Distortions, Infrastructure and Labor Supply in Latin American Countries

This version: October, 2010
Preliminary*

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Abstract

I document differences in labor supply between a set of Latin American countries and the U.S. in the period 1990-2005. These differences are mostly explained by large differences in female labor supply. In the U.S. the female labor force participation was 69% by 1990, while in Brazil and Mexico was 39% and 37%, respectively. Females began to participate more in the labor market of these countries when more households acquired access to basic infrastructure and when distortive policies affecting the price of household appliances were partially removed. I use a model of home production with endogenous labor force participation to account for these facts. I conclude that the price of household appliances and access to infrastructure are quantitatively important in explaining cross-country labor supply differences.

Key words: Labor Force Participation, Latin America, Policy Distortions, Household Appliances.

JEL Classifications: O11, O14, O33.

*I would like to thank B. Ravikumar, Gustavo Ventura and Guillaume Vandenbroucke for their comments and guidance, as well as seminar participants at Atlanta FED, Central Bank of Uruguay, CINVE and SITE-Stanford University. This paper was part of my dissertation thesis at The University of Iowa.

1 Introduction

The existing literature in development has focused on analyzing cross-country differences in GDP per worker. There is a consensus that almost 50% of these differences are accounted for by TFP (Total Factor Productivity) differences (see Hall and Jones (1999), Caselli (2005) and Restuccia (2008) for the case of Latin American countries). However, cross-country gaps between GDP per capita and GDP per worker, driven by differences in labor force participation across countries, have not attracted much attention in existing work.

Many authors, Prescott (2004) and Rogerson (2009) among many others, have studied differences in the labor supply between developed countries, mainly between Europe and the U.S. In this paper I focus on labor supply differences in the developing world. In a sample of Latin American (LA, henceforth) countries I find large differences in labor force participation (LFP), relative to the US, of people aged 25 years and older. By performing a simple accounting exercise, I show that these differences in LFP account for around 15% of the differences in GDP per capita between the LA countries and the U.S. in the period 1980-1990. The aim of this study is to explain these observed labor supply differences. I argue that cross-country differences in labor supply are mainly due to access to infrastructure and distortive policies in developing countries.

There are three novel aspects of the data that motivate this study. I first uncover new data based on household surveys to document differences in LFP of males and females between a set of LA countries and the U.S.. I show that LFP participation differences are mainly due to differences in the participation of women in the labor market. In the U.S. the female labor force participation was 69% by 1990, while in Brazil and Mexico was was 39% and 37%, respectively. Furthermore, this observed gap in female LFP started to decrease at the beginning of the nineties: In 2005 female LFP was 66% and 48% in Brazil and Mexico, respectively. In addition, the survey data show substantial differences in the use of durable household goods across countries. For instance, in the US, about 80% of households operated a washing machine in 1990, whereas in Brazil and Mexico only 24% and 36% of households operated one, respectively.

Second, by using new data obtained from national statistical offices I show a particular pattern for the evolution of the relative price of appliances observed in LA countries. In almost all the LA countries in my sample the relative price of appliances was constant or increased until the beginning of the nineties. This behavior of prices may reflect the effect of many distortions operating in these countries, being trade barriers one of them.

Latin American countries constitute excellent laboratories to analyze the effects of changes in trade policy. Until the mid-1980s, trade policies applied in these countries aimed at keeping sectors protected through high tariffs and import restrictions (also called Import Substitution policies). The collapse of these economies in the 1980s eliminated the credibility of the import-substitution model and set the stage for trade reforms. Since the end of the eighties LA countries have drastically reduced their tariff and non-tariff restrictions. Data on the evolution of average tariff rates in this period suggest a link between the evolution of these prices to the changes in the trade policy just described.

In addition, the access to basic infrastructure and the link with the development process has been a concern in the development literature and policymakers. By using compiled data from household surveys, I am able to document substantial differences in the access to electricity and running water both across countries and within countries in the period analyzed. In the US almost all households had access to running water circa 1990, whereas in Brazil and Mexico only 78% and 81% of the households had access to this service, respectively. Interestingly, when we look at data on the access to infrastructure by income quintile in developing countries in the pre-reform period, we observe large differences in the access to infrastructure between households in different income groups. Around 1990, 97% and 92% of the households in the top income quintile had access to these two services in Brazil and Mexico, but only 35% and 47% of the households in the bottom income quintile had access to these infrastructure services, respectively. This unequal access to basic infrastructure dramatically changed in the post-reforms period: between circa 1990 and 2005 the access to electricity and running water for the bottom income quintile increased by 94% and 53% in Brazil and Mexico, respectively.

In the second part of this paper I use economic theory that incorporates these salient features of the data in order to analyze the economic forces behind these observations. I interpret the evolution of prices and access to infrastructure as barriers to technology adoption by LA households that operated until circa 1990 which then were partially removed by 2005. For this purpose, I develop a simple overlapping generation model with home production that builds on Greenwood, Seshadri, and Yorukoglu (2005) (GSY, henceforth). The key features of the model are: i) heterogeneity in households ability levels and, ii) the access to infrastructure needed to operate household durable goods. More critically, I specifically model the interplay between this type of heterogeneity and the access to infrastructure services in determining the adoption of time saving household technologies.

Each country is a closed economy populated by heterogeneous households, each composed by a male and a female. Household members get utility from the consumption of market goods, home goods and leisure. Households are heterogeneous in their ability levels which is fixed for their entire life. Males always work in the market, and in each period the household decides whether the female does the housework (home work) or offers labor in the market (market work). In addition, each period households choose the amount of savings and whether to buy a composite durable good. There are two types of technologies. A standard Cobb-Douglas production function describes the production of market goods by competitive firms. The home production technology is assumed to be the Leontief type. Once the household purchases the durable good, it operates a new technology that allows the female to save time in performing the household chores.

Countries differ the in the distribution of ability levels which lead to differences in the mean and dispersion of household income, a feature that is suggested by the data. In developed countries, more households choose to buy the durable good. Constrained by low income, fewer households in developing countries buy the durable good, and hence more females do housework. In addition, households of different countries face different market prices of durable goods. These prices are potentially higher in developing countries, so they operate as a barrier to the adoption of new household technologies. In a similar fashion, countries exogenously differ in their access to basic infrastructure which is essential for the household to adopt the durable good. I also exogenously introduce a wedge in the income females receive compared to the income that males receive. This captures the gender earnings gap observed in the data. Finally, countries differ in their technology levels to produce market goods.

I then calibrate the model to the U.S. and compute the steady state predictions for each of the countries in my sample in the pre-reform period (circa 1990) and in the post-reforms period (2005). By using the calibrated model, I vary country specific parameters in order to ask, how much of the observed differences in female labor supply are accounted for by the model both in 1990 and 2005. Specifically, I take average human capital levels, household income inequality, access to basic infrastructure by income quintile, gender earnings gap, total factor productivity and relative price of household appliances to be country specific.

In the case of the US, the model is calibrated for 1990 such that it matches both the adoption and female LFP levels in that year. In addition, I use the model to predict the levels of these variables in 2005, and it closely matches the level of adoption in that year of and predicts an increase in female LFP that is close to the one observed in the data.

More importantly, for the case of Brazil, in the pre-reforms period, I find that the model can account for 63% of the observed female LFP. In the post-reforms period the model accounts for 93% of the observed female LFP in this country. More importantly, the model accounts for 93% of the observed change in female LFP between these two periods. When I compute the model predictions for Mexico, I find that the model over-predicts the levels of female LFP in both periods. However, it succeeds in predicting a higher adoption level than the ones observed in Brazil. In addition, it quantitatively does a good job in accounting for the observed change in female LFP between these two periods: it accounts for 50% of the observed change in female LFP.

In this section, I document differences in labor supply between a set of developing countries and the U.S. by uncovering new comparable data on labor force participation. In addition, I argue that these differences are important in explaining observed differences in GDP per capita in the period 1980-2005. All the data sources are described in Appendix C.

1.1 Labor Force Participation

Figure 1 shows the evolution of total LFP for Brazil and Mexico with respect to the US in the period 1908-2005. In 1980 total LFP in Brazil was around 80% of the US level. In the case of Mexico it was around 90% of the US level. Interestingly, in both countries total LFP participation decreased or remained constant relative to the US until the beginning of the nineties when it started to increase. For instance, in the case of Brazil it totally caught up with the US level by 2005.

More importantly, by decomposing the participation rates by sex, we observe that the observed cross-country differences in total LFP come from differences in *female* LFP. As Figure 2 shows, we do not observe substantial changes in the participation of males during the period with respect to the US. However, by inspecting Figure 3 we see that all the action comes from changes in female LFP. We observe a clear break in circa 1990 in the evolution of the female LFP in these developing countries. Note that in the period 1980-1990 the participation of women in the labor market decreased in the case of Mexico and remained constant in Brazil. In the period 1990-2005 it substantially increased in both countries. I focus my exposition on these two countries (the largest of the region) but the same pattern is observed in the majority of LA countries in the period analyzed.[1] Table 1 shows the stunning differences in the participation of women in the labor markets in 1990 between Brazil and Mexico and the US and the substantial increase observed between 1990 and 2005. For instance, Brazil's female LFP went from

[1] For the average of LA countries, the female LFP grew at an average rate of 1.4% a year from 1980 through 1990 to then grow at an average rate of 2.6% in the rest of the period.

