparative advantage in services (implying $a_1 > a_2$), the equilibrium condition (6) is downward sloping, i.e. $T'(x) < 0$. The intuition is that a higher wage ratio induces substitution away from female labor in all sectors, but substitution is weaker in the sector in which women have a comparative advantage, as implied by (5). Thus a higher wage ratio is associated with a lower share of female hours in the goods sector. As L_{m1}/L_{m2} is proportional to L_{f1}/L_{f2} due to (5), lower L_{f1}/L_f implies lower L_{m1}/L_m and an overall lower share of hours in the goods sector.

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

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

Proposition 1 is solely based on the assumption of gender comparative advantages, and in particular it holds independently of product demand, and the specific process driving structural transformation. This result is similar to Stolper-Samuelson theorem from international trade theory, which predicts that a rise in the relative price of a good will lead to higher return of the factor that is used most intensively in the production of the good.

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

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

and it can only rise following an increase in the relative demand for female labor (ξ) or a fall in its relative supply (L_f/L_m). The rise in aggregate ξ is typically interpreted as a gender-biased demand shift.¹⁴ Note that the equilibrium wage

¹⁴Heathcote et al. (2010) show in a one-sector model that this kind of gender-biased demand shift can explain the bulk of the rise in relative female hours.

ratio in the one-sector model falls within the (x_1, x_2) range defined above if ξ falls within the (ξ_1, ξ_2) range. Specifically, if the two models imply the same hours allocation, (6) and (7) imply equal equilibrium wage ratios if the following condition is satisfied:

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

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

3.2 Structural transformation and marketization

We introduce a home sector to account for changes in the allocation of total work between the market and the home. Households consume goods and a combination of market and home services. The assumed utility function is a nested-CES specification:

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

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

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

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

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

$$L_{gs} + L_{gh} = L_{g2} \quad g = f, m. \quad (11)$$

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

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

3.2.1 Labor allocation across market and home services

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

$$\frac{L_{fs}}{L_{ms}} = \frac{L_{fh}}{L_{mh}} = \frac{L_{f2}}{L_{m2}}, \quad (12)$$

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

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

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

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

Finally, we derive a hypothetical production function for the composite service output c_2 , which is equivalent to (3) for the two-sector model, with the

qualification that the productivity index A_2 depends on A_s and A_h according to (full derivation in Appendix 6.1.2):

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

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

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

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

3.2.2 Labor allocation across goods and services

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

$$\frac{L_{f1}}{L_{f2}} \equiv R(x) = \left(\frac{\omega}{1 - \omega} \right)^\varepsilon \left(\frac{A_2}{A_1} \right)^{1-\varepsilon} \left(\frac{\xi_1}{\xi_2} \right)^\varepsilon \left(\frac{z_2(x)}{z_1(x)} \right)^{1-\varepsilon/\eta}, \quad (15)$$

where

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

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

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

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

We next consider shocks to the allocation condition (17). Given (15), $D(x)$ shifts downwards whenever $\gamma_1 > \gamma_2$, i.e. if and only if productivity grows faster in the goods than the (composite) service sector. The shift in $D(x)$ traces equilibrium downward along the $T(x)$ curve (6), resulting in a higher x and a lower L_{f1}/L_f . Define market service share $s \equiv \frac{L_{fs}+L_{ms}}{L_{fs}+L_{ms}+L_{f1}+L_{m1}}$. Thus the following Proposition can be established:

Proposition 2 *Over time, market services share and the wage ratio rise together if and only if $\gamma_1 > \gamma_2 \geq \gamma_h$.*

Proof. Over time, $D(x)$ shifts down if and only if $\gamma_1 > \gamma_2$, which implies rising x and falling $\frac{L_{f1}}{L_f}$. This implies a higher $\frac{L_{fs}}{L_f}$, as $\frac{L_{fs}}{L_{f2}}$ rises over time, due to $\gamma_s \geq \gamma_h$ and condition (13). Finally, using condition (5), rising $\frac{L_{fs}}{L_f}$ implies rising $\frac{L_{ms}}{L_m}$, as x is rising. The result follows. ■

This result has two components. The first component, related to the shift in $D(x)$, is common to the structural transformation literature: faster labor productivity growth in the goods sector shifts resources from the goods to service sectors, due to poor output substitutability. Given market services and home services are good substitutes, and the productivity growth in the market

is at least as fast as in the home, it follows that market service share must rise. The second component is novel: since women have a comparative advantage in the services sector, uneven labor productivity growth across sectors acts as an increase in relative demand for female labor, which in turn raises the equilibrium wage ratio.

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

$$MF \equiv (\gamma_s - \gamma_h)(\sigma - 1) > 0, \quad SF \equiv (1 - \varepsilon)(\gamma_1 - \gamma_s) > 0, \quad (18)$$

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

$$\frac{\Delta R_{mh}}{R_{mh}} = MF, \quad (19)$$

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

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

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

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

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

where

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

Conditional on x , the service share (21) rises with both structural transformation and marketization.¹⁵

While expression (21) represents the central planner's allocation, the corresponding expression (36) in Appendix 6.2 establishes equivalent results in decentralized equilibrium, giving further insight on relative price and relative expenditure changes. In decentralized equilibrium, faster productivity growth in the goods sector (falling A_1/A_2) raises the relative price of services. As goods and services are poor substitutes ($\varepsilon < 1$), this in turn expands the share of services in household expenditure and market hours. Furthermore, faster

¹⁵There are two further, opposing effects via equilibrium x , represented by the last two terms in equation (22), which turn out to be minimal compared to the direct effects from SF and MF . Given $a_1 > a_2$, the rising wage ratio raises the relative cost of female hours, which has a negative impact on service share. This works through the term $\frac{1+a_1^\eta x^\eta}{1+a_2^\eta x^\eta}$ in (22). On the other hand, rising x induces more women to move from the goods to the service sector, raising s through the term $\left(\frac{1+a_2^\eta x^{\eta-1}}{1+a_1^\eta x^{\eta-1}} \right)^{\frac{\eta-\varepsilon}{\eta-1}}$ in (22).

productivity growth in market relative to home services raises the market wage and 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 represent, respectively, the relative price and income effects emphasized in the structural transformation literature as the forces driving the rise in services (Herrendorf et al., 2013). In our framework income effects are generated by nested CES preferences (9), in which the presence of home services implies non-homothetic utility in goods and market services. Marketization thus provides a channel whereby the income elasticity of demand is higher for market services than for goods.¹⁶

3.2.3 Gender outcomes

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

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

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

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

where the second equality follows from the equilibrium conditions (6) and (17). The first equality describes the substitution effect between male and female hours in home production, whereby a higher wage ratio discourages relative female hours in home production. The second equality links this effect to the role of structural transformation and marketization. Specifically, if women

¹⁶The link between the income elasticity of services and home production is first noted by Kongsamut et al. (2001), who adopt a non-homothetic utility function defined over c_1 and $(c_s + \bar{c})$, where \bar{c} is an exogenous constant that “can be viewed as representing home production of services”.

have a comparative advantage in producing services ($a_1 > a_2$), the rise in female market hours, as reflected in (24), results from structural transformation and marketization according to (20).

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

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

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

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

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

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

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

3.3 Summary of qualitative results

The three-sector model derived above 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 also raising the wage ratio. More specifically, faster productivity growth in goods relative to market services shifts labor from goods into services (structural transformation), while faster productivity growth in market relative to home services shifts labor from the home into market services (marketization). Third, for both genders, the share of market hours falls with structural transformation but rises with marketization (Proposition 3). Fourth, given women’s comparative advantage in services, structural transformation bites relatively more on male hours, while marketization bites relatively more on female hours, and their combination unambiguously raises the gender ratio of market hours (Proposition 4).

