Structural Transformation and Gender Gaps

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Abstract

Recent literature relates the process of structural transformation towards the service sector with the narrowing of gender gaps for rich economies. This paper studies this relationship by focusing on an emerging economy such as Brazil. The country documented a sizable rise in female labor force participation and a reallocation of economic activity and labor force toward the service sector throughout the second half of the 20th century. We present evidence of some stylized facts about the Brazilian economy, such as an increase in female hours worked in the market and a fall for men; an increase in the share of the service sector among market hours; a considerable rise in women's share in market service hours; and a decrease of female home production hours. These trends suggest that women move from home to market production, especially to the service sector. We use a multi-sector model, calibrated to Brazil, that is able to account for the process of structural transformation, marketization of home production, and the narrowing of the wage gap to quantitatively assess the changes in time allocations of men and women across sectors over a given period, according to the evolution of the country's sector productivities. Our counterfactuals experiments and show that: (i) within-sector improvements for women yield a rise in women's hours in market activities; (ii) in case Brazil had labor productivity growth rates the same as in the US, marketization dynamics would be more significant; (iii) in the absence of gender differentials, structural transformation generated by uneven productivity growth rates is entirely gender-neutral.

Key-words: Female Labor Force Participation. Structural Transformation. Home Production. Marketization. Sectoral Labor Allocation.

JEL Codes: J16, J21, J22

Resumo

Há uma literatura recente que relaciona o processo de transformação estrutural para o setor de serviços com a redução do gender gap em economias ricas. Este artigo estuda essa relação focando em uma economia emergente como o Brasil. Ao longo da segunda metade do século XX, o país observou um aumento considerável na participação feminina na força de trabalho e a realocação da economia e da força de trabalho para o setor de serviços. Apresentamos evidências de alguns fatos estilizados sobre a economia brasileira como o aumento das horas trabalhadas pelas mulhores no mercado, e queda para os homens; aumento da participação do setor de serviços entre as horas trabalhadas no mercado; um aumento significativo da participação feminina nas horas trabalhadas no mercado; e uma diminuição das horas dedicadas à produção doméstica pelas mulheres. Essas tendências sugerem

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que as mulheres se movem da produção doméstica para o setor de serviços. Usamos um modelo multissetorial, calibrado para o Brasil, para avaliar quantitativamente as mudanças na alocação de tempo de homens e mulheres entre os setores em um determinado período, de acordo com a evolução das produtividades setoriais do país. Nossos experimentos contrafactuais mostram que: (i) melhorias between-sector específicas para as mulheres geram um maior aumento nas horas ferminas de mercado; (ii) caso o Brasil tivesse uma taxa de crescimento da produtividade do trabalho igual à dos EUA, o movimento de *marketization* seria mais significativo; (iii) na ausência de diferenças entre gêneros, a transformação estrutural gerada por taxas de crescimento de produtividade diferentes é totalmente neutra em termos de gênero.

Palavras-chave: Participação Feminina na Força de Trabalho. Transformação Estrutural. Produção Doméstica. Alocação Setorial de Trabalho.

Área ANPEC: 13 - Economia do Trabalho

1 Introduction

Women's participation in the labor market broadly raised in the 20th century, especially post-World War II in developed countries. In the United States the employment rate of working-age women rose from about 20% in 1900 to 35% in 1945 and 77% at the end of the century. Similar changes are detected in most OECD countries, although with different time lags compared to the US case (Olivetti and Petrongolo, 2016). The ascent in female participation in the labor market converted into a considerable increase in women's participation in the total hours worked and a reduced wage disparities between women and men. There are many studies on the causes and implications of such transformation in the labor market structure of economies but they almost exclusively focus on high-income ones.[1] This article aims to contribute to the literature by shedding light on these issues by looking at an emerging economy such as Brazil.

Some observed implications of such transformation are the narrowing of gender gaps in hours worked and wages. The existing literature studying the underlying causes of these trends includes gender-specific explanations, such as changes in society and legislation in favor of women and health and technological improvements, among others.[2] In addition to these factors, there are gender-neutral ones that may favor women, since it has created jobs that require less brawn skills but more brain. I.e., they are less physically demanding and intensive in communication and interpersonal skills. According to this literature, women may have a comparative advantage in such jobs, whether innate or acquired (Rendall, 2017).

Suppose women have a comparative advantage in services. In that case, the structural transformation of economies from goods to services is a gender-neutral transformation that would boost demand for female labor since women are over-represented in services. Besides, there also exists an important reallocation between the household and the market sector. It is the marketization phenomenon. Within this literature, the work of Akbulut (2011) develops a simple model of time allocation to quantitatively assess the contribution of sector productivity differences to the change in women's labor supply.[3] Akbulut's model accounts for home production, but limits home sector for

[1] See Goldin (2006) for a complete panorama of historical trends in gender outcomes in the United States and their determinant forces. Also, Olivetti and Petrongolo (2016) presents long-run trends in gender outcomes in employment, hours, and wages for a sample of high-income countries.

[2] See among many others, Albanesi and Olivetti (2016), Greenwood et al. (2005), Attanasio et al. (2008) Fernández (2013).

[3] The author builds upon the model of (Rogerson, 2008), which compares the time allocation differences between Europe and the US in the context of structural transformation caused by different technology growth rates between

women and the goods sector for men. The model successfully accounts for a sizable fraction of the observed increase in women's labor supply in the US from 1950 to 2005. This paper is, in fact, closely related to Akbulut's. We also quantitatively assess changes in time allocations of men and women across sectors over a given period, according to the evolution of sector productivities. Nevertheless, our model is much more complete and comprehensive and, to the best of our knowledge, the first to conduct this type of study for a developing economy.

Structural transformation is the reallocation of economic activity across broad sectors, such as agriculture and services. The interplay between structural transformation and the narrowing of gender gaps is built upon trends observed, especially in developed economies. Besides the increase in market hours for women, Ngai and Petrongolo (2017) also identify for the US a fall in market hours for men, an increase in female relative wages, a rise in service sector share among market hours worked, a fall in home production hours (working hours in the household) for women, and an increase for men. According to the authors, US data show that around 1970, 75% of the market time of the average working woman was offered to the service sector, while the average man supplied 50% of his market time to the service sector. Structural transformation augmented the service sector, where women were already overrepresented.

The marketization of home production has also played a role in narrowing gender gaps. According to Ngai and Petrongolo (2017), in the US in 1965, women spent on average 41 hours per week in home production. At the same time, men only spent 11 hours in chores like child care, cleaning, and food preparation. Home production activities have close substitutes in the market service sector and can be easily outsourced. The expansion of the service sector turned cheaper to outsource these activities. Thus we could expect a reallocation of women's work from the household to the market. In a nutshell, the rise of services, driven by structural transformation and marketization of home production, has raised women's relative wages and market hours.

All the labor market trends aforementioned are observed and well documented for the US and some developed economies. What about the developing world? Available work for developing and low-income countries focuses mainly on female labor force participation (Klasen, 2019; Klasen et al., 2021).[4] Can we say that developing countries follow these trends in labor market hours? Or that the processes of structural transformation and marketization are at play regarding women's participation in the labor market? Are there available data to answer those questions? In Dinkelman and Ngai (2021), the authors advocate for a research agenda to develop and build evidence on the marketization of home production, market work allocations, and other gender gap outcomes in the labor market in developing countries. This paper plans to contribute to this literature with a descriptive and quantitative case study for Brazil.

