**Fewer Children, Shorter Commuting Time: Family Structure and Residential Location in Brazilian Urban Centers**

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Resumo: O trabalho considera as mudanças demográficas da família brasileira que apontam para uma forte redução no tamanho das famílias e fornece evidências de uma relação causal entre o número de crianças das famílias e o tempo de commuting do chefe, uma relação esperada de acordo com a Economia Urbana tradicional. Para tal, utiliza a variável instrumental associada aos sexos dos dois primeiros filhos, como sugerido por Angrist e Evans (1998), mas não ao tempo de commuting. Os resultados indicam uma robusta relação causal positiva entre número de filhos e o tempo de commuting dos chefes dos domicílios, importante para planejamento urbano brasileiro. O trabalho também explora os canais de atuação desta relação e provê evidências de que tal efeito está associado ao fato de que uma redução do número de crianças afeta positivamente a inserção dos membros da família no mercado de trabalho, o que tende a tornar a acessibilidade ao emprego mais importante.

**Palavras-Chave**: crianças; acessibilidade; tempo de commuting..

Abstract: The work explores the recent demographic changes of Brazilian families and investigates an existence of casual relationship between the families’ number of children the head commuting time, as expected according to Urban Economic Theory. In order to obtain a causal association, the research uses the same-sex instrumental variable proposed by Angrist and Evans (1998) for the families’ number of families. The results indicate a robust and positive causal relationship between these variables: fewer children, shorter commuting time of the household head. We also show that this relationship is explained by the negative effect of the number of children on the number of families’ members that works. Thus, the smaller the number of children, the more important becomes accessibility to jobs.

**Keywords**: children; accessibility; commuting time.

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**1. Introduction**

Under the traditional model of Urban Economics perspective, families’ residential location decisions involve dilemmas arising from the importance of accessibility to job and services, the quantity of urban space and local amenities (Fujita, 1989; Arnott e McMillen, 2005). As recognized at least since Beckmann (1973), once it implies distinct necessity of space and accessibility, the structure and the demography of the families play a very important role conditioning the location decision involving the above three dimensions (Fujita, 1989; Fujita and Thisse, 2013). In fact, past and present evidence strongly confirm the importance of family structure and demography as fundamental determinants of residential location and commuting time. Craine (2007), for example, uses official data for American cities to show that the bigger the family size, the longer is the commuting of the household head. More recently, also for American cities Edlund et al. (2015) show that the recent increase of distance gradient is associated with the presence of more skilled young professionals presenting longer work periods and less necessity of space.

From 1970’s on, one of the most important aspects of Brazilian society has been its quick demographic transition. As highlighted by Vasconcelos and Gomes (2012) based on official data, for example, the fertility rate of Brazilian women have drop from 4.4 siblings per woman in 1970 to only 1.9 siblings in 2010, i.e., a drop of more than 50% in 40 years. This decline, of course, implied a significant reduction of Brazilian families’ size and of the presence of siblings; according to the information from PNAD, an official annual household survey, the percentage of siblings living the urban Brazilian residences dropped from. Not surprise, this demography transition of Brazilian society has motivated different studies about its reflects on different social and economic dimension, such as income inequality, labor market and economic growth (Wajnman and Menezes-Filho, 2003; Paiva and Wajnman, 2005; Rios-Neto and Oliveira, 1999).

Very few studies, however, treated of the consequences of Brazilian families demographic changes for urban configuration of the cities. To the best of our knowledge, only Silveira Neto and Duarte (2016) have considered the impact of the number of families’ non-working members on the commuting time of the household head. Based on the traditional urban economic theory, the authors argued that a reduction of the number of non-working members implies a lower demand for space and this allows the families to live closer to the job locations. The authors provide evidence for the City of São Paulo confirming the expectations. However, in addition to only consider a unique Brazilian city, this work use a questionable empirical strategy based on using the religious status an instrumental variable to the numbers of non-working members. Importantly, the authors did not provided any evidence about the economic explanation behind the evidence.

The objective of the present work is to investigate the existence of causal relationships and families’ number of siblings and commuting time of the household for the set of all Brazilian urban centers. Note that, in the current Brazilian context of weaker rural-urban migration, this potential causal effect must implied severe changes in the way Brazilian cities are structured. Much probably, it will generate higher density cities and demand important improvement in public transport system and urban planning.

Our strategy relies on using the Angrist and Weiss (1998) ‘s instrumental variable capturing the sex diversity of the first two siblings of the families. As shown by these authors, families with the first tow siblings of the same sex tend to have more siblings than families with the first two siblings of different sex; we use this external information for identifying the impact of the number of children on household’s commuting time. In addition, we also investigate which economic mechanism is behind this relationship; arguably, a positive causal association between number of children and household head commuting time may arise i) because of the higher demand for space, which tend to be cheaper in suburban areas, ii) because of the stronger necessity of living close to schools, generally not close to household head job location, and iii) because a higher number if children tend to affect the partner decision about working time, which may make easier the decision about living in suburban areas.

Our set of evidence confirms the existence of a strong causal relationship between number of children and household head commuting time; this result is robust to different econometric models (2SLS, IV-probit) and different subsamples (car ownership, residence ownership, non-poor families). In our base line specification, we estimated that one more children increases by 21 percentage points the probability of the household head spends more than 30 minutes of commuting time. Furthermore, the additional investigation favors the influence of the number of children on the labor market insertion of the partners as the channel through what the number of children affects the residence location: as there is a negative influence of the number of children on the partner working time, it makes easier for a family to live more distant form job locations.