4 Quantitative results

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

While in most calibration exercises one would match data targets at the start of the sample period and make predictions forward by feeding in an exogenous driving force, we match data targets at the end of the sample period and make predictions backward. The reason for this choice is that our model abstracts from an important factor identified in the literature for the rise in

the wage ratio, and namely the decline in labor market discrimination against women (see, among others, Goldin, 2006). It would be thus unreasonable to force our model to match gender moments for the late 1960s, as the implied parameters would be far from the true ones even if our model were a good description of the economy except for gender discrimination. It seems instead more reasonable for a model without gender discrimination to match gender-specific moments in the late 2000s. Thus we match the wage ratio and time allocation for 2005-2009, and then feed in the measured SF and MF to predict the average wage ratio and time allocation in 1968-1972.

For deriving quantitative results we slightly generalize the three-sector model presented in Section 3 in order to allow women's comparative advantage in services to differ between the household and the market. We thus replace production of services (10) by

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

This generalization allows our calibration to match hour ratios in each of the three sectors considered via the technology parameter ξ_j , $j = 1, s, h$. It is important to point out that Propositions 1-4 hold in this more general model for ξ_s close to ξ_h . The derivation of the generalized model and the details of the calibration procedure are provided in Appendix 6.2. Indeed the calibration used suggests very close values $\xi_s = 0.44$ and $\xi_h = 0.49$.

4.1 Baseline parameters

The driving forces of structural transformation and marketization are defined as $SF \equiv (1 - \varepsilon)(\gamma_1 - \gamma_s)$ and $MF \equiv (\sigma - 1)(\gamma_s - \gamma_h)$, respectively. To obtain an estimate of σ , we borrow from existing estimates of the elasticity of substitution between home and market consumption, discussed in detail by Aguiar et al. (2012). The most common approach to estimate this elasticity has used micro data on consumer expenditure and home production hours (see e.g. Rupert et al., 1995; Aguiar and Hurst, 2007b). More recently, Gelber and

Mitchell (2012) develop an estimate of the elasticity of substitution between home and market goods from the observed hours response to tax changes. Estimates obtained are typically above 1, with an upper bound of 2.6 for single women. As σ in our framework denotes the elasticity of substitution between market services and home production, it should be as least as large as the elasticity of substitution between any market good and home production. Thus we use as benchmark a value of σ that is close to the upper bound of existing micro estimates for the whole population, $\sigma = 2.3$.

As for the elasticity of substitution between goods and services, recent findings in Herrendorf et al. (2013a) on newly-constructed consumption value-added data suggest relatively low estimates for ε . Herrendorf et al. argue that, if the sectoral production functions are value-added production functions, as in our model, the arguments of the utility function should be the value added components of final consumption - as opposed to final consumption expenditures. Using input-output tables to construct time-series for consumption value-added, they obtain an estimate for ε of 0.002, which we use as our benchmark value.¹⁷

Labor productivity growth in market sectors is obtained from Bureau of Economic Analysis (BEA) data, delivering real labor productivity growth in the goods and services sectors of 2.47% and 1.24% respectively, and we approximate their difference to $\gamma_1 - \gamma_s = 1.2\%$.¹⁸

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, 2015, for a recent application to a large set of countries). The BEA approach consists in estimating home

¹⁷Our baseline calibration with $\varepsilon = 0.002$ almost exactly matches the observed rise in services, consistent with the findings of Herrendorf et al. (2013).

¹⁸Strictly speaking γ_j does not coincide with labor productivity growth, as A_j denotes the productivity of the composite labor input L_j defined in equation (3). But one can map labor productivity into A_j using data on gender intensities and ξ_j , which can be obtained from (5). Using this approach we obtain a productivity growth difference between goods and services of 1.12%. The drawback of this approach is to factor in changes in ξ_j , in turn driving changes in gender intensities within sectors, from which our baseline calibration would abstract. As this approach and labor productivity data yield very similar values for differences in productivity growth, we simply use labor productivity data.

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. Bridgeman (2013) obtains productivity in the home sector as:

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

where w_h denotes the wage of private household employees; L_h denotes hours worked in the household sector; K_{jh} denotes the capital inputs used (consumer durables, residential capital, government infrastructure used for home production), with 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 0.51%, which we approximate to 0.5%. Thus we set $\gamma_s - \gamma_h = 0.7\%$ as our benchmark.

Given SF and MF , the model’s predictions for the dynamics of hours allocation and the wage ratio depend on the elasticity of substitution η and the comparative advantages ξ_1 , ξ_s and ξ_h . To choose a value for η , we draw on existing estimates by Weinberg (2000), who obtains an estimate for η for the US of 2.4, and Acemoglu et al. (2004), who obtain estimates ranging between 2.5 and 4. In what follows we set the baseline value of η at 3, which roughly coincides with the average of existing estimates. We perform sensitivity analysis with respect to $(\sigma, \varepsilon, \gamma_s - \gamma_h, \eta)$ in the Appendix.

Finally, setting 2005-2009 as the baseline period, denoted by t^* , six parameters are chosen to match the predicted values for $(x_{t^*}, s_{t^*}, s_{ft^*}, s_{mt^*}, \mu_{ft^*}, \mu_{mt^*})$ in the data at baseline: the gender-specific technology parameters ξ_1 , ξ_s and ξ_h , the gender ratio of total hours, L_{ft^*}/L_{mt^*} , and (a transformation of) relative productivity \hat{A}_{1st^*} and \hat{A}_{sht^*} , defined as:¹⁹

$$\hat{A}_{sht^*} \equiv \frac{A_{st^*}}{A_{ht^*}} \left(\frac{1 - \psi}{\psi} \right)^{\frac{\sigma}{1-\sigma}}; \quad \hat{A}_{1st^*} \equiv \frac{A_{1t^*}}{A_{st^*}} \left(\frac{1 - \omega}{\omega} \right)^{\frac{\varepsilon}{1-\varepsilon}} \psi^{\frac{\sigma - \varepsilon}{1 - \varepsilon} - \varepsilon}. \quad (27)$$

¹⁹Note that the growth rate for $\hat{A}_{jk,t}$ is equal to $(\gamma_j - \gamma_k)$ for $j, k = 1, 2, h$. Thus data on $(\gamma_1, \gamma_s, \gamma_h)$ are sufficient to predict trends in \hat{A}_{jk} .

It is important note that given the time allocation at t^* and the calibrated values for \hat{A}_{sht^*} and \hat{A}_{1st^*} , separate values for ψ, ω and levels of productivity ($A_{1t^*}, A_{st^*}, A_{ht^*}$) are not required for the model's predictions for changes in time allocation and wage ratio.