Brazil deserves special attention on this subject as it is the main economy in Latin America and, at the same time, still struggles as a developing country with low GDP per capita, low levels of productivity, and social problems such as low educational attainment. In terms of the gender gap, according to the Global Gender Gap Index from the 2020 World Economic Forum, Brazil ranks 92nd of 153 countries (Schwab et al., 2019). Moreover, the country has one of Latin America's most significant gender gaps, ranking 22nd out of 25 countries in the region. Even though Brazil has closed both the educational and health gender gaps the economic gender gap remains wide.[5] The low rate of female participation in the labor force, combined with persisting wage and income inequalities, weighs on the country's performance on the Economic Participation and Opportunity subindex, even though

sectors.

[4] The study dives into the heterogeneity of FLFP in developing countries. He discusses a handful of factors that explain the substantial rise in FLFP in Latin America, a modest change in the Middle East, and even a fall in South Asia.

[5] According to the report, there is perfect gender parity in literacy rate (93%) and primary education (95%) besides, a larger proportion of women than men are enrolled in both secondary and tertiary education. Moreover, women can expect to live five years more than men in good health.

the occupation gap is much narrower. Like many other developed economies, Brazil showed declining agricultural employment shares since the 1950s. However, the central displacement of the workforce happened from agriculture directly to services instead of manufacturing, which differs from past development in the US, Europe, and Japan. Furthermore, Brazil has also experienced a significant increase in female labor force participation (FLFP) and a narrowing of the gender gap in wages in the last decades. For example, Scorzafave and Menezes-Filho (2001) find an increase of 14 p.p. in the FLFP between 1982 and 1997, and Barbosa (2014) of 8 p.p. between 1992 and 2012. Thus, in the following sections, we analyze the evolution of female work in Brazil and search for historical trends and sectoral changes.

In addition, we quantitatively assess how structural changes in a developing economy have been reflected in women's hours' allocation between sectors. Historically Brazil has very low productivity growth rates in certain sectors — in specific sectors, rates are even negative. We use a structural transformation model with two market sectors (goods and service) and a home service sector (home production). The model à la Ngai and Petrongolo allows us to go one step further from Akbulut's work, allowing for a richer and more realistic representation of labor market structures and preferences. Unlike Akbulut's model, the one we use allows men and women to spend time in all activities, namely: working in the goods and service sectors, doing housework, and enjoying leisure, but also considering comparative advantages of each gender in each sector. The model also incorporates the wage gap between men and women. Then we calibrate the model with parameters that match Brazilian data targets for 1976 and quantitatively assess how structural changes in the economy have been reflected in women's hours allocation. We also conduct five counterfactual experiments. Specifically, we verify the effects on hours allocations in case of (i) a policy aimed at increasing women's productivity over the years; (ii) Brazil had labor productivity growth rates the same as in the US; (iii) we modify the assumptions regarding women's comparative advantage.

The remainder of the paper is organized as follows. In section 2, we explore the case of Brazil. We briefly review the literature on the process of structural change to the service sector and trends in the labor market for women and bring some data and stylized facts to ground the choice of our model. Section 3 sets out our model, and section 4 calibrates the model to the Brazilian experience from 1976 to 2015. Section 5 uses the model to quantitatively assess structural changes in the Brazilian economy, how they affected women's hours' allocation between sectors and the implications of counterfactual exercises. Finally, the last section concludes the paper.

2 The case for Brazil

Female labor force participation in Brazil has considerably risen over the last four decades. Data from the National Household Sample Survey (PNAD) shows that in 1976 FLFP was 35% and this number becomes 60% in 2015. A large part of such change was among married women. In 1977, the FLFP of married women was 20 p.p. less than men's. By 2002, this difference dropped to 4p.p. (Soares and Izaki, 2002). It is reasonable to think that the closing of the educational gap, the decline in the fertility rate, the increase in the service sector, and the marketization of home production made this change possible for married women.

In this section, we briefly and separately review the available literature for Brazil on the process of structural change to the service sector and the trends in the labor market for women. Then, we bring some data and stylized facts to connect these theories.

2.1 Structural transformation

Conceptually, structural transformation is the reallocation of economic activity across broad sectors. In developed economies, it is related to economic growth and transition from agriculture to manufacturing and then to services. This process has critical aggregate implications when sectoral composition matters, such as productivity, urbanization, inequality, and even labor market outcomes, which leads to our discussion about gender differences in labor.

Starting around 1950, Brazil began a process of structural change that, over six decades, moved the country from a mainly agricultural and rural economy to one predominantly based on the services sector. Firpo and Pieri (2013) provide detailed evidence of how productivity evolved between sectors from 1950 to 2005. They found that Brazil experienced an intense structural change from 1950 to 1970, a period of vigorous industrialization and urbanization driven by external constraints and internal market growth. During this process, employment migrated from the least productive sectors — agriculture — to the most productive ones — industry — promoting, thus, aggregate productivity growth.

In addition, partitioning the Brazilian experience in three periods — 1950-1964, 1964-1994, and 1994-2011 — Firpo et al. (2020) show that between 1964 and 1994, the service sector increased its share in employment from 22% of workers to 44% percent and agriculture shrank from 55% to 26% of workers. Thus, this period depicts an intense structural change in the country. Brazil's structural transformation process was mainly associated with workers' transition from the agricultural sector to the service sector. Even though manufacturing had a relevant role in the 1960s and 1970s, the share of workers in that sector has been almost stable over time since it is less labor-intensive.

2.2 Female labor market

Despite the progress of female labor force participation over the past decades and an observed long-term trend toward reducing the gender wage gap, this gap remains in almost all advanced and developed countries. Machado et al. (2018) study the gender gap over time and the life cycle in the formal labor market in Brazil throughout 1994 and 2015. They highlight the massive entry of women into the workforce within this period and show that overall gender labor differentials fell from 185% to 86%, reflecting relative gains in all labor market components such as participation rates, unemployment rates, hours worked, and hourly wages. Nevertheless, they find that women are less likely to work full-time (40 hours per week) than men, despite the increase of hours supplied by female workers in the formal labor market. The International Labor Organization Statistics (ILOSTAT) time series for "Incidence of part-time employment by sex" shows that this rate for women in Brazil is more the 1.5 times that of men for all years of the series.

In fact, worked hours and hours flexibility are essential factors that influence the gender gap dynamics. In order to document trends in time allocation by gender in Brazil between 2001 and 2015, Barbosa (2018) analyze the evolution of weekly working hours in the market and in home production based on the PNAD. With a particular focus on leisure hours, she uses the weekly hours worked in the market, those dedicated to household chores, and those commuting from home to work to define the weekly leisure hours. Results reveal that men enjoy more leisure time than women, although there is a tendency to reduce this difference over time. Moreover, there has been an increase in the number of leisure hours over the period for men and women. For men, this can be explained by a significant reduction in hours worked in the market, while for women the increase in leisure hours can be explained by a reduction in hours devoted to home production. Since Brazil does not have a specific time survey, Barbosa (2018) results for leisure and home production hours will be essential for our model calibration further on.

