The Service Sector and Female Market Work: Europe vs US*

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ABSTRACT

Aggregate labor market hours differ dramatically across OECD countries. However, differences in hours worked by gender do not necessarily match aggregate market hour differences. Continental Europe has experienced a smaller rise in formal female employment compared with the United States or Scandinavia. Additionally, Continental Europe has a substantially smaller service sector. These facts coincide with job requirements shifting from physical strength to intellectual abilities. This paper gives empirical evidence on why women predominately work in the service sector. Given the empirical evidence, a model is developed where technical change favoring women drives female employment through the growth of the service sector. The key is households can produce a substitute for market services and women are, on average, less productive in sectors requiring more brawn, giving them a comparative advantage with respect to staying home and working in the service sector. Therefore, an economy that imposes high taxes does not facilitate the movement of women into the labor market causing service production to remain at home. This reduces the demand for market services, which feeds back into low total hours worked by women (and the total economy). Subsidies to female employment can circumvent the high tax effect, but will lead to welfare loses.

JEL classification: E21, E24, J20.
Keywords: technological progress, sectoral labor allocation, cross-country differences, female labor supply, labor demand/supply, taxation.

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1 Introduction

A vast literature exists analyzing cross-country differences of hours worked in OECD countries since 1960. The most common forces attributed to cross-country hours worked discrepancies are taxation differences (Prescott, 2004), productivity differences (Rogerson, 2008), and the substitution of market to home production (Ragan, 2006; Rogerson, 2008). All prior research models define the household as a single representative agent. However, McDaniel (2010) finds that changes in market work and home production vary to a large extent when disaggregated by sex, after analyzing time-use survey data across developed countries. One of the greatest phenomena of the 20th century has been the rise in female labor force participation. However, this phenomena has not been uniform, with Continental Europe experiencing a smaller rise in formal female employment compared with the United States or the Nordic countries.[1] The goal of this paper is to quantify the importance of changes in female employment and cross-country differences in aggregate hours worked by introducing a household unit, consisting of either a single agent or a married couple, rather than focusing on the representative agent. Moreover, to explain the large cross-country female employment differences, and its correlation with the service sector size, empirical evidence giving weight to a demand side (technology) story is provided. As with prior research, the model will quantify the importance of taxation and productivity in explaining aggregate hours worked.

Income taxation of the United States relative to Europe has decreased since the 1960s leading to more market work and less hours in home production. While tax rates have increased in all of the developed world, Continental Europe has much higher tax rates, shifting hours from the market to the home. Lastly, Scandinavia has high taxes, but subsidizes market services such as childcare, elderly care, etc. Moreover, some of the subsidies in Scandinavia are specifically target at mothers, with generous maternity leave and comprehensive childcare.

In productivity differences, Continental Europe has a substantially smaller service sector. The correlation between relative female employment change and aggregate service employment is around 0.82 from the 1980s onward for a large set of OECD countries (Rogerson, 2005). In addition,

[1] Given data availability, this study defines Continental Europe as France, Germany and Italy, and Scandinavia is defined as Denmark, Finland and Sweden.

Rogerson (2008) finds that when comparing aggregate employment between the United States and Europe, most of this discrepancy is accounted for by differences in service sector employment. While there are small employment differentials in industry (slightly positive), Europe has an employment differential in services of -9.4 percent in the mid-1950s and -15.5 percent in 2000 when compared to the United States. Rendall (2010) provides empirical results for the United Sates showing that job requirements have shifted away from physical attributes toward intellectual attributes since WWII, benefiting women through greater job opportunities, higher wages and increasing returns to education. Additionally, women in the United States have always worked in occupations with relatively low physical requirements compared to men. While some of the demand shift favoring women is related to job requirements changing intra-occupation, a large portion of the decrease in physical requirements is due to a shift toward services, and away from heavy manufacturing, agriculture and mining.

This study develops a general equilibrium model based on the following three facts of labor supply and sectoral labor allocation across Europe and the United States.

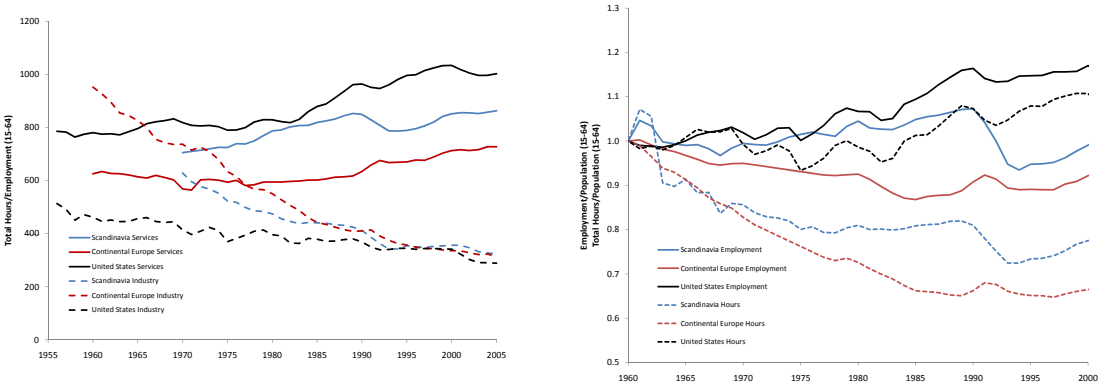
1. Women's labor force participation, age 15-64, rose from about 40 to 68 percent from 1960 to 2000. Scandinavia has seen a similar trend over time with a rise from 43 to 69 percent. However, Continental Europe's female employment has only risen to 53 percent.