The value of L_{ft^*}/L_{mt^*} needs to be consistent with both the hours allocation between the home and the market (obtained from time use surveys) and the share of services in the market economy (obtained from the CPS), and thus it is pinned down by $\mu_{ft^*}, \mu_{mt^*}, s_{t^*}, s_{ft^*}$, and s_{mt^*} . The implied L_{ft^*}/L_{mt^*} for the 2005-2009 is 1.19, which is close to the number obtained by directly adding market and home hours from the CPS and time use surveys, respectively (1.12). These two figures would differ whenever actual hours are also affected by important factors not present in the model, such as discrimination against women or barriers to mobility across sectors. Thus obtaining similar figures suggests that a simple model without discrimination or mobility barriers does a relatively good job at capturing the gender ratio in total hours for 2005-2009. Given L_{ft^*}/L_{mt^*} and x_{t^*} , condition (5) can be solved for ξ_j , $j = 1, s, h$, and conditions (33), (35) and (36) can be solved for \hat{A}_{1st^*} and \hat{A}_{sht^*} . Appendix 6.2 shows detailed steps by which the six data targets ($x_{t^*}, s_{t^*}, s_{ft^*}, s_{mt^*}, \mu_{ft^*}, \mu_{mt^*}$) can be matched by the six parameters ($L_{ft^*}/L_{mt^*}, \xi_1, \xi_s, \xi_h, \hat{A}_{1st^*}, \hat{A}_{sht^*}$).

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

Parameters	Values	Data or Targets
$\gamma_1 - \gamma_s$	1.2%	BEA data.
$\gamma_s - \gamma_h$	0.7%	BEA data for services and Bridgeman (2013) for home sector.
σ	2.3	Various estimates in Aguiar et al. (2012).
ε	0.002	Herrendorf et. al. (2013b).
η	3	Weinberg (2000), Acemoglu et al. (2004).
L_{ft^*}/L_{mt^*}	1.19	match s_{t^*} given $(s_{ft^*}, s_{mt^*}, \mu_{ft^*}, \mu_{mt^*})$
ξ_1	0.332	match x_{t^*} and $\frac{L_{f1t^*}}{L_{m1t^*}} = \frac{1-s_{ft^*}}{1-s_{mt^*}} \frac{\mu_{ft^*}}{\mu_{mt^*}} \frac{L_{ft^*}}{L_{mt^*}}$
ξ_s	0.443	match x_{t^*} and $\frac{L_{fst^*}}{L_{mst^*}} = \frac{s_{ft^*}}{s_{mt^*}} \frac{\mu_{ft^*}}{\mu_{mt^*}} \frac{L_{ft^*}}{L_{mt^*}}$
ξ_h	0.495	match x_{t^*} and $\frac{L_{fht^*}}{L_{mht^*}} = \frac{1-\mu_{ft^*}}{1-\mu_{mt^*}} \frac{L_{ft^*}}{L_{mt^*}}$
\hat{A}_{sht^*}	1.02	match $\frac{L_{fst^*}}{L_{fht^*}} = \frac{\mu_{ft^*} s_{ft^*}}{1-\mu_{ft^*}}$
\hat{A}_{1st^*}	10.8	match $\frac{L_{f1t^*}}{L_{fst^*}} = \frac{1-s_{ft^*}}{s_{ft^*}}$

4.2 Baseline results

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

The next three columns concern time allocation between the market and the home. The average woman allocates 36% of her working hours to the market in the late 1960s, and 45% in the late 2000s, while the corresponding ratio for men falls from 78% to 68%. The model explains 47% of the rise in market hours for women (column 4), 7% of the fall for men (column 5), and 36% of the rise in the gender ratio of market hours (column 6). To relate sectoral gender outcomes to the shift-share analysis of Section 2, we obtain

predictions for the ratio in female share of total market hours, $\mu_f L_f / (\mu_f L_f + \mu_m L_m)$. The model predicts an increase in this ratio from 0.429 to 0.444, which is equivalent to about 19% of its actual change. The shift-share analysis of Section 2 has shown that 34% of the rise in the female hours share was driven by the rise in services. The model thus predicts about 55% (19/34) of the between-sector component of the rise in female hours.

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

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

In Panel C the marketization channel is shut by setting $\gamma_s = \gamma_h$. As in

²⁰During the sample period the raw wage ratio rises by about 17 percentage points (80.5 – 63.2), while the adjusted wage ratio rises by about 13 percentage points (77.5 – 64.1, see Table 5). Thus basic human capital controls explain about 23% of wage convergence.

Panel B, the model predicts a smaller rise in services (columns 1-3). Column 4 shows that marketization is essential to attract female hours to the market, as without marketization female market hours would fall as a consequence of structural transformation, while column 5 shows that removing marketization improves the predictions for male market hours, which now fall more than in the baseline case. Finally, column 7 shows that marketization alone has a small negative effect on wage ratio. This is due to $\xi_h > \xi_s$, i.e. women have stronger comparative advantages in home than market services. Thus marketization shifts female hours to the branch of services in which women have a smaller comparative advantage.

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

4.3 Gender-specific shocks

We next compare baseline results to the outcomes of gender-specific, within-sector shocks.²¹ These are (1) labor supply shocks, represented by changes in the total hours ratio, L_f/L_m , (2) gender-biased technological progress, represented by a rise in ξ_1 and ξ_s ; and (3) gender-biased shift in human capital. The results are presented in Table 5.

²¹Note that the between-sector forces considered predict a fall in the female intensity within each sector, following the rise in relative wages. However, female intensity has risen slightly in the goods sector, and markedly in the service sector (see Table 1). Gender-specific shocks may thus revert model predictions for within-sector female intensities.

4.3.1 Gender shifts in total hours

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

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

4.3.2 Gender-biased technical change

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

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

increase in relative female hours.

Borrowing from Heathcote et al., we let $\xi_1/(1 - \xi_1)$ and $\xi_s/(1 - \xi_s)$ grow at 0.5% per year. The simulation results are reported in Panel C of Table 5. The model now predicts more than the whole rise in female market hours, the whole increase in the gender ratio in market hours, and 68% of the rise in the wage ratio.²² The comparison of Panels A and B reveals that structural transformation and marketization capture an important portion of gender-biased demand shifts, and namely 30% of the predicted increase in the wage ratio (20/68) and 36% of the predicted increase in the gender ratio of market hours.

4.3.3 Human capital

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

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

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

The introduction of human capital affects equilibrium via changes in relative prices and wages. To see this, note that wages and the marginal revenue product of labor is equalized across sectors:

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

²²The reason we cannot explain the whole rise in the wage ratio is that we assume $\eta = 3$ whereas Heathcote et al. (2010) assume $\eta \rightarrow \infty$.

where

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

so the relevant measure of gender comparative advantages is now

$$b_j = \frac{1 - \xi_j}{\xi_j} \left(\frac{h_{mj}}{h_{fj}} \right)^{\frac{\eta-1}{\eta}} = a_j \left(\frac{h_{mj}}{h_{fj}} \right)^{\frac{\eta-1}{\eta}} \quad j = 1, s, h. \quad (28)$$

Whether or not human capital improves labor efficiency in the household has key implications. If human capital is equally useful in the market and at home, i.e. $h_{gj} = h_g \forall j = 1, s, h$, (28) implies that b_1 , b_s and b_h are all falling at the same rate as women are accumulating human capital faster than men. If human capital does not improve labor efficiency at home ($h_{mh} = h_{fh} = 1$), b_h stays constant (with $b_h = a_h$), and b_1 and b_s are falling relative to b_h . This mechanism gives both genders an additional incentive to work in the market, and it is stronger for women than for men. The fall in b_1 and b_s has qualitatively similar impacts to rising ξ_1 and ξ_s in a model without human capital.

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

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

where the h 's are shares of the gender-specific population in each schooling category, and the β 's are the associated coefficients from the wage regression (dropouts being the excluded category). During 1968-2009, the implied human capital index grows at 0.49% per year for females and at 0.38% for males. The steps for the calibration of this extended model are described in Appendix 6.2.

