Household job search and labor supply of secondary wage earners

October 5, 2022

Abstract

We investigate the intra-household labor supply dynamics of secondary wage earners of families – children and mothers – using a household job search approach. We focus on Brazilian youth aged 14 to 24 years living with their parents. We develop and estimate a household job search model that explicitly considers children as decision-makers. The model distinguishes between unemployment and inactivity, allows for different search behavior and job acceptance depending on the situation of the other member in the labor market, and for parental investment in child education. We decompose the contribution of labor market shocks specific to each household member to explain changes in employment and participation rates between 2003-06 and 2010-13. Our estimation results show that the increase in the employment rate of children is the result of better labor market conditions, a worse job arrival rate for mothers, and an increase in mother flow in the labor force. In our counterfactual simulations, we find that most of the observed fall in the children's participation rate is explained by the net effect of movements of children in and out of the labor force and by an improvement in labor market conditions. We also find evidence for the added worker effect: an increase in the father's income reduces the employment and participation of children and mothers. Cross-effects are underestimated if we ignore endogenous schooling. Therefore, our results strengthen the argument about the relevance of household search behavior in the labor supply decisions of secondary wage earners in families.

Keywords: Household search model; youth; labor supply; added worker effect; discouragement effect; schooling.
JEL codes: E23, J64, J22.

1 Introduction

Intra-household labor supply dynamics are important to understand consumption inequality[1], employment and participation rates[2], and to estimate the value of job amenities[3]In addition, labor supply of household members is an insurance mechanism to smooth and insure households against permanent wage shocks.

In the context of negative wage shocks faced by the primary earner of the family, the secondary earners may respond, entering the labor market, which is known as the added worker effect (Lundberg, 1985[28]). On the other hand, secondary workers may have a tendency to leave the labor force when the primary earner in the household gets an opportunity in the labor market or moves to another job with a higher salary, which is known as the discouraged worker effect, first introduced in the paper of Long (1958)[27], and well described by Benati (2001)[5].

Therefore, intra-household decisions determine the replacement of family members in the labor market in order to maintain a constant income in the context of shocks. Thus, aggregate labor market rates, such as employment and participation rates, can be more or less responsive to economic activity, depending on these intra-household dynamics. Employment strongly correlates with GDP around the world. On the other hand, labor force participation is much less correlated with economic activity (OECD, 2018). In Brazil, we observe a similar pattern.

In this paper, we aim to investigate the intra-household labor supply dynamics of the secondary earners of families, using a household job search approach. In developing and developed countries, even with the increase in female labor market participation, men are frequently the primary earner of families, whereas women and children are secondary earners. Thus, we focus on the intra-household labor supply dynamics of these two family members. Our main objective is to use a familiar theoretical approach that allows us to recover the employment and participation rates of children and mothers, and to verify how the labor market decisions of these secondary wage earners are interrelated.

The paper addresses three main questions: (i) Is the decrease in the participation rate of children aged 14 to 24 years related to changes in their mother's labor market status?, (ii) How much of the decrease in children's participation rate is related to the mothers' labor market status, fathers' income, children's own labor market shocks or even to the cost of investing in the children's education?, and iii) What are the impacts on children's

[1]See Blundell et al, 2016[6].
[2]See Mankart and Oikonomou, 2017[30].
[3]See Dey and Flinn, 2008[15], and Conti et al, 2018[13].

well-being of changes in the mothers' labor market conditions and in the father's income?

The way children react to parental unemployment or income shocks has not received much attention in the macro-labor literature. Indeed, the behavior of the youth who live with their parents differs from the behavior of married women, e.g. younger individuals have more volatile employment (Jaimovich and Siu, 2009[25]; Jaimovich et al., 2013 [24]). Moreover, the evidence on the effects of fathers' job loss on employment and participation of children is mixed (Cunningham and Maloney, 2000[14]; Skoufias and Parker, 2006[31]; Duryea et al, 2007[16]). On the other hand, a higher participation and labor income of mothers (not of both parents) significantly reduce the likelihood of their 15-24 children entering the labor force (Vieira et al, 2016[34]).

Furthermore, the added worker effect is widely studied for couples, but the literature on the effect among secondary earners is rare and its magnitude can be amplified when adult children live with their parents. Another fact that motivates our paper is that cohabitation of adult children and parents is widespread in developing countries and Southern Europe, but also increasingly common in the US and UK [4].