2. Service sector employment in the two regions remained constant compared to the United States. Figure 1 plots relative labor hours of services to goods from the GGDC 10-Sector Database (Timmer and de Vries , 2007).

3. The United States has seen the largest rise in employment and no large falls in hours, unlike Europe. Differences in total employment have come from a falling goods sector's (industry and agricultural sector) employment share relative to the United States and higher income tax rates (see Rogerson, 2008).

The paper summarizes empirical evidence from the United States for labor requirements, and their evolution, over time and across sectors and gender. Given the empirical evidence, a general equilibrium model is developed to understand the evolution of female employment and their rise in

Figure 1: Employment Across Countries



(a) Relative Sectoral Hours

(b) Hours and Employment Evolution

the service sector. Men are assumed to have equal productivity across all sectors, while women's average productivity in each sector is taken from wage gap data. Similar to Ngai and Pissarides (2008), households allocate time between the home and labor market, and choose consumption over three types of goods: market produced services, market produced goods and home produced goods/services. The model has two key assumptions. Similar to Rogerson (2008), households can produce a substitute for market produced services (e.g., childcare, elderly care, meals) using home production technology and labor time. Second, given United States and Scandinavian wage gap estimates, women have higher productivity in the service sector. Therefore, women generally prefer working in the service economy where occupations neither require great physical strength nor have adverse working environments. A rise in the service sector is synonymous with a shift in labor factors away from brawn, as similarly suggested by Galor and Weil (1996), which leads to an improvement in women's labor market outcomes, i.e., higher wages.

From the features of woman's sectoral productivity and home substitution, a rich set of dynamics capable of generating both a convergence in female and male labor market outcomes, and a rise in the service sector are presented. That is, an economy that does not initially facilitate the movement of women into the labor market, by, for example, imposing high taxes without the social benefits tied to working women in Scandinavia (e.g., subsidized full-day child care, elderly care) causes the production of services to remain in the home. As a result, women do not enter the workforce and

the growth of the service sector outside the home is considerably slowed. However, in the Nordic system, women enter the labor market through a tax-subsidy distortion, leading to welfare losses compared to the United States.

The model is calibrated to match the evolution of female employment in the United States from 1960 to 2000. First, we quantify how much of the rise in female employment can account for the rise in the service sector and how important differences in productivity across sectors are. Using the calibrated economy of the United States, we can analyze what would have happened if taxes where at the level of Continental Europe. I.e., how much would female employment have grown? How large would the service sector be? Furthermore, in the context of the model, we study the differences between the United States (low taxes) and the Nordic system (high taxes and subsidized market services) with respect to social welfare loses, by setting a subsidy to services which is tied to women's labor force participation that matches female employment levels in the United States.

While the model abstracts from explaining the rise in female employment by modeling representative households, the exercise is useful for various reasons. This research expands on the literature accounting for the differences in aggregate labor between Europe and the United States over the last 40-50 years. Prescott (2004) and Rogerson (2006) show that taxes can account for a large fraction of differences in hours worked between the two regions. Here, adding a mostly ignored fact in the study of labor market differences between Europe and the United States, i.e., female employment, a more accurate picture of the importance of taxes is presented. Moreover, it furthers the discussion on why some countries have not developed a large service sector. Rogerson (2008) shows that taxes and technology can account for the differences in both hours worked and in sectoral labor allocations, with a substantially lower service sector in Continental Europe. Rogerson (2007) also explains the large service sector in Scandinavia. Albeit high tax rates and substantial subsidies to services, such as childcare, elderly care, etc, can lead to a large service sector with low total hours worked. Lastly, this study highlights the differences that have pushed women into the labor market, contrasting the United States and Scandinavia and their taxation policies' associated welfare loses. Most of the literature accounting for the rise in female labor force participation has focused on supply driven stories, i.e. improvements in home technology, such as the invention and marketization of household

appliances (see, for example, Greenwood et al., 2002, and references therein), or the improvements in baby formulas (see Albanesi and Olivetti, 2006), rising female wages (see Jones et al., 2003) and returns to experience (see Olivetti, 2006), or the effects of cultural, social, and intergenerational learning on labor supply (see Fernandez, 2007; Fogli and Veldkamp, 2007). Here, the rise in female labor force participation is driven by changes in market productivity (a shrinking wage gap) due to sectoral reallocation, changes in home productivity and differences in taxes and subsidies.

As women's productivity across sectors and changes in labor demand are the key motivations within this study, Section 2 provides further evidence for the changing labor market, focusing on the evolution of physical and intellectual job requirements in the United States and gender wage gaps across countries and sectors. The general equilibrium model is outlined in Section 3, and Section 4 provides analytical results of productivity growth on labor supply, wages, and sectoral labor shares. Section 5 discusses the estimation and calibration procedure, and Section 6 presents labor market trends across regions resulting from differences in taxation and work subsidies. Section 7 concludes.

2 Labor Market Requirements

To explore the relationship between the rise in the service sector, female labor force participation and changes in labor demand, this study provides United States' labor demand requirements across sectors. Further gender wage gaps across countries and sectors are provided showing women's comparative advantage in service occupations.

