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Maids and School Teachers: Low Skill Migration and High Skill Labor Supply.

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Abstract

Over the last 40 years the pattern of migration has changed significantly with an increase in the share of female migrants, and especially low skill female migrants. These low skilled women migrants often work in the domestic service sector, a close substitute for household work.

This paper analyzes how low skill rural-urban migration in Brazil from 1986 to 2000 led to an increase in the labor supply of high skill women living in urban areas. In our model we show how large inflows of low skill women migrants decrease the relative price of domestic services. The largest beneficiaries of this trend are high skill women, who respond to the decrease in the cost of domestic services by joining the labor force and working more hours. We use Census data from Brazil from 1991 and 2000 to test this hypothesis. Using weather shocks in rural areas, and historical patterns of migrations, we are able to build an exogenous migration shock by skill to cities. Using this as an instrument for the price of domestic services and local wages we find that a 10% decrease in the wage of domestic workers increases the labor participation of high skill women by 3%.

Keywords: Gender; Labor Supply; Migration; Rural Urban Migration; Skill Complementary.

JEL Classification Numbers: J16, O15, O18.

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1 Introduction

Over the past 40 years there were significant changes in migration patterns all over the world. For instance, according to MPI [2009] the percentage of legal immigrants in the U.S. who were female increased from 50% in 1986 to 55% in 2000. The pattern is even more striking in other countries, such as Sri Lanka, where as many as 79% of out-migrants were women in 1996 (Oishi [2005]). We observe the same trend at the internal level. In Brazil, the percentage of female rural urban migrants increased from 44% in 1960 to 56% in 1995 (Camarano and Abramovay [1997]).

During the same time the labor participation of women has increased in most countries. For instance, in the U.S. the labor participation of women increased from 37% in 1960 to 60% in 2000 (BLS [2009]). The same is true for Brazil, where the labor participation of women has increased from 40% in 1982 to 52% in 1997 (Scorzafave and Menezes-Filho [2001]).

In this paper we show the relation between these two trends. We focus on cross-skill complementarities in the labor market. As pointed out by Vernez [1999] for the U.S., and Oishi [2005] for Singapore and Hong Kong, a large proportion of female migrants end up working in the domestic sector at their destinations. The associated decrease in the costs of domestic production allowed high skilled women to join the labor market. We find the same pattern in Brazil. Cities that receive more low skill women, have a lower (median) hourly wage of maids, which in turn leads to a higher participation rate of high skilled women.

The existing international migration literature has focused on wages. Borjas [2003], Borjas [2006], Ottaviano and Peri [2008] for instance, use data from the U.S. census from 1960 to 2000 and find little or no effect of migration on native wages.

By contrast, Khananuskul [2004], Kremer and Watt [2005] and Cortes and Tessada [2007] attempt to determine how migration affects the cost of domestic services. They control for the endogeneity of migration by using historical patterns of migration, region and time dummies. However, a large enough city or region specific demand shock can still increase the demand for migrants, biasing estimates. Furthermore, none of these papers try to separate the effect of migration on own wages

from the effect of migration on the cost of domestic production. By not controlling for wages, and the impact of migration on wages, their estimates, at best, reflect changes in the relative wage. Therefore it is impossible to attribute the observed pattern to a decrease in the cost of domestic services.

We start by developing a simple general equilibrium model of hours worked and wages, for men and women, both high and low skilled. In it, we show how the gender composition of the migration flow will affect the relative prices of domestic services. In particular, when most migrants are low skilled women there is a larger decrease in the relative price of domestic services, as women are more effective at producing domestic goods at home and so have a lower demand for domestic goods produced in the market. Local high skill women benefit by increasing their labor supply.

We test the hypothesis that migration leads to lower price of domestic services, using data on rural-urban migration in Brazil. In our empirical section we use Census data from 1970 to 2000 to determine how the increased feminization of rural-urban migration affected maids wages and the labor supply of urban high skilled women. The major obstacle is the endogeneity of rural-urban migration flows ¹. In order to isolate the impact of migration on (median) maids' hourly wages, we use weather shocks at the origin and changes in transportation costs (reflecting improvements in the transportation network) combined with historical patterns of migration to construct an exogenous migration shock to cities. We estimate labor supply equation for each gender and skill group, instrumenting for wages and the cost of domestic services (proxied by median hourly wage of maids) with migration shocks from rural areas.

The results from our regressions are in line with the predictions of the model. We find that the migration of low skilled women to cities leads to a decrease in maids' wages. When controlling for the impact of migration on wages, we find that lower maids' wages lead to higher labor supply of high skill women, and has no effect on the supply of high skill men.

Our results have important implications for the international migration literature. Katz and Murphy [1992], Card [2001], Borjas [2003], Borjas [2006], Peri [2007] and Ottaviano and Peri [2008], in their

¹Migration can be driven by push factors, such as changes in living conditions in rural areas, and pull factors, such as industrial shocks in urban areas.

analysis of the impact of migration on wages, all assume that local labor supply is constant. This implies that when these papers simulate the effect of migration on high and low skill wages, they are inflating the effect of migration on the high to low skill wage gap.

The fact that men and women have a different impact on the local population also has policy implications. In particular, countries may want to consider granting low skilled women temporary work permits, in order to increase the labor participation of high skilled population. As pointed out by Oishi [2005], this was the case of Hong Kong and Singapore in the 1990's. These countries had a liberal migration policy for female household workers, in particular from the Philippines, with the purpose of increasing the labor participation of local high skilled women without setting up a system of daycares.

The paper is organized as follows. In section 2 we look at the theoretical framework and show how low skill female migration may lead to an increase in labor supply. In section 3 we introduce the data, and look at the peculiarities of Brazilian Census. In section 4 we present our regression results. In section 5 we conduct some robustness checks and in section 6 we conclude.

2 Theoretical Model

In this section we expand the models of Cortes and Tessada [2007] and Kremer and Watt [2005] and those of Card [2001], Borjas [2006], Card [2007] and Peri [2007], into a general equilibrium model of wages, cost of domestic production and labor supply.

The intuition behind the model is that men and women are different in their productivity of domestic goods, leading to different demands for market goods. Therefore the migration of low skill women leads to a decrease in the relative price of domestic goods, as they can efficiently provide domestic goods at home. The decrease of the price of domestic services, reduces the cost of joining the labor market for local high skill women (those more likely to earn enough money to pay for the services of domestic workers).

As pointed out by Borjas [2006] and Ottaviano and Peri [2008] both the total number of workers

(extensive margin) and the number of hours worked (intensive margin) can be affected by migration. More importantly, migration can increase the number of workers at the cost of the average number of hours worked. While in our theoretical model we focus on the the number of hours worked, it is trivial to expand this model to focus on labor participation decisions. However the advantages of the additional complexity of having corner solutions in a model without a closed form solution are not clear. Since in the data we cannot measure hours worked correctly (we don't have work history), in our empirical section we will focus on labor participation.

Consider a model with three goods and four types of consumers (or workers): Men and Women (indexed by $j \in \{M, W\}$); High and Low Skill (indexed by $i \in \{H, L\}$). The difference between men and women lies solely on their wage elasticity of labor supply ², while the difference between high and low skill lies in its relative scarcity (fewer high skill people) and their higher efficiency in the production of market goods. First we analyze the consumer's problem, followed by the producer's problem and finally the market clearing conditions.

2.1 Consumer's Problem

Our formulation of the consumer problem is similar to Cortes and Tessada [2007], though we assume a specific functional form in order to obtain a computable general equilibrium solution. Each type of consumer has preferences over three goods: two market goods (x_{1ij} and x_{2ij}), and a home produced good ($f(h_{ij})$). One of the market goods (x_{2ij}) is a closer substitute to the home produced good than the other. In particular, consider the following utility function:

$$U_{ij} = x_{1ij}^\alpha \left[c x_{2ij}^\beta + (1 - c) (f(h_{ij}))^\beta \right]^{\frac{\alpha}{\beta}} \quad (1)$$

Where $\alpha \in (0, 1)$ is the elasticity of substitution between a general market produced good x_{1ij} and a second set of household goods, which we can think of as household care, like taking care of children, cleaning or cooking, which can be either produced at home, $f(h_{ij})$, or can be bought in the market

²And we achieve this by having men and women have different efficiency in producing the domestic goods at home, as suggested by Killingsworth and Heckman [1995].

place, x_{2ij} . The elasticity of substitution between x_{2ij} and $f(h_{ij})$ is related to $\beta \in (-\infty, 1)$. Also, $c \in (0, 1)$ measures the relative importance of having a good produced at home versus goods bought in the market. We assume the production function of home goods is given by: $f(h_{ij}) = a_j h_{ij}^{b_j}$, where $a_j > 0$, $b_j > 0$ ³, and $h_{ij} \in (0, 1)$ is time spent producing the home good. As pointed out by Killingsworth and Heckman [1995] in order for women's wage elasticity to be larger than men's, we need to assume that women are more efficient in the production of household goods, that is we will assume that $a_W > a_M$ and that $b_W > b_M$. The remaining time can be used to work for a wage, w_{ij} (total time is normalized to 1). Consumers spend their income between the two market goods (x_{1ij} and x_{2ij}). The budget constraint is then:

$$x_{1ij} + px_{2ij} = w_{ij}(1 - h_{ij}) \quad (2)$$

Where p is the price of good 2 relative to good 1. The consumer problem is then:

$$\begin{aligned} \max U_{ij} &= x_{1ij}^\alpha \left[cx_{2ij}^\beta + (1 - c) \left(a_i h_{ij}^{b_i} \right)^\beta \right]^{\frac{1-\alpha}{\beta}} \\ \text{s.t. } x_{1ij} + px_{2ij} &= w_{ij}(1 - h_{ij}) \\ h_{ij} &\in (0, 1) \\ x_{1ij} &> 0 \\ x_{2ij} &> 0 \end{aligned} \quad (3)$$

The consumer maximization problem will give us the amount of goods (x_1 and x_2), and the amount of house production good (h), for each consumer's type (high and low skill; men and women) as a function of wage and price of good 2 relative to good 1 ($x_{1ij}^*(w_{ij}, p)$, $x_{2ij}^*(w_{ij}, p)$, and $h_{ij}^*(w_{ij}, p)$).