We focus on Brazilian children aged 14 to 24 years living with parents – 63% of this age group (PME, 2015). We develop and estimate a structural household job search model with on-the-job search considered by Dey and Flinn (2008)[15]. We build on this previous work to allow for the unemployment – workers who are willing to work or have made an attempt to find a job among individuals of working age – and inactivity – individuals outside the labor market who do not search for jobs among the individuals of working age – of mothers and children who are subject to employment shocks and income shocks to fathers. These shocks may determine different search behavior and job acceptance, depending on the job status and the wage of the other family member.

Modeling inactivity as a distinct state from unemployment is relevant not only because of the greater movement of children out of the labor force in recent years[5], contrary to mothers, whose inactivity diminished, but also because the literature has documented that such transition plays a fundamental role to explain why participation among married female is relatively stable (e.g. Guner, Kulikova and Valladares-Esteban, 2015).

The model is estimated using data from the Monthly Employment Survey (PME/IBGE) for two periods: i) first period: pooling of data from 2003 to 2006 and ii) second period:

[4]It is 66% of Italians aged 18-34 and higher than 60% in Spain and Greece (Eurostat, 2018); 26% in 2005 to 34% in 2015 for the US among the individuals aged 18-34 (US Census Bureau); and 18% in 2005 to 25% in 2015 for Britain (ONS).

[5]In Brazil, an increase of the inactivity among children aged 15 to 24 years can be related to growing number of children in full- or part-time education, as discussed by Cabanas, Komatsu, and Menezes Filho (2015).

grouping of data from 2010 to 2013. We used two poolings of data to avoid annual data fluctuations. The first period is the beginning of a decade of economic growth in Brazil, with a higher average level of GDP growth, while the second is the end of this period of prosperity. Also, we estimate the household job search model for two periods since we aim to simulate counterfactual scenarios. These counterfactual simulations allow verifying the relevance of parameters, wage offer distributions, and other household income changes – particularly the labor income of fathers – when explaining the trends in employment and participation rates of family members.

Furthermore, following Bobba, Flabbi, and Levy (2017)[7] and Flinn and Mullins (2015)[20], the proposed model allows children to optimally choose the level of education to be obtained before entering the labor market. Thus, this member's educational decision becomes endogenous, which can be justified by the persistent impacts that *ex-ante* schooling decisions have on workers' outcomes throughout the life cycle. In addition, young individuals are the part of the workforce most likely to be at the time of decision-making on education level.

Our main contributions are the following: i) we model the labor supply decisions of children and their mothers; then, we explicitly consider children as decision-makers in a household job search model, which, to the best of our knowledge, it is still not performed in the household job search literature; ii) unlike most of the literature, the model distinguishes between unemployment and inactivity of mothers and children and for different search behavior and job acceptance, depending on the situation of the other member in the labor market, and the non-labor and labor income of the primary earner in most families, the father; iii) we add one important long-term benefit: parental investment in child education; and iv) we decompose the contribution of labor market shocks specific to each household member to explain changes in employment and participation between 2003-06 and 2010-13.

Our estimation results show that the increase in the employment rate of children is the result of better labor market conditions, a worse job arrival rate for mothers, and an increase in mothers' flow out of inactivity. Higher participation of mothers in the labor market may allow greater investment in the education of children and a higher level of children's employment due to returns to education. These mechanisms overcome the children's flow out of inactivity and the increase in the income of fathers, which could contribute to diminishing the employment of children. On the other hand, the participation of children is decreasing and the mechanisms behind this trend could be a decrease in the flow out of inactivity and an increase in the income of fathers, despite

an improvement in their labor market conditions, an increase in mother's flow out of inactivity and a fall into mother's job finding rate. For mothers, both the employment and participation rate are increasing as a result of better labor market conditions, and a higher mother's flow out of inactivity that overcomes other mechanisms such as a higher flow into inactivity, a decrease in the job arrival rate, and an increase of father's income.

In our counterfactual simulations, we verify that most of the observed fall in children's participation rate is explained by (i) movements of children in and out of the labor force and (ii) improvement in labor market conditions. We also find evidence for the added worker effect: (i) an increase in the father's income reduces employment and participation of children and mothers, and (ii) the mother's lower job finding rate attenuates the fall in the participation rate of children. Finally, we verify that important cross-effects are underestimated if we ignore endogenous schooling. Our results strengthen the argument about the relevance of household search behavior in the labor supply decisions of secondary earners in families and about how using individual job search models to understand aggregate employment and participation can be misleading.