39% to 66% in just 15 years.

1.2 Labor Supply and Development in Latin America

In order to assess the importance of differences in labor supply in the development process we can perform the following accounting exercise. For a particular year or period we can compare the GDP per capita of country i relative to country j and decompose this ratio between the ratio of GDP's per worker and LFP.

By definition,

$$\frac{GDP_{pw,i}}{GDP_{pw,j}} = \frac{\frac{GDP_i}{LF_i}}{\frac{GDP_j}{LF_j}}, \tag{1}$$

where GDP_i is the GDP in country i, $GDP_{pw,i}$ is the GDP per worker of country i and LF is the labor force or number of workers of country i.

Since

$$LF_i = LFP_i \times POP_i, \tag{2}$$

where LFP_i and POP_i represent the labor force participation and total population of country i, respectively. Then substituting (2) into (1), we get

$$\frac{GDP_{pw,i}}{GDP_{pw,j}} = \frac{\frac{GDP_i}{LFP_i \times POP_i}}{\frac{GDP_j}{LFP_j \times POP_j}}. \tag{3}$$

Using the definition of GDP per capita and rearranging terms

$$\frac{GDP_{pw,i}}{GDP_{pw,j}} = \frac{GDP_{pc,i}}{GDP_{pc,j}} \times \frac{LFP_j}{LFP_i}, \tag{4}$$

or

$$\frac{GDP_{pc,i}}{GDP_{pc,j}} = \frac{GDP_{pw,i}}{GDP_{pw,j}} \times \frac{LFP_i}{LFP_j}. \tag{5}$$

The previous literature in developing accounting has focused on the observed differences in GDP per worker across countries (the first term of the right hand side of (5)) and not much in labor force participation differences (the second term of the right hand side of (5)). By using (5) to compare the average of LA to the U.S. in the period 1980-2005, we have

$$\frac{GDP_{pc,LA}}{GDP_{pc,US}} = \frac{GDP_{pw,LA}}{GDP_{pw,US}} \times \frac{LFP_{LA}}{LFP_{US}}. \tag{6}$$

By taking logarithms in both sides of (6) we can find the contribution of the documented differences on labor force participation to explain the observed differences in GDP per capita in that period. Interestingly, in both Brazil and Mexico, differences in labor force participation explain around 20% of the differences in GDP per capita between these countries and the U.S. in 1990. Providing the dramatic increase in LFP after the beginning of the nineties, by 2005 LFP differences explain only 1% and 10% of the GDP per capita differences between Brazil and Mexico and the US, respectively.[2] As it is argued below, this study provides a detailed explanation for this non trivial amount of the observed cross country differences in income per capita.

2 Differences in Household Technology Across Countries

In this section, I document differences in the diffusion of new household technologies across countries in the period 1990-2005 by exploring data at the household level for a set of LA countries and the U.S. All the data sources are described in Appendix C.

2.1 Adoption of Appliances

I explore compiled data from household surveys to document evidence cross-country differences in the technologies used at the household level. The available data start in circa 1990 which is the year in which all the major changes in female LFP began in the region. As an approximation of the adoption of time saving devices I have access to data on the percentage of households with washing machines in circa 1990 and circa 2005.

Table 2 shows the adoption of washing machines for Brazil, Mexico and the US. In circa 1990, 80% of households operated a washing machine in the U.S., but less than 40% and 30% of Brazilian and Mexican households, respectively, have one. The adoption of washing machines substantially increased during the period. From circa 1990 to circa 2005, the percentage of households with washing machines increased by 50% (from 24% to 36%) in Brazil and by 77% (from 36% to 64%) in Mexico.

[2]For the average LA country, differences in labor force participation explain more than 15% of ratio of GDP per capita between LA and the U.S. in 1990.

3 Barriers to Technology Adoption

In this section, I provide evidence on barriers to the adoption of new technologies at the household levels in a set of LA countries. I first show differences in the access to basic infrastructure across countries. In addition, I provide unique data on the evolution of the price of household appliances for these developing countries that present an interesting pattern which we can connect to the different observed figures regarding the adoption of new technologies by Latin American households. Finally, I provide data on average tariff levels before and after the reforms that took place at the beginning of the nineties which I argue could be one of the reasons behind the particular evolution of prices reflected in the data.

3.1 Infrastructure

In order to adopt the technology embodied in new appliances, the proper infrastructure needs to be available for the household: electricity and/or running water depending on the specific appliance. Table 3 shows the mean access to electricity for Brazil, Mexico and the US in circa 1990 and 2005. In the period analyzed, we see a notable increase in the access to this basic service in the case of Brazil (from 90% to 97%) and Mexico (from 91% to 99%) which I will argue has a non trivial effect on the increase in the labor force participation in these countries. The mean access to running water is depicted in Table 4. Again, Brazil and Mexico experienced a substantial expansion in the access to this basic service: the percentage of households with access to running water increased by 15.4% and 12.3% in Brazil and Mexico, respectively.

These figures refer to the mean access to these basic infrastructure services, but by exploring data on the access to infrastructure by income quintile we can obtain a better picture of the substantial changes in this margin experienced by the households of these countries. Table 5 presents the percentage of households with access to electricity *and* running water by income quintile in Brazil in circa 1990 and 2005. We can clearly see the high inequality in the access to infrastructure in 1990: while almost all the households at the top of the income distribution has access to these services, only 35% of the poorest households could use these infrastructure services. That means that for the majority of poor households, even in the case they could afford new durable goods they could not adopt the new households technologies due to the lack of access to the infrastructure needed to use them. The picture dramatically changed in 2005. As we observe in the third column of Table 5, by 2005 we observe much less inequality in the access to infrastructure providing the major improvements in the access to these services for poor households. The access rates increased by 41% and 94% for the households in last two income quintiles.

We observe the same pattern for Mexico. As Table 6 shows, in 1990 92% of households in the top income quintile had access to electricity and running water whereas only 47% of the households at the bottom had access to these basic services. Again, by 2005 we observe a more equal distribution in the access to infrastructure: access rates increased by 53% for the households in the bottom income quintile.

3.2 Price of Household Appliances

In order to explore the possible causes behind the different adoption pattern across countries observed in the labor participation data I look at the evolution of the relative price of household appliances for each of the countries analyzed. The idea is to use relative prices as indicators of distortions that vary across countries and time. There is a vast literature that focus on the differences in relative prices of investment goods to explain differences in investment rates of physical capital across countries observed in the data (see Restuccia and Urrutia (2001) among others). It is argued that these price differences reflect distortions to the accumulation of physical capital. However, it has been difficult to identify the origin of such distortions or the policies that could explain this disparity on prices levels of investment goods. The novelty here is that I focus on an specific type of investment goods (household appliances) and a particular channel through which they affect the labor supply of a particular country.

I uncover new data from national statistical agencies for some countries in the sample in order to observe the particular dynamics of the relative price of appliances. Figures 4 and 5 present the evolution of the relative price of household appliances for Brazil and Mexico, respectively. For the US case, the seminal work by GSY shows that the observed declining path of the price of household appliances is the main force that spurred the adoption of new durable goods by households which consequently explains the increase in the female LFP in the U.S. during the 20th century. Interestingly, in the case of LA countries the relative price of household appliances show an upward or constant trend until the end of the eighties to then start to decline at a very fast rate until the end of the period analyzed. This is shown in Figures 4 and 5. In the case of Brazil, the relative price declined 60% between 1990 and 2005, and in Mexico by 26% between these two periods. Also tote that the price of home appliances started to decline at the beginning of the 90's and this coincides with the increase in female LFP documented above as it is also depicted in the figures.

Why do we observe a different pattern in the evolution of prices in LA countries? The timing of the break in the trend of the price of household appliances in LA countries coincides with the the timing of the trade liberalization period which was characterized by the removal of trade policies that introduced distortions in the price of imported goods in the period I study. Among them, we have the import substitution policies applied until the beginning of the nineties. These policies sought to promote and develop a domestic manufacturing industry through the application of tariffs and para-tariff barriers on imported goods. To provide some evidence in this direction, Table 7 shows the average effective applied tariff rates in Brazil and Mexico in the period that preceded the reforms (circa 1990) and in the post reforms period (2005). By just looking at the average tariff levels in in circa 1990, we can notice that on average, Brazilian consumers had to pay an extra 43% when purchasing imported goods. In the case of Mexico, the average tariff rates are lower since the trade reforms were initiated earlier than in Brazil. Yet, in both countries, tariff rates were reduced between these two periods. In Brazil, average tariff rates decreased by 70%. This value is close to the observed reduction on the price of household appliances between the same two periods (60%). In Mexico, tariffs were reduced by 30% and the price of appliances declined 26%. The changes in tariff rates are similar for the case of manufactured goods, as it is also depicted in Table 7. There is some evidence that for the case of consumer durables the level of protection was even more aggressive as it is documented in Table 8 in Cole, Ohanian, Riascos, and Schmitz (2005). For instance, the average nominal tariff applied to durables was 266% in Argentina in 1960. In addition, it is well known that measures of tariff rates are just an approximate indicator of trade restrictions since they do not take into account para-tariff barriers (duties and custom fees) and quantitative restrictions. Other measures of trade restrictions in the pre-reforms and post reforms periods are documented in Loayza and Palacios (1997) which show a similar pattern of changes in trade restrictions.