As you can see from the Appendix, there are no close solutions to this problem, and we have no

³Notice that we don't assume that the production function of home goods is concave. This causes complications, as we are no longer in the conditions of Kakutani's Fixed Point Theorem, and so the existence of a solution is not trivial. However we do this for presentation purposes only. We would obtain the same results if we assume concavity of the home production goods.

expression for the demand for each good or amount of time worked.

We have assumed that women's decision to work are independent of men's. However, as pointed out by Becker [1991], it is important to consider the distribution of labor inside the family in the production of the domestic good. It is trivial to show that, in the standard model with family production of domestic goods, the impact of a decrease in the price of domestic services on women's labor participation, would be even larger (since women bare the largest burden of domestic good production within the household in a Becker [1991] type model).

2.2 Producer's Problem

This section we use a simplified version of the model of Card [2001], Borjas [2006], Card [2007] and Peri [2007]. First of all, we don't want our results to be driven by the different productivity of men and women in different sectors. Therefore we assume that both goods in the economy are produced by perfectly competitive firms, using the same decreasing returns to scale production function, using solely labor as an input ⁴. We can aggregate individual firms' production functions, into one production function for each sector in each city. Therefore each good $g \in \{1, 2\}$ is produced using a total amount of labor, N :

$$Y_g = AN_g^\gamma \tag{4}$$

where Y_g is the aggregate output for each good, A is a common technology component for both goods ⁵, and $\gamma \in (0, 1)$ is the productivity of labor. N_g is a labor aggregate of high skill (N_{Hg}) and low skill (N_{Lg}) labor, nested in a constant elasticity of substitution (CES) production function, defined as:

$$N_g = \left[dN_{Hg}^\theta + (1 - d)N_{Lg}^\theta \right]^{\frac{1}{\theta}} \tag{5}$$

⁴Introducing capital would only reduce the effects of migration on wages, as capital would increase, as a response to labor inflow.

⁵In this case, A includes capital.

where d is the productivity of high skill relative to low skill labor. A higher d implies that high labor is relatively more productive than low skill labor in the production of good g . Any common multiplying factor is absorbed by A . The parameter θ is related to the elasticity of substitution between high and low skill labor.

Notice that the we have assumed the same technology in the production of the domestic goods produced by the market. The standard assumption in previous work by Khananuskul [2004] and Cortes and Tessada [2007] is that low skill women are the main input in the production of domestic services (x_2). If this is the case then migration of low skill women will, not surprisingly, increase the supply of (x_2) and decrease the price of domestic services. However, as pointed out by Kremer and Watt [2005], high and low skill labor are used to produce some of these goods (e.g. nurseries, or the production of white goods) ⁶. Therefore, our assumption is more general than the standard assumption in the literature.

A major simplifying assumption of the model is that men and women are perfect substitutes in the production of market goods. Though we could assume imperfect substitution of men and women in the production of goods, previous work by Ottaviano and Peri [2007] finds that men and women are perfect substitutes. Furthermore, the benefits of introducing this extra complication to the model are unclear.

Therefore producers only decide the amount of high (N_{Hg}) and low skill (N_{Lg}) labor to employ. It also implies wages for men and women are the same for a given skill level ($w_{HMg} = w_{HWg}$ and $w_{LMg} = w_{LWg}$). Furthermore, because workers of each skill are allowed to freely move between sectors, the wages paid to each type of labor does not depend on which sector they work ($w_{H1} = w_{H2} = w_H$ and $w_{L1} = w_{L2} = w_L$).

Producer's of good one maximize profits given by:

⁶Though they assume that the production function will not be the same as the general market good as well.

$$\max \pi_1 = Y_1 - w_H N_{H1} - w_L N_{L1} \quad (6)$$

$$s.t. N_{H1} > 0$$

$$N_{L1} > 0$$

While producer's of good two maximize profits given by:

$$\max \pi_2 = pY_2 - w_H N_{H2} - w_L N_{L2} \quad (7)$$

$$s.t. N_{H2} > 0$$

$$N_{L2} > 0$$

where p is the relative price of good 2 in terms of good 1. The solution to these maximization problems will give us the amount of high and low skill labor hired by each sector, as a function of wages and prices ($N_{H1}^*(w_H, w_L, p)$, $N_{H2}^*(w_H, w_L, p)$, $N_{L1}^*(w_H, w_L, p)$ and $N_{L2}^*(w_H, w_L, p)$). As you can see from the Appendix, there is no close solution to these demand functions.

2.3 Market Clearing Conditions

Finally the conditions linking the consumer to producer problems are straight forward. All goods must be sold:

$$Y_1 = x_{1HM} \bar{N}_{HM} + x_{1LM} \bar{N}_{LM} + x_{1HW} \bar{N}_{HW} + x_{1LW} \bar{N}_{LW} \quad (8)$$

$$Y_2 = x_{2HM} \bar{N}_{HM} + x_{2LM} \bar{N}_{LM} + x_{2HW} \bar{N}_{HW} + x_{2LW} \bar{N}_{LW} \quad (9)$$

In the production of goods, the amount of time employed in each sector for each type of worker,

must equal the amount of time people want to work. Supposing there are \bar{N}_{Hj} high skilled people and \bar{N}_{Lj} low skilled people living in the city, with $\bar{N}_{Hj} < \bar{N}_{Lj}$, the equilibrium in the labor market requires that:

$$\bar{N}_{HM}(1 - h_{HM}) + \bar{N}_{HW}(1 - h_{HW}) = N_{1H} + N_{2H} \quad (10)$$

$$\bar{N}_{LM}(1 - h_{LM}) + \bar{N}_{LW}(1 - h_{LW}) = N_{1L} + N_{2L} \quad (11)$$

The relative price of good 2 relative to good 1 (p), and wages of high and low skilled labor (w_H and w_L) adjust to satisfy these conditions.

2.4 Solution to the Model and Comparative Statics

As is made clear in the Appendix, there is no closed form solution to the model. Therefore we will simulate the model and show, for a given set of parameter values, how female low skill migration will lead to a decrease in the relative price (p), with a corresponding increase in the average amount of hours worked of high skilled women (h_{WH}).

In order to run our simulations we must assign values to 4 parameters in the production problem (A , γ , θ and d) and 7 parameters from the consumer problem (α , β , c , a_j and b_j , where $j \in \{M, W\}$). Finally, we must also give 4 parameters describing the number of men and women, high and low skill people living in a city (\bar{N}_{HM} , \bar{N}_{LM} , \bar{N}_{HW} and \bar{N}_{LW}).

Ottaviano and Peri [2008] reports a typical value for θ in the literature of 0.3, and a γ of 0.3⁷. There are no estimates for d , as it is usually reported as part of controls in the regressions estimating θ . However we can use equation 41 in the Appendix, and the ratio of high to low skill wages and labor from our data to obtain a value for d of 0.60⁸, which implies that high skill workers are 6.6 times more productive than low skill people. Finally, since A plays no specific role, only affecting scale,

⁷The value of γ is derived from the macroeconomics literature and corresponds to the percentage of income that can be attributed to labor.

⁸Given that wages are the same, independent of the sector, the ratio of high to low skill wages, from equation 41

we set A to 10 to simplify our simulations.

It is harder to attribute values to the 7 parameters from the consumer problem, since there are few estimates on consumer preferences and productivity in domestic work. For our presentation we assume that $\alpha = 0.65$, $\beta = 0.45$, $a_M = 1$, $a_W = 5$, $b_M = 0.3$, $b_W = 7$, and $c = 0.8$ ⁹. Notice that we set $a_M < a_W$ and $b_M < b_W$.

Finally, with respect to the parameters of total population in the economy, we set \bar{N}_{HM} and \bar{N}_{HW} to 10 each and \bar{N}_{LM} and \bar{N}_{LW} to 40 each, so that the proportion of high and low skill, men and women is the same as in the Brazilian Census of 1991.¹⁰

We model migration as an increase in low skill men or women (or both), \bar{N}_{LM} and \bar{N}_{LW} living in the city. From the Brazilian Census of 1991, the average percentage of rural-urban migrants, from 1986 to 1991, is 7% of the low skill population living in one of the 123 agglomerations, while in the U.S. (table 1 of Ottaviano and Peri [2008]), during the period of 1990 to 2006 low skill people in the U.S. increased due to migration by 13.2%. Therefore we simulate migration as an increase in low skill people of 15% (from 40 to 46).

We consider two extreme cases. First, all migrants are men, as is usually assumed in the literature. Next, we consider the case where all migrants are women. We compare the evolution of wages, prices and labor participation for these two extremes. In the data the effect should be between these two extreme cases we simulate.