In a related paper (see for details Rendall, 2010), job characteristics by the United States census occupation and industry classifications from the 1977 Fourth Edition Dictionary of Occupational Title (DOT) and the 1991 Revised Fourth Edition Dictionaries of Occupational are reduced using principle component analysis to summarize aggregate labor market requirements. The 1977 and 1991 DOT were developed by the United States Department of Labor, who evaluated approximately 40 job requirements for more than 12,000 occupations, documenting: (1) general educational development; (2) specific vocational training; (3) required working aptitudes; (4) temperaments or adaptability requirements; (5) physical strength requirements; and (6) environmental conditions. For example, general educational development measures the formal and informal educational at-

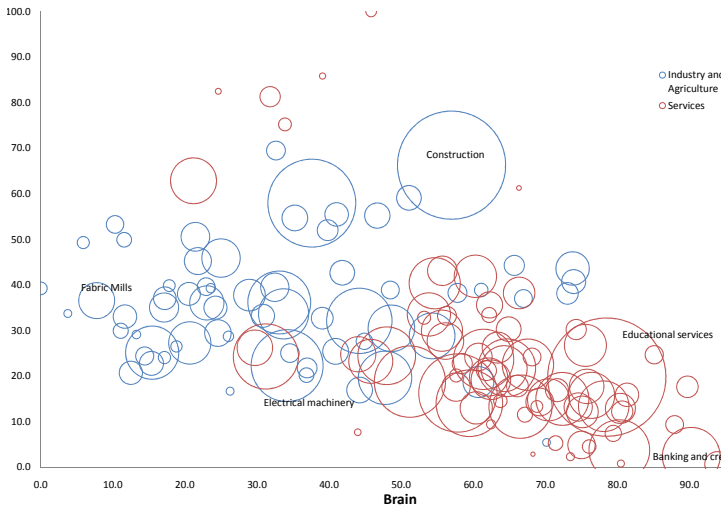
Table 1: *Factor Composition*

Brain	**Brawn**	**Motor Skills**
Reasoning Development	Climbing/Balancing	Motor Coordination
Mathematical Development	Stooping/Kneeling/	Finger Dexterity
Language Development	Crouching/Crawling	Manual Dexterity
Specific Vocational Preparation	Strength Requirement	Seeing
General Intelligence	Indoor or Outdoor Work	Spatial Aptitude
Verbal Aptitude	Environmental Exposure	Form Perception
Numerical Aptitude		Reaching/Handling/
Clerical Aptitude		Fingering/Feeling
Talking and Hearing		

tainment required to preform a job effectively by rating reasoning, language and mathematical development. Each reported level is primarily based on curricula taught in the United States, where the highest mathematical level is advanced calculus, and the lowest level only requires basic operations, such as adding and subtracting two-digit numbers. Specific vocational preparation is measured in the number of years a typical employee requires to learn the job tasks essential to perform at an average level. Eleven aptitudes required of a worker (e.g., general intelligence, motor coordination, numerical ability) are rated on a five point scale. Ten temperaments required of a worker are reported in the DOT, where the temperament type is reported without any numerical rating. An example of a temperament is the ability to influence people in their opinions or judgments. Physical requirements include a measure of strength required on the job, rated on a five point scale from sedentary to very heavy, and the presence or absence of tasks such as climbing, reaching, or kneeling. Lastly, environmental conditions measure occupational exposure (presence or absence) to environmental conditions, such as extreme heat, cold and noise.

Factor analysis or principal component analysis, similarly to Ingram and Neumann (2006), reduces the dimensionality of DOT job characteristics. That is, using principal component analysis, a linear relationship between normally distributed broad skill categories and the DOT characteristics is estimated from the associated correlation matrix. Using maximum likelihood estimation methods, three factors, brain, brawn and motor coordination, are determined to be sufficient in capturing the information contained in the 1977 and 1991 DOT characteristics. This study focuses on the first two factors, brain and brawn, as the coordination factor remains steady over time and has little cross-

Figure 2: Occupation Factor Requirements by Sector



gender difference. Each factor includes the job characteristics outlined in Table 1.[2] For additional detail on the estimation procedure and the resulting factor loadings see Rendall (2010).

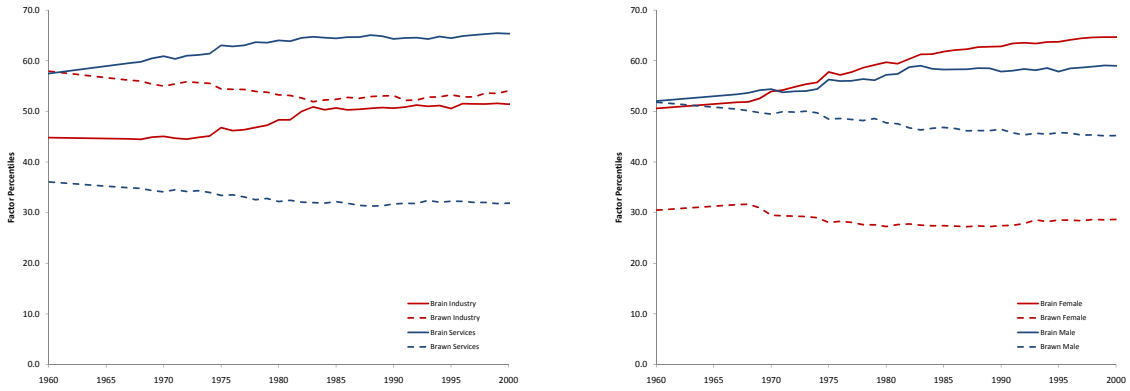
The aggregate factors are merged with the 1960 United States Census data and the 1968 to 2000 Current Population Survey (CPS) data to compute trends over time.[3] Figure 2, which plots all 1977 occupational brain and brawn combinations by sector in 1970, clearly depicts the difference in brain and brawn requirements across sectors. Figure 3 depicts brain and brawn averages in the sector and by gender over time. To compute aggregate factor demand changes in the United States over time, occupation-industry factor estimates are aggregated using United States Census and CPS civilian labor force weights.[4] Since factors following principal component analysis have no natural scale, factors from the principal component analysis are normalized, following Autor et al. (2003), to percentiles of the 1960 US factor distributions. That is, factors are assigned a percentile rank for the United States using 1960 Census population weights for individuals aged 25 to 64. All

[2]See also Schoellman (2009) for a similar use of principal component analysis on DOT data.