Panels D1 and D2 of Table 5 report quantitative results. The wage ratio x is now calibrated to the unadjusted wage ratio, which increases from 0.63 to 0.81. If human capital is useful in all sectors (panel D1), the rise in relative female human capital simply drives, unsurprisingly, a larger increase in the unadjusted

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

5 Conclusion

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

In our proposed model, marketization and structural transformation, in turn driven by differential productivity growth, jointly act as a demand shock, generating a simultaneous increase in both women’s relative wages and market hours. While the source of both forces is gender neutral, their combination has female friendly outcomes. Marketization draws women’s time into the market and structural transformation creates the jobs that women are better suited for in the market. These outcomes are consistent with evidence on gender

convergence in wages, market work, and household work. When calibrated to the U.S. economy, our model adequately predicts the rise in services and it explains about a half of the rise in women’s market hours and 20% of the rise in the wage ratio.

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 (3), 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. 2009. “Gender Roles and Technological Progress”, NBER Working Paper No. 14873.
- [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 (4): 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?”. Forthcoming, *Labour Economics*.
- [11] Baumol, William J. 1967. “Macroeconomics of Unbalanced Growth: The Anatomy of Urban Crisis.” *American Economic Review*, 57(3): 415–26.
- [12] Bertrand, Marianne. 2011. “New Perspectives 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. 2011, “Structural Change and the Kaldor Facts in a Growth Model with Relative Price Effects and Non-Gorman Preferences,” forthcoming in *Econometrica*.
- [15] Borghans, Lex, Bas ter Weel, and Bruce Weinberg. 2005. “People People: Social Capital and the Labor-market Outcomes of Underrepresented Groups.” IZA Discussion Paper No. 1494.
- [16] Borghans, Lex, Bas ter Weel, and Bruce Weinberg. 2008. “Interpersonal Styles and Labor Market Outcomes.” *Journal of Human Resources* 43 (4): 815–858.
- [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(5), 23-36.

- [18] Bridgman, Benjamin. 2013. “Home Productivity”, Working Paper 0091, Bureau of Economic Analysis.
- [19] Bridgman, Benjamin, Duernecker, Georg and Berthold Herrendorf. 2015. “Structural Transformation, Marketization, and Household Production around the World”, mimeo.
- [20] Buera, Francisco J. and Joseph P. Kaboski. 2012. “The Rise of the Service Economy,” *American Economic Review*, 102, 2540–2569.
- [21] Buera, Francisco J., Joseph P. 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*.
- [23] Caselli, Francesco and Wilbur John Coleman (2001), “The U.S. Structural Transformation and Regional Convergence: A Reinterpretation,” *Journal of Political Economy* 109, 584–616.
- [24] Dickerson, Andy and Francis Green. 2004. “The Growth and Valuation of Computing and Other Generic Skills”. *Oxford Economic Papers* 56, 371-406.
- [25] 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.
- [26] Fernández, Raquel. 2013. “Cultural Change as Learning: The Evolution of Female Labor Force Participation over a Century”, *American Economic Review* 103: 472-500.
- [27] Fernández, Raquel, Alessandra Fogli and Claudia Olivetti. 2004. “Mothers and Sons: Preference Formation and Female Labor Force Dynamics”. *Quarterly Journal of Economics* 119: 1249-1299

- [28] Freeman, Richard and Ronald Schettkat. 2005. “Marketization of Household Production and the EU-US Gap in Work”, *Economic Policy* 41: 5–39.
- [29] Fuchs, Victor. 1968. *The Service Economy*, New York: Columbia University Press.
- [30] Galor, Oded and David Weil. 1996. “The Gender Gap, Fertility, and Growth.” *American Economic Review* 86: 374-87.
- [31] Gelber, Alexander and Joshua W. Mitchell. 2012. “Taxes and Time Allocation: Evidence from Single Women and Men.” *Review of Economic Studies* 79: 863-897.
- [32] Goldin, Claudia. 2006. “The Quiet Revolution That Transformed Women’s Employment, Education, and Family”. *American Economic Review, Papers and Proceedings* 96: 1-21.
- [33] Goldin, Claudia and Lawrence F. Katz. 2002. “The Power of the Pill: Oral Contraceptives and Women’s Career and Marriage Decisions”. *Journal of Political Economy* 100: 730-770.
- [34] Greenwood, Jeremy, Ananth Seshadri and Mehmet Yorukoglu. 2005. “Engines of Liberation”. *Review of Economic Studies* 72: 109–133.
- [35] 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.
- [36] Herrendorf, Berthold, Richard Rogerson, and Ákos Valentinyi. 2013a. “Two Perspectives On Preferences and Structural Transformation.” *American Economic Review* 103: 2752-2789.
- [37] 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.

- [38] Hsieh, Chang-Tai, Erik Hurst, Chad Jones and Pete Klenow. 2013. “The Allocation of Talent and U.S. Economic Growth”. Mimeo, Chicago Booth.
- [39] Jones, Larry, Rodolfo Manuelli, Ellen McGrattan. 2003. “Why Are Married Women Working So Much?” Staff Report 317, Federal Reserve Bank of Minneapolis.
- [40] Kongsamut, Piyabha, Sergio Rebelo, and Danyang Xie. 2001. “Beyond Balanced Growth,” *Review of Economic Studies* 68, 869–882.
- [41] Lebergott, Stanley. 1993. *Pursuing Happiness*. Princeton Univ. Press, Princeton, NJ.
- [42] Lee, Donghoon and Ken Wolpin. 2006. “Intersectoral labor mobility and the growth of the service sector”. *Econometrica* V74(1): 1-46.
- [43] 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(1): 68-85.
- [44] Katz Lawrence F. and Kevin M. Murphy. 1992. “Changes in Relative Wages, 1963-1987: Supply and Demand Factors”. *Quarterly Journal of Economics* 107: 35-78.
- [45] Mulligan, Casey and Yona Rubinstein. 2008. “Selection, Investment and Women’s Relative Wages over Time”. *Quarterly Journal of Economics* 123: 1061-1110.
- [46] Ngai, L. Rachel and Christopher A. Pissarides. 2007. “Structural Change in a Multi-sector Model of Growth”. *American Economic Review* 97, 429–443.
- [47] Ngai, L. Rachel and Christopher A. Pissarides. 2008. “ Trends in Hours and Economic Growth”. *Review of Economic Dynamics* 11: 239-256.
- [48] Olivetti, Claudia. 2006. “Changes in Women’s Aggregate Hours of Work: The Role of Returns to Experience”. *Review of Economic Dynamics* 9: 557-587.

- [49] Olivetti, Claudia and Barbara Petrongolo. 2014. “Gender Gaps Across Countries and Skills: Supply, Demand and the Industry Structure”. Forthcoming, *Review of Economic Dynamics*.
- [50] Olivetti, Claudia. 2014. “The Female Labor Force and Long-run Development: The American Experience in Comparative Perspective”. In L. Platt Boustan, C. Frydman and R.A. Margo (eds.), *Human Capital in History: The American Record*. Chicago: Chicago University Press, forthcoming.
- [51] Ramey, Valerie A., and Neville Francis. 2009. “A Century of Work and Leisure.” *American Economic Journal: Macroeconomics* 1: 189-224.
- [52] Rendall, Michelle. 2010. “Brain versus Brawn: The Realization of Women’s Comparative Advantage.” Mimeo, University of Zurich.
- [53] Rendall, Michelle. 2014. “The Service Sector and Female Market Work.” Mimeo, University of Zurich.
- [54] Reid, Margaret (1934). *Economics of Household Production*. Wiley, New York.
- [55] Rogerson, Richard (2008). “Structural Transformation and the Deterioration of European Labor Market Outcomes.” *Journal of Political Economy* 116(2), 235-259.
- [56] Roter, Debra, Judith Hall and Yutaka Aoki (2002). “Physician Gender Effects in Medical Communication.” *Journal of the American Medical Association* 288(6), 756-764.
- [57] Rupert, P., Rogerson, R., Wright, R., 1995. “Estimating Substitution Elasticities in Household Production Models”. *Economic Theory* 6, 179–193.
- [58] Weinberg, Bruce A. 2000. “Computer Use and the Demand for Female Workers”. *Industrial and Labor Relations Review* 53: 290-308.