In figure 1 we have the result for our simulations when we increase the number of low skill men from 40 to 46, on high skill men hours of work (upper left graph), high skill women hours of work (upper right graph), high skill wages (lower left graph) and the relative price, p (lower right graph). We can see that an increase in the number of low skill men, increases high skill wage, as hypothesized

in the Appendix is given by:

$$\frac{w_H}{w_L} = \frac{d}{1-d} \left(\frac{N_{1H}}{N_{1L}} \right)^{\theta-1} \quad (12)$$

From equation ?? in the Appendix, we can see that the ratio of high to low skill workers in any sector can substituted by ratio of total high to low skill workers. From the Brazilian Census of 1991, the average ratio of hourly wages across 123 agglomerations is 2.9 and the ratio of high to low skill hours worked is 0.39.

⁹Our results are not dependent on these values. In particular we can assume that $b_W \in (0, 1)$ and obtain similar, but harder to visually interpret, results.

¹⁰Again our results are not dependent on these values. The important issue is the proportion of each group.

in the migration literature, and increases the labor supply of high skill men.

In figure 2 we add to figure 1 the case where all migrants are low skill women (dashed lines). In this case an increase in the number of low skill women, leads to an increase in high skill wage, and an increase in the labor supply of high skill men, just as before, though these effects are smaller than in the previous case. The major difference is that the labor supply of high skill women increases more than in the previous case. This occurs because of the larger decrease in the price of domestic goods. Furthermore, because of the increased supply of high skilled women into the labor market, high skill wages increase less than in the previous case.

In conclusion, it is clear that, under reasonable assumptions, the labor supply response to a change in the cost of domestic services will be larger for women than men. Therefore the gender composition of migration flows, men vs women, matters in the impact on labor supply. We will measure this impact in the empirical section.

3 Rural-Urban migration in Brazil: the data

We use the 1970, 1980, 1991 and 2000 Brazilian Census. The 1970 and 1980 Census is a 25% sample of the population, while the 1991 and 2000 Census sample 10% of the population in municipalities with predicted population of more than 15,000 and 20% for the remaining municipalities. We use the 1970 and 1980 Census solely to provide a base for population, active population, hours worked and wages in each agglomeration.

In Brazil, municipalities are the lowest level of Government, according to the 1988 Constitution, with its own sources of income and autonomy, through which an increasing number of public services are provided. Municipalities have changed considerably over time, increasing from 3951 in 1970 to 5501 in 2000 as pointed out by Reis et al. [2007]. Therefore, to compare municipalities across time we use Minimal Comparable Areas (or MCAs), developed by IPEA to compare municipalities between 1970 and 2000. In figure 3 we have a map of the 3661, MCAs we use our work. Unlike counties and cities in the U.S., municipalities in Brazil are generalist units, that provide most public

services.

We define cities as agglomerations defined in da Mata et al. [2005], with characteristics similar to the U.S. Metropolitan Statistical Areas. These agglomerations are based on 1991 MCAs and can be used for comparison of data from 1970 to 2000. In figure 3 we have a map of the 123 agglomerations (composed of 447 MCAs) that we use in our work. This definition is preferred to IBGE's (Brazilian Census Bureau) definition of urban area, which, as pointed out by Camarano and Abramovay [1997], over estimates urban areas, with urban areas in all municipalities in Brazil, even those deep in the Amazon.

In figure 4 and 5, we have the distribution by years of education of non-migrants and migrants in 1991 and 2000 (respectively). Average years of schooling are low, particularly in rural areas (3 to 5 years of schooling in urban areas in 1991 and 4 to 6 years of schooling in urban areas in 2000) despite the fact that recently, the number of years of compulsory education raised to 8 years. Therefore we define high skill (or high education) as a person with 9 or more years of education.

Due to the low level of education in Brazil many people join the job market at an early age. In fact, IBGE considers people over 10 years of age as active in the workforce. Also, workers in the private sector workers can retire at 65 (and women at 60), while workers in the public sector can retire at 60 (women at 55). Therefore for our analysis we consider active workers as people between the age of 15 and 55 (inclusive), who report having labor income and number of hours worked and are not students.

Since the Census has no information on employment history, or household consumption, we aggregate our data by MCA, year, level of education (high or low education) and gender. To construct our data, we weight our observations by personal weights provided for each year before merging the data from different years. In table 1 we have basic statistics for the 123 cities/agglomerations we use in our data. It can be easily seen, that the number of women working in cities has increased over time, to that point that now they represent 1/3 of active population.

Brazil faced serious hyper inflation (including changing currency three times) from 1974 to 1995, we use deflators provided by Corseuil and Foguel [2002] to convert current wages to January 2002

values. We focus on median hourly labor income of each group, and we use median hourly wages of domestic workers as a proxy for the price of domestic goods. The average number of hours worked is 41 hours in both rural and urban areas in 1991 and increased to 43 hours in 2000. Hourly wages for each group are presented in table 1.

We argue that cities with a lower maids' wage have a higher labor participation of high skill women (versus men). In figure 6 and 7 we have plotted the relationship between maids' wages and the ratio of labor participation of men versus women, for 123 agglomerations, in 1991 and 2000 respectively. You can see there is a negative relationship between the two, for both years, implying that, cities with smaller maids' wages, have more women working (for a fixed labor supply of men). We will also argue that migration will affect maids' wages.

We define migrant status based on where people lived 5 years before the date of the Census, similar to Card [2001]. Rural-Urban migrants are people who moved to an agglomeration in the past 5 years. In figure 8 and 9 we have a map of out migration from rural areas (as a percentage of municipality's total population) for 1991 and 2000. As you can see, rural areas closer to urban areas have a larger out-migration. In figure 10 and 11 we have a map of the distribution of rural-urban migrants (as a percentage of total migrants), for 1991 and 2000. Since there are 123 cities/agglomerations, we would expect each city receiving less than 1% of total migrants. However we observe in figure 10 and 11 that São Paulo is an outlier, with as many as 15% of all migrants going into this city. In figure 12 and 13 we have the impact of migrants in each city (number of migrants as a percentage of total population living in the city), for 1991 and 2000. As you can see, migrants represent a larger share of the population (therefore have a larger impact) in other cities spread through the country (and not in São Paulo or Rio de Janeiro).

The 1991 Census also provides information on people were living in 1981 and time people are living in the current municipality. We use this data of historical patterns of migration (in particular, how people moved from rural to urban areas between 1981 and 1985) to determine how people respond to distance in their decision. We can see from figure 14, that female migrants don't necessarily follow male migrants to cities, as the ratio of men to women migrants into cities varies significantly.

We will show that distance between origin and destination matters more for women than men.

We can use information on table 1 to easily show that rural-urban migrants (of the past 5 years), represent 6% of the working population in 1991 (5% in 2000). Though the amount of rural-urban migrants is decreasing slightly, the percentage of women is increasing (from 37% in 1991 to 40% in 2000). Not surprisingly, rural-urban migrants are on average about 4 years younger than workers from agglomerations, and also have, on average, one year less of education when compared with workers in cities. Non-migrants' wages are higher than migrants', and, on average, they work fewer hours. From figure 15 and 16 you can see that the biggest difference in terms of jobs between migrants and non-migrants (for both men and women) is that migrant women are almost twice as likely to work in domestic services when compared with non-migrant women (both in 1991 and in 2000) ¹¹.

In figure 17 and 18 we have the relationship between maids' wages and low skill women migrants, in 123 agglomerations, for 1991 and 2000 respectively. You can see there is a negative relationship between the two. Cities that receive more low skill women migrants also have a lower maids' wage on average.

Finally, we use data on where people were living 5 year before in the 1991 and 2000 Census, to rebuild population and migration patterns from rural areas from 1986 to 1990 and 1995 to 1999. We use data on precipitation (in centimeters monthly average each year) from the Inter-Governmental Panel on Climate Change (IPCC) (see Mitchell et al. [2002] for a complete description of the data set), for 1985 to 1990 and 1994 to 1999 as a weather shock to rural areas that affects wages in rural areas and leads to out-migration. The geographical pattern of average monthly rainfall over 100 years (1900 to 2000) over the 3661 MCAs is shown in figure 19.

We also use data from Castro [2002] on transportation costs from each municipality to São Paulo. Castro [2002] constructs an index that measures the benefits of improvements in highway infrastructure from 1970-1995 as the change in equivalent paved road distance from each municipality to the state capital of São Paulo, accounting for the construction of the network as well as the difference

¹¹In those cities with a large proportion of female, there is also a large proportion of school teachers, hence the title of this paper.

in vehicle operating costs between earth/gravel and paved roads. We argue that improvements in the transportation network (reduction in transportation costs) allowed more people to migrate from rural to urban areas.

Finally, we use data from the Agricultural Census of 1985 and 1995 on agricultural area and irrigation area (hectares), as a control for the importance of agriculture in each MCA.

The basic statistics of rural areas are in table 2. Notice the importance of farming in rural areas, for low education population. As most people working in rural areas are working in farming, it is likely that their income (and therefore their decision to migrate) will be affected by weather shocks.

4 Empirical Approach

Our objective is to estimate the impact of a decrease in the cost of domestic services (proxied by maids' hourly wages) on labor supply (measured by labor force participation). Our hypothesis is that a decrease in maids' wages leads to a increase in women's labor supply (in particular larger than men's increase in labor supply).