2.3 Data Analysis

As Dinkelman and Ngai (2021) argue, in developing countries (specially non-OECD) one way to see the process of marketization and structural transformation is to look at employment shares by broad sector of work. Furthermore, with data on time spent on household chores, we can depict the level and process of marketization of home production, and, with data on employment shares by sector we can document the transition of an economy towards the service sector. Brazil does not have a time use survey, as The American Time Use Survey (ATUS), but we fill this gap with data from the National Household Sample Survey (PNAD). This section brings some evidence on structural changes that occurred in the Brazilian economy from 1976 to 2015 and gender-specific trends for employment, hours, and home production.

We present labor market trends through the National Household Sample Survey (PNAD) microdata. The PNAD survey is a national household sample survey that has been conducted annually from 1971 to 2015. Our data sample covers the year from 1976 to 2015 and includes individuals aged 15–65. To build a single database for all years, we first made a compatibility table with variables of interest for each year. The format and structure of the survey questionnaire are similar between the years in the same decade, so we built and cleaned the base separately for each decade and then joined them.

Figure 1.A shows a trend well documented and explored in the literature: the increase in female participation in the workforce. Labor force participation (LFP) is the ratio of the economically active population over the working-age population. Disaggregating by gender, we see an increasing trend for women and a slight decline for men. Fig 1.B shows total and gender-specific employment rates for the years of analysis. It is also widely documented that unemployment is higher among women than among men. However, we see the employment rate among women increasing over time, while men's is slightly declining, showing the closing of the gender gap in the employment rate.

Figure 2 shows the gender-specific sectoral change in employment, i.e., among all employed population, we compute the fraction of each gender and sector. To classify individuals' occupations within this broad classification of sectors — goods and services — we used a PNAD variable that identifies the primary work field of activity of the individual in the survey week. In *goods*, we consider agricultural activities, all transformation industry, construction, and other industrial activities. Everything else falls under the category *services* — trade and repair; services such as accommodation, food, transport, and communication, among others; education, health, social and domestic services, and public administration. The category with the most significant drop was men in goods, while the employment of women in this sector remained stable. Notice that for women and men, the share of the service sector grows, but for women the rate of this increase is higher. For men, the increase comes mainly from the decrease in the share of employment in the goods sector. As for women, the significant increase in employment in the service sector may be correlated with marketization, that is, by a shift from domestic production to the market.

Figure 1 – Gender-specif trends in labor force and employment

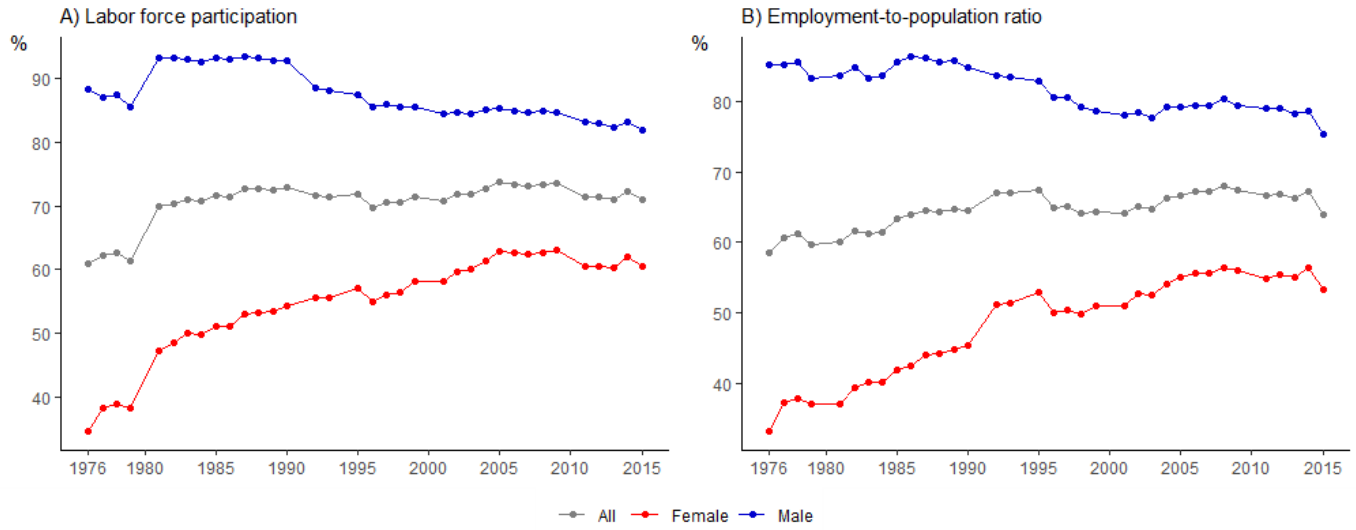
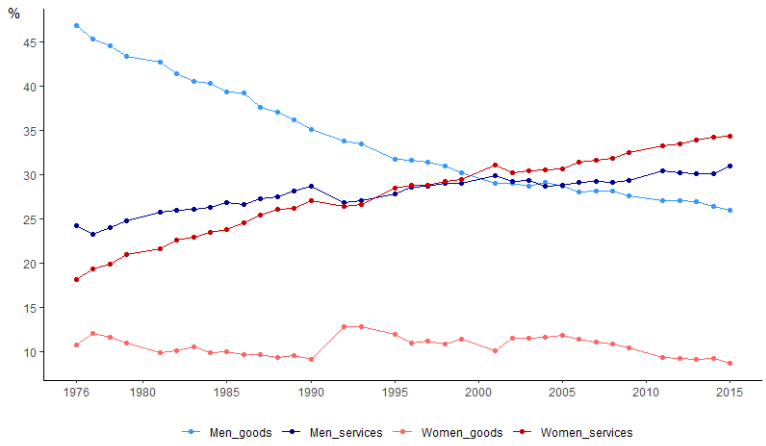


Figure 2 – Gender-specific sectoral change in employment



Now we turn to trends on hours worked. The PNAD contains a continuous variable representing the usual hours worked by an individual per week in their primary occupation. Figure 3 shows the shares of men and women hours in the total hours worked in the Goods and Services sectors and for the whole economy. Over the years, women's working hours have almost taken the lead over men's working hours in the service sector. In the goods sector, shares remained constant, with male hours being four times more than female's. Figure 4 shows the average hours worked per week each year by gender. Analyzing the hours worked in levels, the characteristics of the Brazilian labor market and its legislation emerge. Men work around 40 hours per week on average, compatible with 8 hours per working day. In addition, it shows a slightly decreasing. For women, the average number of hours per week has been increasing, but it is still far below the average for men, revealing that women work fewer hours than men. Indeed, women are majority in part-time jobs numbers. Nevertheless, the period shows an increase for women and a decrease for men, resulting in stability in the total.[6]

Figure 5 plots the proportion of hours worked in the service sector over total market hours — for all individuals, men and women. It shows that the share of market hours worked by men and women in services has increased by about 20 percentage points. For women, the share of hours in services is considerably higher than men's and rose from 62% to 82%. For men, it increased from 34% to 55%.