This evidence suggest that the removal of these distortive policies may be the main reason behind the break in the pattern of relative prices observed in the figures and could potentially contribute to explain the rise in the adoption of appliances by LA households observed in the data. The link suggested by the presented facts about the adoption of modern household technologies, relative price of household appliances and its evolution (that may reflect distortions or barriers) and, access to infrastructure (which also operates as a barrier) are introduced in a home production model which is described in the next section.

4 The Model

A stationary description of the model environment is provided below.

4.1 Model Environment

Preferences, Endowments and Heterogeneity Time is discrete. The economy is populated by a continuum of individuals of measure one. A household of age-j belongs to the set $\mathcal{J} = 1, 2, ..., J$. There are J overlapping generations of households, each of them with an exogenous weight $\theta_j \in \mathcal{J}$ in the total population, with $\theta_1 + ... + \theta_J = 1$. Households are born with no assets and are heterogeneous in their ability levels (efficiency units of labor) denoted by h, which is realized at the beginning of their life. Ability is drawn from the distribution $\pi(h)$, and it is fixed over their life cycle.

The household is composed by a male and a female, each of them endowed with one unit of time. They also share the same ability level h. The male splits its time between market work and leisure, whereas the female can spend its time in market work, home work and leisure. It is assumed that labor is indivisible and the portion of time that is allocated to market work is fixed and given by ω. Males always supply labor to the market and their income is given by $w\omega h$, being w the wage rate. For females, in case they work in the market they obtain $\phi w \omega h$, where ϕ stands for the gender earnings gap. Households get utility from the consumption of market goods, home goods and leisure time.

The objective of a household is to maximize

$$\sum_{j=1}^{J} \beta^{j-1} \left[\lambda \ln c_m(j) + \nu \ln c_n(j) + (1 - \lambda - \nu) \ln l(j)\right],$$

where $c_m(j)$ is the consumption of market goods at age-j, $c_n(j)$ is the consumption of home goods at age-j, $l(j)$ is leisure at age-j. β is the discount factor, λ is the weight of market goods and ν is the weight of home goods.

Technologies The technology for producing home goods is given by

$$c_n = \min\{d, \zeta \times n\} \tag{7}$$

where c_n denotes the quantity of home goods produced and consumed in the household, d represents the durable good which is assumed to be lumpy, ζ is the level of the technology to produce home goods, and n is the home labor done by the female, which is indivisible.

There are two technologies available for the household to produce home goods. When households are born they are endowed with the *Old* technology, which we can interpret as the one used to produce hand made home goods. The *New* technology requires the purchase of a durable good at the exogenous price q. Once the household purchase the durable good it will operates the new technology for its entire life. In addition, in order to adopt the new technology, it is required for the household to have access to the basic infrastructure needed for that purpose. For instance running water and electricity are necessary in order to operate a washing machine. The access to infrastructure is given to the household when they are born and, it is introduced in the model as an exogenous variable $\gamma \in 0, 1$. If $\gamma = 1$ the household has access to infrastructure, and if $\gamma = 0$ it has no access to infrastructure.

There is a standard Cobb-Douglas technology that describes the production of market goods by competitive firms, and it is given by

$$y = zK^{\alpha}(L)^{1-\alpha}, \tag{8}$$

where y is total output, K is the aggregate stock of physical capital, L represents the labor input, z is the technology parameter and α is the share of physical capital in output.

Capital is accumulated according to

$$K' = (1-\chi)K + i, \tag{9}$$

where χ describes the depreciation rate and i the investment done by firms operating in competitive markets.

The resource constraint reads

$$y = c_m + i + qd. \tag{10}$$

4.2 Household Decision Problem

A recursive description of the household decision problem is presented below.

For and age-j household optimization consists of choosing the amount of assets to carry to the next period a' and two discrete choices: if the female participates in the market or stays at home and, if it purchases the durable good or not. Besides its age j, relevant to its decisions will be the assets it enters to the period, a; the efficiency units which it is endowed with, which together with the wage rate will determine both the income of the male and the female in case she works in the market; if it has adopted the new technology in the past or not and; if it has access to infrastructure, since absent the access to basic infrastructure the household can not adopt the new technology in any period. So, the state of a household is summarized by the vector $x = (a, h, \gamma, \tau, j)$. τ is the state variable describing the adoption of technologies by the age-j household. It takes the values $\{0, 1\}$, where $\tau = 0$ means that the household has adopted the new technology in the past and, $\tau = 1$ means that the household has not adopted the new technology in the past. a is the asset level, h is the ability level and γ describes the access to infrastructure for this household as it is described above.

Define the participation of the female in the market by the indicator function I_P which takes the value 1 if the household chooses that the female works in the market and 0 if she stays at home. In the same way, whether to continue operating the old technology (for which she is endowed with) or purchase the durable good at price q and operate the new technology be described by the indicator function I_A, that takes the value 1 if the household purchase the durable good and 0 if not. Let also define $V_\tau(a, h, \gamma, \tau, j)$ as the lifetime utility of age-j household.

First, consider the case of an age-j household that is born with access to infrastructure (i.e. $\gamma = 1$) and has adopted the new technology sometime in the past (i.e. $\tau = 0$). This household chooses the level of assets it is going to carry to the next period and if the female participates in the market or stays at home performing the household chores. Its budget constraint reads

$$c_m = w\omega h + (\phi w\omega h)I_P + ra - a' \tag{11}$$

The value function obeys the following recursion.

$$\begin{aligned} V(a, h, 1, 0, j) = \max_{a', I_P \in \{0,1\}} \Big[& \lambda \ln(w\omega h + (\phi w\omega h)I_P + ra - a') + \\ & \nu \ln(c_n) + (1 - \lambda - \nu)\ln(l) + \beta V(a', h, 1, 0, j+1) \Big], \end{aligned} \tag{12}$$

subject to

$$c_n = \min\{d, \zeta \times n\}. \tag{13}$$

Now consider the age-j household that is born with access to infrastructure (i.e. $\gamma =$

1) and has *not* adopted the new technology in the past (i.e. $\tau = 1$). This household chooses if it is going to purchase the durable good (adopt the new technology) in the current period or not, in addition to the assets level to carry to the next period and, if the female participates in the market or not. Its budget constraint is given by

$$c_m = w\omega h + (\phi w\omega h) I_P + ra - a' - qI_A. \tag{14}$$

Therefore its value function reads

$$\begin{aligned} V(a,h,1,1,j) = \max_{a', I_P \in \{0,1\}, I_A \in \{0,1\}} & \Big[\lambda \ln(w\omega h + (\phi w\omega h) I_P + ra - a' - qI_A) + \\ & \nu \ln(c_n) + (1-\lambda-\nu)\ln(l) + \\ & \beta[I_A V(a',h,1,0,j+1) + (1-I_A)V(a',h,1,1,j+1)]\Big], \end{aligned} \tag{15}$$

subject to

$$c_n = \min\{d, \zeta \times n\}. \tag{16}$$

Finally, we have the households that are born without access to infrastructure (i.e. $\gamma = 0$). It is assumed that the household needs to have access to infrastructure in order to operate modern technologies (i.e. electricity and running water to use a washing machine). Therefore, without access to infrastructure they can not purchase the durable good in their entire life. In this case we have that

$$I_A = 0 \quad \text{for} \quad j = 1, .., J. \tag{17}$$

Each period the household chooses its asset levels to carry to the next period and if the female works in the market or not. The value function reads as follows

$$\begin{aligned} V(a,h,0,1,j) = \max_{a', I_P \in \{0,1\}} & \Big[\lambda \ln(w\omega h + (\phi w\omega h) I_P + ra - a') + \\ & \nu \ln(c_n) + (1-\lambda-\nu)\ln(l) + \beta V(a',h,0,1,j+1)\Big], \end{aligned} \tag{18}$$

subject to

$$c_n = \min\{d, \zeta \times n\}. \tag{19}$$

Abusing notation somewhat, denote the optimal decision rules for assets by $a'(x)$, the female participation function $I_P(x)$ and, the adoption function $I_A(x)$.

Aggregates For aggregation purposes it necessary to specify the position of households across states.

Let $\psi_j(B,H;\gamma,\tau)$ be the mass of households, with asset position $a \in B$, efficiency units $h \in \mathcal{H}$, $j \in \mathcal{J}$, access to infrastructure γ and adoption state τ. The measure ψ is defined for all $B \in \mathcal{B}$ the class of Borel subsets of $\mathbb{R}$, all Borel subsets $H \subset \mathcal{H}$, all $j \in \mathcal{J}$, $\gamma \in \{0,1\}$ and $\tau \in \{0,1\}$. The dynamic evolution of the mass of households reads as follows.