From the consumer's maximization problem discussed in section 2.1 it is clear that labor supply by an individual is a function of both wages, w_i , and costs of joining the labor market, namely p :

$$(1 - h_{ijst}) = f^1(w_{ijst}, p) \quad (13)$$

We proxy the relative price of domestic services, p , with the median maids' hourly wage, as we described in the previous section. A more comprehensive model of labor supply, as Blundell and MaCurdy [1998], would include controls for non-labor income, I_{ijrst} , (which includes family non-labor income), as well as other "taste shifters", Z_{ijrst} (e.g. age/sex distribution). Therefore we will estimate:

$$\ln(1 - h)_{ijst} = \beta_0 + \beta_1 w_{ijst} + \beta_2 p + \beta_3 Z_{ijst} + e_{ijst} \quad (14)$$

We use log labor participation of each group for $\ln(1 - h)_{ijst}$. In order to control for differences across cities (Z_{ijst}) we differentiate the data (instead of introducing city fixed effects), as we only measure the flow of migrants (as opposed to the stock of migrants, in particular in the 1980 Census).

Our estimates of β_1 and β_2 are reported in table 3. In columns 1 and 2 we report the OLS estimates for high skilled men and women respectively. In columns 3 and 4 we control for differences across cities by looking at changes between 1980-1991 and 1991-2000, for high skilled men and women (respectively). As you can see from column 4 of table 3, once we control for differences across cities, there is a negative, statistically effect of maids' hourly wage on the labor participation of high skilled women (in particular when compared with the labor participation of high skilled men in column 3). A 1 standard deviation decrease in maids' wages leads to 4.36% increase in the labor supply of high skill women.

The problem with these estimates is that maids' wages (and wages of high skilled workers as well) is also a function of labor supply (reverse causality). Therefore, we must instrument for both maids' wages and wages of high skilled workers. From the international migration theory (see for instance ?), we know that migration will affect wages (both maids' wages and high skilled workers' wages). First, we estimate the impact of migration on wages. Next, we estimate the impact of changes in wages on labor participation.

Our biggest obstacle is to isolate push factors from pull factors in rural-urban migration. If migration is positively correlated with conditions at the destination, such as industrial shocks in urban areas, then our estimates of the impact on maids' wages (and high skilled workers' wages) would be biased.

We start by addressing the endogeneity of migration flows by building an exogenous migration shock to each city, in response to weather shocks and changes in transportation costs at the origin (rural areas). Next we use this migration shock to look at changes on the price of domestic services. Finally, we show that high skill women's labor supply increases in response to the decrease in the price of domestic goods.

4.1 Rural-Urban Migration - why do people migrate

We start by determining how many people of each group (men or women with high or low education) migrate from rural to urban areas in response to rainfall shocks in rural areas, and changes in transportation costs (improvements in the transport network). We expect that years of drought lead to out migration, in particular low skilled people, by affecting farming production, and therefore rural wages. We also expect that reductions in transportation costs leads to more migration.

Our basic regression is then:

$$\ln Migrants_{ij,rural,t} = \alpha_0 + \alpha_1 \ln N_{ij,rural,(t-10)} + \alpha_2 Rain_{rural,t} + \alpha_3 Transp_{rural,t} + \alpha_4 X_{ij} + e_{ij,rural,t} \quad (15)$$

Where $N_{ij,rural,(t-10)}$ is the lagged population size in a rural area in the previous year, $(t - 1)$, for men or women, i , high or low education, j ; $Rain_{rural,t}$ is the rainfall at year t (we also include its lag), $Transp_{rural,t}$ is the log of an index of transportation costs to São Paulo (for 1985 and 1995 only), while X_{ijr} is a set of dummies controls for characteristics of the rural area of origin (these include log agricultural area, log agricultural area with irrigation, year dummies, rural municipality (MCA) fixed effects, dummies for semi-arid area, and controls for women and high education).

We use data from the 1991 and 2000 Census on where people were living in 1986 and 1995 (respectively), and time living in the current area, to rebuild population and migration flows for each year from 1986 to 1991 and 1995 to 2000. We use data from the agricultural census of 1985 and 1995 on the agricultural area and the agricultural area with irrigation, to control for the importance of agriculture in each particular rural municipalities (MCA). Finally, we use the IPCC data on monthly precipitation, to obtain average yearly precipitation for each year from 1986 to 1991 and 1994 to 2000. In figure 19 we have a map with the average monthly rainfall (in mm) over the period of 1900 to 2000 for each MCA. Data on transportation costs for 1985 and 1995 comes from Castro [2002]. In table 2 we descriptive statistics for these rural areas.

In table 4 we have the results from our regressions for each group (men/women, high/low skill). Since we include rural municipalities (MCA) fixed effects, our results can be interpreted as deviations from the mean (across years). As we anticipated, years of drought lead to more out-migration from rural areas, in particular a 1 standard deviation decrease in rainfall in a given year leads to a 6% increase in out-migration (lagged rainfall has no impact for any group), but only for low skilled workers (men and women), while for high skilled workers (men and women) it has no statistically significant impact. The impact for low skilled men and women are statistically indistinct. In the semi-arid area (an area of chronic drought), years of plentiful rainfall lead to more out migration instead. As described in detail by Baer [2008], government intervention during years of bellow average rainfall (by providing funds for local governments to hire workers), leads to low out migration during years of drought. Instead, in years of plentiful rainfall and no government intervention, migration increases for all groups (high/low skill, men/women).

Decreases in transportation costs from 1985 to 1995, have lead to an increase in migration but only for high skilled people, with no statistically significant difference between men and women. In particular a 10% reduction in costs, leads to a 2.9% increase in out-migration from rural areas of high skilled people. We would expect that a reduction in transportation costs would affect both high and low skill workers. The results we find could be due to noise, since we only observe changes in transportation costs across two years.

These instruments are jointly significant (statistically), with a F-test of 17.19, pooling all groups. If we split by group the F-test for the instruments varies between 3.95 (low skill women migrants) and 14.85 (high skill women migrants).

In conclusion, we have found that drought leads to out-migration of low skill people (both men and women) from rural areas, except in the semi-arid area, where years of above average rainfall leads to out-migration (of high and low skill men and women), due to the decrease in government subsidies. Reductions in transportation costs between 1985 and 1995 also increased out-migration from rural areas, but, surprisingly, only for high skilled people.

Next we look at migrants' decision of destination.

4.2 Rural-Urban Migration - where do migrants decide to move to

So far we have isolated rural-urban migration from shocks to the urban sector. However, rural-urban migration may respond to shocks to specific cities (i.e., in any one particular year more people may move to São Paulo rather than Rio de Janeiro in response to the opening of a large factory in São Paulo).

While we could use historical patterns of migration to try to control for the endogeneity of choice location (similar to Cortes and Tessada [2007] and Peri [2007]), this is only valid if these historical patterns do not reflect long term trends, that are still relevant today.

Therefore we go a step forward and try to explain these historical patterns with distance. In particular, we explain rural-urban migration patterns (from 3214 rural origins to 123 urban destinations) from 1981 to 1985 (from the 1991 Population Census) for each group (high and low skill men and women) with distance between origin and destination. Therefore we run the following regression

$$\frac{Migrants_{i,c,rural,80-85}}{\sum_c Migrants_{i,c,rural,80-85}} = \beta_0 + \beta_1 Distance_{urban,rural} + \epsilon_{i,c,rural,80-85} \quad (16)$$

Where $PercMigrants_{i,rural,81-85}$ is the percentage of migrants of group i , who migrated from rural area, *rural* to urban area *urban*, between 1981 and 1985, 81 – 85. The percentage of migrants from each group from a rural area to the 123 agglomerations adds to 100%. We measure distance, $Distance_{urban,rural}$ in kilometers from the center of the rural area (MCA), to the center of the urban area (calculated from maps).

Our results are in table 5, and are consistent with what we had already see in figure 8 and 9. From columns 1 and 2 you can see that rural-urban migrants move to cities which are closer to their rural area of origin. A 10% increase in average distance leads to a 0.2 percentage points decrease in the number of rural-urban migrants to a particular city. High skilled migrants are less affected by distance, while women (high and low skill) are more affected by distance.

It is however possible that distance from a city could be correlated with the supply of high and low

skill workers in a rural area (male of female) who are able to migrate. Therefore to control for this we introduce the interaction between the size of the group in the origin interacted with the the size of the group at the destination. As you can see in columns 3 and 4 of table 5 it has no impact on our results.

Having determined how each group migrates from a rural to an urban area, we can now build an exogenous migration shock.

4.3 Rural-Urban Migration - migration shock

Having determined why people migrate and where do they migrate to, we can now construct an exogenous migration shock to each city (that is dependent of changing conditions at the origin, rather than the destination), that we will use to determine the effect of migration on wages (maids' wages and high skilled wages). We construct the migration shock in the following way:

$$\left(\Delta \hat{N}_{ij,s,91}\right)^{migration} = \sum_{t=86}^{91} \sum_{rural} \frac{Migrants_{ij,rural,s,85}}{\sum_s Migrants_{ij,rural,s,85}} Migrants_{ij,rural,st} \quad (17)$$

Where $\frac{Migrants_{ij,rural,s,85}}{\sum_s Migrants_{ij,rural,s,85}}$ are the predicted values from our equation 16, explaining where people decide where to move, while $Migrants_{ij,rural,st}$ is the predicted values from equation 15, explaining how people decide to move from rural areas.

Our instrument therefore explores 2 sources of variation. How rainfall and transportation costs changed over time and space (for each of the four groups: high and low skill men and women) and the decision of where to go varies across space across the four groups.

We argue that this migration shock can be used as an instrument for changes in maids' and high skilled workers wages.

4.4 Migration and Maids' Wages

Having determined migration flows from rural to urban areas, are driven by rainfall shocks in rural areas and changes in transportation costs, we can use it to see how it affects the cost of domestic services, proxied by median maids' hourly wages.