[6] This trend is also documented in Rogerson (2008) and Olsson et al. (2019).

Figure 3 – Gender shares in worked hours

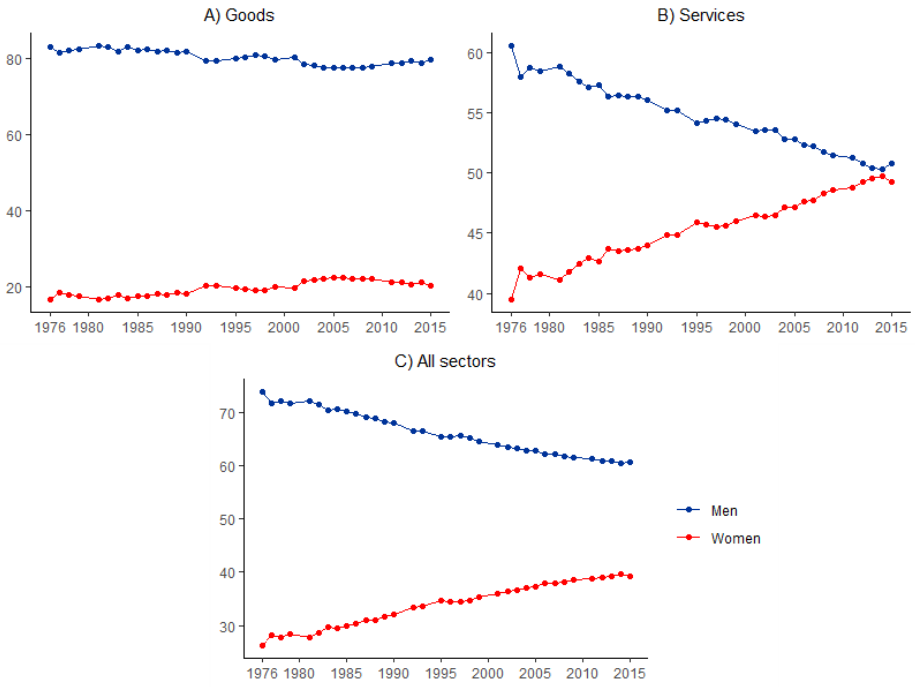


Figure 4 – Average weekly hours worked

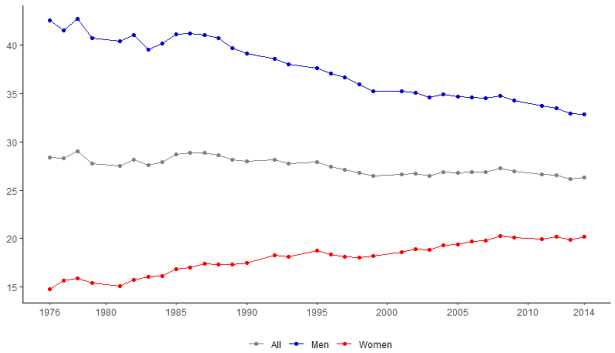
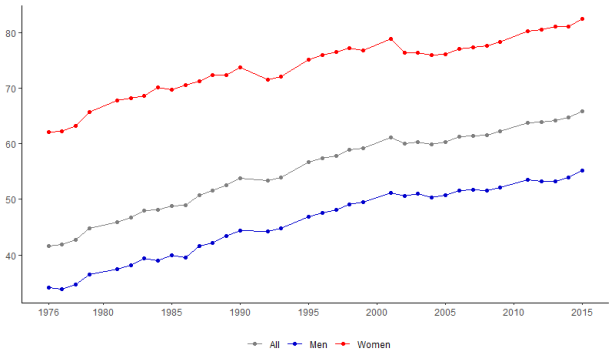


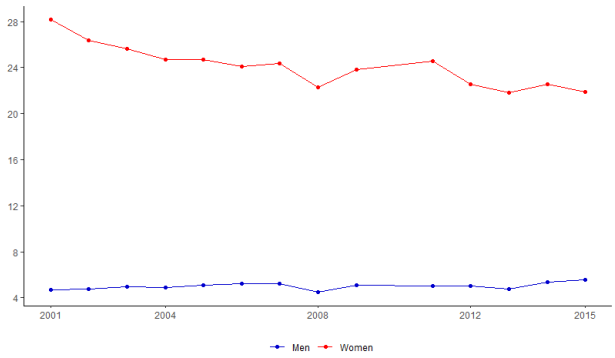
Figure 5 – Fraction of hours in services



In 2001, the PNAD survey added a question to measure hours dedicated to housework — tasks or activities that do not fall under the concept of paid work — per week. Some household chores considered are: tidying or cleaning the house, cooking, laundering, ironing, washing dishes; guiding domestic paid workers in the performance of domestic tasks; taking care of children. Figure 6 shows the massive gap between men and women in household chores. Although the gender gap in working hours is reducing over time, indicating a process of marketization of home production in Brazil, there is no data prior to 2001 on hours spent on household tasks. Even covering only the period between 2001 and 2015, we can observe for women a reduction in the hours dedicated to home production and an infinitesimal increase for men. For women, the average hours dropped from 28 in 2001 to 21 in 2015, while for men, the increase was from 4.72 hours to 5.55. These results also indicate that social norms still play a significant role in Brazil and that women should be more responsible for the care of the household, children, elderly, and other dependent individuals (Codazzi et al., 2018).

Moreover, this corroborates the fact that household paid services are performed mainly by women in Brazil. At the same time, the low qualification required generates an alternative for low-educated and unskilled women, subjecting them to low wages and a high level of informality — but reinforcing the marketization phenomena. Time use surveys support this conjecture for other countries, showing that the share of discretionary time used for homework is declining over time.

Figure 6 – Average weekly hours in household chores



In this section, we presented evidence of some stylized facts about the Brazilian economy. First, an increase of female participation in the labor market and in hours worked in the market, and a fall for men. Second, an increase in the share of the service sector among hours worked in the market, beyond the considerable rise of women's share in market service hours. Third, home production hours for women are decreasing. These trends might suggest that women move from home to market production, especially to the service sector. Furthermore, the process of structural transformation augments the service sector and opens up even more space for women in the labor market. This reasoning is the main motivation for the choice of the model used in quantitative analysis. The model accounts for this set of facts by embodying the process of structural transformation and marketization of home production.