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

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

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

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

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

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

Table 3
Data Targets

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

Table 4: Baseline results

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

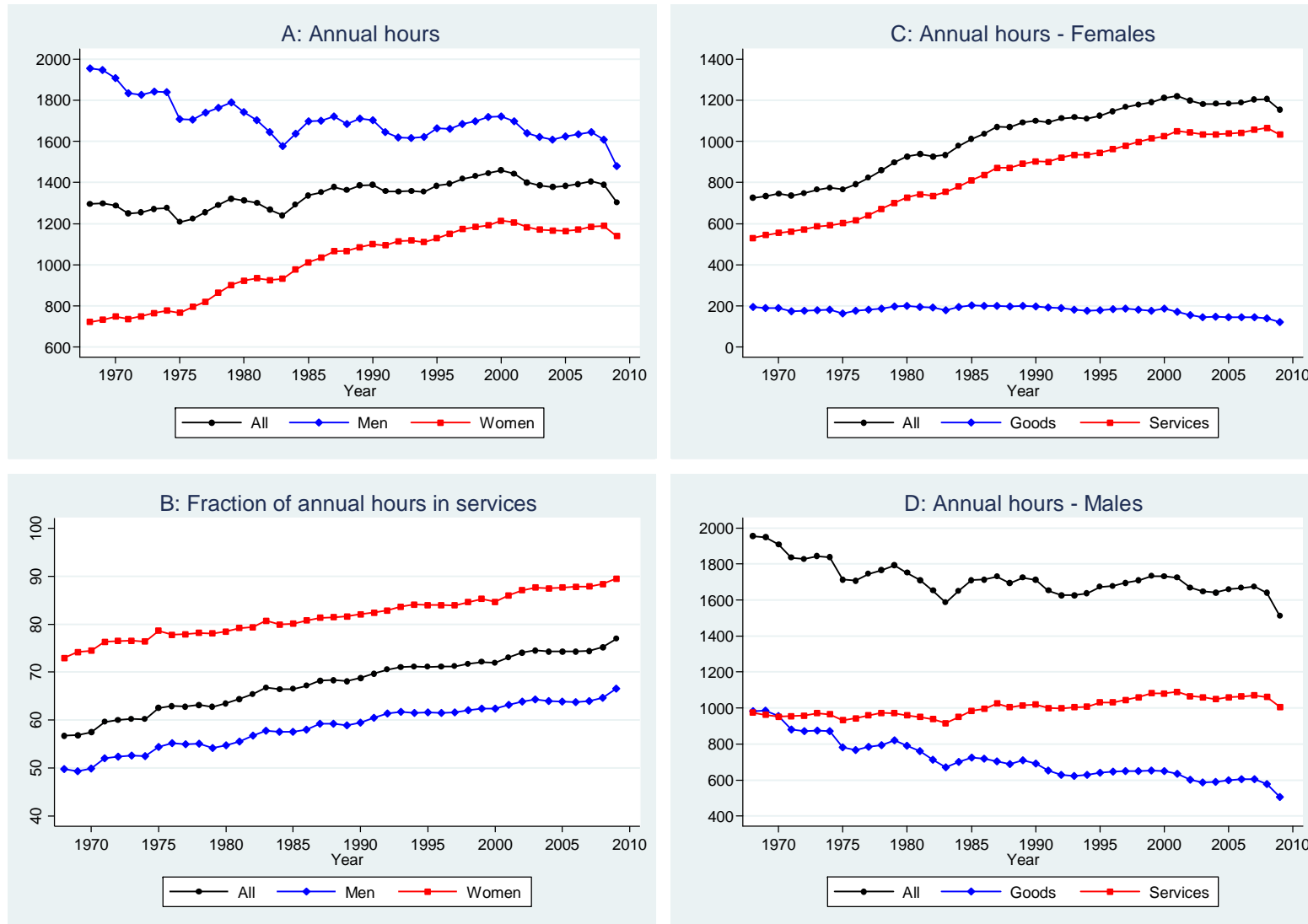
Notes. All parameter values are baseline values, unless otherwise indicated. The % explained are obtained as $100 \times \frac{z_t - \hat{z}_{t-1}}{z_t - z_{t-1}}$, where z denotes the target variable, t denotes 2005-09, $t - 1$ denotes 1968-72, and a superscript hat indicates model (backward) predictions.

Table 5: Gender-specific shocks

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

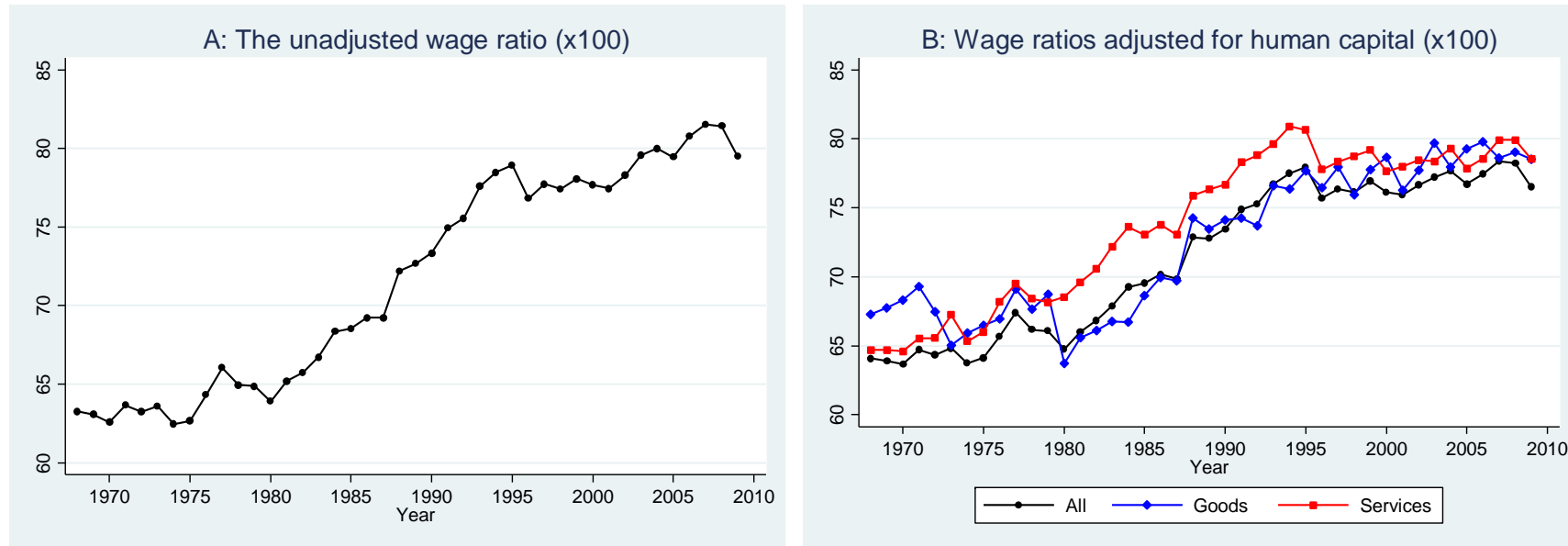
See notes to Table 4.