This paper firstly relates to the literature on the relevance of household-level decisions in affecting labor market outcomes, since Becker's theory of the family (Becker, 1981, 1974). In addition, we relate to the literature on household (dual) search models. Burdett and Mortensen (1977)[9] presented the first study that theoretically developed and analyzed a two-person household search model, but in the empirical literature, the pioneering article in developing and estimating a household job search model with on-the-job search is that of Dey and Flinn (2008)[15]. These authors extend a standard partial equilibrium job search model, allowing the head and spouse in the household to search for jobs. These authors highlight the potential dependence of couples' labor market decisions and show that the single-agent specifications are misspecified because they do not account for the earning process and job status of the other member. They also indicate that the household job search model generates different equilibrium decisions compared to the individual job search model. Moreover, they argue that the conclusions of empirical studies focused on individual behavior to estimate the marginal willingness to pay for health insurance must be questioned[6]

The article also relates to recent articles that introduce wealth in a household search model, such as Mankart and Oikonomou (2016)[29], and Garcia-Perez and Rendon (2020)[21]; and to the literature on individual job search and schooling decisions, e.g. Flinn and

[6]Flabbi and Mabli (2012)[19] extend Dey and Flinn (2008) to have intensive margin labor supply and fertility shocks.

Mullins (2015), Bobba et al (2019). It is important to highlight that none of these papers model children's labor market decisions, or schooling investment in a household job search environment, and rarely account for the possibility to distinguish unemployment from inactivity.

Finally, we also relate to studies on the added worker and discouraged worker effects. Both effects occur during a recession with opposite effects on the labor force participation (Lundberg (1985)[28], Stephens, (2002), Blundell et al (2018), Tansel and Ozdemir (2018)[32], Benati (2001)[5], Beland-O'Keefe (2004)[3], Kell and Wright (1990)[26]). The discouraged-worker effect is significant for the US, Canada, and UK. The added worker effect (AWE) is mostly found in countries where female labor force participation is relatively low and the welfare state is weak. For Brazil, Fernandes and Felicio (2005)[18] estimate the added worker effect for wives.

This paper is organized into six sections, in addition to this introduction. The second section presents a background section about the Brazilian labor market. The third section is a detailed description of the household job search model which we develop in the article, whereas the fourth section presents the estimation and identification procedure. The fifth section describes the dataset and sample. Estimation and simulation results are in the sixth section. The last section presents final remarks, conclusions, and directions for improvements in this research.

2 The Brazilian labor market

2.1 Aggregate labor market statistics

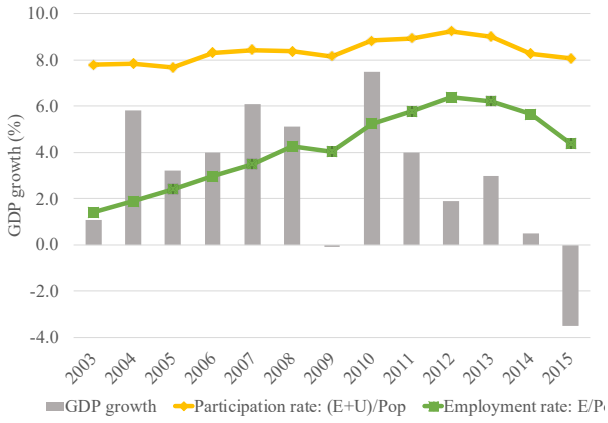
In this section, we first discuss the aggregate labor market statistics of Brazil, both in the general sample of individuals aged 14 to 65 years, including individuals who live alone, and in the sample of households with children aged 14 to 29 years. In this paper, we are particularly focused on a broader group of secondary earners, including children and mothers. We also discuss the statistics for subgroups of children based on the educational level.