3 Model

The model depicted here has two market sectors; one produces goods and the other services. The household preferences are such that goods and services are poor substitutes. A third sector produces home services, the home production sector. Market and home services are goods substitutes. The production technology of each sector is represented by a CES function that combines female and male work. Women have a comparative advantage in the production of services — market and home. Market sectors are perfect competition, firms are identical, and they employ men and women according to the CES technology. The model is a sequence of static time allocation problems. Preferences are constant over time, but productivities vary. Labor productivity growth rates are uneven between sectors. To ease the notation, time subscripts are suppressed.[7]

3.1 Households

The representative household, composed by a man and a woman, derives utility jointly from the consumption of goods (C_g), market services (C_s), home services (C_h), and leisure (l). The following utility function represents the household preferences:

$$U(C_g, C_s, C_h, l) = \alpha_c \ln C + (1-\alpha_c)\ln l \quad (1)$$

$$C = [\alpha_g \, {C_g}^{\varepsilon} + (1-\alpha_g){S}^{\varepsilon}]^{\frac{1}{\varepsilon}} \quad (2)$$

$$S = [\alpha_s \, {C_s}^{\eta} + (1-\alpha_s){C_h}^{\eta}]^{\frac{1}{\eta}} \quad (3)$$

$$l = [\alpha_l \, {l_f}^{\upsilon} + (1-\alpha_s){l_m}^{\upsilon}]^{\frac{1}{\upsilon}} \quad (4)$$

[7] The full model derivation is available upon request.

where α_g is the share of goods in aggregate consumption C and α_s is the share of market services in S, which is the aggregate consumption of services in general, market and home. The parameter ε represents the substitutability between goods and services ($\frac{1}{1-\varepsilon}$ is the elasticity of substitution), whereas η is the same for market services and home services. We assume that goods and services are poor substitutes so $\varepsilon < 0$, while $0 < \eta < 1$ because market and home services are good substitutes. The household leisure time is given by the aggregation of men and women's leisure. Considering that leisure time of household members is poorly interchangeable because husband and wife like to spend time together, thus $\upsilon < 0$.

Each household member: a woman (f) and a man (m) allocates time between four activities: working in the goods sector (L_{ig}), working in the market services production (L_{is}), producing home services (L_{ih}) and enjoying leisure (l_i), according to the following constraint:

$$L_{ig} + L_{is} + L_{ih} + l_i = L_i \qquad \text{with} \quad i = f, m \tag{5}$$

Household members offer time to produce home services, which they will consume within the household. Home production technology is:

$$Y_h = A_h L_h \tag{6}$$

$$L_h = \left[\gamma_h \, {L_{fh}}^{\kappa} + (1-\gamma_h) {L_{mh}}^{\kappa}\right]^{\frac{1}{\kappa}}, \tag{7}$$

The household budget constraint is:

$$p_g C_g + p_s C_s = w_f (L_{fg} + L_{fs}) + w_m (L_{mg} + L_{ms}) \tag{8}$$

Thus, given wages (w_f, w_m) and prices (p_g, p_s), the representative household chooses (C_g, C_s), home production time (L_{fh}, L_{mh}) and leisure time (l_f, l_m) that maximize the utility function subject to equations (2)-(8).

3.2 Firms

There are two competitive market sectors in this economy: goods (g) and services(s). Labor is the only production input, but each sector employs female and male labor. Production technology is:

$$Y_j = A_j L_j \tag{9}$$

$$L_j = \left[\gamma_j \, {L_{fj}}^{\kappa} + (1-\gamma_j) {L_{mj}}^{\kappa}\right]^{\frac{1}{\kappa}}, \qquad j = g, s \tag{10}$$

where $\frac{1}{1-\kappa}$ is the elasticity of substitution between hours of men and women. We assume that $\gamma_s > \gamma_g$ to capture the female comparative advantage in the service sector.

Taken wages and prices as given, the representative firm $j = g, s$ chooses labor allocations $\{L_{fj}, L_{mj}\}$ to maximize profits:

$$\Pi_j = p_j Y_j - w_f L_{fj} - w_m L_{mj} \tag{11}$$

In the production function of sector $j = g, s, h$, A_j represents labor productivity, which grows at a rate $\dot{A}_j / A_j \equiv \theta_j$. We assume that $\theta_g > \theta_s > \theta_h$ to represent that the goods sector productivity grows at a faster pace than services. To generate the shifts in hours worked across sectors — one of the outcomes of structural transformation — the model has to have uneven productivity growth rates across sectors. Thus, relative productivities will change over time across activities.[8] In addition, the elasticities of substitution of what the household consumes are not unitary. These two features together will reallocate labor hours across activities.

[8] Uneven technological progress across sectors is only one type of mechanism that yields structural changes across sectors in a model. Rogerson (2008) gives a detailed explanation of other features that yield the same outcome.

3.3 Equilibrium

A competitive equilibrium in this economy is a collection of prices (p_g, p_s), wages (w_f, w_m) and allocations (C_g, C_s, C_h, L_{fg}, L_{mg}, L_{fs}, L_{ms}, L_{fh}, L_{mh}, l_f, l_m) such that, given values of state variables (A_g, A_s, A_h):

(i) The representative firm in each sector maximize profits subject to the production technology;

(ii) The representative household maximizes utility subject to his budged constraint;

(iii) Given firms and households optimal choices, all markets clear:

$$\begin{aligned} C_j &= Y_j, \qquad j = g, s \\ L_{ig} + L_{is} &= L_i - L_{ih} + l_i, \qquad i = f, m \end{aligned}$$

We assume free labor mobility across sectors for both genders. Thus, wages are equal between sectors, but a wage gap exists between genders. In addition to that, on the one hand, we assume goods and services as poor substitutes. Thus, a higher productivity growth rate in goods relative to services will shift labor from the former to the latter. On the other hand, since market services and home services are good substitutes, then a higher productivity growth rate in the market relative to home will move labor out of home production. Appendix A presents the complete model derivation.

4 Calibration

In this section, we describe the calibration procedure for the quantitative exercise. We calibrate baseline parameters to match the time allocation and wage ratio in the 1976 Brazilian economy. Among elasticities, preferences, and gender-specific parameters, we have 12 parameters that need to be defined. Sectoral labor productivities levels and growth rates are exogenous and add more six parameters, totaling 18 parameters required to determine the time allocation by gender in the quantitative analysis.

4.1 Data targets

Table 1 presents data on the service share of total market hours worked (s), its gender components (s_f and s_m), shares of market hours for women and men (M_f/L_f and M_m/L_m), and total work hours of women and men (T_f/L_f and T_m/L_m), for the start and end of the sample period, years 1976 and 2015.[9] The service shares are obtained directly from the PNAD following the categorization of hours worked within the goods/services sectors.

The first column of Table 1, s, presents the share of hours worked by all individuals in services over hours worked in the market, i.e., goods sector plus service sector. Throughout the period we are analyzing, there was an increase of 51% in services participation in total hours worked in the market. The gender component s_f in column two measures the share of hours worked by women in services over total female hours worked in the market (s_m depicts the same for men). In 1976, 63% of hours worked by women were in the service sector, while for men, this figure was 35%. In 2015, the participation of the service sector in market hours increased for both genders. For women, 81% of total hours worked in the market were in the service sector, while for men, this number increased to 54%.

[9] The number for 1976 is the average between 1976-1979, and for 2015, it is the average between 2012-2015. The goal is to prevent possible outliers for a single year and to smooth short-run fluctuations.