In addition to this introduction, the paper is organized in six more sections. In the section two, we provide some evidence about recent urban changes occurring in Brazilian urban centers. In the section three we discuss the theory and a set of evidence about the relation between family size and residential location. In the section four we discuss our data and empirical approach and in the section five we presented our first set of results. Section seven present additional set of evidence about the channels for understanding the effects of the number of children on household head commuting time. Final remarks are presented in the section seven.

**2. Families’ size reduction, residential space and commuting time in Brazilian urban centers: some stylized facts**

The strong drop in the fertility rate of Brazilian women observed by Vasconcelos and Gomes (2012) from 1970 on, have been producing a significant reduction of families’ size in Brazilian. The reasons behind the drop of the fertility rates in Brazil include dissemination of information through new kind of communication and the increasing the woman schooling and labor market insertion (see, for example, Faria 1989, Faria and Potter 1999, and Cravalho and Brito 2005). In the Figure 1, we show that this movement continued in the 1990s and 2000’s and implied a significant reduction of the share of siblings in the total of household members of Brazilian urban centers. In 2013, this share was around 27.8%, after a monotonic reduction since 1995, when this participation was above 37%. As expected, this strong movement potentially affects households’ economic decisions and choices, including residential locations and the necessity of space.

Figure 1 – Mean of the share of siblings (%) of the total household members –

Brazilian urban centers.

Actually, as can immediately be noted from the number of Figure 2 below, following this reduction of the presence of siblings in the Brazilian families, we perceive a consistent reduction of the average number of bedrooms of urban Brazilian residence from 1995 to 2013. This movement in the direction of smaller residences also happens when considering total number of rooms of the residence (not only bedrooms) and, importantly, occurs during a period of increasing per capita income of the Brazilian families. In fact, as we show in a next section, the apparent reduction of the residential space is not only consistent with the above movement of families’ size reduction, but it is partial and effectively caused by the reduction in the number of children of the Brazilian urban families.

Figure 2 – Mean of the number of bedrooms of Brazilian urban residences**.**

The reduction of necessity of residential space following the reduction of Brazilian families’ size has potential important implications for urban structure of its cities. Firstly, the smaller the residence, the closer to the jobs locations it tends to be located. This happens because residential space is generally cheaper in the suburban locations of the cities than in the moral central areas (Beckmann, 1973). Second, the fewer the number of children, more active in the labor market tend to be the two households, mainly the wife (Angrist and Wies, 1998). This tends to increase the importance of being located closer to the jobs’ locations. Finally, the greater the number of children, the stronger is the importance of accessing child and young specific services, such as schools. Again, there is here an influence in the residential location.

Our data set does not contain any information about residential location, but we can use information about the household head regular commuting time from residential location to job location to get some suggestion of the influence of these forces. In the following Figure 3, considering only urban families, we show the evolution of the share of household heads living in residence with less than 3 bedrooms (smaller residences) in the total of household heads with less than 30 minutes of commuting time. The evidence indicates a robust increasing of this share and suggests a movement for living in smaller residences closer to the job locations.Even been consistent with other demographic tendencies and urban problems, such as getting married later or general increasing importance of accessing job and servicesbecause of commuting cost, it also may reflect the reduction of residential specific locations associated with fewer children.

Figure 3 – Share of household heads living in residence with less than 3 bedrooms (%)

in the total of household heads with less than 30 minutes of commuting time.

This point looks even more probable when we look at the relationship between the number of children of the families and the household head commuting time. In the below Figure 4, we show the shares of the families with household head’s commuting time in the categories of up to 30 minutes (shorter) and more than 30 minutes (longer) for different number of household’s children. Consistent with the above arguments, the evidence makes clear that the bigger the number of children, the higher is the share of household heads presenting longer commuting time (for example, the share of household head with commuting time longer than 30 minutes increases from 34.5%, for the households with only one children, to 39.3%, for households with six children).

In the next sections we show evidence favoring a causal interpretation of this relationship and discuss the alternative economic mechanisms for explaining it. But we begin, in the next section, discussing more precisely theoretical arguments behind it and some evidence of the literature.

Figure 4 – Number of siblings and household head commuting time in Brazilian

urban centers -2013. The numbers represent shares of each category in the total of

families.

**3. Family structure and commuting time: theory and evidence**

Beckmann (1973) was the first to directly incorporate the family structure as an additional determinant of residential location and, thus, commuting time of the household head. In the simplest formalization, the higher the number of household non-working members, the weaker the valuation of accessibility to job by the household and the stronger the importance of residential space. Thus, being space cheaper in suburban areas, other characteristics equal, a family with more children tend to live much far from CBD or of the job locations than families with fewer children. The model can be extended to incorporate the addition effect of the presence of children associated, for example, with necessity of schools services on household location decision.

Fujita (1989) provides a simple formalization of Beckmann’s (1973) initial idea. Assuming that the family structure is characterized by tow parameters, *d* (the numbers of children of dependents) and *n* (total numbers of components), and an utility function depending of the consumption of composite good (*z*), residential space (*s*), and, of laser time (), we have . Thus, for example, the problem of the family can be initially stated as:

(1)

and

Where the first restriction is the budget of the family and assumes that each worker member has the same commuting costs (pecuniary, denoted by *ar*), where *r* denotes distance form CBD and *a* marginal transport cost, and salary (*w*). The second restriction represents de time allocation of each family’s member among work (), laser , and the trajectory form home to job location (*br*, where *b* is a technology parameter).