As argued in the introduction, employment strongly correlates with GDP around the world. On the other hand, labor force participation is much less correlated with economic activity. In Brazil, we observe a similar pattern. Figure 1 below, based on data from the Monthly Employment Survey (PME) of the Brazilian Institute of Geography and Statistics (IBGE), a longitudinal and monthly database that investigates the population

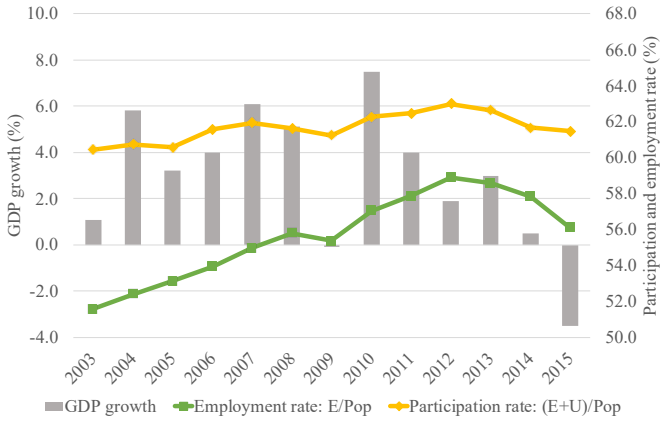
resident in urban areas of six Brazilian metropolitan regions[7], show for the period from 2003 to 2015 that the Brazilian GDP presents a temporal trajectory more correlated with the employment rate, while the participation rate has a more constant behavior and is less correlated with economic growth. This behavior is observed for the working age population (14 to 65 years old), but also for individuals who are part of the working age population and who belong to families with at least one young person (14 to 29 years old) cohabitating with parents.

Figure 1: Aggregate employment and participation rates

(a) Population 14 to 65 years



(b) Households with children 14-29



Source: Elaborated by the authors based on data from the Monthly Employment Survey (PME/IBGE) 2003-2015.
Note: Unemployment rate, as calculated using the first interview of individuals, is the proportion of unemployed individuals who were willing or searching for jobs, among individuals 14 to 65 years of age.

Figure 2 shows the participation and the employment rate among individuals who are part of the working age population and who belong to families with at least one young child living with parents, for the period 2003 to 2015, and calculated separately for fathers, mothers, children 14-22 years old, and children 23-29 years old, using data from the PME (IBGE). We observe that the participation and employment rates decreased for both subgroups of children, mainly from 2012. However, these rates show a growth trend in the period for mothers, whereas these rates among fathers were almost constant.

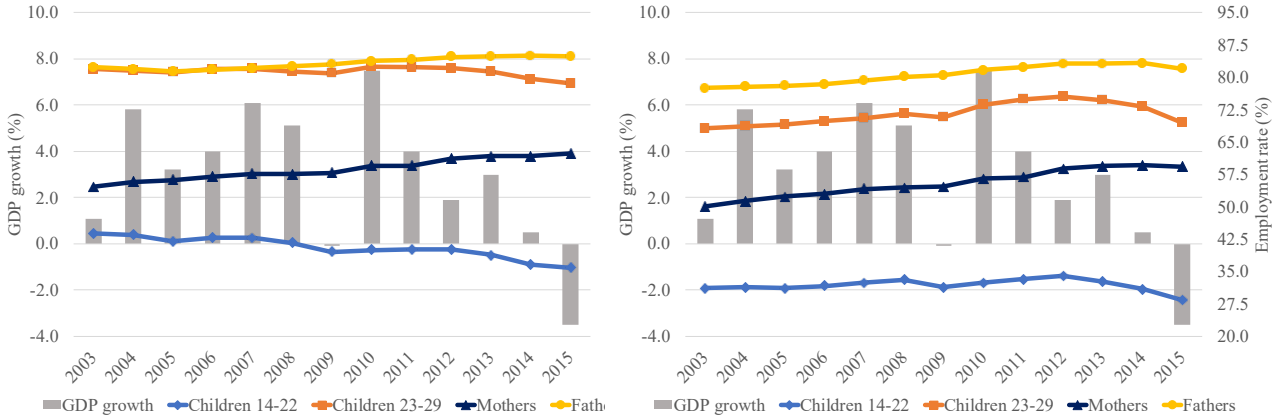
In next tables, we show the monthly labor market flows across the three states: employment - decomposed on rates to the same job and job-to-job transitions, unemployment

[7]We apply the PME's weight (variable V215) in all of the statistics generated in this study.