Table 1 – Data moments from PNAD

Time	Service Share s	Service share women s_f	Service share men s_m	Market hours women M_f/L_f	Market hours men M_m/L_m	Total work women T_f/L_f	Total work men T_m/L_m
1976	0.427	0.634	0.348	0.207	0.552	0.691	0.588
2015	0.645	0.811	0.538	0.291	0.439	0.628	0.510

The columns M_f/L_f and M_m/L_m in Table 1 show hours worked in the market over the endowment of hours by gender. We compute the average weekly hours worked in the market directly from PNAD data, but we need a weekly average of hours in home production and leisure to obtain the endowment of hours. Here we borrow the numbers of Barbosa (2018). In her paper, she computes the home-to-market hours ratio for women and men between 2001 and 2015. We multiply this ratio by the average hours in the market to get a weekly average of hours in home production. From Barbosa (2018), we also borrow the average hours of leisure for men and women.[10] By adding the average hours in the market, home production, and leisure, we get the total weekly endowment of hours for men and women. Then, we compute M_f/L_f and M_m/L_m. Between 1976 and 2015, the market hours share of total hours increased 40% for women and decreased by 20% for men, showing a narrowing in the gender gap of market hours. Total work for each gender (T_i/L_i) is simply the sum of market hours and home hours as a share of the endowment of hours. Despite allocating fewer hours in the market, women work more hours than men due to a more significant load of domestic work. Between 1976 and 2015, total work decreased for women and men due to reduced home production and market hours, respectively.

The model presented in the previous section allocates the endowment of time of men and women across four activities: market work (goods and services), home production, and leisure. Table 1 shows data from PNAD that we use to compute the implicit time allocation within these four model categories. Table 2 presents the full-time allocation across the four activities implied by the model. In the first row, we present the formulas of how we combine data from Table 1 to reach the value of rows 2-5. Table 2 transforms the PNAD data into shares of L_i, i.e., we are adjusting the data in terms of the time constraint given by the equation 5 to compare the quantitative results to the data.

Table 2 – Full time allocation across activities derived from PNAD data

	Goods	Services	Home	Leisure	Total
	$\frac{L_{ig}}{L_i} = \frac{M_i}{L_i}(1-s_i)$	$\frac{L_{is}}{L_i} = \frac{M_i}{L_i}s_i$	$\frac{L_{ih}}{L_i} = \frac{T_i}{L_i} - \frac{M_i}{L_i}$	$\frac{l_i}{L_i} = 1 - \frac{T_i}{L_i}$	
Time			Women		
1976	0.052	0.091	0.547	0.309	1
2015	0.035	0.149	0.445	0.372	1
			Men		
1976	0.212	0.113	0.264	0.412	1
2015	0.103	0.121	0.286	0.490	1

[10] As the time horizon of Barbosa's paper runs from 2001 to 2015, we compute the growth rate of both numbers between 2001 and 2015 and project to obtain those numbers for the year 1976.

4.2 Parameters

Elasticity parameters are: $\varepsilon, \eta, \kappa$ and υ. More precisely, they are the substitution parameters that define the elasticities of substitution. That is, for any substitution parameter x, the elasticity of substitution is given by 1/(1-x). The parameter ε determines how time is reallocated from goods to total services (home and market) given the relative changes in productivity. Hence, the value must be negative to result in a reallocation from the sector with higher productivity growth (goods) to one with lower productivity growth (services). We follow Rogerson (2008) and Akbulut (2011) and set the value as -1.28. Ngai and Pissarides (2008) claim that ε ranges from -2.33 till -9. η is also a key parameter since it defines the substitutability of market and home services and determines labor reallocation from home into market given different productivity growth rates. Gelber and Mitchell (2012) obtained estimates from 0.33 to 0.6. Rogerson (2008) and Akbulut (2011) chose 0.45, a value within this range. Olivetti (2006) states that the elasticity of substitution between market and non-market services, such as in our model, is consistent with a higher elasticity of substitution; thus, she uses 0.75. We follow Ngai and Petrongolo (2017) with 0.5.

For κ and υ, we decided to calibrate similarly as Ngai and Petrongolo (2017). The substitution parameter in the production function, κ, is set to match the observed response in the home hours ratio to changes in the wage ratio. This parameter reflects the substitutability of male and female input in production. Ngai and Petrongolo (2017) obtained a value of 0.56 with US data. We find 0.304 with Brazilian data. In turn, υ is set to match the response in leisure hours ratio to changes in the wage ratio. Since this parameter reflects complementarity of male and female leisure time, we expect $\frac{1}{1-\upsilon} < 1$. We obtained 0.11, while Ngai and Petrongolo (2017) got 0.19.

Gender-specific parameters, $\gamma_g, \gamma_s,$ and γ_h, are fixed by conditions from the first order conditions, evaluated in 1976. This gives $\gamma_g = 0.16$, $\gamma_s = 0.30$, and $\gamma_h = 0.45$, pointing out women's comparative advantage in the services relative to the goods sector. Similarly, α_l is also pinned down by an equation from the model derivation, giving 0.0013.

Given, η and κ, preference parameters, $\alpha_c, \alpha_g,$ and α_s are calibrated to match gender-specific relative labor allocations in 1976. The resulting values are found in Table 3. Lastly, $(\frac{L_m}{L_f})_{76}$ is the relative time endowment for 1976. We assume that this parameter does not change over years and we set it to match the service share in the initial year of our sample. We find a value of 1.15. Table 3 sums up the calibrated parameters.

Table 3 – Parameters for the benchmark model

	Description	Values
ε	Elasticity of substitution: goods and services $(\frac{1}{1-\varepsilon})$	-1.28
η	Elasticity of substitution: market and home services $(\frac{1}{1-\eta})$	0.5
κ	Elasticity of substitution: female and male hours in technology $(\frac{1}{1-\kappa})$	0.304
$(\frac{1}{1-\upsilon})$	Elasticity of substitution: female and male hours in leisure	0.11
γ_g	Share of female labor in goods production technology	0.16
γ_s	Share of female labor in market services production technology	0.30
γ_h	Share of female labor in home services production technology	0.45
α_l	Share of female leisure in the composition of household leisure	0.013
α_c	Share of consumption in the utility function	0.62
α_g	Share of goods in the composition of consumption	0.28
α_s	Share of market services in the composition of services	0.163
$(\frac{L_m}{L_f})_{76}$	Time endowment ratio at the initial year (1976)	1.15

4.3 Productivities

In our model, the engine for structural changes across sectors is the different productivity growth rates. Hence, we need a measure for these growth rates and sectoral productivity data levels for 1976. We use the 10 Sector Database and Economic Transformation Database to collect annual series of value-added at constant prices and persons engaged per sector. We aggregate the sectors of the database into our two categories, *Goods* and *Services*, and compute labor productivity (output per worker). *Goods* comprehends the following categories: agriculture, mining, manufacturing, utilities, and construction. *Services* comprehends trade services, transport services, business services, and Government services. The implied annual growth rate for labor productivity in the goods sector is 2.42%, and for market services is 0.0827%.

As highlighted by Akbulut (2011), measuring productivity in nonmarket services (home production) is a challenge, and we have the same data limitation for Brazil. Her approach was to identify activities in the service market that are similar to those at home, using data from the Annual Industry Accounts provided by the US Bureau of Economic Analysis. Then, she assumes that the measured productivity growth rate of such activities reflects the upper limit for productivity growth of home services. We follow this idea to overcome the same challenge.

The 10 sector database has an economic activity category named 'Community, social and personal services' — *personal services* further on. This category includes community activities such as recreational, cultural, and sporting activities, but also private household activities such as service-producing for own use, i.e., home production. We split *personal services* into two subcategories, one representing home production and the other, with everything else, representing general market services, which is afeter included in *Services* aggregation. The home production subcategory is weighted to match the average share of *Serviços Domésticos* on total value added from the Brazilian System of National Accounts. We did the same procedure to the number of persons engaged. Thus, we constructed a labor productivity series for home production and found an implied annual productivity growth rate of -0.63%.