[3]Census and CPS data is obtained from the IPUMS-USA (Ruggles et al., 2010) and the IPUMS-CPS project (King et al., 2010). The IPUMS projects provide a consistent 1960 United States Census classification of occupations and industries over the years, which is used in merging 1977 DOT and 1991 DOT brain and brawn factors.

[4]The 1991 DOT is only merged on occupations, as a merge on industries is not possible

Figure 3: Average Factor Requirements



(a) Factors by Sector

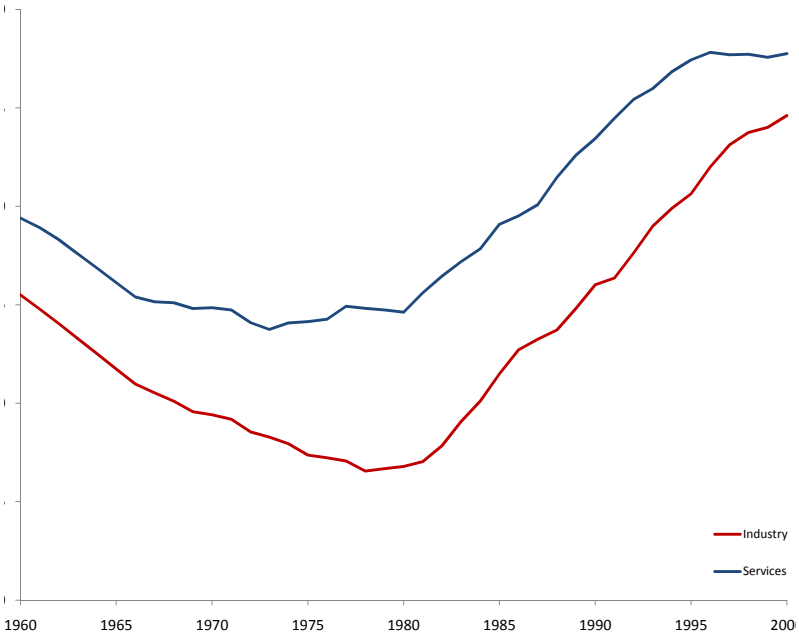
(b) Factors by Gender

factors have, therefore, mean 50 in 1960 for the United States. While both sectors have gained in occupations with brain requirements, the relative brawn share has been virtually constant across sectors. Additionally, the service sector has always had a low level of brawn requirement. The graph on the right shows the selection of women into occupations with low brawn requirements. Assuming women have lower innate brawn levels, this bias toward low brawn occupations can be either due to employee self-selection or employer "discrimination." Goldin (1990) observes that as far back as the 1920s/1930s women made work choices based on the level of brawn required.

> Clerical work was cleaner and less strenuous than manufacturing work ... It is understandable why young women preferred office work and why the growth of the clerical sector would lead to the continued employment of women after marriage and childbearing. ... If the considerable difference in the earnings of males and females in manufacturing was largely due to rewards to strength, then the replacement of brain for brawn work should have evened starting salaries. ... Although the difference in starting salaries implied by the earnings functions between unmarried male and female clerical workers was negligible, it was 47% in manufacturing. Extract from Goldin, Understanding the Gender Gap (1992) pp. 108-109

This evidence gives strong support to the hypothesis of productivity differences across sector em-

Figure 4: Gender Wage Gap by Sector



ployment rather than overall labor market discrimination.

Moreover, decomposing gender wage gaps across sectors and countries provides further evidence of women's higher productivity in the service sector. Figure 4 depicts the wage gap of individuals working at least 1,400 hours per year across services and industry in the United States. The wage gap in services is consistently smaller from 1960 to 2000. The difference between the service and industrial gap averages around 6.2 percentage points.[5] Cross-country results from the GGDC EU KLEMS datasets provide similar results. The EU KLEMS data provides hours information and labor compensation by three age groups 15 to 29, 30 to 49, and 50 plus. This allows for the computation of hourly gender wage gaps for a number of European Union countries starting in 1970. Table 2 summarizes gender wage gaps by decade for the Continental European and Scandinavian countries with EU KLEMS labor data. The wage gap differences between the service and industrial sector are somewhat larger in Europe, with a difference of over 10 percentage points. Data for Germany is

[5]The wage gap in agriculture shows large fluctuations across time given the small number of observations, especially of women. Since, the female labor share in agriculture is close to zero, the results are omitted here.

Table 2: *Sectoral Wage Gap Differences*

Decade	**Germany**	**Italy**	**Finland**	**Denmark**
1970s	-	-2.0	17.4	-
1990s	2.4	16.8	3.2	12.9
1970-2000		8.3	7.4	

only available starting in 1990 and for Denmark in 1980. To control for some of the issues of work experience, only wage gaps for the youngest age group are provided. The general patterns hold for the older cohorts as well. Moreover, computing wage gaps by education level show similar wage gap differences across sector.

Given the above facts, a general equilibrium model, concentrating on the service sector and female employment, is presented in the following section.

3 General Equilibrium Model

The simulated economy consists of a representative married household, composed of a man and a woman;[6] two competitive production sectors, industry and services; and a government.

3.1 Government

The government, who solves a balanced budget, taxes individuals labor income at rate, τ (yielding the underlying cross-country differences over time). Tax revenues are rebated to households as a lump-sum transfer, T. The government also provides price subsidizes on market services, v, and/or rebates service goods indexed to women's labor supply as in Ragan (2006), ϕ.

$$\tau(w_t^m h_t^m + w_t^f h_t^f) = T_t + v p_{st} c_{st} + \phi h_t^f, \tag{1}$$

where w_t^m, w_t^f are male and female wages detailed below and h_t^m, h_t^f are the respective labor supplies.