Figure 1
Trends in market hours, by gender.



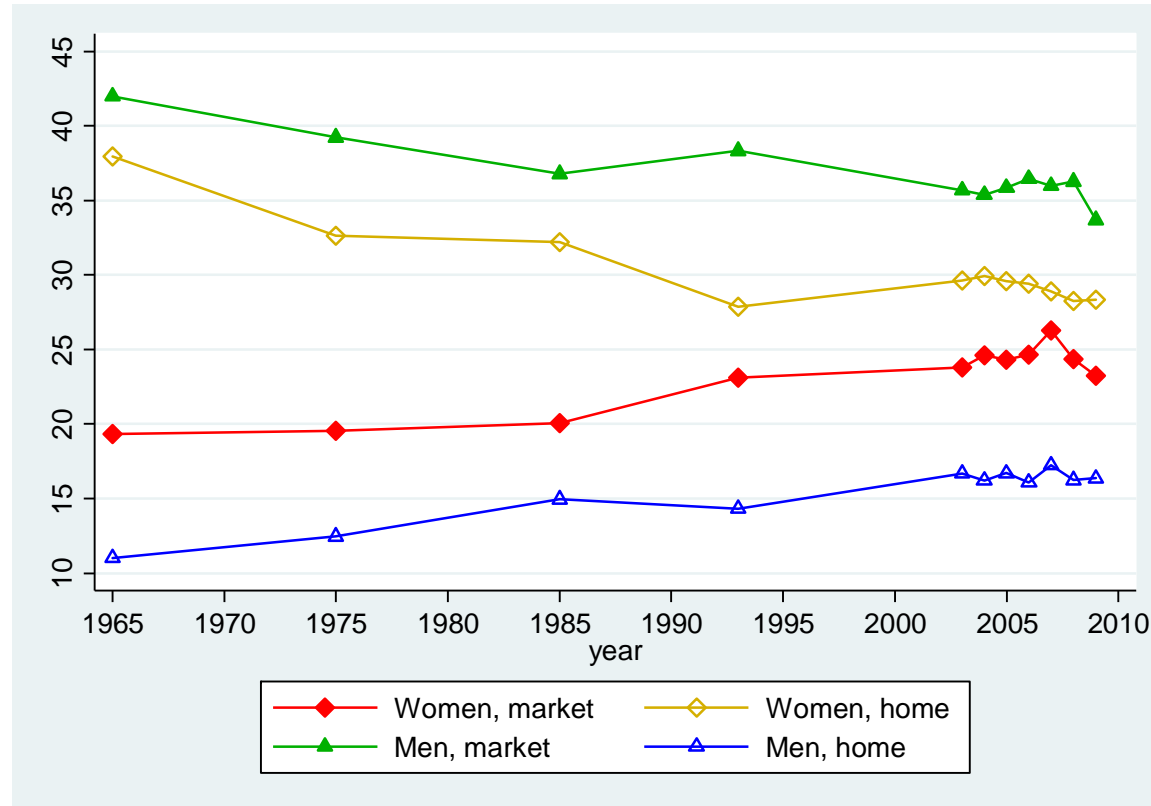
Notes. See Table 1 for definition of the service sector. Source: CPS: 1968-2009.

Figure 2
The gender wage ratio



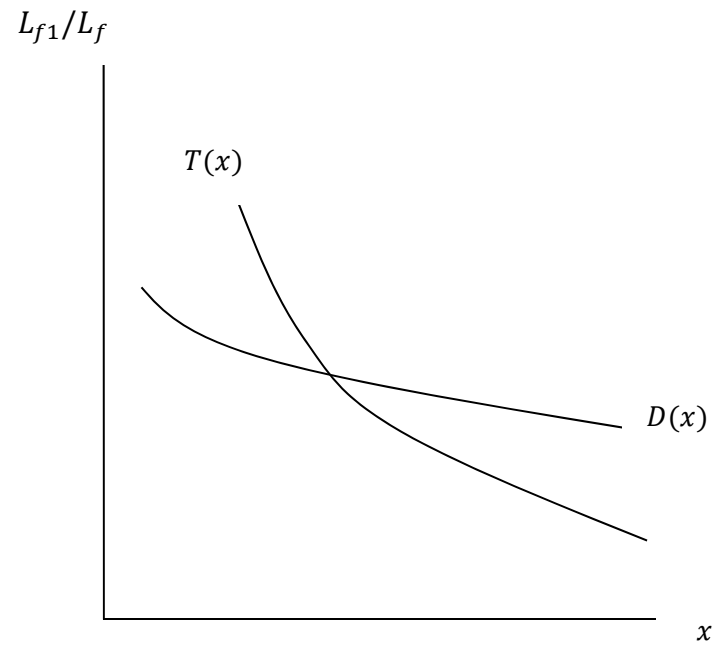
Notes. In panel A the wage ratio is obtained as (the exp of) the coefficient on the female dummy from yearly log wage regressions that only control for gender. In panel B the wage ratio is obtained from corresponding regressions that also control for age, age squared, education (4 categories) and ethnicity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

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



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

Figure 4
The equilibrium wage ratio



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

6 Appendix (Not for publication)

6.1 The model

6.1.1 Uniqueness of equilibrium

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

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

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

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

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

Proof. From (6):

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

From (17):

$$D'(x) = \frac{R'(x)}{[1 + R(x)]^2}; \quad \frac{R'(x)}{R(x)} = -\frac{(\eta - \varepsilon)(a_1 - a_2)x^{\eta-2}}{(1 + a_2x^{\eta-1})(1 + a_1x^{\eta-1})}$$

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

$$\begin{aligned} D'(x) - T'(x) &= -\frac{R(x)}{[1 + R(x)]^2} \frac{R'(x)}{R(x)} + \frac{\eta x^{-\eta-1}}{a_1 - a_2} \left(\frac{L_m}{L_f} \right) \\ &= \frac{x^{-\eta-1}}{a_1 - a_2} \left(\frac{L_m}{L_f} \right) \left[\eta + \frac{xR'(x)}{R(x)[1 + R(x)]} \right] - \frac{a_2}{a_1 - a_2} \frac{R'(x)}{R(x)[1 + R(x)]} \end{aligned} \quad (29)$$

The second term in (29) is positive, and the term in square bracket is:

$$\begin{aligned} & \eta + \frac{xR'(x)}{R(x)[1+R(x)]} \\ = & \frac{\eta}{1+R(x)} \left(\frac{2a_2x^{\eta-1} + 1 + a_2x^{\eta-1}a_1x^{\eta-1}}{(1+a_2x^{\eta-1})(1+a_1x^{\eta-1})} + R(x) \right) + \frac{\varepsilon(a_1 - a_2)x^{\eta-1}}{(1+a_2x^{\eta-1})(1+a_1x^{\eta-1})[1+R(x)]} > 0 \end{aligned}$$

for any $x = x^*$. ■

Proposition 8 *Equilibrium x^* is unique.*

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

6.1.2 Aggregation across market and home

The production function (10) can be rewritten as

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

which implies

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

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

$$c_2 = c_s \left[\psi + (1 - \psi) \left(\frac{\psi A_s}{(1 - \psi) A_h} \right)^{1-\sigma} \right]^{\frac{\sigma}{\sigma-1}} = c_s \left(\psi \frac{1 + R_{mh}}{R_{mh}} \right)^{\frac{\sigma}{\sigma-1}}. \quad (30)$$

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

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

which can be substituted into (30) to obtain A_2 :

$$A_2 = A_s \frac{R_{mh}}{1 + R_{mh}} \left(\psi \frac{1 + R_{mh}}{R_{mh}} \right)^{\frac{\sigma}{\sigma-1}} = A_s \psi^{\frac{\sigma}{\sigma-1}} \left(\frac{R_{mh}}{1 + R_{mh}} \right)^{\frac{-1}{\sigma-1}}. \quad (31)$$

The results for γ_2 follow from taking the time derivative of (31) and using (13).