Differently from the papers that study the US — which in general find much higher values for labor productivity growth rate in the service sector (θ_s) and positive values for the home sector (θ_h) — we found an almost zero growth rate for the former and a negative growth rate for the later. Nevertheless, similar to other studies, the relatively lower productivity growth in the home services compared to market services will shift women from home to the service sector. Table 4 summarizes all annual average sector productivity growth rates (θ_g, θ_s and θ_h) and labor productivity levels (output per worked) for 1976 (A_{g76}, A_{s76} and A_{h76}).

Table 4 – Productivities parameters for the benchmark model

A_{g76}	A_{s76}	A_{h76}	θ_g	θ_s	θ_h
10.97	32.58	4.08	2.42%	0.0827%	-0.63%

5 Quantitative Analysis

In this section, first we quantitatively assess how structural changes in the Brazilian economy have been reflected in women's hours' allocation between sectors using the calibrated baseline model. We access the calibration accuracy relative to data and then conduct five counterfactual experiments. The experiments use the baseline model, but they vary some specific parameters according to the what we want to test. Specifically, we verify the effects on hours allocations in case of: (i) a policy aimed at

increasing women's productivity over the years; (ii) Brazil had labor productivity growth rates the same as in the US; (iii) we modify the assumptions regarding women's comparative advantage.

5.1 Baseline Results

Table 5 presents the results from the baseline model. Here, we aim to check if the model we calibrate for Brazil can account for the changes in labor allocations observed between 1976 and 2015. Data information in Table 5 replicates Table 2 content. In the data, the share of women's hours in the goods sector decreased from 0.052 in 1976 to 0.035 in 2016. In the baseline model, it decreases to 0.032, accounting for 117% of the observed change. For market services, home production, and leisure time, the benchmark model was able to explain 26%, 42%, and 88%, respectively, of the change in the data. Results for male hours are lesser accurate. Despite having managed to reproduce the direction of the changes, namely, a reduction of hours in the goods sector and an increase of hours in other activities, the model greatly overestimated the hours dedicated to leisure. This can be explained by the calibration of α_l, which is the weight of female leisure in the household's joint leisure. In our calibration, we found a $\alpha_l = 0.013$, far below the value in Ngai and Petrongolo (2017), 0.29.

5.2 Counterfactuals

In Table 6, we show the quantitative results of the model solution. The top row reports the percentage change between 1976 and 2015 data. The following rows present predicted changes from model calibrations. In the row named baseline, we show the percentage change of allocations of the baseline model depicted in Table 5.

Table 5 – Baseline results for gender and sector-specific time allocations

	1976		2015		Account for the observed
	Data	Model	Data	Model	change
Female					
Goods	.052	.057	.035	.032	117%
Services	.090	.080	.149	.105	26%
Home production	.539	.503	.448	.501	42%
Leisure	.319	.360	.368	.363	88%
Male					
Goods	.210	.158	.104	.093	109%
Services	.112	.068	.121	.096	-174%
Home production	.267	.172	.284	.182	-489%
Leisure	.411	.603	.491	.629	274%

5.2.1 Anti-discrimination policies

In Model A (third row), we use the baseline model for 1976, but allow changes in technology parameters γ_g and γ_s over years. We want to simulate the effect of anti-discrimination policies aimed at increasing the perceived productivity of women over time. Thus we imposed that in 2015, gender-specific parameters would be 45% higher.[11] In this case, the model doubles female hours in

[11] This percentage was chosen based on Machado et al. (2018), who found that gender labor differentials decreased 45% between 1994 and 2015.

market services, overpredicting the 65% increase in the data (first row, second column). However, the direction of the changes in time allocations is the same as in the baseline case. We are imposing within-sector improvements for women, but the between-sector dynamics in place are the same as we described in section 4.3. The higher productivity growth rate in goods relative to services, plus the poor substitutability between them, will shift labor from the former to the latter. Moreover, a higher productivity growth rate in the market relative to home, plus market services and home services being good substitutes, will move labor out of home production for women.

5.2.2 US labor productivity growth rates

Unlike developed countries, Brazil has a historically low productivity growth rate in services. Thus, in model B, we adopt US labor productivity growth rates borrowed from Akbulut (2011). The remaining parameters are the same as the baseline model. In this case, $\theta_g = 2.3\%$, $\theta_s = 1.3\%$ and $\theta_h = 0.1\%$. The greater the difference $\theta_g - \theta_s$, the more labor hours migrate from goods to market services. Since θ_s for Brazil is very low, and θ_g is higher than in the US, the reduction in the share of hours in the goods sector is bigger in baseline than in model B. The same reasoning is applied to the relative productivity between market and home services, $\theta_s - \theta_h$. This difference is bigger with US productivities growth rates, resulting in a bigger movement of women out of home production in model B compared to the baseline. Those results together lead to a bigger rise in female market service hours in model B than in the baseline model. With this exercise, we infer that marketization dynamics could be bigger if Brazil had a higher productivity growth in the service sector. Male market hours follow the same path, indicating that men would also benefit from higher productivity growth in the service sector.

5.2.3 Different scenarios for women's comparative advantage

The remaining cases of table 6 — models C, D, and E — analyze counterfactual scenarios modifying assumptions about the comparative advantage of women assumed in the model of section 4. Here we go back to Brazilian productivity growth rates, θ's values from Table 4.

In model C we assume that women have a comparative advantage in services relative to the goods sector, but across market and home services, parameters are equal, i.e., $\gamma_h = \gamma_s = 0.3 > \gamma_g = 0.16$. Results for female hours in home production and leisure diverge relative to data and baseline cases. This is related to a drop in female relative wages. The model predicts that when female relative wages rise, the opportunity cost of working at home also rises, moving women's hours to the market. In C, we got an increase in home hours and a decrease in relative equilibrium wages between 1976 to 2015. In general, when the relative female wage increases, female hours diminishes in sectors where they do not have a comparative advantage and increase in sectors they do have. Thus, when we assume that $\gamma_h = \gamma_s$, it leads to a rise in hours in market and home services.

In model D, we assume that women only have a comparative advantage at home relative to market activities, thus $\gamma_h = 0.45 > \gamma_s = \gamma_g = 0.16$. The resulting percentage changes in hours allocations between 1976 and 2015 is the closest to the baseline.

The last case, model E, is such that $\gamma_h = \gamma_s = \gamma_g = 0.5$. Here, we do not consider comparative advantages or differences in male and female productivity. Results show virtually no gender differences in allocated hours and wages in this hypothetical scenario. The presence of different sector productivity growth rates generates a negligible variation in relative wage. Consequently, changes in time allocations between activities are practically the same for women and men. This exercise shows that in the absence of gender differentials, structural transformation generated by uneven productivity growth rates is entirely gender-neutral. One aspect of Model E is that it fails to reproduce the wage gap

between men and women, which is similar to the model of Akbulut (2011). Hence, our model is more adequate for analyzing an economy such as Brazil.