Figure 2: Participation and employment rate of household members

(a) Participation rate

(b) Employment rate



Source: Elaborated by the authors based on data from the Monthly Employment Survey (PME/IBGE) 2003-2015.
Note: Employment rate is calculated using the first interview of individuals.

and out of the labor force or also called inactivity in this paper. Finally, we document the wage growth for children, mothers and fathers.

Tables of this section are also constructed from the PME (IBGE) data and correspond to observations spanning the years 2003 to 2006 and 2010 to 2013. The labor force (LF) is the sum of individuals who are either employed or unemployed (as a percentage of the total). According to the definitions provided by the IBGE, individuals are employed if they have been working at least one hour during the week before the PME survey - if they have been paid or not; unemployed are those individuals who are not working, though they want jobs and search [8] in the labor market during the last thirty days before the PME survey. In our analysis we will follow the official definitions and assume that the labor force consists of employed and unemployed individuals [9].

In Table 1, we document the employment population rate, the unemployment rate (total number of unemployed over number of employed + unemployed), and the labor

[8]The job search can be the contact established with employers; the application for a position in a government office; the consultation with the employment agency, union, or similar institution; the response to a job posting; the request of a job to a relative, friend, colleague or by means of an advertisement; to take action to start a business, etc.

[9]This is the convention followed by the considerable literature on search and matching models, including Mankart and Oikonomou (2017). According to the authors, two exceptions are Hall (2005) and Krusell et al. (2011) that consider non-searchers as part of unemployment.

force participation. We begin by documenting these aggregate labor market statistics for all the individuals aged 14 to 65 years, and then for individuals belonging to households with at least one child aged 14 to 29 years. The table shows that the employment rate and participation in the workforce are lower in the sample of families with children aged 14 to 29 years, in comparison with the sample that considers all individuals aged 14 to 65 years, in the period 2003-2006 and 2010-2013. This selection process for the sample of households is expected since these families have younger members, who have a higher rate of unemployment and inactivity.

We see an increase of about 5% in the employed population, but a decrease - about 5% for the general sample and 6% for the sample of families - in the unemployment rate, between the first and the second period, which determines an increase in the workforce of about 2%.

Table 1: Aggregate labor market statistics

	2003-2006			2010-2013		
	E-pop	U-rate	LF	E-pop	U-rate	LF
General sample (14 to 65 years)	0.579	0.113	0.653	0.627	0.060	0.667
Households with children 14-29	0.527	0.133	0.608	0.579	0.072	0.625

Source: Elaborated by the authors based on data from the Monthly Employment Survey (PME/IBGE) for 2003-2006 and 2010-2013.
Notes: The table shows labor market statistics for the Brazilian aggregate labor market and for the sample of households with children aged 14-29 years. E-pop is the employment population rate, U-rate is the unemployment rate(total number of unemployed over number of employed + unemployed), and LF refers to the labor force participation rate.

In Table 2, we focus on the sample of households with children and the intrahousehold behavior of the labor market statistics. We document the employment and unemployment rates and the labor force participation for fathers, the usual primary earner in Brazilian households, but also for a broader group of secondary earners modeled in our paper, including children and mothers. For children, we document the rates for the group most likely to be studying - 14 to 24 years old - and for an older group of young workers - 25 to 29 years old. In this paper, we focus on children aged 14 to 24 years.

We observe that the employment rate of children aged 25 to 29 years is about twice as high as that of children aged 14 to 24 years (in both periods). The labor force participation is also greater in this group of older children. On the other hand, the unemployment rate among older children is almost 60% lower. It is worth mentioning that the inactivity rate of children aged 14 to 24 years, the group most likely to be studying, is about 52% in the

first period and 55% in the second period; for older children, is 17% in both periods.

The employment rate of mothers increases between periods, but it is lower than that of older children and about 30% lower than that of fathers, in the first period. Otherwise the unemployment rate of mothers is about twice as high as that of fathers, but it is lower than that of children aged 25-29 and 14-24, as this group of younger workers has less experience and educational level and a higher difficulty in allocating to the labor market.

Between the two periods analyzed, we observed an increase in the inactivity rate of the group of children aged 14-24 years (from 52% to 55%), a decrease for mothers (from 43% to 40%) and a stable rate for children aged 25-29 years (around 17%) and for parents (around 15%). The decrease in the unemployment rate occurs for all groups, indicating that the increase in inactivity among the younger groups is related to the decrease in the employment rate among this group, determining a decrease in the workforce.