The realization of γ determines the mass of newborns without access to infrastructure

$$\psi_1(B,H;0,1) = \theta_1 \int_{\mathbb{R}\times H} I_{\{\gamma=0\}} z(h)dh \quad if \quad 0 \in B.$$

Recall that the no access to infrastructure status stays constant for the entire lifetime which prevent these households to adopt the new technology. For $1 < j \leq J$, we need to consider the mass of households without access to infrastructure for which $a \neq 0$. That means,

$$\psi_{j+1}(B,H;0,1) = \theta_j \int_{\mathbb{R}\times H} I_{\left\{a'(a,0,1)\in B\right\}} d\psi_j(a,h;0,1).$$

Similarly, the mass of households with access to infrastructure

$$\psi_1(B,H;1,1) = \theta_1 \int_{\mathbb{R}\times H} I_{\{\gamma=1\}} z(h)dh \quad if \quad 0 \in B.$$

Notice that I am using the assumption that a newborn is endowed with the old technology and so has not adopted the technology in the past ($\tau = 1$).

Since all households die at J, we have that

$$\psi_{J+1}(B,H;\gamma,\tau) = 0.$$

For $1 < j \leq J$, ψ obeys the following recursion.

For the case of past adopters, i.e. $\tau = 0$,

$$\begin{aligned}\psi_{j+1}(B,H;1,0) =& \theta_j \int_{\mathbb{R}\times H} I_{\left\{a'(a,1,0,j)\in B\right\}} d\psi_j(a,h;1,0) + \\ & \theta_j \int_{\mathbb{R}\times H} I_{\left\{a'(a,1,1)\in B\right\}} I_A(a,1,1,j) d\psi_j(a,h;1,1).\end{aligned}$$

In words, the mass of past adopters in $j+1$ is equal to the mass of past adopters in j (first term on the right hand side) plus the mass of new adopters (second term on the right hand side).

In the same way, the mass of no adopters in $j+1$ is given by,

$$\psi_{j+1}(B, H; 1, 1) = \theta_j \int_{\mathbb{R}\times H} I_{\left\{a'(a,1,1,j)\in B\right\}} \Big(1 - I_A(a, 1, 1, j)\Big) \\ d\psi_j(a, h; 1, 1).$$

Now we have all the elements to provide an equilibrium definition.

Equilibrium In this economy, a stationary competitive equilibrium consists of value functions $V(x)$, decision rules $a'(x)$, $I_P(x)$, $I_A(x)$; aggregate variables K and L; a measure ψ, and a set of prices w, r and q, such that:

1. Optimal decision rules $a'(x)$, $I_P(x)$, $I_A(x)$ solve the households' dynamic problem given w, r and q and, $V(x)$ are the resulting value functions.

2. Factor prices are competitive:

$$w = (1-\alpha)z(L/K)^{-\alpha}$$

$$r' = \alpha z(L'/K')^{(1-\alpha)} + (1-\chi)$$

3. Labor and capital markets clear:

$$L = \sum_{j=1}^{J} \theta_j \omega \int_{\mathbb{R}\times H} h d\psi(x) + \phi\omega \sum_{j=1}^{J} \theta_j \int_{\mathbb{R}\times H} h I_P(x) d\psi(x),$$

and

$$K = \sum_{j=1}^{J} \theta_j \int_{\mathbb{R}\times H} a d\psi(x).$$

4. Measure of agents is generated as described above.

5 The Benchmark Economy

5.1 Specification of the Household Technology

In order to take the model to the data, following GSY, it proves convenient to parameterize the home production technology in the following way. Assume there are two types of technology, the *old* and the *new* one. If the household operates the old technology the amount of durable goods is given by

$$d = \delta, \tag{20}$$

and when it operates the new technology it is given by

$$d' = \overbrace{\kappa}^{>1} \delta > d. \tag{21}$$

Regarding the amount of labor, n, required to produce home goods with the old technology, assume that

$$n = \overbrace{\rho}^{>1} \eta, \tag{22}$$

and when it operates the new technology it is given by

$$n' = \eta < n. \tag{23}$$

Combining these four equations, we have that the productivity to produce home goods with the old technology is given by

$$\zeta = \frac{\delta}{(\rho\eta)}, \tag{24}$$

and when it operates the new technology it is given by

$$\zeta' = \frac{\kappa\delta}{\eta} = \kappa\rho\zeta > \zeta. \tag{25}$$

Given the Leontief specification for the production of home goods, this implies that the quantity of home goods produced with the old technology is

$$c_n = \min\{d, \zeta n\} = \delta, \tag{26}$$

and with the new technology

$$c_n' = \min\{d', \zeta' n'\} = \kappa\delta > c_n. \tag{27}$$

5.2 Parameterization

I calibrate the model to the US economy in 1990. The model period is 13 years with $J = 4$. The first three periods are working periods and the last one is a retirement period in which members of the household do not work. In the model, households start life at the age of 25 and retire at the age of 64 (which is consistent with the age of the workers in the data I aim to target), they die when they are 77 years old. The parameter that represents the technology in market production, z, is set to be 1. Regarding the weight of each generation in the total population, I use data on population by age from the International Data Base of the US Census Bureau. According to these data, I set $\theta_1 = 0.42, \theta_2 = 0.28, \theta_3 = 0.14, \theta_4 = 0.16$.

There are eight parameters, $\alpha, \chi, \omega, \eta, \rho, \kappa, \delta$; that I also take directly from data. The share of capital in market production, α, is set to 0.3. The depreciation rate, χ, is set to 10% which is the estimated depreciation rate of physical capital (without including durable goods) by the Bureau of Economic Analysis.

The remaining five parameters have to do with the production of home goods. ω is set to 0.36 by assuming that a market worker works in the market 40 hours a week of her 112 hours of non sleeping time. η and ρ set the allocation of time of female to perform household chores with and without household appliances. According to Lebergott (1993), using household appliances females spend on average 18 hours a week to produce home goods, that means, $\eta = 18/112 = 0.16$. However, when they did not have access to these durable goods they had to spend 58 hours a week, and so $\rho \times \eta = 58/112 = 0.52$ which means $\rho = 3.25$. κ and δ control the aggregate relative stock of appliances before and after the adoption of the durable goods. According to the data in NIPA, the stock of appliances when household adopt the new technologies is eight times the one observed when almost none household use these durable goods. Therefore, after fixing $\delta = 1$ we have that $\kappa = 8$.

For the efficiency units, I assume that h are distributed $log(h) \sim N(\mu_h, \sigma_h)$. I normalize the US distribution by setting $\mu_h = 0$. In the US, the proportion of households with access to to electricity *and* running water is close to 100%, so I set $\gamma = 1$ for all the households.

It remains to pin down values for $\phi, \sigma_h, \beta, \lambda, \nu, q$. These are picked together to match: i) the observed GINI index for household income, ii) female labor force participation, iii) the percentage of nondurable goods consumption over GDP (nondurables plus services), iii) the percentage of households with washing machines, iv) female earnings as a percentage of male earnings reported by the Bureau of Labor Statistics, and v) the capital to output ratio; all in 1990. The parameter values are the following: $\phi = 0.86$, $\lambda = 0.23$, $\nu = 0.2$, $q = 0.22$, $\beta = 0.96$ and $\sigma = 0.76$. The fit of the model to the targets is shown in detail in Table 8.

6 Model Mechanics: Steady State Effects

In this section, the model framework is explored by considering a hypothetical economy where the long-run consequences of changing the price of household appliances, average efficiency units of labor, the dispersion of efficiency units of labor, access to infrastructure and, total factor productivity are investigated. Highlighting the long-run effects and the role of the various forces at work, steady states for the aggregate economy are compared with the benchmark economy. In order to analyze the general equilibrium effects on the variables of interests, I perform the experiments for both the case where factor prices are fixed and for equilibrium factor prices.

The Effects of Changing the Average Level of Efficiency Units of Labor In the first experiment I only change the parameters that govern the distribution of efficiency units of labor. Specifically, I lower μ_h to -0.54 and raise σ_h to 0.97 such that the average efficiency units is this hypothetical economy is 70% of the one in the benchmark economy, but maintaining the variance of the efficiency units (the log-normal distribution) constant across these two economies. The experiment is aimed to analyze the effects of reducing the average income of households through the efficiency units channel. Since my study focuses on the population aged 25 and older, we could interpret this change in efficiency units of labor as changes in average human capital levels across different economies, an issue that will be addressed below. Table 9 summarizes the results. The percentage of households with durable goods goes down significantly, from 79% to 50%. As a result, female LFP declines, going from 69% to 50%. The results are similar in both the case of fixed prices and equilibrium prices. There is a cutoff level of efficiency units that divides the households between the ones for which is optimal to purchase the durable good and the ones for which it is not. The fact that we reduce the average efficiency units of labor in this economy and maintain the price of household appliances, prevent a large percentage of households to purchase the durable good or adopt the new technology (the poorer ones). As a result, less females are able to participate in the labor market. It is also interesting to note, that the fact that less females participate in the market, which are also the poorer ones in the income distribution, makes the economy more unequal. This is observed in the increase in the Gini for income, which goes from 0.43 to 0.55.