6.2 Decentralized equilibrium and calibration

This section describes the decentralized equilibrium of the economy to gain further insight on the impact of uneven productivity growth on gender outcomes via households choices. In doing this, gender comparative advantages are allowed to differ across the three sectors of the economy, as emphasized in (26). We then describe how this model is calibrated to the US economy.

6.2.1 Firms and households

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

$$w_f = p_j A_j \xi_j \left(\frac{L_j}{L_{fj}} \right)^{1/\eta} ; \quad w_m = p_j A_j (1 - \xi_j) \left(\frac{L_j}{L_{mj}} \right)^{1/\eta} ; \quad j = 1, s. \quad (32)$$

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

$$\frac{p_k}{p_j} = \frac{A_j \xi_j}{A_k \xi_k} \left(\frac{z_j(x)}{z_k(x)} \right)^{1/\eta} ; \quad j, k = 1, s. \quad (33)$$

Each household consists of a male and a female, with a joint utility function (9). Given wages (w_f, w_m) and prices (p_1, p_s) , a representative household chooses a consumption vector (c_1, c_s, c_h) and home production vector

(L_{mh}, L_{fh}) , and supply the remaining working time to the market. Specifically, the household maximizes the utility function (9) subject (26) and the household budget constraint:

$$p_1 c_1 + p_2 c_2 = w_m (L_m - L_{mh}) + w_f (L_f - L_{fh}). \quad (34)$$

Utility maximization implies that (5) holds for the home sector, $j = h$; and that the marginal rate of substitution across any two commodities must equal their relative price. Perfect labor mobility between the household and the market implies that (32) holds for $j = h$, thus an implicit price for home services can be defined as $p_h \equiv \frac{w_g}{A_h(\partial L_h / \partial L_{gh})}$, $g = f, m$, and condition (33) also holds for $j = h$.

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

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

and the corresponding relative expenditure is given by

$$E_{sh} \equiv \frac{p_s c_s}{p_h c_h} = \left(\frac{p_h}{p_s} \right)^{\sigma-1} \left(\frac{\psi}{1 - \psi} \right)^\sigma. \quad (35)$$

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

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

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

and the relative expenditure is:

$$E_{1s} = \left(\frac{p_1}{p_s} \right)^{1-\varepsilon} \left(\frac{\omega}{1 - \omega} \right)^\varepsilon \psi^{\frac{\sigma-\varepsilon}{\sigma-1}} \left[1 + \left(\frac{1 - \psi}{\psi} \right)^\sigma \left(\frac{p_s}{p_h} \right)^{\sigma-1} \right]^{\frac{\sigma-\varepsilon}{\sigma-1}}. \quad (36)$$

As relative prices are a function of the wage ratio, the relative expenditure is also a function of the wage ratio. As derived in (33) for $j = 1, s, h$, uneven labor productivity growth implies a rising relative price of market services to goods, p_s/p_1 , and a rising cost of home production relative to market services, p_h/p_s . Both imply a fall in the relative expenditure E_{1s} according to (36).

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

Finally, using the budget constraint (34), the supply of female home production hours can be derived as a function of the relative expenditures:

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

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

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

As relative expenditures are functions of the wage ratio as in (35) and (36), the fraction of female hours supplied to the market $\mu_f \equiv 1 - L_{fh}/L_f$ is also a function of the wage ratio. Intuitively, (37) states that when the expenditure for either market commodity rises relative to home production, and/or when the female wage bill share in the market rises more than in the household, women reallocate their working time from the household to the market.

6.2.2 Equilibrium

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

$$\frac{L_{fi}}{L_{fj}} = E_{ij} \frac{\xi_i}{\xi_j} \left(\frac{z_i(x)}{z_j(x)} \right)^{1/\eta-1} = E_{ij} \frac{I_i(x)}{I_j(x)}, \quad i, j = 1, s, h, \quad (38)$$

which states that the sectoral allocation of hours is determined by the between-sector allocation of expenditure and the within-sector gender wage bill shares. By substituting (38) into the female time constraint (11), the demand for female home production time is given by

$$\frac{L_{fh}}{L_f} = \frac{1}{\sum_{j=1,s,h} E_{jh} \frac{I_j(x)}{I_h(x)}}, \quad (39)$$

and is a function of the wage ratio. Together with the supply condition in (37), labor market clearing implies that the equilibrium wage ratio x satisfies:

$$I(x) \sum_{j=1,s,h} E_{jh} - \sum_{j=1,s,h} I_j(x) E_{jh} = 0. \quad (40)$$

Thus the gender wage ratio x , and, as a result, female labor supply μ_f , depend on relative expenditures, in turn reflecting gender neutral shocks.

6.2.3 Calibration of the baseline model

Below we give detailed steps on how to match $(s_f, s_m, \mu_f, \mu_m, s, x)$ in 2005-09. Data on the time allocation by gender (s_f, s_m, μ_f, μ_m) correspond to the

model's variables L_{gj}/L_g for $g = m, f$:

$$\frac{L_{gj}}{L_g} = \begin{cases} \mu_g (1 - s_g) & \text{for } j = 1 \\ \mu_g s_g & \text{for } j = s \\ 1 - \mu_g & \text{for } j = h \end{cases}. \quad (41)$$

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

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

Using (41) yields

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

Using the observed wage ratio x and hours ratio L_{fi}/L_{mi} ,²³ we obtain ξ_j from equilibrium condition (5).

Finally, the (transformed) relative productivities $\hat{A}_{1,s}$ and $\hat{A}_{s,h}$, defined in (27), are pinned down by data on time allocation $(L_{fj}, L_{mj})_{j=1,s,h}$ and the wage ratio x . We first compute the female wage bill shares and relative expenditures across sectors:

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

²³Note that the gender hours ratio in each of the three sectors is related to (s_f, s_m, μ_f, μ_m) and the obtained level of L_f/L_m according to:

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

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

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

Combining (43) and (33) gives:

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

The marketization equation (35) implies

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

which, together with (44), solves for $\hat{A}_{s,h}$. Similarly the structural transformation equation (36) implies

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

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

6.2.4 Calibration of the extended model with human capital

The calibration is exactly the same as before with the presence of the term h_{mj}/h_{fj} starting from equation (43)

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

which gives values for

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

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

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

so the effective relative productivity becomes

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

which has the same growth rate $(\gamma_s - \gamma_h)$ as before if $h_{fs} = h_{fh}$ and a growth rate $(\gamma_s - \gamma_h + \gamma_{h_f})$ if $h_{fh} = 1$, where γ_{h_f} is the growth rate in h_f .

6.3 Sensitivity analysis

We next perform some sensitivity analysis on parameters $\varepsilon, \sigma, \gamma_s - \gamma_h$ and η . The results are reported in Table A1. In Panel B we allow for a higher elasticity of substitution between male and female labor, $\eta = 10$. All baseline predictions remained virtually unchanged, except the model now can only account for 6% of the rise in the wage ratio, as higher gender substitutability reduces the implied female comparative advantage in services, according to (5). In particular the resulting (ξ_1, ξ_s, ξ_h) values are (0.40, 0.44, 0.45), and ξ_1 and ξ_s are too close to each other for structural transformation to have a sizeable impact on the wage ratio.