From our model, we know that the price of domestic goods is a function of the supply of all four types of labor, men/women of high/low education:

$$p = f^1(\bar{N}_{HM}, \bar{N}_{LM}, \bar{N}_{HW}, \bar{N}_{LW}) \quad (18)$$

In the Population Census there is no information on either consumption of domestic services, or costs of domestic production (financial or time costs). Therefore we proxy it with median maids' hourly wages. This will give us a lower bound for the cost of domestic services, as the choice to work as a maid is dependent of maids' wages. In particular, migration may not fully reflect changes in maids' wages, as people may start working in other sectors as maids' wages go down ¹².

We run the following regression on median maids' hourly wage:

$$\Delta maids' wage_{st} = \alpha_1 + \alpha_2 \Delta \ln \tilde{N}_{Lst} + \alpha_3 \Delta \frac{\tilde{N}_{WLst}}{\tilde{N}_{MLst}} + e_{st} \quad (19)$$

Where $\Delta \ln \tilde{N}_{Lst}$ is the log number of low skilled migrants moving into a city, namely the predicted value from equation ???. In order to control for the fact that female and male low skill migrants flows are correlated, we also include the ratio of female to male low skill migrants $\frac{\tilde{N}_{WLst}}{\tilde{N}_{MLst}}$, as a measure of how many women's migration flows compare to men's. We argue that places that received more low skilled women (and therefore a larger ratio of women to men), face a decrease in maids' wages.

Our results are in columns 1 and 2 of table 6. Since maids' wages only varies by city (and not by high skill men and women) the results of columns 1 and 2 are the same. They show that though

¹²Note that in Brazil domestic servants have less rights than the average worker. It was only after the year 2000 that domestic servants were given the right to 40 hours work week and holidays.

an increase in low skill migrants can lead to an increase in maids' wages, only if there are very few women migrating into the city, but more importantly, the more women flow into a city, the lower maids' wages (joint F test of 21.59).

4.5 Migration and High Skilled Wages

Migration also affects high skill wages, in a similar fashion as described in equation 18, that is wages are a function of four types of labor (high and low skill men and women). In particular, as argued by Borjas [2003], Borjas [2006] and Ottaviano and Peri [2008], if high and low skilled workers are imperfect substituted in the production of goods, low skilled migration should lead to an increase in high skilled wages. Ottaviano and Peri [2007] has found that men and women are perfect substitutes in production, therefore migrants' gender should not matter.

Our results are in columns 1 and 2 of table 7 do not support this hypothesis. In particular, only the ratio of women to men low skill migrants is statistically significant (with a joint F test of 4.28 for high skilled men and 4.86 for high skilled women). This could be related with the fact that there is a positive correlation between the total number of migrants and the number of women migrants (cities receiving more migrants also receive a larger proportion of women - 0.22 correlation between low skill migration and the ratio of women to men). However even taking this into consideration, there is still a negative effect between low skill migration and high skill wages of both men and women.

As pointed out by Card [2007], cities differ in several ways, making it hard to estimate the impact of migration on average (or for that matter, median) wages. In an attempt to improve our estimates we include another commonly used instrument for wages: the Bartik Industrial Shock, which we explain next.

4.6 Bartik's Industrial Shock and High Skilled Wages

Bartik [1991] proposed using national demand shocks to predict changes in regional wages ¹³, under

¹³See Blanchard and Katz [1992], Bound and Holzer [2000], Autor and Duggan [2002], and Luttmer [2005] for other

the assumption that changes in employment at the national level are uncorrelated with city-level labor supply shocks and therefore represent plausibly exogenous (demand-induced) variation in agglomeration wages.

We use cross-city differences in industrial composition and national-level changes in high skill employment to predict changes in high skill wages. In particular:

$$\psi_{H,t} = \sum_v \lambda_{v,80} \psi_{H,v,t} \quad (20)$$

where $\psi_{H,v,t}$ is the log change in employment share of high skilled workers, H , employed in (two digit) industry v , in year t (excluding own city employment change), while $\lambda_{v,80}$ is the share of employment in industry v in (base year) 1980. Positive demand shocks at the national level should lead to higher wages at the local (city) level.

Our results are in columns 3 and 4 of table 7. While a positive demand shock leads to an increase in (median) hourly wages of high skilled men, it has no impact on high skilled women’s wages. In particular, a 10% increase in employment leads to a 0.2 *Reais* increase in (median) hourly wage of high skilled men. It is unclear why high skilled women wage’s are unresponsive to demand shocks. One possibility, as pointed out by Killingsworth and Heckman [1995], is that women’s labor supply is more responsive to changes in wages than men’s (so that demand shocks are reflected in wages for men and labor supply for women). Furthermore, notice that when we include Bartik’s Industrial Shock as an instrument in columns 3 and 4 of table 6 it is not statistically significant, nor does it change (significantly) our estimates of the impact of low skill female migration on maids’ (median) hourly wages.

We can now use these instruments in estimating the effect of maids’ wages and high skilled wages on the labor supply of high skilled men and women.

applications of this instrumental variable.

4.7 Instrumental Variable Estimates

We argue that our least square estimates are biased, since maids' wages and high skill wages (of both men and women) are also a function of labor supply (reverse causality).

In columns 5 and 6 of table 3 we look at the effect of changes in maids' wages and high skill wages on labor participation, instrument for changes in maids' wages and high skill wages with log low skill migration and the ratio of low skill women to men migrants, while in columns 7 and 8 we add Bartik's Industrial Shock (demand shocks) to our instrument list. As you can see from all 4 columns, our IV estimates show a larger impact of maids' wages on labor participation, when compared with our OLS estimates (consistent with reverse causality).

As you can see from columns 5 and 6, when we include only log low skill migration and the ratio of low skill women to men migrants as instruments, own wage has no effect on labor participation for both high skilled men and women. However, a 1 standard deviation decrease in maids' wages leads to a 27% increase in the labor participation of high skilled women. While we also observe a negative effect of maids' wages on the labor participation of high skilled men, this effect is much smaller (statistically significant), and disappears as soon as we include demand shocks as instruments in columns 7 and 8 (while the effect of maids' wages on high skilled women's labor participation remains essentially the same).

In summary, our results are consistent with our model. A decrease in maids' hourly wages lead to an increase in the labor participation of high skilled women (in particular, when compared with high skilled men's labor participation).

5 Robustness Checks

So far we have looked at the intensive margin of labor supply (the number of people working). However, as pointed out by Borjas [2003], it is possible that in response to an increase in the intensive margin (number of workers) there is a negative, and of equal size, effect on the extensive margin (hours worked). We have no information on work history, and so we cannot analyze the

impact on the extensive margin alone. However, we do measure total number of hours worked (by all workers), a measure of both intensive and extensive margin¹⁴. Therefore we estimate the impact of maids' wages and high skilled wages, on total hours worked by population for each group (high skill men and women) in order to check if the effect on the extensive margin (number of workers) is not fully nullified by an equal effect on the intensive margin (hours worked).

Our results are in table 8. In the level regression there is a positive and statistically significant effect of maids' wages on hours worked, which disappears (becomes statistically insignificant) when we control for city fixed effects (first difference regressions). When we instrument for maids' wages and high skill wages with log low skill migration and the ratio of low skill women to men migrants, in columns 5 and 6, a decrease in maids' hourly wages leads to an increase in the amount of hours worked, for both high skill men and women (not statistically different). Adding Bartik's demand shock to the instruments in columns 7 and 8, our results are similar to those we found before (a statistically negative impact on the amount of hours worked by high skill women, but no impact for high skilled men). In particular, a 1 standard deviation decrease in the (median) hourly wage of maids leads to an increase in the number of hours worked by high skilled women (as a percentage of total women working in the city) by 25%.

6 Conclusion

We showed how the migration of low skilled women can lead to an increased labor participation of local high skilled women, by decreasing the cost of domestic services.

We find that historical patterns of rural-urban migration can be explained by distance (more migrants decide to move to a nearer city). Next, using rainfall shocks in rural areas and changes in transportation costs we are able to build an exogenous migration city to each city (driven by changes at the origin only). We find that cities that receive relatively more low skilled women have, on average, lower maids' hourly wages. A 1 standard deviation decrease in maids' wages leads

¹⁴In the 1980 Population Census hours worked are reported in intervals. We create intervals for the continuous measure of time worked in the 1991 and 2000 Population Census to make our approach consistent across years.

to a 27% increase in the labor participation of high skilled women, when using migration as an instrument for changes in maids' wages and high skill wages.

These results have implications for migration policy. They point to benefits from certain types of migration. In particular, giving special permits to low skill women migrants, as Hong Kong and Singapore did in the 1990's, we can increase the average skill level of workers in the economy. This in turn can benefit workers across the entire wage distribution.

The previous international migration literature has focused on the impact of migration on wages. A major assumption is that local labor supply is constant. If the increase in the labor supply of high skilled women is large enough, low skill women migrants can actually have a positive effect on the high to low skill wage gap.