The Effects of Changing Income Inequality Now I consider an hypothetical economy with higher income inequality compared to the benchmark one. In order to perform this experiment, I change the parameters of the distribution of efficiency units of labor so that the log-normal distribution of my hypothetical economy has a higher variance than the benchmark economy but they share the same average level of efficiency units. Specifically, I set $\mu_h = -0.1$ and $\sigma_h = 0.88$. I present the results in Table 10. In this case the adoption levels slightly go down, from 79% to 74%. This change in the adoption level causes that less females participate in the market, their participation goes from 69% to 59%. The changes in the parameters of the distribution generates a higher variance in the efficiency units of labor. This generates both a larger mass of households in the lower efficiency unit levels and more high type households. In this experiment, the first force dominates and so we have a higher concentration of low ability households compared to the benchmark economy. Therefore, a smaller mass of households can adopt the new technology which cause that less females participate in the labor market. However, the changes as not as large as in the previous case in which the movement in the distribution of ability was more significant. As expected, income inequality raises as it is evident from the Gini Indexes in shown in Table 10. Finally, again we do not see much general equilibrium effects in driving the results as we can notice by comparing columns 2 and 3 of Table 10.

The Effect of Changes in the Price of Household Appliances In this experiment I consider an economy in which households face a higher relative price of household appliances which potentially prevent the adoption of new household technologies. For that purpose I raise q so that the price of appliances is 40% higher than in the benchmark economy. Table 11 shows the results of this experiment. As we increase the price of household appliances, we have a smaller mass of households for which it is optimal to adopt the new household technology. As a result, the proportion of households that adopt the new technology goes down (from 79% to 58%) and we have less females participating in the labor market (from 79% to 58%). Again, the fact that we have less females working in the market raises the income inequality. Note that in this case, the effect on female LFP is slightly different if we compare the fixed prices case and the equilibrium prices case.

The Effect of Changes in the Access to Infrastructure Now I move to consider the effect of access to basic infrastructure which as it was discussed above, could also operate as a barrier to the adoption of new technologies by households. Motivated by household surveys data, I set the proportion of households with access to infrastructure depending on their location in the income distribution. Specifically, as I will discussed below in my cross country analysis, I have access to data on access to electricity and running water by income quintile. Therefore, in my experiment, I set different proportion of households with access to infrastructure by income quintile. In this experiment, I consider the case where 50% of the households in the first income quintile have access to infrastructure, 70% of the households in the second income quintile, 82% of the households in the third, 85% of the households in the fourth and, 92% of the households in the last one. Table 12 shows the results. This experiment is the one that shows the major effects. Note that adoption is reduced by more than 60% (it goes from 79% to 30% in both cases). This dramatic change in the adoption of new technologies reflects the infrastructure restrictions that households face in this hypothetical economy. Since access infrastructure is a necessary condition to adopt the new technology, for instance, 50% of the households in the lower income quintile can not adopt the new technology and this affects the households decisions regarding the female participation. Note, that female LFP dramatically changes, going down from 69% to 20%. As a result, the Gini Index increases from 0.43 to 0.51.

The Effect of Total Factor Productivity Finally, I analyze the effect of changes in total factor productivity. In the model, it enters as a technology parameter, z, which was set to one for the benchmark economy. In this experiment I lower z to 0.8. The results are depicted in Table 13. By comparing column 2 and 3 of this table, we see that this is the case where the general equilibrium effects play a crucial role. Note that when prices are fixed we do not observe changes in both the adoption percentages and female LFP. However, in the case of having equilibrium factor prices, through changes in total factor productivity, the marginal product of labor is much lower than in the benchmark economy (the wage rate goes from 0.36 to 0.26). This lowers the labor income of households and, for the same price of the durable good, there are less households for which it is optimal to adopt the new technology (adoption goes from 0.79% to 0.58%). The change in the adoption lowers the female LFP which is also affected by the change in the wage rate since it makes the labor market less attractive for females.

7 Model Predictions for the US

I now compute the model's predictions for the US in 2005. The experiment consist in picking the price of durable goods in 2005 in the units of the model, i.e. q_{2005}, to reproduce the change in the relative price of household appliances we observe in the data between 1990 and 2005:

$$\frac{q_{2005}}{q_{1990}} = 1 + \pi$$

where π is the change in the relative price of durable goods we observe in the data and q_{1990} is the relative price of durable goods in 1990 in the model's units. Since I observe a drop of 33% the prices, I set $q_{2005} = 0.15$. In addition, I set $\phi = 1.17$ in order to match and observed gender earnings gap of 0.81 in 2005. Furthermore, since the Gini coefficient is higher in 2005, specifically 0.46, I raised σ to 0.93. Finally, since all households had access to electricity and running water both in 1990 and 2005, there no need to do changes in this margin. Table 14 presents the results. The first row contains the predicted and actual levels of female LFP and adoption of washing machines in 1990. Given that the price q_{1990} was chosen to match the adoption levels in the calibration exercise, the model does very well in matching the adoption data for that year. The same applies for the female LFP levels in 1990 since it was also targeted in the calibration of the US (the benchmark economy). However, both the adoption and the female LFP in 2005 are freely determined by the forces at work in the model. By looking at the second row of the table we can notice the good performance of the model for the case of the US: It perfectly predicts the adoption level and slightly overpredicts the female LFP. I consider this exercise as good test for the model which I will use for other countries in the sections that follow.

8 Model Predictions for Brazil

I first compute a steady state for Brazil in 1990. The experiment is done as follows. I first use data from the 1985 benchmark of the Penn World Tables to get the relative price of washing machines of Brazil relative to the US. According to the data I set q^{BRA}_{1990} such that $q^{BRA}_{1990}/q^{US}_{1990} = 0.8$, which gives $q^{BRA}_{1990} = 0.18$.

There is a set of parameters that are specific to Brazil. They are picked together to reproduce a set of moments but each of them is linked to a particular moment in the data. Regarding the distribution of abilities, I set $\sigma_h = 0.94$ to resemble a Gini coefficient of Brazil in 1990 of 0.59. In addition, I set $\mu_h = -0.73$ so that the mean of h in Brazil over the mean of h is 0.56 which corresponds to the ratio of average human capital levels between Brazil and the US in 1990 computed by using data on average years of education of people aged 25 and older and the Mincerian returns calculated in Hall and Jones (1999).

The population structure varies across countries. Specifically, there are relatively more young adults in developing countries. For these reasons, I set the weights of the four different age groups in Brazil such that 51% the population are of the first age group, 29% of the second, 12% of the third and 8% of the fourth group.

As it is clear in the data, access to infrastructure varies across countries. In addition, it varies within each of the developing countries according to the position of households in the income distribution. Recall that this is relevant in my computation providing that, by construction, households without access to basic infrastructure cannot purchase the durable good and so adopt the new technology. Therefore, when computing the steady state for Brazil in 1990, I assign to each household a $\gamma = 1$ or $\gamma = 0$ such that, in the steady state equilibrium, 35% of Brazilian households in the first income quintile have access to electricity *and* running water, 58% in the second income quintile, 73% in the third, 84% in the fourth and 97% in the fifth.

We also observe differences in the gender earning gaps across countries. This is an endogenous object in the model that depends on the type and percentage of females that participate in the market in equilibrium and the wage rate gap ϕ. For Brazil I change ϕ to match female earnings as a percentage of male earnings observed in the data, that is 0.65. Finally, according to the Penn World Tables data (version 6.2) the output per worker in international dollars in Brazil was 40% of the one in the US, I lower the technology parameter z to 0.75.

The second row of Table 15 depicts the levels of female LFP and adoption predicted by model and their data counterpart. The model does a really good job in explaining the level of female LFP which is the main object of the exercise: It accounts for 89% of the observed female LFP in 1990. Moreover, if we compare US and Brazil female LFP levels, the model accounts for 63% of the gap in female LFP between the US and Brazil in 1990. This suggests that the theory proposed is quantitatively important in accounting for observed differences in female labor supply between these two countries. However, by exploring the adoption levels in Table 15, we see that the model falls quite short in in accounting for the levels of adoption of durable goods. This is not surprising considering that the adoption levels in the data are just for washing machines and the model refers to a composite durable good. Still the model qualitatively succeeds in predicting a much lower adoption rate in Brazil compared to the US, as we observe in the data.

I now compute a steady state for Brazil in 2005. As in the case of the US experiment, I set the relative price of durable goods, q^{BRA}_{2005}, to be consistent with the decline of 60% in this price observed in the data between 1990 and 2005. Specifically, I set $q_{2005} = 0.07$. In addition, according to the data, in 2005 the relative earnings of females with respect to males is 0.86, so I set ϕ_{2005} accordingly. I also raise $\mu_h = -0.53$ so that the relative human capital level (computed as before) of Brazil with respect to the US in 2005 is 0.63, higher than its level in 1990. Furthermore, I set $\sigma = 1.15$ to resemble a lower Gini coefficient for income in 2005, that is 0.54.