[6]The rise in labor force participation was considerably greater for married women, thus the analytical model focuses on married households. Adding single households does not result in further dynamics within the model, and does not affect any of the qualitative results. The simulation results will add single households to match the quantitative targets.

3.2 Production

The competitive sectors only use labor to produce final services and industrial goods $\{Y_s, Y_i\}$. By assumption, women are less productive in producing industrial goods than services (services require less brawn). Moreover, women also face "general" discrimination, that is, women's productivity levels are $\{\tau_i, \tau_s\}$, where $\tau_i < \tau_s \leq 1$. The final sectoral output is linear in labor,

$$Y_{jt} = A_{jt} L_{jt} \text{ for } j = i, s, \tag{2}$$

where L_{jt} is aggregate labor supply and A_{jt} is total factor productivity for each sector j. Therefore, normalizing wages to one, relative prices are proportional to total factor productivity $p_{jt} = \frac{1}{A_{jt}}$.

3.3 Household Preferences

Household members are indexed with the superscripts $g \in \{f, m\}$ for their gender. The only difference between genders is their market productivity. There is no bargaining in the households and the households solves a unitary utility $u(C, L)$, by allocating the labor time of both agents to the market, home production, and leisure; purchasing goods, c_i, and services, c_s, in the market; and producing home produced service substitutes at home, c_n.

$$\max_{\{c_{it}, c_{st}, h_t^m, h_t^f, n_t\}} \log(C_t) + \psi \log(L_t) \tag{3}$$

s.t.

$$\begin{aligned}
p_{it} c_{it} + (1 - v) p_{st} c_{st} &= (1 - \tau)(w_t^m h_t^m + w_t^f h_t^f) + T_t, && (4)\\
1 &= h_t^m + n_t^m + \ell_t^m, && (5)\\
1 &= h_t^f + n_t^f + \ell_t^f, && (6)\\
n_t &= n_t^m + n_t^f, && (7)
\end{aligned}$$

where C is the consumption composite of services and goods (suppressing time subscripts), i.e.,

$$C = (a_i c_i^{\epsilon} + (1 - a_i) F(\hat{c}_s, c_n)^{\epsilon})^{\frac{1}{\epsilon}}, \tag{8}$$

where $F(\hat{c}_s, c_n)$ is the service composite, i.e.,

$$F(\hat{c}_s, c_n) = \left(a_c \left(c_s + \phi h^f\right)^{\eta} + (1 - a_c) c_n^{\eta}\right)^{\frac{1}{\eta}}, \tag{9}$$

where $\hat{c}_s = c_s + \phi h^f$ are the total market purchased services, both privately and rebated by the government for female hours worked. Home production is linear in labor $c_n = A_n n$. Leisure of spouses are assumed to be perfectly complimentary, i.e., husbands and wives prefer spending time together when not engaged in work.[7]

3.4 Wages

Since women will always prefer to work in services, the simulation assumes that only a fraction λ of women find employment in the service sector. Therefore, since wages are normalized to one, and men have equal productivity in all sectors, the wage gap equals,

$$Gap = \lambda \tau_s h_{st}^f + (1 - \lambda) \tau_i h_{it}^f, \tag{10}$$

where h_{st}^f are hours worked of women that have wages $w_t^f = \tau_s$ and work in the service sector, and h_{it}^f are hours worked of women that have wages $w_t^f = \tau_i < \tau_s$ and work in the industrial sector.

3.5 Decentralized Equilibrium

An equilibrium, given productivity $\{\tau_{st}, \tau_{it}\}$, market prices $\{p_{it}, p_{st}\}$, and government prices $\{\tau, v, \phi\}$, consists of the time path of households' allocation $\{c_{it}, c_{st}, h_t^m, h_t^f, n_t\}$, firm output $\{Y_{it}, Y_{st}\}$ and government allocation $\{T_t\}$ such that for all t:

1. $\{c_{it}, c_{st}, h_t^m, h_t^f, n_t\}$ solves the Household Problem (3);

[7] The single household problem is identical, expect for leisure, where leisure is enjoyed by the single agent alone.

2. $\{T_t\}$ solves the government problem (1);

3. Markets clear, with

   a The labor market, $L^s_{jt} = L^d_{jt}$ for $j = i, s$; and

   b The goods market, $c_{jt} = Y_{jt}$ for all $j = i, s$.

4 Analytical Results

The firm's problem is straight forward. Technical change in terms of total factor productivity, i.e. a rise in $\frac{A_{it}}{A_{st}}$, leads to a fall in relative goods to service prices.

4.1 Household Optimization

For a household, the problem is similar to Ngai and Pissarides (2008). Specifically, the household problem can be solved in steps. The household solves three intertemporal choices, starting with the service consumption decision, proceeding to the goods consumption decision, and ending with the leisure decision. Since men have a comparative advantage in the labor market, household members specialize, with the man entering the labor market first. As such, we will only analyze the case of $n^m = 0$, i.e., women spend at least a fraction of their time in the labor market.[8] Time subscripts are omitted for all intertemporal decisions.