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7 Appendix 1 - Solving the Model

We can use the consumer problem in section 2.1 to set up a Lagrangian for each group:

$$\mathcal{L}_{ij} = x_{1ij}^\alpha \left[cx_{2ij}^\beta + (1-c) \left(a_i h_{ij}^{b_i} \right)^\beta \right]^{\frac{1-\alpha}{\beta}} - \lambda [x_{1ij} + px_{2ij} - w_{ij}(1 - h_{ij})] \quad (21)$$

From the Lagrangian of each group we can get the following first order conditions:

$$\frac{\partial \mathcal{L}_{ij}}{\partial x_{1ij}} = \alpha x_{1ij}^{\alpha-1} \left[cx_{2ij}^\beta + (1-c) \left(a_i h_{ij}^{b_i} \right)^\beta \right]^{\frac{(1-\alpha)}{\beta}} - \lambda = 0 \quad (22)$$

$$\frac{\partial \mathcal{L}_{ij}}{\partial x_{2ij}} = (1-\alpha) cx_{2ij}^{\beta-1} x_{1ij}^\alpha \left[cx_{2ij}^\beta + (1-c) \left(a_i h_{ij}^{b_i} \right)^\beta \right]^{\frac{(1-\alpha)}{\beta}-1} - \lambda p = 0 \quad (23)$$

$$\frac{\partial \mathcal{L}_{ij}}{\partial h_{ij}} = (1-\alpha)(1-c)b_i a_i^\beta h_{ij}^{b_i\beta-1} x_{1ij}^\alpha \left[cx_{2ij}^\beta + (1-c) \left(a_i h_{ij}^{b_i} \right)^\beta \right]^{\frac{(1-\alpha)}{\beta}-1} - \lambda w_j = 0 \quad (24)$$

Using equation 23 and 24 we get:

$$\left[\frac{x_{2ij}}{a_i h_{ij}^{b_i}} \right]^{1-\beta} = \left[\frac{w_i}{p} \frac{c}{1-c} \frac{1}{b_i a_i} \right] h_{ij}^{1-b_i} \quad (25)$$

or

$$x_{2ij} = \left[\frac{w_i}{p} \frac{c}{1-c} \frac{1}{b_i} \right]^{\frac{1}{1-\beta}} \frac{1}{a_i} h_{ij}^{\frac{\beta}{1-\beta} \frac{1-b_i\beta}{1-\beta}} \quad (26)$$

Which gives us a relationship between h_{ij} and x_{2ij} . Using equations 22, 24 we get:

$$x_{1ij} = \frac{\alpha}{1-\alpha} \frac{w_i}{(1-c)b_i} \left[cx_{2ij}^\beta a_i^{-\beta} h_{ij}^{1-b_i\beta} + (1-c)h_{ij} \right] \quad (27)$$

And replacing x_{2ij} with what we found in equation 26 we get:

$$x_{1ij} = \frac{\alpha}{1-\alpha} \frac{w_j}{b_i} h_{ij} + \frac{\alpha}{1-\alpha} \left(\frac{w_j}{b_i} \frac{c}{1-c} \right)^{\frac{1}{1-\beta}} \left(\frac{1}{a_i p} \right)^{\frac{\beta}{1-\beta}} h_{ij}^{\frac{1-b_i\beta}{1-\beta}} \quad (28)$$

Which gives us a relationship between x_{1ij} and h_{ij} . We can put these together in the budget constraint:

$$\begin{aligned} & \left(\frac{\alpha}{1-\alpha} \frac{w_j}{b_i} + w_j \right) h_{ij} + \\ & + \left(\frac{\alpha}{1-\alpha} \left(\frac{w_j}{b_i} \frac{c}{1-c} \right)^{\frac{1}{1-\beta}} \left(\frac{1}{a_i p} \right)^{\frac{\beta}{1-\beta}} + p \left[\frac{w_j}{p} \frac{c}{1-c} \frac{1}{b_i} \right]^{\frac{1}{1-\beta}} \frac{1}{a_i} \right)^{\frac{\beta}{1-\beta}} h_{ij}^{\frac{1-b_i\beta}{1-\beta}} = w_j \end{aligned} \quad (29)$$

which cannot be solved explicitly. However we can implicitly differentiate this equation with respect to wage: .

$$\frac{\partial h_{ij}}{\partial w_j} = \frac{\left(\frac{\alpha}{1-\alpha} \frac{1}{b_i} + 1 \right) h_{ij} + \frac{1}{1-\beta} \frac{1}{1-\alpha} \left(\frac{c}{(1-c)b_i} \right)^{\frac{1}{1-\beta}} \left(\frac{w_j}{a_i p} \right)^{\frac{\beta}{1-\beta}} h_{ij}^{\frac{1-b_i\beta}{1-\beta}} - 1}{\left(\frac{\alpha}{1-\alpha} \frac{w_j}{b_i} + w_j \right) + \frac{1-b_i\beta}{1-\beta} \left(\frac{w_j c}{(1-c)b_i} \right)^{\frac{1}{1-\beta}} \left(\frac{1}{a_i p} \right)^{\frac{\beta}{1-\beta}} h_{ij}^{\frac{1-b_i\beta}{1-\beta}} - 1} \quad (30)$$

So that the uncompensated elasticity of labor supply is given by:

$$\frac{\partial h_{ij}}{\partial w_j} = \frac{\left(\frac{\alpha}{1-\alpha} \frac{w_j}{b_i} + w_j \right) h_{ij} + \frac{1}{1-\beta} \frac{1}{1-\alpha} \left(\frac{w_j c}{(1-c)b_i} \right)^{\frac{1}{1-\beta}} \left(\frac{1}{a_i p} \right)^{\frac{\beta}{1-\beta}} h_{ij}^{\frac{1-b_i\beta}{1-\beta}} - w_j}{\left(\frac{\alpha}{1-\alpha} \frac{w_j}{b_i} + w_j \right) h_{ij} + \frac{1-b_i\beta}{1-\beta} \left(\frac{w_j c}{(1-c)b_i} \right)^{\frac{1}{1-\beta}} \frac{1}{a_i p} \left(\frac{1}{a_i p} \right)^{\frac{\beta}{1-\beta}} h_{ij}^{\frac{1-b_i\beta}{1-\beta}}} \quad (31)$$

In the producer problem in section 2.2 because of decreasing returns to scale, in each sector $g \in \{1, 2\}$ each input is paid their marginal productivity:

$$w_{1H} = A \left[dN_{1H}^\theta + (1-d)N_{1L}^\theta \right]^{\frac{(1-\gamma)}{\theta}-1} (1-\gamma)dN_{1H}^{\theta-1} \quad (32)$$

$$w_{1L} = A \left[dN_{1H}^\theta + (1-d)N_{1L}^\theta \right]^{\frac{(1-\gamma)}{\theta}-1} (1-\gamma)(1-d)N_{1L}^{\theta-1} \quad (33)$$

$$w_{2H} = pA \left[dN_{2H}^\theta + (1-d)N_{2L}^\theta \right]^{\frac{(1-\gamma)}{\theta}-1} (1-\gamma)dN_{2H}^{\theta-1} \quad (34)$$

$$w_{2L} = pA \left[dN_{2H}^\theta + (1-d)N_{2L}^\theta \right]^{\frac{(1-\gamma)}{\theta}-1} (1-\gamma)(1-d)N_{2L}^{\theta-1} \quad (35)$$

Given the fact that people can move across sectors, wages for high and low skill must be the same:

$$\left[dN_{1H}^\theta + (1-d)N_{1L}^\theta \right]^{\frac{(1-\gamma)}{\theta}-1} N_{1H}^{\theta-1} = p \left[dN_{2H}^\theta + (1-d)N_{2L}^\theta \right]^{\frac{(1-\gamma)}{\theta}-1} N_{2H}^{\theta-1} \quad (36)$$

$$\left[dN_{1H}^\theta + (1-d)N_{1L}^\theta \right]^{\frac{(1-\gamma)}{\theta}-1} N_{1L}^{\theta-1} = p \left[dN_{2H}^\theta + (1-d)N_{2L}^\theta \right]^{\frac{(1-\gamma)}{\theta}-1} N_{2L}^{\theta-1} \quad (37)$$

So that we can obtain the relationship between employment in each sector:

$$\frac{N_{2H}}{N_{2L}} = \frac{N_{1H}}{N_{1L}} \quad (38)$$

We can use equation 10 and 11 to obtain:

$$\frac{\bar{N}_{HM}(1-h_{HM}) + \bar{N}_{HW}(1-h_{HW}) - N_{1H}}{\bar{N}_{LM}(1-h_{LM}) + \bar{N}_{LW}(1-h_{LW}) - N_{1L}} = \frac{N_{2H}}{N_{2L}} \quad (39)$$

Using equation 38 and manipulating the above equation we finally get:

$$\frac{\bar{N}_{HM}(1-h_{HM}) + \bar{N}_{HW}(1-h_{HW})}{\bar{N}_{LM}(1-h_{LM}) + \bar{N}_{LW}(1-h_{LW})} = \frac{N_{1H}}{N_{1L}} \quad (40)$$

Which in turn implies that we can use total labor supply as a proxy for the ratio of labor supply as

for either sector. Therefore high skill wage is given by:

$$w_H = A \left[dN_H^\theta + (1-d)N_L^\theta \right]^{\frac{1-\gamma}{\theta}-1} (1-\gamma)(d)N_H^{\theta-1} \quad (41)$$