Additionally, I assign to each household a $\gamma = 1$ or $\gamma = 0$ such that in the steady state equilibrium 68% of Brazilian households in the first income quintile have access to electricity *and* running water (the access level was 35% in 1990), 82% in the second income quintile (it was 58% in 1990), 89% in the third (it was 73% in 1990), 96% in the fourth (it was 84% in 1990)and, 99% in the fifth (it was 97% in 1990). For Brazil I set $\phi = 1.26$ to match female earnings as a percentage of male earnings observed in the data, that is 0.65. Finally, I lower the technology parameter z to 0.55 providing that GDP per worker in Brazil was 25% of the US one in that year.

The third row of Table 15 shows the female LFP and adoption levels that the model predicts and their data counterpart in 2005. The model accounts for 82% of the observed female LFP level in this year. Moreover, the model accounts for 78% of the observed differences in female LFP between Brazil and the US. As in the case of the 1990 steady state, the model is not as successful in predicting the adoption levels but the same caveats apply here since we are comparing the model predictions with just the adoption of washing machines. However, it does a really good job in predicting an increase in the number of households that use the new technologies embedded in the durable goods as we observe in the data for the case of washing machines. [3]

Another important dimension to evaluate the theory at work is to compare the predicted and observed change in female LFP for each country. This is shown in Table 16 for the case of Brazil. According to the data female LFP rose by 74% between these two periods and the model predicts an increase of 59%, that means, the model accounts for 91% of the observed change in female LFP. The model succeeds in this dimension which I interpret to be the most important of the experiment. The results suggest that the economic forces incorporated in the theory proposed are quantitatively important in

[3]As another approximation for the adoption of new technologies we can also look at available data on the the percentage of households with refrigerators. According to these data, from 1990 to 2005 the percentage of households with refrigerators in Brazil increased by 24%.

accounting for observed changes in female labor participation observed in this country.

9 Model Predictions for Mexico

I now the take the model to the Mexican data. I first compute a steady state for 1990. As before, I use data from the 1985 benchmark of the Penn World Tables v.6.2 to get the relative price of washing machines of Mexico relative to the US. Therefore, I pick q_{1990}^{MEX} such that $q_{1990}^{MEX}/q_{1990}^{US} = 0.94$, which gives $q_{1990}^{MEX} = 0.21$.

Again, there is a set of parameters that are specific to Mexico. I set $\sigma_h = 0.76$ to resemble a Gini coefficient of Mexico in 1990 of 0.49. In addition, I set $\mu_h = -0.43$ so that the average human capital level of Mexico is 65% of the one computed for the US in 1990.

The population structure of Mexico is similar to the one observed in Brazil and so I set the weights of the four different age groups such that 52% the population are of the first age group, 28% of the second, 11% of the third and 8% of the fourth group.

Regarding the access to infrastructure in Mexico, when computing the steady state, I assign to each household a $\gamma = 1$ or $\gamma = 0$ such that, in equilibrium, 47% of Mexican households in the first income quintile have access to electricity *and* running water, 64% in the second income quintile, 78% in the third, 86% in the fourth and 92% in the fifth.

I also pick ϕ to match female earnings as a percentage of male earnings observed in the Mexican data, that is 0.73. Finally, according to the Penn World Tables data (version 6.2) the output per worker in international dollars in Mexico was 50% of the one in the US, I lower the technology parameter z to 0.76.

In addition, I compute another steady state for Mexico but now in 2005. As before, I set the relative price of durable goods, q_{2005}^{MEX}, to be consistent with the decline of 26% in this price observed in the data between 1990 and 2005. Specifically, I set $q_{2005}^{MEX} = 0.15$. In addition, according to the data, in 2005 the relative earnings of females with respect to males is slightly higher, 0.77, so I change ϕ accordingly. I also raise $\mu_h = -0.29$ to reflect a narrower gap in human capital levels between Mexico and the US: the human capital level of Mexico in 2005 is 74% of the calculated for the US in the same year. Furthermore, I set $\sigma = 0.8$ to resemble a Gini coefficient for income in 2005 of 0.49.

Additionally, in order to reflect the improvements in access to infrastructure observed in the data, I now assign to each household a $\gamma = 1$ or $\gamma = 0$ such that in the steady state equilibrium 72% of Mexican households in the first income quintile have access to electricity *and* running water (the access level was 47% in 1990), 86% in the second income quintile (it was 64% in 1990), 92% in the third (it was 78% in 1990), 96% in the fourth (it was 86% in 1990)and, 98% in the fifth (it was 92% in 1990). Finally, I lower the technology parameter z to 0.66 providing that GDP per worker Mexico was 35% of the US one in that year (as in the case of Brazil, Mexico got poorer relative to the US between 1990 and 1005).

Table 17 shows the adoption levels in Mexico in the model versus the data. It accounts for 86% and 74% of the adoption levels observed in the data in 1990 and 2005 respectively. However, the same caveats apply for the Mexican case: Even though the model does a much better job than in the Brazilian case, the adoption levels in the data only refers to the adoption of washing machines. Still, as the data shows, the model qualitatively succeeds in three important dimensions: i) it predicts lower adoption rate compared to US, ii) an adoption rate that is higher than Brazil and, iii) an increase in the adoption rate between 1990 and 2005 (it accounts for 67% of the observed increase in the adoption rate).

Table 17 depicts the levels of female LFP and adoption predicted by model and their data counterpart. Contrary to the Brazilian case, the model overpredicts the levels of female LFP in both 1990 and 2005: by 48% in 1990 and by 31% in 2005. Apparently, for the case of Mexico, there are variables that were not incorporated in this simple model that makes it fail to reproduce the observed levels of female LFP. Compared to the US, even though the model predicts a narrower gap in female LFP between Mexico and the US compared to the data (this is a direct consequence of overpredicting the levels for Mexico), qualitatively it still does a good job since it predicts a lower female LFP for Mexico as we observe in the data. More importantly, by looking at Table 18 we see that the exogenous variables incorporated in the model account for 50% of the observed changes in female LFP in this country. This suggests that the theory proposed is quantitatively important in accounting for observed changes in female LFP in this country.

10 The Importance of Access to Infrastructure and Distortions

In this section I perform a counterfactual experiment in which I shut down the observed increase in the access to infrastructure and the change in the price of appliances between 1990 and 2005. Here, "shutting down" means keeping them at their 1990 levels. Since these two variables are potentially linked and this correlation is not modeled here I take this two factors together. The experiment is used to assess the impact of these two factors in generating the observed increase in female LFP in Brazil and Mexico. Specifically, I solve the model for both Brazil and Mexico in 2005 but setting the access to infrastructure and the relative price of household appliances in their 1990 levels.

Table 19 shows the results. According to the model, in this counterfactual case where household maintain the 1990 levels of access to electricity and running water and where the price of appliances were kept at their 1990 levels, the model accounts for just 4% and 7% of the observed increase in female LFP in Brazil and Mexico respectively. According to these results, access to infrastructure and the reduction in the price of household appliances are the main forces behind the observed increase in female LFP in these countries.

11 Conclusions

I document that differences in the access to basic infrastructure and relative price of household appliances are quantitatively important in accounting for differences in female LFP between a set of LA countries and the US. In addition, because total factor productivity (and the wage level) and human capital levels are lower in developing countries, households purchase fewer time saving household durable goods that prevent females to participate in the market. I support the theory uncovering new disaggregated data based on household surveys for a set of LA countries, and with a model of home production with endogenous female LFP. One important implication of this study is that distortive policies that affect household production, like trade restrictions (applied in these countries until the beginning of the nineties), may have very undesirable effects in the labor supply. Moreover, by analyzing the interplay between the access to basic infrastructure and labor force participation, this study provides new insights regarding the returns to infrastructure investments, which will be the object of future research.

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Data Appendix

Labor Force Participation

The data on labor force participation comes from the 5th edition of Key Indicators of the Labor Markets database issued by the International Labor Organization (ILO). The labor force participation rate is calculated by expressing the number of employed and unemployed persons in the labor force as a percentage of the population of age between 25 and 64. Both formal and informal sector participants are taken into account.

($http://www.ilo.org/empelm/what/lang--en/WCMS_1$14240)

Gender Earnings Gap

The gender earnings gap is calculated as the average income of employed women as a percentage of the average income of employed men, in urban areas. The data is provided by the Economic Commission for Latin American and the Caribbean (ECLAC) and it was prepared based on household surveys of each country.

(http://websie.eclac.cl/sisgen/ConsultaIntegrada.asp?idAplicacion=11&idTema =194&idIndicador=1140)

Relative Price of Household Appliances

For the pre-reforms period (circa 1990) I use the 1985 benchmark data of the PWT which presents data across counties of the price of washing machines and the aggregate consumption in international dollars. For each country I compute the relative price of washing machines and then I divide that ratio by the relative price computed for the US. *(http://pwt.econ.upenn.edu/Downloads/benchmark /benchmark.html)*

The time series for the relative price of household appliances for each country is calculated by dividing the price index of household appliances over the general price index. In the case of the U.S. the data is obtained from Bureau of Labor Statistics (BLS) and the specific category used to represent the price of household appliances is called Major Appliances (Series ID: WPU 1241), which is a subcategory of the group called Furniture and Household Durables. The general price index is obtained from the same source (Series ID: WPU 00000000).