Assuming simple function form for the utility function, it is not difficult to show that in the family locational equilibrium we get two important associations (see Fujita, 1989):

and , (2)

in other words and respectively, the value of the unit of space decrease with the distance to the CBD (reflecting the traditional urban dilemma between access and space) and an increase in the number of non-working members (children) makes easier for a family to trade access for residential space. This happens because increase the relative importance of residential space in the welfare of the family. Thus, according to this traditional perspective, everything more equal, families with more children would locate more distant from the CBD.

The above simple model, however, does not take into account all potential effects of a bigger number of children on the residential location decision of the family. In fact, at least two additional channels can be identified. First, a bigger number of children can also favor a residential location decision closer to schools that, because it demands much spaces, are generally not located in the CBDs of cities. Second, the number of children can also affect the partners’ decision about the degree of labor market insertion. As shown by Angrist and Evans (1998), for example, the bigger the number of siblings, the weaker is the married women active participation in the labor market. This influence, thus, makes less important for more members of the family to be located nearer the jobs locations (CBDs). Importantly, note that both these additional influences also tend to favor a positive association between the number of children and more suburban residential location or household head’s commuting time.

The empirical literature is amply favorable to a positive association between family size and more distant residential location or household head’s commuting time. Quigley (1976) and Wienberg (1979), for example, were of the firsts to empirically study the relation for US cities, confirming a positive association, which was interpreted through demand for residential space channel. More recently, for example, Kim et al. (2005) have highlighted the importance of the number of children for residential location choice in the case of Oxfordshire, United King, and Buzar et al. (2005) have discussed more amply the relation between family demography and urban configuration for European west counties. Even more recently, Moos (2015) showed that the bigger the family size, the lower urban density in the case of Canadian cities, and Edlund et al. (2015) provided evidence indicating the importance of the demography for understanding de residential location patterns of American families. In particular, these last authors show families with children tend robust and regularly to live more distant from the CBD of the cities. Junga and Yang (2016) also showed that the bigger the number of children, the higher the probability of suburbia residential location of the household.

As for Brazilian cities, the association between family structure and commuting time or residential location is barely investigated. Based on information about the city of Belo Horizonte and using a multilevel model, Miranda and Domingues (2010) present evidence favoring a negative relationship between number of children and household’s commuting time. This evidence differs, however, from those obtained more recently by Monsueto et al. (2015), for the state of Goiás, and by Silveira Neto et al. (2015) and Duarte and Silveira Neto (2016), for the City of São Paulo. In line with international evidence, these authors found evidence favoring a positive relationship between non-working members of the household and household head’s commuting time. Although their importance, none of this works for Brazilian cities, however, presented evidence of a casual relationship between numbers of children and residential location or the commuting time of the household head.

**4. Empirical strategy and data**

In order to obtain a estimative of the causal influence of the number of children on the household head’s commuting time we need to consider the challenge posted by two traditional econometric problems, much evident in the case of Brazilian urban centers: the possibility of reverse causality and of omitted variable associated both to the number of children and to the commuting time. More clearly, reverse causality is an obvious problem, once better residential location (in terms of access to job and services) tend to attract familiar members, generating an spurious and weaker association between number of children and household head’s commuting time. Additionally, as in Brazilian urban centers the poorest families simultaneously tend to live at cities’ periphery or suburban locations and have more children, omission of adequate controls variables generates spurious and (now) stronger association between household’s number of children and household head’s commuting time.

Fortunately, in the present specific case, we can use the instrument variable proposed initially by Angrist and Evans (1998) that use the information about the diversity of sex of the two first siblings. As convincingly argued by these authors, when the first two siblings are of the same sex, families tend to have another sibling than when the first two siblings are of different sex. As having the first two siblings of the different of same sex is not a choice of the family, this generates an external source of variation of family number of children. The limitations of the strategy are that it not can be applied when families choice the sex of the siblings, neither it is possible to be applied for families with less than two children. However, the first limitation does not apply in the case of Brazilian families and, as it is shown in the next sections, the second one appears to be empirically unimportant.

More formally, denoting the number of children of the family *i* by *Ci* , an indicator if the two first siblings are of the same sex by *Samesexi*, a set of control variables by *Xi*, and the household head’s commuting time by *Ti* , we use 2SL-IV estimator in a system represented by the following specifications:

(1)

(2)

Where *α, β, γ, θ* e *ρ* are parameters and and error terms. Thus, equation (1) represents the first stage specification and equation (2) the second stage.

In order to get reliable estimative (consistency and low bias), we have to have a good instrument (in terms of association between the endogenous variable and the instrument, i.e., and the exclusion restriction applied (). As we show in the next sections, the first condition is easily obtained. As for the second one, we relied on the fact the extreme majority of Brazilian families does not choice the sex of the siblings and presumably, thus, we have an exogenous source of variation in the number of children of these families.

The set of control variables includes traditional variables used in the empirical literature of determinants of commuting time (Craine, 2007; Silveira Neto et al. 2016). Thus, the variables reflect i) the influence of different kinds of preference with respect to residential location, ii) the influence of the location economic activities and kind of occupation, and iii) urban locations (metropolitan region and state). In first group, we include personal and familiar characteristics, such as sex, race, age, marital status, and per capita income; in the second group, we consider economic sectors and different kinds of occupation; and in the third category we include a set of dummies for the 10 metropolitan regions and for the 27 Brazilian sates. In the next Table 2, we present descriptive statistics of these control variables.