6 Conclusion

Recent literature analyzes the relationship between the process of structural transformation towards the service sector with the narrowing of gender gaps in those rich economies. This paper focuses on an emerging economy to find evidence of such a relationship. With a structural transformation path different than developed economies, Brazil documented a sizable rise in female labor force participation and a reallocation of economic activity and labor force toward the service sector throughout the second half of the 20th century. We use PNAD data from 1976 to 2015 to present evidence of some stylized facts about the Brazilian economy, such as an increase in female hours worked in the market and a fall for men, an increase in the share of the service sector among market hours, a considerable rise in women's share in market service hours, and a decrease of female home production hours. These trends suggest that women move from home to market production, especially to the service sector.

We also quantitatively assess how structural changes in Brazil have been reflected in women's hours' allocation between sectors. Historically, the country has very low productivity growth rates compared to developed economies. We use a structural transformation model with two market sectors (goods and service) and a home service sector (home production) to go one step further from Akbulut (2011). The model allows men and women to spend time in all activities, considers comparative advantages of each gender in each sector, and incorporates the wage gap between men and women.

Our counterfactual experiments show that: (i) within-sector improvements for women, such as non-discrimination policies, yield a rise in women's hours in market activities; (ii) in case Brazil had labor productivity growth rates the same as in the US, female market service hours would be even greater than in the baseline model, suggesting that marketization dynamics could be more significant.

The last counterfactual exercise shows that if we do not consider comparative advantages or differences in male and female productivity, there are virtually no gender differences in allocated hours and wages. Consequently, changes in time allocations between activities are practically the same for women and men. In the absence of gender differentials, structural transformation generated by uneven productivity growth rates is entirely gender-neutral. This scenario failed to reproduce the wage gap between men and women, which is similar to the model of Akbulut (2011). Therefore, we conclude that our model is more suitable for analyzing an economy such as Brazil.

Table 6 – Quantitative results

	Percentage change 1976-2015								
	Goods	Services	Home production	Leisure	Goods	Services	Home production	Leisure	Relative Female Wage
	Female				Male				
Data	-33.4	65.2	-16.9	15.7	-50.5	8.2	6.5	19.3	34.17
Model - baseline	-44.4	32.5	-0.6	0.6	-40.8	41	5.8	4.4	1.92
Model (A) - γ_g and γ_s increase 45%	-15.0	105.8	-14.6	-0.7	-43.4	14.1	10.5	6.8	14.9
Model (B) - US values for θ_g, θ_s and θ_h	-38.4	45.2	-12	12.8	-29.7	65.6	0.5	0.3	20
Model (C) - $\gamma_h = \gamma_s = 0.3$	-42.3	45.5	9.5	-1.1	-38.6	54.9	16.5	6.5	-0.88
Model (D) - $\gamma_s = \gamma_g = 0.16$	-44	32.5	-1.1	3.3	-40.5	40.9	5.1	4.6	3.75
Model (E) - $\gamma_h = \gamma_s = \gamma_h = 0.5$	-41.4	37.1	3.2	3.5	-41.8	36.1	2.4	2.6	-0.0001

References

Akbulut, R. (2011). Sectoral changes and the increase in women's labor force participation. *Macroeconomic Dynamics*, 15(2):240–264.

Albanesi, S. and Olivetti, C. (2016). Gender roles and medical progress. *Journal of Political Economy*, 124(3):650–695.

Attanasio, O., Low, H., and Sánchez-Marcos, V. (2008). Explaining changes in female labor supply in a life-cycle model. *American Economic Review*, 98(4):1517–52.

Barbosa, A. L. N. d. H. (2014). Participação feminina no mercado de trabalho brasileiro.

Barbosa, A. L. N. d. H. (2018). Tendências nas horas dedicadas ao trabalho e lazer: uma análise da alocação do tempo no brasil. Technical report, IPEA, Texto para Discussão.

Codazzi, K., Pero, V., and Albuquerque Sant'Anna, A. (2018). Social norms and female labor participation in brazil. *Review of Development Economics*, 22(4):1513–1535.

Dinkelman, T. and Ngai, R. (2021). Home production, women's market work and structural transformation. *Structural Transformation and Economic Growth. STEG Pathfinding Paper*.

Fernández, R. (2013). Cultural change as learning: The evolution of female labor force participation over a century. *American Economic Review*, 103(1):472–500.

Firpo, S., Pieri, R., and Nogueira, R. (2020). Inclusive growth without structural transformation?: The case of brazil. Technical report, World Institute for Development Economic Research (UNU-WIDER).

Firpo, S. P. and Pieri, R. G. d. (2013). Structural change, productivity growth and trade policy in brazil.

Gelber, A. M. and Mitchell, J. W. (2012). Taxes and time allocation: Evidence from single women and men. *The Review of Economic Studies*, 79(3):863–897.

Goldin, C. (2006). The quiet revolution that transformed women's employment, education, and family. *American economic review*, 96(2):1–21.

Greenwood, J., Seshadri, A., and Yorukoglu, M. (2005). Engines of liberation. *The Review of Economic Studies*, 72(1):109–133.

Klasen, S. (2019). What explains uneven female labor force participation levels and trends in developing countries? *The World Bank Research Observer*, 34(2):161–197.

Klasen, S., Le, T. T. N., Pieters, J., and Santos Silva, M. (2021). What drives female labour force participation? comparable micro-level evidence from eight developing and emerging economies. *The Journal of Development Studies*, 57(3):417–442.

Machado, C., Neri, M., and Neto, V. P. (2018). The gender gap, education, and the life cycle profile in the brazilian formal labour market. Technical report, World Institute for Development Economic Research (UNU-WIDER).

Ngai, L. R. and Petrongolo, B. (2017). Gender gaps and the rise of the service economy. *American Economic Journal: Macroeconomics*, 9(4):1–44.

Ngai, L. R. and Pissarides, C. A. (2008). Trends in hours and economic growth. *Review of Economic dynamics*, 11(2):239–256.

Olivetti, C. (2006). Changes in women's hours of market work: The role of returns to experience. *Review of Economic Dynamics*, 9(4):557–587.

Olivetti, C. and Petrongolo, B. (2016). The evolution of gender gaps in industrialized countries. *Annual review of Economics*, 8:405–434.

Olsson, J. et al. (2019). Structural transformation of the labor market and the aggregate economy. *Unpublished Manuscript, University of Amsterdam*.

Rendall, M. (2017). Brain versus brawn: the realization of women's comparative advantage. *University of Zurich, Institute for Empirical Research in Economics, Working Paper*, (491).

Rogerson, R. (2008). Structural transformation and the deterioration of european labor market outcomes. *Journal of political Economy*, 116(2):235–259.

Schwab, K., Crotti, R., Geiger, T., Ratcheva, V., and Zahidi, S. (2019). The global gender gap report 2020. In *World Economic Forum*.

Scorzafave, L. G. and Menezes-Filho, N. A. (2001). Participação feminina no mercado de trabalho brasileiro: evolução e determinantes. *Pesquisa e planejamento econômico*, 31(3):441–478.

Soares, S. and Izaki, R. S. (2002). A participação feminina no mercado de trabalho. 127.