For Brazil and Mexico, I use the general price index and the price index of Furniture, Appliances and household accessories. The source for Mexico is the Bank of Mexico *(http://dgcnesyp.inegi.org.mx/cgi-win/bdieintsi.exe/NIVL1000100020001 00020#ARBOL)*. For Brazil I obtained the data on wholesale price indexes from the Fundacao Getulio Vargas *(http://portalibre.fgv.br/main.jsp?lumChannelId=402880811D8E34B 9011D92B6F9D30FAE)*.

Population

The data on the population structure of each country was obtained from the International Data Base (IDB) of the Census Bureau.

(http://www.census.gov/ipc/www/idb/country.php)

Washing Machines, Electricity and Running Water in LA Households, Household income Gini Indexes

For Latin American countries, the data for these categories were obtained from Socio-Economic Database for Latin America and the Caribbean (CEDLAS and The World Bank). This database site includes statistics on social and economic variables of Latin American and Caribbean countries. All statistics are computed from microdata of the main household surveys in these countries.

(http://www.depeco.econo.unlp.edu.ar/sedlac/eng/index.php)

In the case of the US, the data on household appliances is obtained from the Appliance Reports of the Energy Information Administration.

(http://www.eia.doe.gov/emeu/reps/appli/contents.html)

Human capital levels

Human capital measures are calculated by using the average years of education of people aged 25 to 65 from CEDLAS and The World Bank data and, by using Mincerian returns to schooling computed in Hall and Jones (1999).

Tariff rates

The data on average tariff rates was obtained from the World Development Indicators Database. It refer to the simple mean of effectively applied rates for all products subject to tariffs calculated for all traded goods and for manufactured traded goods.

http://databank.worldbank.org/ddp/home.do?Step=12&id=4&CNO=2

GDP per capita

Data on GDP per worker used in my calculations are from Penn World Table v. 6.2.
$http : //pwt.econ.upenn.edu/php_site/pwt62/pwt62_form.php$

Tables

Table 1: Female LFP levels (%)

	1990	2005
Brazil	39	66
Mexico	37	48
United States	69	72

Note: This table presents the female labor force participation rates for Brazil, Mexico and the US in 1990 and 2005.

Table 2: Households with Washing Machines (%)

	circa 1990	2005
Brazil	24	36
Mexico	36	64
United States	80	90

Note: This table presents data on the percentage of households with washing machines in Brazil, Mexico and the US in the periods circa 1990 and 2005.

Table 3: Households with access to Electricity

	circa 1990	2005
Brazil	90	97
Mexico	91	99
United States	100	100

Note: This table presents data on the percentage of households with access to electricity in Brazil, Mexico and the US in the periods circa 1990 and 2005.

Table 4: Households with access to Running Water

	circa 1990	2005
Brazil	78	90
Mexico	81	91
United States	100	100

Note: This table presents data on the percentage of households with access to running water in Brazil, Mexico and the US in the periods circa 1990 and 2005.

Table 5: Brazil: Access to Infrastructure by Income Quintile

	circa 1990	2005	%Change
Top	97	99	2.1
Second	84	96	14.3
Third	73	89	21.9
Fourth	58	82	41.4
Bottom	35	68	94.3

Note: This table presents data on the percentage of households with access to both electricity and running water by income quintile in Brazil in the periods circa 1990 and 2005. *Top* refers to the top income quintile, *Second* to the second income quintile and so forth.

Table 6: Mexico: Access to Infrastructure by Income Quintile

	circa 1990	2005	%Change
Top	92	98	6.5
Second	86	96	11.2
Third	78	92	17.9
Fourth	64	86	34.4
Bottom	47	72	53.2

Note: This table presents data on the percentage of households with access to both electricity and running water by income quintile in Mexico in the periods circa 1990 and 2005. *Top* refers to the top income quintile, *Second* to the second income quintile and so forth.

Table 7: Average Tariff Levels (%)

	All Products		Manufactured Products	
	circa 1990	2005	circa 1990	2005
Brazil	43	12	44	13
Mexico	14	9	14	9

Note: This table presents data on average applied tariffs rates in Brazil and Mexico for all products and manufactured products.

Table 8: Calibration - Targets

Target	Model	Data	Source
Female Participation in 1990	69%	69%	ILO
Non-durables Consumption/GDP	0.43	0.56	NIPA
Adoption of Washing Machines in 1990	79%	80%	Household Survey
Access to Electricity and Water in 1990	100%	100%	Household Survey
Capital-to-output ratio	2.8	2.8	NIPA
Gini income	0.43	0.43	BLS
Female Earnings/Male Earnings	0.73	0.73	BLS

Note: This table presents the results of the calibration exercise when the model is calibrated to the US in 1990. It describes the targets in the data and their values computed by suing the model. It briefly shows the data sources for the targets.

Table 9: Model Mechanics: Average Efficiency Units

	Benchmark	Fixed Prices	Equilibrium Prices
Adoption	79	50	49
Female LFP	69	49	49
Gini Income	0.43	0.55	0.55
Output	100	72	72

Note: This table presents the results of the first experiment done to explore the model mechanics: an exogenous change in the average efficiency units of households labor. It presents the value of the variables of interest for the benchmark economy (second column), resulting from the experiment when factor prices are fixed (third column) and resulting from the experiment with equilibrium factor prices (fourth column). The units for Adoption and Female LFP are percentage points. The value of output is normalized to 100 in the benchmark economy.

Table 10: Model Mechanics: Income Inequality

	Benchmark	Fixed Prices	Equilibrium Prices
Adoption	79	74	74
Female LFP	69	59	59
Gini Income	0.43	0.49	0.49
Output	100	94	94

Note: This table presents the results of the second experiment done to explore the model mechanics: an exogenous change in household income inequality. It presents the value of the variables of interest for the benchmark economy (second column), resulting from the experiment when factor prices are fixed (third column) and resulting from the experiment with equilibrium factor prices (fourth column). The units for Adoption and Female LFP are percentage points. The value of output is normalized to 100 in the benchmark economy.

Table 11: Model Mechanics: Higher Price of Household Appliances

	Benchmark	Fixed Prices	Equilibrium Prices
Adoption	79	58	58
Female LFP	69	54	52
Gini Income	0.43	0.48	0.47
Output	100	94	94

Note: This table presents the results of the third experiment done to explore the model mechanics: an exogenous change in the relative price of household appliances. It presents the value of the variables of interest for the benchmark economy (second column), resulting from the experiment when factor prices are fixed (third column) and resulting from the experiment with equilibrium factor prices (fourth column). The units for Adoption and Female LFP are percentage points. The value of output is normalized to 100 in the benchmark economy.

Table 12: Model Mechanics: Less Access to Basic Infrastructure

	Benchmark	Fixed Prices	Equilibrium Prices
Adoption	79	30	30
Female LFP	69	22	20
Gini Income	0.43	0.50	0.51
Output	100	89	94

Note: This table presents the results of the fourth experiment done to explore the model mechanics: an exogenous change in the access to basic infrastructure. It presents the value of the variables of interest for the benchmark economy (second column), resulting from the experiment when factor prices are fixed (third column) and resulting from the experiment with equilibrium factor prices (fourth column). The units for Adoption and Female LFP are percentage points. The value of output is normalized to 100 in the benchmark economy.

Table 13: Model Mechanics: Total Factor Productivity

	Benchmark	Fixed Prices	Equilibrium Prices
Adoption	79	79	58
Female LFP	69	69	54
Gini Income	0.43	0.43	0.48
Output	100	83	72

Note: This table presents the results of the fifth experiment done to explore the model mechanics: an exogenous change in total factor productivity. It presents the value of the variables of interest for the benchmark economy (second column), resulting from the experiment when factor prices are fixed (third column) and resulting from the experiment with equilibrium factor prices (fourth column). The units for Adoption and Female LFP are percentage points. The value of output is normalized to 100 in the benchmark economy.

Table 14: Model Predictions US

	Female LFP (%)		Adoption (%)	
	Data	Model	Data	Model
1990	69	69	80	80
2005	72	75	90	90

Note: This table presents the predictions of the model for the US. It presents the predicted and actual values of female labor force participation (second and third column) and adoption rates (fourth and fifth column).

Table 15: Model Predictions Brazil

	Female LFP (%)		Adoption (%)	
	Data	Model	Data	Model
1990	38	34	24	9
2005	66	54	36	42

Note: This table presents the predictions of the model for Brazil. It presents the predicted and actual values of female labor force participation (second and third column) and adoption rates (fourth and fifth column).

Table 16: Brazil: Female LFP 1990 versus 2005

	Data	Model
Brazil 1990	100	100
Brazil 2005	174	159

Note: This table presents the change in female labor force participation observed in the data and the change predicted by the model for Brazil between 1990 (=100) and 2005.

Table 17: Model Predictions Mexico

	Female LFP (%)		Adoption (%)	
	Data	Model	Data	Model
1990	37	55	36	31
2005	48	63	64	47

Note: This table presents the predictions of the model for Mexico. It presents the predicted and actual values of female labor force participation (second and third column) and adoption rates (fourth and fifth column).

Table 18: Mexico: Female LFP 1990 versus 2005

	Data	Model
Mexico 1990	100	100
Mexico 2005	130	115

Note: This table presents the change in female labor force participation observed in the data and the change predicted by the model for Mexico between 1990 (=100) and 2005.