Our data set is obtained from the micro data of PNAD of the year of 2013, an official household survey provide by IBGE (Brazilian Institute of Geography and Statistics). Our final sample from PNAD includes only urban household heads between 18 and 65 years old that worked out of their residence. In addition, in order to maintain families making locational residential choices, we include only families that owner or rent the residence, i.e., we exclude families living in residences due to favors or other motives. The final sample amounts to 44,788 households of Brazilian urban centers and, from these households, the total of households with at least two siblings amounts to 14,033. In the following Table 3 we present some descriptive statistics of these two samples.

As can be noted from the numbers of Table 2, the two samples are not very different, except for the fact that the sample of households with at least two children, as expected, present a higher perceptual of married household head (around 75%), lower per capita income, and a bigger number of children (2.7).

**Table 2 – Descriptive Statistics**

|  |  |  |
| --- | --- | --- |
|  | **All Families**  **(1)** | **Unless two siblings families**  **(2)** |
| Married (%) | 69.25 | 74.55 |
| Woman (%) | 31.55 | 31.47 |
| Education1 (%) | 10.00 | 11.50 |
| Education2 (%) | 15.52 | 17.32 |
| Education3 (%) | 16.95 | 18.67 |
| Education4 (%) | 57.53 | 52.51 |
| Age1 (%) | 6.92 | 4.69 |
| Age2 (%) | 26.24 | 24.88 |
| Age3 (%) | 44.17 | 49.87 |
| Age4 (%) | 22.66 | 20.56 |
| White (%) | 44.70 | 40.90 |
| Fulltime (%) | 82.48 | 82.22 |
| Commerce (%) | 17.88 | 17.21 |
| Services (%) | 54.59 | 53.87 |
| Manufacturing (%) | 14.04 | 14.17 |
| Civil Building (%) | 13.50 | 14.75 |
| Working members | 1.8 | 2.3 |
| Per capita familiar income (R$) | 1,361.58 | 1,031,85 |
| Formal (%) | 61.32 | 59.90 |
| Informal (%) | 16.98 | 18.21 |
| Employer (%) | 5.02 | 4.87 |
| Self-employed (%) | 16.69 | 17.01 |
| Children (numbers) | 1.2 | 2.7 |
| Commuting time (%) | 34.59 | 35.35 |
| Observations | 44,788 | 14,033 |

Source: Authors’ calculation using data from the PNAD 2013. Commuting time indicates the share

with more than 30 minutes in the trajectory from residence location to job location.

As discussed above**,** our instrumental variable is presumably exogenous with respect the conditionings of commuting time (apart from the influence through the number of children), something, of course, difficult to prove. The numbers of the next Table 3, that presents descriptive statistics for groups of household with the first two siblings of the same sex (column (1)) and with the first two siblings of different sex (column (2)), however, indicates that our instrumental variable does a good job in balancing the variables among the two samples. In other words, there is no any important difference between the groups on the distribution of the variables. The balance of the set of variables between the two groups, thus, mimics what we would expect from a random distribution of them between the two kinds of households; this favors using the variable as an instrument for the number of children.

**Table 3 – Descriptive Statistics – Households with at least two siblings**

|  |  |  |
| --- | --- | --- |
|  | **First two siblings of the same sex**  **(1)** | **First two siblings of different sex**  **(2)** |
| Education (years of schooling) | 9.4 | 9.9 |
| Age (years) | 45.8 | 41.3 |
| White (%) | 39.78 | 40,99 |
| Fulltime (%) | 81.33 | 82.51 |
| Commerce (%) | 16.99 | 17.23 |
| Services (%) | 54.53 | 53.82 |
| Manufacturing (%) | 15.03 | 14.10 |
| Civil Building (%) | 13.45 | 14.86 |
| Formal (%) | 60.41 | 59.86 |
| Informal (%) | 17.83 | 18.85 |
| Employer (%) | 4.48 | 4.91 |
| Self-employed (%) | 17.25 | 16.99 |
| Children (numbers) | 3.0 | 2.5 |
| Commuting time (%) | 36.80 | 35.17 |

Source: Authors’ calculation using data from the PNAD 2013. Commuting time indicates the share

with more than 30 minutes in the trajectory from residence location to job location.

**5. Results**

In this section, we present estimative of the impact of the number of children of the household on the commuting time of its head, i.e., on time it takes daily form residence to job location. In order to highlight the importance of our strategy, we start presenting traditional OLS and Probit estimations that, as discussed before, hardly can be taken as a good approximation of the effects we look for. Thus, in second subsection, we present our base line estimation that relies on using an indicator of the siblings’ sex diversity of the two first siblings as instrument for the number of children. We finish the section presenting some robustness checks for this base line result; the tests involve obtaining new estimation by varying the econometric IV estimator, by adding new controls variables, and by considering specific samples.

**5.1 Exploratory evidence: OLS and probit estimative**

In the following Table 4, we present the estimation of the impact of number of children on household head commuting time using traditional Linear Probabilty Model (OLS estimator) and Probit model (ML estimator), both considering all kind of families (columns (1) and (3)) and only families with at least two siblings (columns (2) and (4)). In all cases we use an dummy indicator for the fact that the household spend more than 30 minutes of commuting time as dependent variable and the set of control variables presented in Table 2.

As can be immediately noted from any of the four estimative, the results indicate a positive association between the number of children and household head commuting time. The association, nevertheless, appears not very important; for the OLS estimative using all kinds of families, for example, the result indicate that an additional children increases by only 0.8 perceptual point the probability of spending more than 30 minutes, value that is the same when using only families with at least two siblings. The estimative obtained using probit model is higher (a 2.5% perceptual points impact), but still no so important, and again we get similar value for the reduced sample.