Table 2: Labor market statistics for children 14-24 and 25-29, mothers and fathers

	2003-2006			2010-2013		
	E-pop	U-rate	LF	E-pop	U-rate	LF
Children 14-24	0.361	0.250	0.481	0.384	0.151	0.452
Children 25-29	0.711	0.141	0.828	0.764	0.084	0.834
Mothers	0.509	0.105	0.569	0.568	0.056	0.601
Fathers	0.809	0.052	0.854	0.834	0.025	0.855

Source: Elaborated by the authors based on data from the Monthly Employment Survey (PME/IBGE) for 2003-2006 and 2010-2013.
Notes: The table shows labor market statistics for the sample of households with children aged 14-29 years. E-pop is the employment population rate, U-rate is the unemployment rate(total number of unemployed over number of employed + unemployed), and LF refers to the labor force participation rate.

From this table, the analyzes focus on the group of children to be studied in the article, since this shows, by the data presented in this section, to be the group of children who live with parents whose labor market decisions are possibly more related to other members' labor market decisions, especially mothers. The table shows the statistics by subgroups of years of schooling of the children.

It is possible to observe that children with a higher level of education - more than 7 years of study, which is the last year of elementary school - have an employment rate that is more than double the observed employment rate for children with less education, in the two years analyzed. The unemployment rate for these children with less education is also higher, but the big difference is in the employed population and in the participation in the workforce, indicating that children with less education also have a higher level of

Table 3: Labor market statistics for children 14-24 with a higher/lower level of education, and mothers

	2003-2006			2010-2013		
	E-pop	U-rate	LF	E-pop	U-rate	LF
Children Low	0.199	0.264	0.270	0.158	0.180	0.193
Children High	0.430	0.247	0.571	0.458	0.148	0.538
Mothers	0.509	0.105	0.569	0.568	0.056	0.601

Source: Elaborated by the authors based on data from the Monthly Employment Survey (PME/IBGE) for 2003-2006 and 2010-2013.
Notes: The table shows labor market statistics for the sample of households with children aged 14-24 years, with a higher/lower level of education. E-pop is the employment population rate, U-rate is the unemployment rate(total number of unemployed over number of employed + unemployed), and LF refers to the labor force participation rate.

inactivity.

This lower level of participation in the workforce for children with a lower level of education, given that children aged 14 years or older should have already reached this higher level of education in 7 years of study, may be related to age distortion -series that diminish the opportunities to act in the labor market - more incident among the poorest families, but also the greater probability that this group may have to be still studying, in search of reaching the number of years of study adequate to the demand of the Marketplace.

It should be noted that between the two periods analyzed, we observed an increase in the employment rate among children with a higher level of education and among mothers, but a decrease in this rate among children with a lower level of education. The unemployment rate decreases for all groups, given the improvement in the conditions of the labor market, but the rate of participation in the labor market only increases for mothers (increase of 3 p.p.). For children with a lower level of education the workforce is reduced by 8 p.p. and for children with a higher level of education, by 3 p.p ..

2.2 Labor market flows

It is possible to observe that children with a higher level of education - more than 7 years of study, which is the last year of elementary school - have lower rates of monthly flow from unemployment to inactivity (30% versus 36%, in 2003-2006, and 34% versus 45%, in 2003-2006) and employment for inactivity (6% versus 14%, in 2003-2006, and 7% versus 16% , in 2003-2006). In contrast, the exit from inactivity, whether for employment or

Table 4: Monthly flow rates: children 14-24 with a higher/lower level of education and mothers

	Children 14-24								Mothers			
	Low				High							
2003-2006												
	To				To				To			
From	E	E'	U	I	E	E'	U	I	E	E'	U	I
E	0.788	0.034	0.040	0.138	0.885	0.024	0.034	0.058	0.921	0.010	0.010	0.060
U	0.134	-	0.505	0.361	0.122	-	0.582	0.296	0.134	-	0.530	0.336
I	0.040	-	0.038	0.922	0.064	-	0.109	0.828	0.072	-	0.035	0.893
2010-2013												
	To				To				To			
From	E	E'	U	I	E	E'	U	I	E	E'	U	I
E	0.783	0.033	0.025	0.159	0.892	0.022	0.020	0.066	0.927	0.008	0.006	0.058
U	0.141	-	0.406	0.453	0.157	-	0.501	0.342	0.156	-	0.511	0.333
I	0.032	-	0.020	0.948	0.068	-	0.067	0.864	0.085	-	0.024	0.891