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

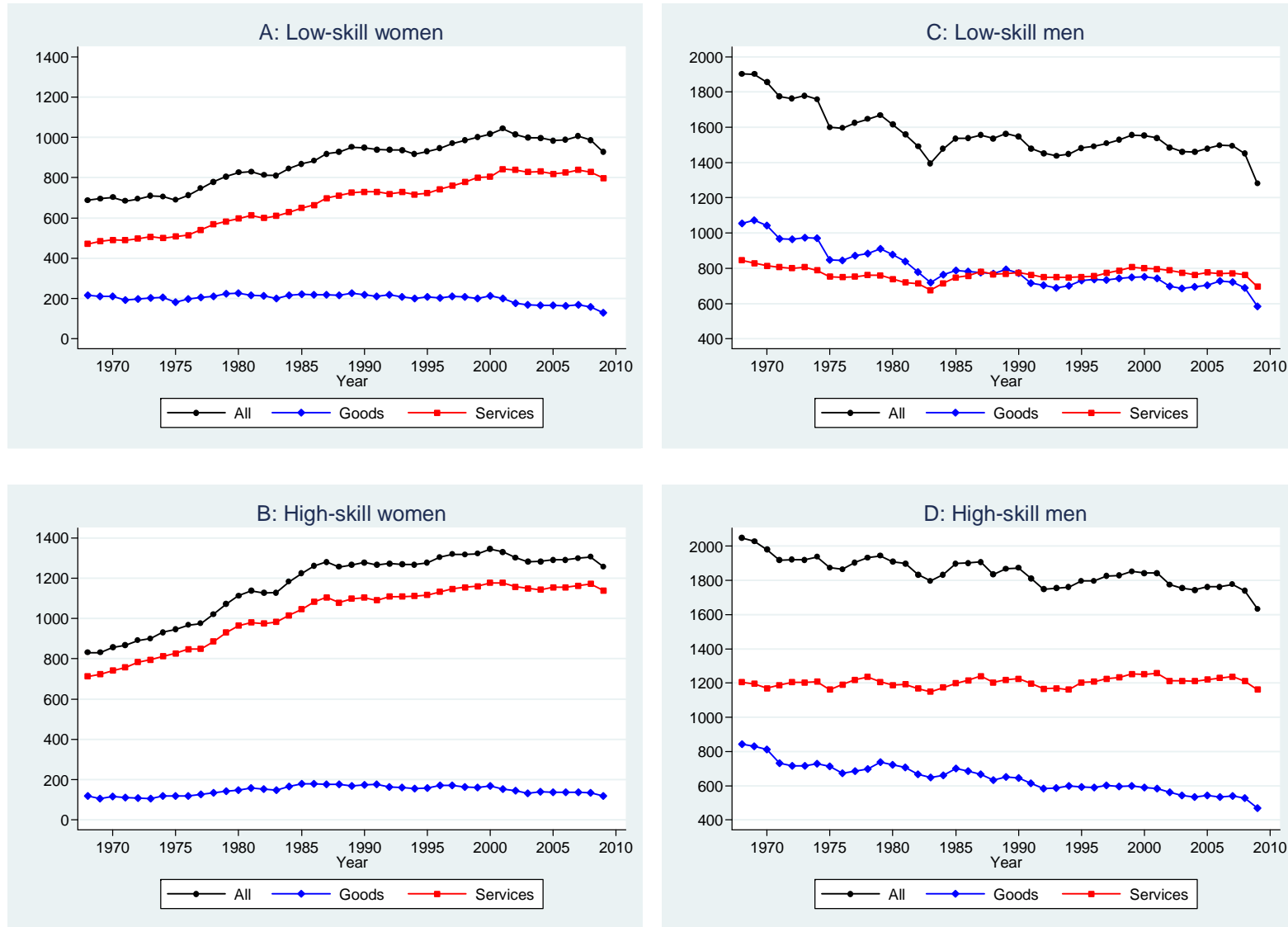
in most other dimensions, consistent with Propositions 1-4.

We next let $\sigma = 1.7$ in Panel C, which roughly corresponds to the middle point of available micro estimates for the elasticity of substitution between home and market goods. A lower elasticity of substitution between home and market services that in our baseline calibration implies weaker marketization, and therefore the model performs better at predicting the fall in men's market hours, but worse at predicting the rise in women's market hours.

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

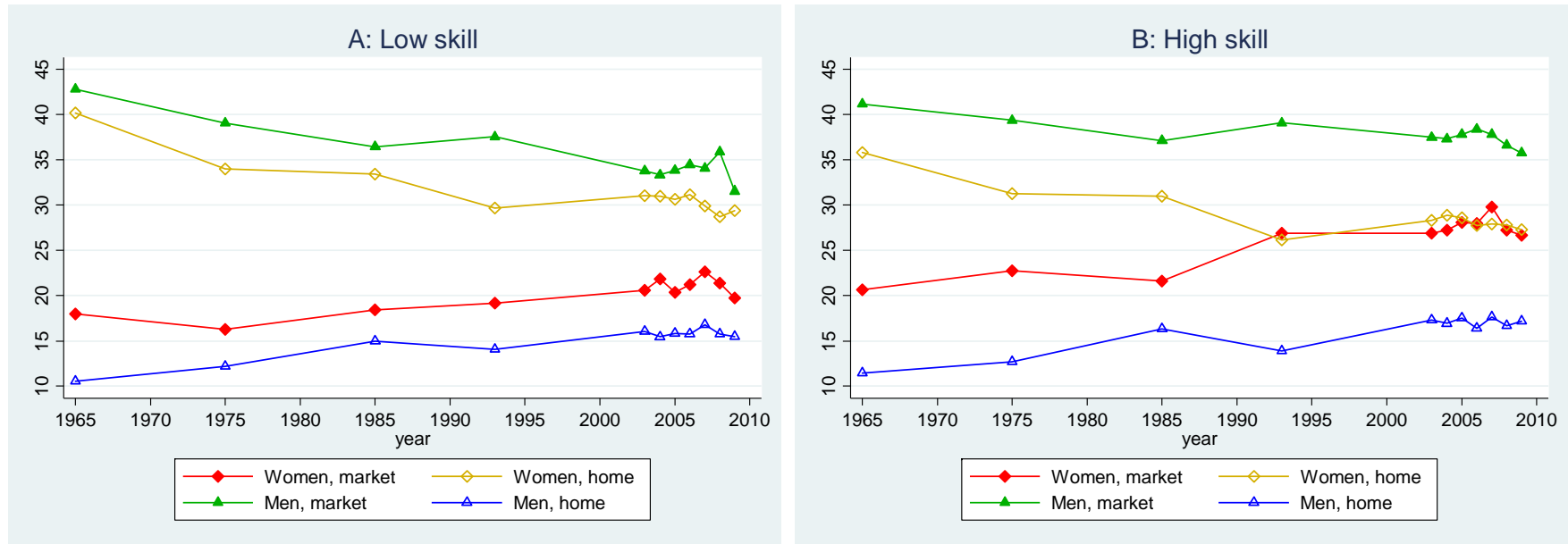
Appendix Tables and Figures

Figure A1. Trends in market hours, by skill



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

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



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

Table A1: Sensitivity analysis

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

See notes to Table 4.