Note that the not so important associations between the two variables obtained using both models are consistent with a potential endogeneity arising form reverse causality discussed before: as the residential locations are nearer to job locations, they are probably closer to other kind of services that matter for other components of the household, what tends to make the residential locations attractive to these components, including children. This fact favors an underestimation of the influence of children on household head’s commuting time. Perceive, in addition, that the fact that using different samples generates similar results is welcome; it suggests that the potential bias acts in the same way on the estimative and provides some confident that our results using IV estimator and the reduced sample probably presents some validness in a more general context.

**Table 4 - The influence of the number of children on the household head’s commuting time – Brazilian cities – The dependent variable is an indicator of more than 30 minutes of commuting time.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **LPM – OLS** | | **Probit *–* ML** | |
|  | **All**  **Families**  **(1)** | **Two or more siblings**  **(2)** | **All**  **Families**  **(3)** | **Two or more siblings**  **(4)** |
| Children | 0.008\*\*  (0.002) | 0.008\*\*  (0.004) | 0.024\*\*  (0.006) | 0.025\*\*  (0.011) |
| Controls | Yes | Yes | Yes | Yes |
| R2/Pseudo R2 | 0.0767 | 0.0764 | 0.0626 | 0.0617 |
| F/Wald | 96.72\*\* | 30.31\*\* | 3278.87\*\* | 1023.93\*\* |
| Observations | 44,788 | 14,033 | 44,788 | 14,033 |

Obs.: Robust standardized error in parenthesis. \*\* p < 0.05, \* p < 0.1. Controls include all the variables presented in Table 3.

**5.2 IV estimative**

We now present our IV estimative for the influence of the number of children on the household head’s commuting time. As discussed, this evidence is obtained using the “same-sex” variable as instrument for the number of children, once, presumably, this variable affect the number of children of the couple and it is not associated with the commuting time of the household head though a different channel than the number of children. The estimative are presented in the following Table 4, both for the reduced form (column (1))) and or the structural form (column (2)). Again, all the estimative ere obtained considering the set controls presented in Table 2.

From the first column of Table 5, we note that there is a positive and statically significant association between the instrument (indicator if the first two siblings are of the same sex) and the dependent variable (indicator of more than 30 minutes of commuting time), something welcomed for getting confident in using the variable as instrument.

In the column (2) we present both first and second stages of the IV regression (using 2SLS). First of all, note that both Durbin and Wu-Hausman statistics indicate rejection of the null hypothesis of exogeneity of the variable represented by the number of children. Thus, IV estimator is preferable to OLS estimator[[1]](#footnote-1). In addition, the results of the first stage provides confident for using the proposed instrument; using the Same-sex variable as a regressor for the number of children we obtained a positive and statistically influence of the instrument on the number of children: by having the tow first sibling of the same sex increases the number of children by 0.17, which is an important effect, considering the number of children of Brazilian urban families.

In fact, the set of statistics presented for evaluating the instrument provides strong confident for using it. First, note the *F* statistic for the first stage is statistically significant and assume a value that easily exceeds 10, the cutoff value suggested by Stock, Wright, and Yogo (2002). Second, by comparing the Cragg-Donald statistic for testing the weakness of the instrument with the values proposed by Stock and Yogo (2005) for a rejection rate of Wald test of 5% of no more than 10%, we reject the null hypothesis of a weak instrument.

The results for the second stage of the IV SLS strategy are present in the second part of column (2) of Table 5. The estimative indicates now a significant impact of the number of children on the probability of the household spends more than 30 minutes of commuting time: for families with at least two children, one more children increase this probability by 21.3 perceptual points. This effect is statically significant eve using the AR (Anderson and Rubin) robust statistic proposed by Finlay and Magnusson (2009) when the instrument is weak. Consistent with previous expectation, we note that this estimative is considerably higher than the one obtained by the OLS regression and suggest that the family structure is a substantive factor conditioning household residential location in Brazilian urban centers.

**Table 5 - The influence of the number of children on the household head’s commuting time – Brazilian cities – Base line.**

|  |  |  |
| --- | --- | --- |
|  | **Reduced form – OLS**  **(1)** | **IV - 2SLS**  **(2)** |
|  |  | *First Stage* |
| Same-sex | 0.036\*\*  (0.016) | 0.170\*\*  (0.038) |
| Controls | Yes | Yes |
| *F* | 30.25\*\* | 17.79\*\* |
| R2 | 0.0764 | 0.0801 |
|  |  | *Second Stage* |
| Children | **-** | 0.213\*\*  (0.107) |
| Controls | - | Yes |
| Wald |  | 1169.38\*\* |
| *F* | - | 19.37\*\* |
| Durbin (score, *Chi*) | - | 4.540\*\* |
| Wu-Hausman (*F*) | - | 4.544\*\* |
| Cragg-Donald | - | 26.296\*\* |
| AR robust | - | 4.95\*\* |
| Observations | 14,033 | 14,033 |

Obs.: Robust standardized error in parenthesis. \*\* p < 0.05, \* p < 0.1. Controls includes all the variables

presented in Table 3. The instrumented variable is the number of siblings (“Children”) and the excluded instrument is an indicator of having the first two children of the same sex (“Same-sex”).