Composite Service Consumption

Households choose time to be allocated to home production, n, in maximizing (9) s.t. (4). The resulting first order condition can be summarized in terms of relative market services to home services,

$$\frac{\hat{c}_s}{c_n} = \left(\frac{a_s}{1 - a_s} \left(\frac{p_n}{(1 - v)p_s} + \frac{\phi}{A_n} \right) \right)^{\frac{1}{1-\eta}}, \tag{11}$$

where p_n is an implicit home production price $p_n = \frac{w^f(1-\tau)}{A_n}$. As in Ngai and Pissarides (2008), services are "marketized" if $\frac{\hat{c}_s}{c_n}$ rises. The comparative statics for the "marketization" of services, if

[8] The case with $n^m > 0$ is very similar, however, the implicit home production price will be different in the two cases.

market and home services are gross substitutes, $0 < \eta < 1$, can be summarized as follows:

- $\frac{\partial \hat{c}_s/c_n}{\partial \tau} < 0$, that is, higher taxes discourage market work;
- $\frac{\partial \hat{c}_s/c_n}{\partial \tau^f} > 0$, higher brain demand encourages female market work ($\tau^f = 1_{(s=1)}\tau_s + 1_{(s=0)}\tau_i$);
- $\frac{\partial \hat{c}_s/c_n}{\partial \phi} > 0$, governments subsidies, e.g., on childcare for working mothers, encourages female market work; and
- $\frac{\partial \hat{c}_s/c_n}{\partial w/((1-v)p_s)} > 0$, a fall in service prices through subsidies or technological progress through higher wages, encourages female market work.

Composite Consumption/Industrial Goods Consumption

Next households maximize (8), the final composite consumption, by choosing c_i. The first order condition can be summarized as relative market service to goods consumption,

$$\frac{\hat{c}_s}{c_i} = \left(\frac{1-a_i}{a_i} \frac{p_i}{(1-v)p_s} a_s \left(\frac{\hat{c}_s}{F(\hat{c}_s, c_n)} \right)^{\frac{\eta-\epsilon}{\eta}} \right)^{\frac{1}{1-\epsilon}}. \tag{12}$$

Again, we can look at the comparative statics with respect to the key parameters. If services and goods are gross compliments, that is $\epsilon < 0$ and with $0 < \eta < 1$:

- $\frac{\partial \hat{c}_s/c_i}{\hat{c}_s/F(\hat{c}_s,c_n)} > 0$, more service marketization leads to rise in relative market service consumption as $\frac{\eta-\epsilon}{1-\epsilon} > 0$;
- $\frac{\partial \hat{c}_s/c_i}{\partial \tau} < 0$, higher taxes, lead to lower service marketization and, therefore, relatively less market service consumption (indirect effect through lower marketization, similarly this will be true for a smaller brain demand);
- $\frac{\partial \hat{c}_s/c_i}{\partial \phi} > 0$, again through the indirect effect of marketization, the government can artificially increase the relative service demand; and
- $\frac{\partial \hat{c}_s/c_i}{\partial v} > 0$, with a price subsidy on all service goods, the government can increase the relative services demand even further, through both an indirect effect through marketization and a direct price effect.

To summarize the comparative statics between different government actions, if a price subsidy is equivalent to the work subsidy, and the government only employs one at a time. The relative service share will be largest with the price subsidy and smallest without any subsidy, assuming the same tax rate for all economies, i.e., $\left(\frac{\hat{c}_s}{c_i}\right)_{\{v>0,\phi=0\}} > \left(\frac{\hat{c}_s}{c_i}\right)_{\{v=0,\phi>0\}} > \left(\frac{\hat{c}_s}{c_i}\right)_{\{v=0,\phi=0\}}$.

In conclusion, large taxation will lead to a smaller service sector, as fewer women participate in the formal labor market and less services are marketized. The government can affect the relative sector demands by subsidizing consumption of services. However, a subsidy tied to women working is less powerful.

Leisure

To conclude the intertemporal choices of the household, individuals choose leisure by maximizing (3). The first order condition can be described in terms of relative leisure to consumption,

$$\frac{\ell}{C} = \frac{1-a_c}{a_c a_i} \frac{p_i}{w(1-\tau)(2-\tau^f) + (1-v)p_s\phi} \left(\frac{c_i}{C}\right)^{1-\epsilon} \tag{13}$$

where $\ell = \ell^m = \ell^f$. That is, leisure will be greater with government price and work subsidies given equal tax rates.

4.2 Sectoral Labor Shares

Lastly, using market clearing, household allocation, and assuming women only work in services, $\lambda = 1$, labor shares in the economy are as follows,

$$\begin{aligned} \frac{L_s}{L_i} &= \frac{\hat{c}_s}{c_i}\frac{p_s}{p_i} \\ &= \left(\frac{1-a_i}{a_i}\frac{a_s}{(1-v)}\left(\frac{\hat{c}_s}{F(\hat{c}_s, c_n)}\right)^{\frac{\eta-\epsilon}{\eta}}\right)^{\frac{1}{1-\epsilon}} \left(\frac{A_{st}}{A_{it}}\right)^{\frac{\epsilon}{1-\epsilon}}. \end{aligned} \tag{14}$$

The labor share of services rises, with a relative faster productivity growth in industry, given $\epsilon < 0$. Moreover, marketization leads to a rise in service labor shares.

In summary, this section has shown that larger government taxation leads to a smaller service sector and less female labor force participation. Governments can increase female labor force

Table 3: *Tax Rates*

Year	**USA**	**C.E.**	**SK**
1960	28.43	39.32	30.80
2000	41.26	58.17	60.59
$\Delta_{2000-1960}$	12.83	18.85	29.79

participation, and therefore also the service labor share, by subsidizing female employment or the purchase of services. In addition, subsidizing female employment through a rebate in services has the added effect of increasing service employment, e.g., more childcare facilities do not only provide services for households, but also employment opportunities for women.