8 Appendix 2 - Figures

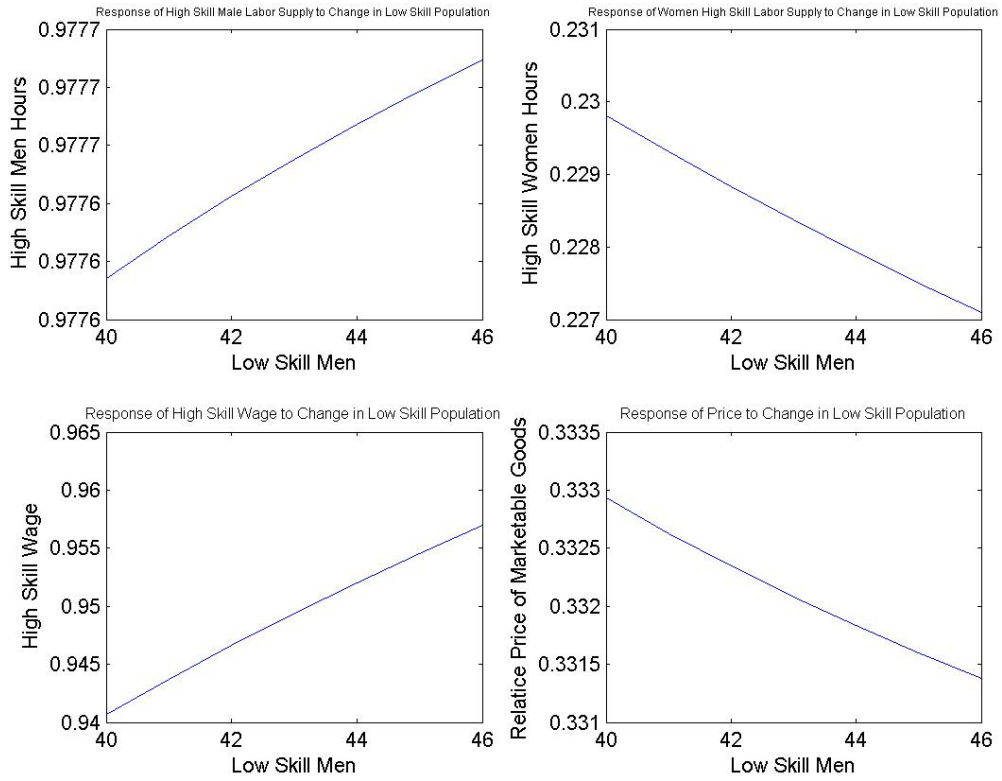


Figure 1: Simulating the solution to the model, when migrants are only men. $A=10$, $\alpha = 0.65$, $\beta = 0.45$, $\gamma = 0.3$, $\theta = 0.3$, $a_M = 1$, $a_W=5$, $b_M =.3$, $b_W = 7$, $c = .8$, $d = 0.6$, $N_{HM} = 10$, $N_{HW} = 10$, $N_{LW} = 40$ and N_{LM} goes from 40 to 46. On the upper left corner we have the labor participation of high skilled men, on the upper right corner the labor participation of high skilled women, on the bottom left high skill wages and on the bottom right prices.

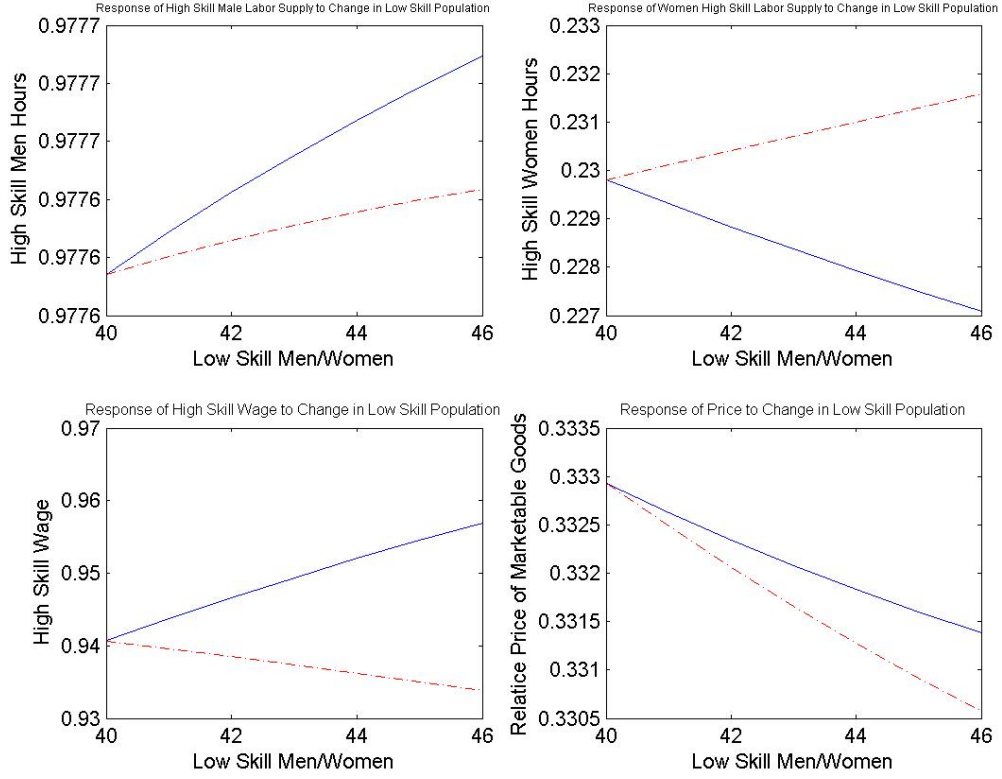


Figure 2: Simulating the solution to the model. Blue full line is when migrants are only men. Red dash line is for an increase in low skill women (migrants). $A=10$, $\alpha = 0.65$, $\beta = 0.45$, $\gamma = 0.3$, $\theta = 0.3$, $a_M = 1$, $a_W=5$, $b_M =.3$, $b_W = 7$, $c = .8$, $d = 0.6$, $N_{HM} = 10$, $N_{HW} = 10$, N_{LW} or N_{LM} goes from 40 to 46 (depending on case). On the upper left corner we have the labor participation of high skilled men, on the upper right corner the labor participation of high skilled women, on the bottom left high skill wages and on the bottom right prices.

9 Appendix 3 - Tables

Basic Statistics for 123 Agglomerations						
	1980		1991		2000	
	Mean	SD	Mean	SD	Mean	SD
Median Hourly Wage						
Men High Skill	3.39	0.85	2.84	0.73	2.54	0.54
Women High Skill	1.77	0.43	1.63	0.48	1.62	0.35
Men Low Skill	1.76	0.46	1.11	0.37	1.26	0.34
Women Low Skill	0.93	0.26	0.66	0.23	0.84	0.21
Median Maid Hourly Wage	0.62	0.22	0.75	0.27	0.93	0.28
Participation Rates						
Men High Skill	89.0%	0.055	85.0%	0.033	76.9%	0.038
Women High Skill	51.8%	0.067	58.1%	0.039	56.4%	0.038
Men Low Skill	79.8%	0.065	81.4%	0.057	70.7%	0.067
Women Low Skill	28.6%	0.057	34.3%	0.059	36.8%	0.061
Avg Migrants						
Men Low Skill			3,319	36,962	4,025	44,823
Women Low Skill			3,251	36,200	3,745	41,699

Table 1: Basic Statistics for 123 Agglomerations over 1991 and 2000, by group: Men/Women and High Education (9 or more years of education) and Low Education (less than 9 years of education). Means and standard deviations.

	1991				2000			
	<9 yrs of Edu		≥ 9 yrs of Edu		<9 yrs of Edu		≥ 9 yrs of Edu	
	Male	Female	Male	Female	Male	Female	Male	Female
Perc. Administrative	5.43%	4.50%	30.84%	29.44%	3.98%	3.60%	20.96%	24.14%
Perc. Technical or Scientific	0.90%	5.39%	16.81%	43.75%	1.34%	4.23%	16.25%	36.78%
Perc. Farming	52.14%	26.25%	7.52%	0.93%	37.43%	13.68%	6.71%	0.77%
Perc. Mining	1.38%	0.12%	0.33%	0.03%	0.66%	0.05%	0.20%	0.01%
Perc. Industry	19.03%	11.45%	12.97%	3.84%	25.38%	10.05%	17.51%	4.57%
Perc. Commerce and Trade	6.64%	8.93%	12.64%	11.22%	8.21%	10.78%	14.38%	15.13%
Perc. Transport	5.11%	0.71%	4.46%	1.31%	6.88%	0.51%	6.12%	1.38%
Perc. Services	3.73%	38.96%	3.38%	5.89%	6.27%	50.04%	5.26%	12.77%
Perc. Domestic Services	0.49%	26.08%	0.14%	2.68%	0.94%	33.76%	0.21%	6.98%
Perc. Security and National Defense	1.04%	0.05%	6.30%	0.35%	0.95%	0.04%	6.16%	0.38%
Perc. Other	4.59%	3.63%	4.75%	3.24%	8.91%	7.03%	6.46%	4.07%
No Migrants	1403454	435290	284529	179502	1125683	426150	400489	296881
No Non-Migrants	13660763	4338761	2288760	1991011	11255160	4524492	3630459	3451467
Rain	11.27	4.19 (sd)			11.14	4.34 (sd)		
Transportation costs to Sao Paulo	1810.7	1436.99 (sd)			1549.34	1126.06 (sd)		

Table 2: Basic Statistics for 3214 rural municipalities (MCA - Minimal Comparable Areas), by group: Men/Women and High Education (9 or more years of education) and Low Education (less than 9 years of education) for 1991 and 2000. Rows 1-11 has the percentage of people (of each group) working in each sector (low skill workers concentrate in farming). Rows 12 and 13 has the average number of migrants (people who moved out of a rural area in the last 5 years) and non-migrants for each group. Row 14 have the mean monthly rainfall and standard deviation in brackets in rural areas for 1991 and 2000. Row 15 has the average and standard deviation in brackets of the index of transportation costs from rural area to São Paulo.