**5.3 Robustness checks**

We now consider two kinds of robustness checks for the above results. First, by assuming a specific distribution for the error component of equation (2) and (3) (Normal distribution), we obtain evidence of the impact of the number of children on the household head’s commuting time by implementing two different IV-probit approaches. As highlighted by Angrist and Pristich (2009), this implies using more restrictive approaches once an additional hypothesis is assumed. Nevertheless, it is useful here just to test if our base line results are not specifically associated with the specific econometric model we used to get it. The second kind of test relies on considering specific subsamples and additional control variable. The idea if to verify is our results are due to the influence or presence of families with specific characteristics.

In the following Table 6 we present our estimative for two different approaches using IV-Probit estimator considering as dependent variable an indicator for household head’s commuting time longer than 30 minutes (the same as before). The results in column (1) shows the results obtained by ML estimator when the parameters of the relation between the endogenous regressor and the instruments are estimated jointly with the parameters of the probit model. On the other hand, the results in column (2) are obtained by using Newey’s (1987) minimum chi-squared estimator that is based on Rivers and Vuong’s (1988) two-step estimator, which tends to be less inefficient than the ML estimator[[2]](#footnote-2).

The estimated coefficient obtained using the two approaches are not immediately comparable, once the second approach provides an estimative normalized by the conditional variance of error term, but both estimated associated with number of children indicate a positive effect of it on the probability of a household head to spend more than 30 minutes of commuting time. In column (1), for example, we get an increase on this probability about 52.2 perceptual points, an effect much higher than the previous one obtained using 2SLS-IV estimator. Note that, based on the Wald statistic, in both cases we also reject the null hypothesis of the exogeneity of the instrumented variable and the null hypothesis of non-effect of the instrumented variable on the household head’s probability of a longer commuting time when using a weak instrument robust statistic. Thus, this set of evidence indicates that previous result qualitatively continuous valid when using traditional models for discrete dependent variable.

**Table 6 - The influence of the number of children on the household head’s commuting time – Brazilian cities – IV estimative – Robustness checks I: different IV estimators**

|  |  |  |
| --- | --- | --- |
|  | **IV-Probit**  **(1)** | **2S-IV-Probit**  **(2)** |
| Children | 0.522\*\*  (0.209) | 0.589\*\*  (0.107) |
| Controls | Yes | Yes |
| Wald | 1472.97\*\* | 914.53\*\* |
| Wald (exogeneity) | 4.02\*\* | 4.19\*\* |
| AR robust | 4.56\*\* | 4.56\*\* |
| Observations | 14,033 | 14,033 |

Obs.: Standardized error in parenthesis. \*\* p < 0.05, \* p < 0.1. Controls includes all the variables

presented in Table 3. The instrumented variable is the number of siblings (“Children”) and the excluded instrument is an indicator of having the first two children of the same sex (“Same-sex”).

Now we investigate if the results of the previous sections can be attributed to the presence of particular kind of families. First, we consider the effects of car ownership and of residential ownership. Arguably, the number of children can affect the decision about to own or not a car and thus to affect the household head’s commuting time. Controlling for this channel provides additional evidence about the influence of the number of the children on household residential location in a broader scenario. On the other hand, we also expect that residence ownership reflects more long run locational decisions that are associated with structural factors, such as number of siblings of the family. Families that rent the housing service presents more facility of moving but they residence condition may reflect more short run factors, such as temporary job opportunities. These new results are presented in columns (1) and (2), respectively, of Table 7.

Second, due to their clear spatial location in Brazilian cities, we obtain additional evidence considering a sample of non-poor (or richer) families. As poor-families have many children and live in suburban locations of Brazilian cities, where residential infrastructure services conditions are much worse (Feitosa et al., 2007; Oliveira and Silveira Neto, 2015), this, as discussed before, could be a source of problem due to a spurious association between residential location (and so commuting time) and the number of children. In addition of using familiar income as control, our instrumental variable approach, how ever, is capable of ruling out this kind of influence. In order to make this point clearer, we provided specific evidence of the effect of the number of children on the household head’s probability of having a longer commuting time for two specific samples: a sample of residences with access to a complete set of infrastructure services (garbage regular collection, sewage, piped water, and brick walls) and a sample composed excluding the 25% poorest families (measure by per capita family income). These new results are presented, respectively, in columns (3) and (4) of Table 6.

The results presented in column (1) of Table 1 indicate that controlling for car ownership does not affect the result obtained in the previous section. The new diagnostic tests for exogeneity and for weakness of the instrument also present similar results. In fact, the estimated coefficient for the number of children is practically the same with or without controlling for car ownership, which suggest that the effect of this family variable on the household head’s commuting time does not depend on the way the household head use to move from residence to job location. The results for residence ownership are presented in column (2) of Table 6 also look similar to the previous one. Note, however, that here we get a higher effect for the influence of the number of children on residential location (a 34.3% perceptual point effect on the probability of the household head’s present a longer commuting time). Consistent with previous expectations, this evidence suggests stronger adjustment to the number of children for this kind of families.

Finally, the set of evidence from columns (2) and (3) of Table 7 indicates our previous results do not qualitatively change when considering residences with complete residential infrastructure services and richer families. In fact the new estimated coefficients for the influence of the number of children is a little higher, which is consistent with stronger locational arbitrage capacity of these families. More important, these new evidence confirm that our strategy ruled out spurious association between the number of children and household head’s commuting time that could arises from the poorest families (which tend to have more children) living in Brazilian cities’ periphery.