5 Calibration

The model is simulated to the United States, tax rates are then adjusted to account for differences between Continental Europe, Scandinavia, and the United States. It is assumed that the United States has reached its steady state by 2000 (there is evidence of flattening female labor force participation and gender wage difference in the last few years). Therefore, the results simulate two steady states in 1960 and 2000, omitting the transition path.

Tax rates are taken from McDaniel (2007). Tax rates have been increasing over time in all three regions, increasing more so in Europe than the United States. Average tax rates are computed using both income and consumption tax rates, i.e.,

$$\tau = 1 - \frac{1-\tau_h}{1+\tau_c}, \tag{15}$$

where τ_h is the sum of the average tax rate on household income and the average payroll tax rate, including both taxes paid by employer and employee, and τ_c is the average tax on consumption expenditures. To compute tax rates across regions, country specific taxes from (15) are weighted by population. Table 3 summarizes the tax rates from each region in 1960 and 2000.

Table 4 summarizes the calibrated parameters. The parameter governing the elasticity of substitution between home and market services, η, and the elasticity between goods and services, ϵ,

Table 4: *Calibrated Parameter Values*

η	ϵ	g_a	g_i	g_s	g_n	ψ	a_i	a_s
.45	-2.33	3.26	2.47	1.26	-.018	1.31	.094	.65

are taken from previous studies. Various studies have estimated η on microeconomic and macroeconomic data. The resulting elasticities vary from 1.60 to 2.00 by Rupert et al. (1995), depending on whether households are married, single females or single males, to 2.3 by Chang and Schorfheide (2003). Aguiar and Hurst (2006) find an elasticity of 1.80, which implies an η of 0.45, which is used in this calibration. Ngai and Pissarides (2008) suggest that, given price elasticities of the entire service sector of -0.30 to -0.06, in a model with home production the elasticity of 0.30 should be an upper bound, implying a value of $\epsilon = -2.30$, which is used in the calibration below.

Women's sectoral productivity are taken from table 2. Since the results do not control for selection effects, all country simulations use the same wage gap. The results below are for a wage gap difference of 12 percentage points, a mid-range given country estimates. The probability that women find service sector employment, λ_t is set to match the fraction of women in services in both 1960 and 2000. That is, λ is allowed to vary with time, consistent with the fact that the service sector is growing and should, therefore, make it easier for women to find their most desirable job.

Productivity in all sectors are set to one in 1960, i.e., $\{A_{i1960} = A_{s1960} = A_{n1960} = 1\}$, since consumption share parameters $\{\psi, a_i, a_s\}$ can control for relative productivity differences. Productivity growth rates are taken from Rogerson (2008), with industry growing at $g_i = 2.48$, and services growing at $g_s = 1.44$. Home productivity g_n is calibrated to simulate improvements in home technology, which could partly explain the rise in female employment. In the initial calibration, home productivity is set following Rogerson (2008) at $g_n = -.002$. However, this productivity growth does not match the rise in female employment, therefore, g_n is also calibrated to match the rise in female employment. That is, home productivity growth, and the remaining parameters $\{\psi, a_s, a_i\}$, are set in order to match the following four steady state 1960 and 2000 targets:

- Relative services hours in 1960;
- Female market hours in 1960;

- Male market hours in 1960;
- Male market hours in 2000; and
- The home productivity growth rate is matched with female market hours in 2000.

Home hours are taken from Ramey and Francis (2009) who document weekly home and market hours by age and gender from 1900 to 2005. For Europe market hours are taken from OECD data, EU KLEMS, and the Ten-Sector Database mentioned in Section 2.

5.1 Results

The model does well in matching all targets, with home productivity of $g_n = -.002$. Table 5 shows the United States data targets with the model results. Only values labeled with stars were targeted in the calibration. The calibration underestimates the rise in female hours worked by four percentage points and it over estimates women's relative market to home hours, this is partially due to the simplified modeling of home production. In the model, men do no home production and spouse's leisure are perfect compliment. The larger initial male hours also stems from this same simplifications. Table 6, provides the match of total hours data, the gender wage gap, and

Table 5: *United States Targets*

	H_s/H_g	H_m	H_f	H_f/N_f
1960 Data	1.70	0.35	0.12	0.32
1960 Model	1.70*	0.37*	0.12*	0.45
2000 Data	3.03	0.32	0.23	0.82
2000 Model	3.03	0.33*	0.19	0.96

λ the probability for a woman to have the opportunity of working in a service job. Note, woman can always decide not to work. Therefore, the data row provides the fraction of women working in services in the United States, while the model row represents the probability that a woman has the opportunity to work in a service job within the model. The model, by construction, matches the fraction of women in services one-to-one. Since, the model does well in matching the hours increase by gender, it also does well in matching the overall trend. The model overestimates the

Table 6: *Model Statistics*

	Total Hours	**Wage Gap**	λ
1960 Data	0.24	0.67	0.72
1960 Model	0.25	0.70	0.69
2000 Data	0.27	0.78	0.85
2000 Model	0.26	0.81	0.82

wage gap by a few percentage points. This is not surprising given that the model abstracts from ability, education and other potential selection effects, such as high earning spouses.

To highlight the importance of productivity differences across sectors, the model without sectoral differences generates 45 percent rather than 64 percent of the observed labor force participation rise in the United States.

Increasing home productivity to $g_n = -0.018$ increases women's employment to 23 percent. However, it also increases relative service to industry hours to 3.66, overestimating the 2000 target. Nonetheless, male employment stays at 33 percent, therefore, increasing total hours worked in the United States to 28 percent.