Estimating the impact of maids' wage on log labor participation									
OLS					IV				
	Level		First difference		First difference		First difference		
	Men	Women	Men	Women	Men	Women	Men	Women	
(Median) Hourly Wage	0.0598 (13.61)**	-0.026 (1.48)	-0.0031 (0.62)	0.0089 (0.21)	0.0018 (0.02)	0.104 (0.33)	-0.172 (2.40)*	0.375 (1.34)	
(Median) Maids' Hourly Wage	-0.087 (4.83)**	0.193 (6.86)**	-0.042 (1.43)	-0.157 (2.71)**	-0.460 (3.58)**	-1.248 (3.97)**	-0.224 (1.47)	-0.983 (3.54)**	
Observations	360	360	237	237	237	237	237	237	
R-squared	0.28	0.2	0.01	0.02					

Table 3: Estimates of the impact of the cost of domestic services (proxied by median maids' hourly wages) and wages on labor participation of high skilled men and women. T-statistics in parentheses (robust standard errors, clustered at agglomeration level). * significant at 5%; ** significant at 1%. For columns 1 and 2 we regress the log of labor participation on hourly maids' wages and group's hourly wage, for 123 agglomerations in 1980, 1991 and 2000, dropping missing values for some cities in the north of Brazil in 1980. For columns 3-8 we regress the change in log labor participation (change between 1980 and 1991 and 1991 and 2000, for 123 agglomerations, dropping missing cities for 1980 in the north of Brazil) on the change in median hourly wage of maids' and own group's hourly wage. In columns 5 and 6 we use as instruments for change in maids' wages and high skilled wages the ratio of female to male low skill migrants and the (log) number low skill rural migrants both obtained using equation 17. In columns 7 and 8 we add to the to our instruments Bartik's industrial shock (changes in employment at the national level, from equation 20) for high skill workers only.

Estimate for Impact of Transportation Costs and Rainfall on Log Number of Migrants				
	Low Skill		High Skill	
	Men	Women	Men	Women
Log Lag Natives	0.824 (11.78)**	0.862 (13.11)**	0.097 (3.19)**	0.095 (2.75)**
Log Agricultural Area (in he)	-0.065 (2.14)*	-0.067 (1.89)	0.021 (0.51)	-0.075 (1.98)*
Log Transportation Cost to Sao Paulo	0.087 (0.90)	0.108 (1.14)	-0.287 (2.00)*	-0.289 (2.08)*
Current Precipitation (in mm)	-0.0056 (2.29)*	-0.0069 (2.95)**	-0.0058 (1.37)	0.0025 (0.62)
Previous year's Precipitation (in mm)	-0.0016 (0.61)	-0.0035 (1.37)	-0.0023 (0.53)	-0.0016 (0.38)
Current Precipitation (in mm) in Semi-Arid Area	0.016 (2.77)**	0.00804 (1.44)	0.063 (5.98)**	0.049 (4.87)**
Previous year's Precipitation (in mm) in Semi-Arid Area	0.029 (4.71)**	0.017 (2.97)**	0.061 (5.70)**	0.069 (6.58)**
Municipalities (MCA) Fixed Effects	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
Observations	25712	25712	25594	25700
Number of Rural Municipalities (MCA)	3214	3214	3210	3214
Number of Zeros	753	676	7944	5707
R-squared	0.07	0.08	0.08	0.11

Table 4: Estimates of the impact of weather shocks and reductions in transportation costs on out migration from rural areas (3214 rural municipalities (MCA - minimal comparable areas) for 1987 to 1991 and 1996 to 2000, by group: high and low Skill, men and women. T-statistics in parentheses (robust standard errors, clustered at the MCA level). * significant at 5%; ** significant at 1%.

Estimates for Distance as an Explanation for Migration Location Decision				
	Percent Rural-Urban Migrants			
Log Distance	-0.021 (93.17)**	-0.022 (87.38)**	-0.023 (91.99)**	-0.022 (89.35)**
Log Distance (for Women)		-0.0012 (8.37)**	-0.0015 (9.91)**	-0.0013 (8.97)**
Log Distance (for High Skilled)		0.0033 (13.23)**	0.0063 (21.45)**	0.00401 (14.95)**
Log Distance (for High Skilled Women)		-0.00105 (3.71)**	-0.0018 (6.11)**	-0.0012 (4.14)**
(Log) People living in rural area* people living in urban area			0.0011 (94.45)**	0.0012 (35.16)**
Log number of people living in rural area				-0.0091 (30.00)**
Log number of people living in urban area				0.00094 (4.04)**
Dummy for High Skill	Yes	Yes	Yes	Yes
Dummy for Women	Yes	Yes	Yes	Yes
Dummy for High Skilled Women	Yes	Yes	Yes	Yes
Municipality (MCA) Fixed Effects	Yes	Yes	Yes	Yes
Observations	1581288	1581288	1578213	1578213
Number of Rural Municipalities (MCA)	3214	3214	3214	3214
R-squared	0.05	0.05	0.07	0.08

Table 5: Estimates of distance as an explanation of choice in destination (123 cities/agglomeration) from rural areas (3214 MCAs) for each group: High and Low Skill, Men and Women. T-statistics in parentheses (robust standard errors, clustered at the rural municipality (MCA - minimal comparable area)). * significant at 5%; ** significant at 1%.

Change in Maids' (Median) Hourly Wage				
	High Skill			
	Men	Women	Men	Women
Ratio Women to Men	-1.501	-1.501	-1.707	-1.707
Low Skill Migrants	(6.52)**	(6.52)**	(8.33)**	(8.33)**
Log Low Skill Migrants	0.094	0.094	0.114	0.114
	(2.88)**	(2.88)**	(3.57)**	(3.57)**
Bartik's Industrial Shock			-0.0021	-0.0021
			(1.17)	(1.17)
Observations	237	237	237	237
R-squared	0.11	0.11	0.12	0.12

Table 6: First Stage of IV - Instrumenting for (median) Maids' Hourly Wages. T-statistics in parentheses (robust standard errors, clustered at the agglomeration level). * significant at 5%; ** significant at 1%. In columns 1 and 2 we use as instruments for changes in maids' hourly wages (changes between 1980 and 1991 and between 1991 and 2000 for 123 agglomerations, dropping some missing observations for cities in the north in 1980) with the ratio of female to male low skill migrants and the (log) number low skill rural migrants both obtained using equation 17. Because maids' hourly wages vary only by location, the results are the same for high skilled men and women. In columns 3 and 4 we add to our instruments Bartik's industrial shock (changes in employment at the national level, from equation 20) for high skill workers only.

Change in High Skilled Workers' (Median) Hourly Wage				
	High Skill			
	Men	Women	Men	Women
Ratio Women to Men	-2.520	-1.335	-0.5995	-1.580
Low Skill Migrants	(2.40)*	(2.14)*	(0.60)	(2.94)**
Log Low Skill Migrants	-0.169	-0.104	-0.362	-0.079
	(1.22)	(1.66)	(2.40)*	(1.27)
Bartik's Industrial Shock			0.0198	-0.0025
			(2.62)**	(0.78)
Observations	237	237	237	237
R-squared	0.03	0.04	0.06	0.04

Table 7: First Stage of IV - Instrumenting for (median) hourly wages of high skilled workers (men and women). T-statistics in parentheses (robust standard errors, clustered at the agglomeration level). * significant at 5%; ** significant at 1%. In columns 1 and 2 we use as instruments for changes in high skilled workers' hourly wages (changes between 1980 and 1991 and between 1991 and 2000 for 123 agglomerations, dropping some missing observations for cities in the north in 1980) with the ratio of female to male low skill migrants and the (log) number low skill rural migrants both obtained using equation 17. In columns 3 and 4 we add to our instruments Bartik's industrial shock (changes in employment at the national level, from equation 20) for high skill workers only.

Estimating the impact of maids' wage on log hours worked (total).									
	OLS			First difference			IV		
	Level			First difference			First difference		
	Men	Women		Men	Women		Men	Women	
(Median) Hourly Wage	0.0036 (1.17)	-0.0396 (2.15)*		-0.025 (1.92)	0.022 (0.50)		0.161 (0.79)	0.202 (0.66)	-0.593 (3.29)**
(Median) Maids' Hourly Wage	0.062 (4.16)**	0.230 (7.94)**		-0.053 (0.78)	-0.081 (1.31)		-1.514 (4.01)**	-1.205 (3.86)**	-0.487 (1.31)
Observations	360	360		237	237		237	237	237
R-squared	0.06	0.23		0.02	0.01				

Table 8: Estimates of the impact of the cost of domestic services (proxied by median maids' hourly wages) on total hours worked per group for high skilled men and women. T-statistics in parentheses (robust standard errors, clustered at agglomeration level). * significant at 5%; ** significant at 1%. For columns 1 and 2 we regress the log of total hours worked by population of each group on hourly maids' wages and group's hourly wage, for 123 agglomerations in 1980, 1991 and 2000, dropping missing values for some cities in the north of Brazil in 1980. For columns 3-8 we regress the change in log of total hours worked by population of each group (change between 1980 and 1991 and 2000, for 123 agglomerations, dropping missing cities for 1980 in the north of Brazil) on the change in median hourly wage of maids' and own group's hourly wage. In columns 5 and 6 we use as instruments for change in maids' wages and high skilled wages the ratio of female to male low skill migrants and the (log) number low skill rural migrants both constructed using equation 17. In columns 7 and 8 we add to the to our instruments Bartik's industrial shock (changes in employment at the national level, from equation 20) for high skill workers only.