**Table 7 - The influence of the number of children on the household head’s commuting time – Brazilian cities – IV estimative – Robustness checks II: different controls or samples.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Car**  **Ownership**  **(1)** | **Residence Ownership**  **(2)** | **Complete Infrastructure**  **(3)** | **Non-poor Families**  **(4)** |
| Children | 0.230\*\*  (0.108) | 0.343\*\*  (0.151) | 0.358\*\*  (0.178) | 0.365\*  (0.189) |
| Controls | Yes | Yes | Yes | Yes |
| Wald | 1336.77\*\* | 730.00\*\* | 686.02\*\* | 752.75\*\* |
| *F* | 19.78\*\* | 13.03\*\* | 10.48\*\* | 13.63\*\* |
| Durbin (score, *Chi*) | 5.61\*\* | 8.27\*\* | 6.34\*\* | 5.59\*\* |
| Wu-Hausman (*F*) | 5.62\*\* | 8.31\*\* | 6.36\*\* | 5.60\*\* |
| Cragg-Donald | 26.87\*\* | 17.84\*\* | 14.63\* | 13.39\* |
| AR robust | 5.99\*\* | 8.87\*\* | 6.80\*\* | 5.96\*\* |
| Observations | 14,033 | 10,752 | 10,726 | 10,515 |

Obs.: Robust standardized error in parenthesis. \*\* p < 0.05, \* p < 0.1. Controls include all the variables presented in Table 3. The instrumented variable is the number of siblings (“Children”) and the excluded instrument is an indicator of having the first two children of the same sex (“Same-sex”). The “Car ownership” specification includes am additional control for car ownership; the “Complete Infrastructure” specification considers only a sample of residences with sewage general net access and brick walls; “Non-poor families” specification excludes the 25% poorest families; and “Residence Ownership” specification includes only families that are proprietary of the residence (excludes families that rent they housing service).

The set of evidence presented in Tables 5-7, thus, are clearly favorable to our previous result that there is causal association between the number of children of the families and the commuting time of the household head for the Brazilian urban centers: the bigger the number of families, the higher the chance of a household head presents a longer commuting time. But identifying this casual association does not mean clear knowledge about the economic mechanism through it operates. We try to deal with this point in the next section.

**6. Fewer children and longer commuting time: smaller residence or weaker partner labor activity?**

Traditional Urban Economic Theory identify a clear channel for the impact of the number of children on household residential location and, thus, on household head commuting time (Fujita, 1989, Fujita and Thisse, 2013): as the number of non-working member of family increases, the stronger is the demand for residential space and more distant from jobs location is the family residence, once space is cheaper is locations of less favorable access. However, as we agued before, this is not the only channel for a positive association between number of children and household commuting time. Fewer children can also turn weaker the necessity of being near some services that needs space, such as schools; this effect can make the household head commuting shorter, once the residential location becomes less dependent of other members necessity. In addition, fewer children can make weaker the necessity of executing household tasks by the partners (in Brazil, probably, the wife) and affect the supply of labor by the couple. This last effect can also favor more central (close to jobs) residential locations and, thus, generate shorter the commuting time. In this section we provided evidence of the importance of two of these mechanisms for the case of Brazilian urban centers.

Although there is abundant evidence of the importance of schools location for the residential location of families in the case of US and European cities (see, for example, Black, 1999; Bogart and Cromwell, 2000; Gibbon and Machin, 2005), the available evidence for Brazilian cities are scarce. To the best of our knowledge, Amrein (2010) is the unique study about the question and specifically try to investigate the proprieties price capitalization associated to the proximity of schools in the city of São Paulo. The evidence obtained form this work indicates no effect of proximity of schools on propriety price. The scarcity of the investigation and the evidence form this specific work are probably explain by the fact that in Brazil there is no institutional link between residential location and school attendance. Thus, we decide to focus on the importance of the other two mechanisms, i.e., to study the importance of residential space and of the effect on the couple labor supply associated with the number of children.

To begin with, using the same IV approach for identifying the effect of the number of children on the commuting time, in the following Table 8 we present evidence of the influence of the number of children on the numbers of rooms and bedrooms (proxies for residential space) (columns (1) and (2)) and on the number of household workers (column (3)). Only the second stage results are presented but results for the first one can be available upon request.

From the numbers of columns of Table 8, we note that all the estimative present expected signals: a higher number of children affect positively the number of bedrooms and rooms and negatively the number of household workers[[3]](#footnote-3). Thus, this set evidence favor the ideas that the higher the number of children, both the bigger are the residential space and the lower the number of partners working.

**Table 8 - The influence of the number of children on residential space size and on the**

**numbers of household workers– Brazilian cities – IV-2SLS and OLS estimative.**

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Bedrooms**  **(1)** | **Rooms**  **(2)** | **Household partners**  **working**  **(3)** |
| Children | 0.238\*\*  (0.062) | 0.045\*\*  (0.015) | -0.128\*\*  (0.042) |
| Controls | Yes | Yes | Yes |
| Wald/F | 2468.18\*\* | 92.24\*\* | 1459.54\*\* |
| *F* | 142.88\*\* | - | 157.89\*\* |
| Durbin (score) | 9.04\*\* | 0.12 | 17.55\*\* |
| Wu-Hausman | 9.06\*\* | 0.12 | 17.96\*\* |
| Cragg-Donald | 203.61\*\* | - | 227.46\*\* |
| AR robust | 15.59\*\* | - | 10.46\*\* |
| Observations | 14,033 | 14,033 | 14,033 |

Obs.: Robust standardized error in parenthesis. \*\* p < 0.05, \* p < 0.1. “Bedrooms” indicates the

number of bedrooms of the residence, “Rooms” indicates the number of rooms, and “Household workers”

indicates the number of the non-siblings workers in the household. “Controls” includes all the variables

presented in Table 3. In specifications (1) and (3), the instrumented variable is the number of siblings

(“Children”) and the excluded instrument is an indicator of having the first two children of the same sex

(“Same-sex”).