5.2 Europe

To simulate Continental Europe, following Rogerson (2008), productivity levels in 1960 and 2000 of all sectors are matched to the total labor productivity per hour of the region, assuming all sectors lag the United States by the same years. According to the TEDI 2010 tables, Continental Europe had a labor productivity of about half of the United States in 1960 and 90 percent in 2000, while Scandinavia had a productivity of 56 and 84 percent respectively. Given these labor productivity estimates, Europe lagged the United States by 38 years in 1960 and by 8 years in 2000, while Scandinavia lagged the United States by 32 years in 1960 and 12 years in 2000. Moreover, λ is adjusted to match the fraction of women in the service sector in Europe, which is 47 percent and 78 percent in 1960 and 2000, respectively. The following results use the home productivity growth rate of $g_n = -.018$.

The model does generate a considerably smaller female labor force participation when adding

Continental European tax and productivity differences, and very different growth rates. It also generates a large fall in hours, but it is unable to match the initial high hours level of 28 percent. While it does generate a smaller service sector in both 1960 and 2000, it is unable to match the targets perfectly. Part of this may be due to differences in sectoral total factor productivity between Europe and the United States or subsidies to the goods sector. While we do not have good hours data by gender, average weekly hours worked by gender from the OECD show that hours per worker are very stable and very comparable across countries. That is, working women in the United States and Europe work usually 33 to 35 hours, while men work on average 40 to 42 hours. Therefore, total hours should mostly differ due to labor force participation rates. Women's labor force participation

Table 7: *Continental Europe Changes in Labor Force Participation*

	H_s/H_g	H_m	H_f	**Total Hours**
1960 Data	0.66	-	-	0.28
1960 Model	0.99	0.41	0.07	0.24
2000 Data	2.12	-	-	0.20
2000 Model	2.95	0.28	0.13	0.20

in Europe has been roughly 77 percent of the United States. The model generates female hours worked equal to 61 percent of the United States in 1960 (7 over 12 percent) , but only 56 percent in 2000. Therefore, the model misses roughly 16 to 20 percent of the difference between the United States and Europe. The model does better in matching differences between men. Men work 1.08 as much in Europe than in the United States in 1960 in the data, and 1.11 times as much in the model. The model does similarly well in 2000, since European men work about 84 percent of American men in the data compared to 87.5 percent in the model.

Table 8 highlights the importance of tax differences. The results corroborate the results from earlier work by Prescott (2004) that taxes indeed can explain most of the difference in employment across the United States and Europe. Simulating Continental Europe with United States taxes leads to a large rise in women's labor hours. The difference between Europe and the United States is now only 2 percentage points. Moreover, men's hours are identical to the United States simulated hours. Overall hours are, therefore, only one percentage point lower.

Table 8: *Continental Europe with United States Taxes*

	H_s/H_g	H_m	H_f	**Total Hours**
1960 CE Taxes	0.99	0.41	0.07	0.24
1960 US Taxes	0.91	0.40	0.10	0.25
2000 CE Taxes	2.95	0.28	0.13	0.20
2000 US Taxes	3.22	0.33	0.21	0.27

5.3 Scandinavia

To simulate Scandinavia, the same procedure as with Europe are followed. Scandinavia has higher taxes, but provides large subsidies, especially in the form of childcare, elderly care, etc. Since there is no good estimate of the size of ϕ, the government subsidies tied to female employment, ϕ is set to zero in 1960 and to match the United States working hours in 2000 with a $\phi = 0.3$. This allows for a welfare loss computation of the higher tax system. In addition, λ is adjusted to match the fraction of women in the service sector, which is 65 percent and 85 percent in 1960 and 2000, respectively, numbers very similar to the United States. Home productivity growth rate is still assumed to be $g_n = -.018$.

Table 9 summarizes the main results. Not surprisingly, the model generates a large rise in the service sector, female employment, and a large drop in male hours. Total hours worked are roughly constant. While the model generates two percentage points lower male employment rate than in

Table 9: *Scandinavian Simulation*

	H_s/H_g	H_m	H_f	**Total Hours**
1960 Data	-	-	-	0.28
1960 Model	1.06	0.39	0.10	0.24
2000 Data	2.39	-	-	0.20
2000 Model	3.23	0.29	0.23	0.25

Continental Europe due to higher taxes. It is consistent in generating a large drop in male hours worked, to roughly 90 percent of the United States. While there is no relative hours data for 1960, in 1970 the relative hours ratio of services to industry was 1.12. The estimate of 1.06 seems reasonable.

However, in 2000, the model vastly overestimates the labor share in services. This is mainly due to the high increase in female employment. A model with trade, would likely match the data better, since more men would remain in the industry sector.

Finally, high taxes with subisidies distort individuals optimal choices and therefore lead to potential welfare losses. The welfare loss in utils associated with a higher tax rate and subsidies to increase female employment is roughly fourteen percent or the equivalent of 9.8 percent in consumption equivalent units. That is consumption of the aggregate good C would have to increase by 9.8 percent for individuals in Scandinavia to have on average the same utility as indivduals in the United States.

6 Conclusion

To summarize, this paper develops a theory that can explain both a rise in services and a rise in female labor supply concurrently. The model is consistent with general trends in labor supply (male and female) and leisure. It accounts well for differences between Continental Europe and the United States in the service sector labor share and female employment over time. A high tax country will have a smaller service sector and lower female employment by subduing marketization. A simple computation of the social welfare loss of high taxes and subsidizing female labor force participation in Scandinavia compared to an equivalent outcome in female labor force participation with low taxes and no subsidies shows a non-negligible loss. However, while the rise in the service sector is important in explaining part of the rise in female employment, a striking conclusion is that high taxes are the main cause in generating lower market hours and lower female employment in Europe compared to the United States.

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