Table 19: The Importance of Infrastructure and Price of Appliances

Female LFP (1990=100)

	Data	Model Prediction	Counterfactual	Contribution
Brazil	174	159	103	4%
Mexico	130	115	102	7%

Note: This table presents the change in female LFP in Brazil and Mexico between 1990 and 2005 observed in the data (column 2), the model predictions in the baseline case (column 3) and in the counterfactual experiment (column 4). Column 5 shows the contribution of the model in the counterfactual experiment in explaining the data.

Figures

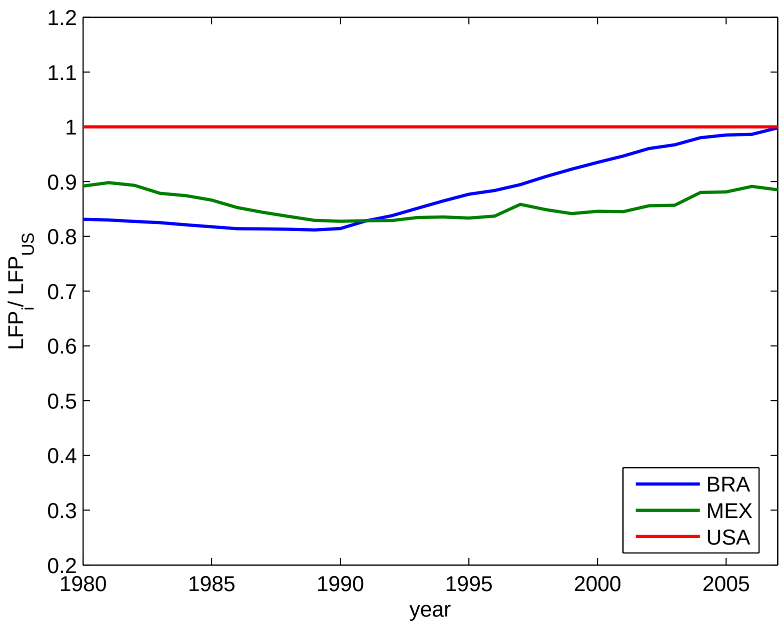

Figure 1: Labor Force Participation relative to the U.S.

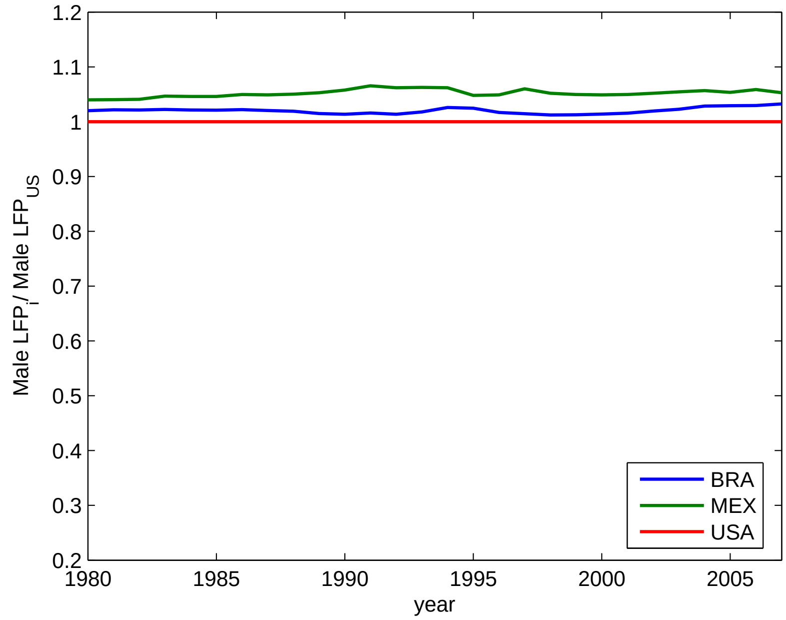

Figure 2: Male Labor Force Participation Relative to the U.S.

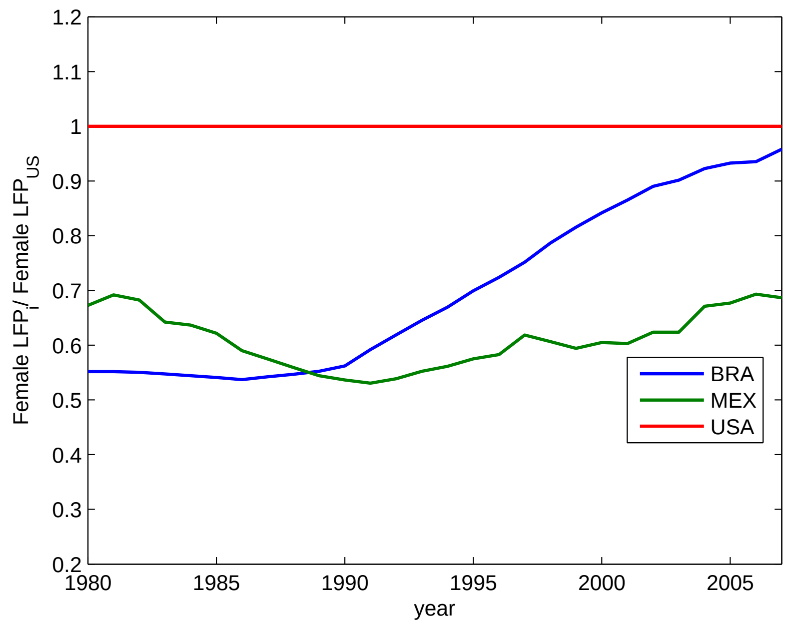

Figure 3: Female Labor Force Participation Relative to the U.S.

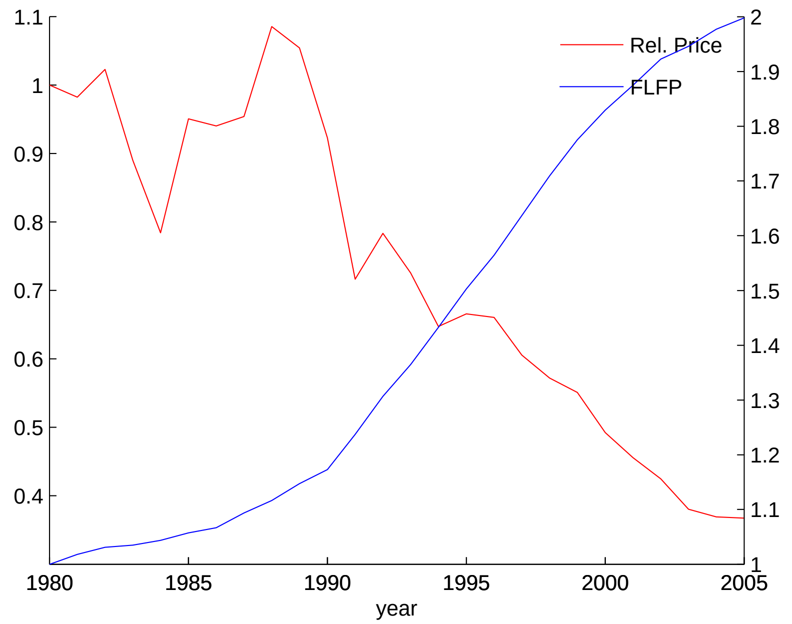

Figure 4: Relative Price of Appliances and Female LFP in Brazil

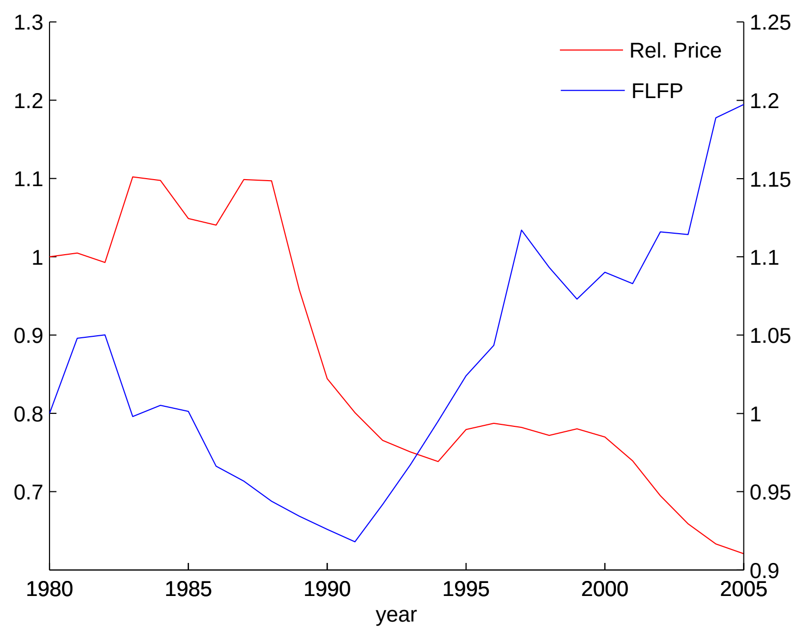

Figure 5: Relative Price of Appliances and Female LFP in Mexico