In order to evaluate the importance of these effects as mechanism behind the effect of the numbers on the household head chance of presenting a longer commuting time, we addition these variables as new control variables in our initial specification used to measure this association. The set of new evidence is presented in the following Table 9; the columns (1)-(3) present evidence considering the residential space variables and the column (4) presents the estimative when considering the number of working partners as an additional explanatory variable. Again, for space reasons, only second stage coefficient estimative for the number of children is presented.

As can be immediately noted form the estimative for the coefficients of specifications (1)-(3), the value obtained for the number of children barely change when compared to our base line estimative (see Table 5). On the other hand, the addition of the variable capturing the number of working partners of the household to our initial specification turn the coefficient for the number of children statistically insignificant (column (4) of Table 9). Thus, the set of evidence of Table 8 indicates that although a higher number of children appears to increase the demand to space, this effect is not enough for families trade-off accessibility for residential space. Nevertheless, a higher number of children appear to affect the household head’s commuting time thought its effect on the household partners labor market insertion; together with the evidence of Table 9, this result is consistent with weaker (stronger) necessity of home services associated with lower (higher) number of children and, thus, with more (less) importance of accessibility to jobs when deciding the residential location.

**Table 9 - The influence of the number of children on residential space size and on the chance of a longer commuting time– Brazilian cities – IV-2SLS.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **(1)** | **(2)** | **(3)** | **(4)** |
| Children | 0.220\*\*  (0.110) | 0.211\*\*  (0.107) | 0.215\*  (0.110) | 0.281  (0.180) |
| Controls | Yes | Yes | Yes | Yes |
| Bedrooms | Yes | No | Yes | No |
| Rooms | No | Yes | Yes | No |
| Household partners workers | No | No | No | Yes |
| Wald/F | 1164.27\*\* | 1213.60\*\* | 1206.65\*\* | 1039.99\*\* |
| *F* | 18.68\*\* | 19.43\*\* | 18.52\*\* | 7.82\*\* |
| Durbin (score) | 4.67\*\* | 4.42\*\* | 4.42\*\* | 3.35\* |
| Wu-Hausman | 4.68\*\* | 4.42\*\* | 4.43\*\* | 3.34\* |
| Cragg-Donald | 25.45\*\* | 26.39\*\* | 25.24\*\* | 10.90 |
| AR robust | 5.13\*\* | 4.85\*\* | 4.85\*\* | 3.57\* |
| Observations | 14,033 | 14,033 | 14,033 | 14,033 |

Obs.: Robust standardized error in parenthesis. \*\* p < 0.05, \* p < 0.1. “Bedrooms” indicates the number of bedrooms of the residence and “Rooms” indicates the number of rooms. In the specifications of columns (1) and (2) controls include all the variables presented in Table 3, except the economic activity and occupation variables; for the specifications of columns (3)-(5), controls includes the variables of Table3 plus “bedrooms” and/or “rooms” according to the table indication. In all specifications, the instrumented variable is the number of siblings (“Children”) and the excluded instrument is an indicator of having the first two children of the same sex (“Same-sex”).

**7. Final Remarks**

In the last decades, Brazilian society experienced a substantive reduction of the family size, with fertility rates dropping from 4.4 siblings per woman in 1970 to 1.9 siblings in 2010. As the family size is an important determinant of household residential location, once it affects the demand for space, it is much surprise that the consequences of this demographic change for cities configuration was virtually not studied. In this paper we investigated the causal impact of the number of children on the household head commuting time in Brazilian cities and explore the potential economic channels.

In order to deal with potential endogeneity (good location, for example, can attract people), the main set of evidence was obtained using the “same-sex” indicator proposed by Angrist and Evans (1998) as an instrumental variable for the number of children of the household. Our base line result indicates that one more children increases by 21.3 perceptual points the probability of a household head presents a commuting time of more than 30 minutes, a very significant influence. This result survives to a set of robustness checks, including using different econometric models (ex. IV-Porbit) and specific subsamples (ex: considering only families owners of car or residence and non-poor families).

We also provided evidence about the channels through which the variation in the number of children affects the household head commuting time. Although our evidence indicates that the fewer the number of children, the smaller the residential space and the stronger the labor market involvement of both partners, only the second effect appears explain the above initial result. In other words, here our results strongly suggest that the fewer the number of children, the stronger families’ members in the labor market and thus more important becomes accessibility to jobs when deciding about residential location.

As in the next years we will probably continue to have a decreasing in the Brazilian rural-urban migration, the size of families living in urban areas will become even more important to understand space Brazilian cities configuration. Thus, our set of evidence indicates that we will continue to experience an economic force favoring within cities movements to more central areas, what certainly can increase cities’ density and generate more intense use of urban infrastructure (including worsening traffic congestion and sewage deficit). If the urban planning of Brazilian cities does not take in account this movement, there is a good chance of decreasing our urban quality of life

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1. Both estimators a biased in this situation, but only IV can generate consistent estimative. [↑](#footnote-ref-1)
2. See Wooldridge (2010) for a detailed discussion of these approaches. [↑](#footnote-ref-2)
3. Note that for the number of rooms we do not reject the hypothesis of erogeneity of the variable associated with the numbers of children, thus we use OLS estimator. For the other two variables, all diagnostic tests for exogeneity and instrument weakness present strong evidence favoring IV estimator (the same applies to the specification of Table 8). [↑](#footnote-ref-3)