Source: Elaborated by the authors based on data from the Monthly Employment Survey (PME/IBGE) for 2003-2006 and 2010-2013.
Notes: The table shows average monthly transition probabilities across the four labor market states: employment (same job) E, employment (other job), unemployment U, and out of the labor force I; for children aged 14-24 years, with low and high schooling level (cutoff: 7 years of formal education), mothers and fathers.

unemployment, is more prevalent among children with a higher level of education (14% versus 5%, in the first period, and 17% versus 8% - adding the transitions of employees to inactivity and unemployed to inactivity).

It should also be noted that the monthly flows of transitions between jobs, from employment to unemployment and from unemployment to employment are lower for children with a higher level of education, in both periods, indicating lower turnover and greater market stability. of work for this group of children - 88% of this group remains employed between the two interviews considered, while 79% of the youngest children remain in this situation.

In the comparison between the monthly transitions of children and mothers, we observed that mothers have a lower monthly rate of entry into inactivity than children with less education, but a higher rate of exit from the labor force than children with a higher level of education. schooling. The monthly outflow of mothers' inactivity is lower than the outflow rate of more educated children and higher than that of children with less education. The transition from job to job to mothers' unemployment is less than that of

children, regardless of schooling.

The comparison for the two analysis periods shows that the monthly flow from employment to unemployment (job destruction) decreases for the three groups analyzed, while the transition from unemployment to employment (obtaining a vacancy by the unemployed) increases for the three groups analyzed, reflecting the improvement in the conditions of the labor market and the economy between the periods. However, between periods, the monthly transitions from employment to inactivity and, mainly, from unemployment to inactivity increase for both groups of children and decrease for mothers. It should be noted that, for children with a low level of education, the monthly flow from unemployment to inactivity goes from 36% to 45%. This increase is 4 p.p. for children with a high level of education.

These differences found for the two groups of children depending on the level of education could also be associated with the age heterogeneity between these two groups. However, at 14 years old, without serious age distortion, young people should have completed elementary school or be in the last year of this cycle, that is, they should already have completed 7 years of schooling in Brazil.

Table 5: Wage growth for children 14-24 ith a higher/lower level of education, mothers and fathers

	2003-2006	2010-2013
Children Low	0.013	0.074
Children High	0.018	0.035
Mothers	0.030	0.026
Fathers	0.015	0.019

Source: Elaborated by the authors based on data from the Monthly Employment Survey (PME/IBGE) for 2003-2006 and 2010-2013.
Notes: The table shows wage growth for children aged 14-24 years, with low and high schooling level (cutoff: 7 years of formal education), mothers and fathers.

The last table in this section shows the average annual growth rate of wages for different family members, including parents. For children, the rate per schooling subgroup is calculated - high or low. It is possible to verify that the annual wage growth rate is higher in the second period than in the first period. However, these rates are lower than the rates observed for mothers, in both periods analyzed - between 2003 and 2006, the rate of wage growth of mothers is twice as high as the rate observed for fathers. The average

annual growth rates also increase significantly for the two groups of children analyzed, with emphasis on the salary growth of children with less education, which goes from 1.3% to 7.4% between periods. Only mothers showed a decrease in the rate of wage growth between the two periods.

The best labor market conditions for all individuals in the economy and even for younger children, already verified through the monthly flows of transitions, are confirmed by means of this table. And even with this improvement in conditions, we observed an increase in the monthly transitions of young children to inactivity and a decrease in the workforce among this group.

3 Household search model

3.1 Environment

In this study, we build on the household search model of Dey and Flinn (2008)[10], in which the economy comprises a continuum of stable households. Time is continuous, search is random, and households are infinitely lived and make labor market decisions to maximize their lifetime expected income. A household comprises a child (member 1) and his/her mother (member 2), who have preferences represented by a household utility function, and may have a father whose decisions are determined outside the model, for simplicity. These two members maximize a common utility function where they pool income, as occurs in a unitary model of the household, i.e. all income is a public good within the household[11]. We consider the shocks that may affect member 1 or member 2, who may be in one of the following states: employed (e), unemployed (u) or inactive/outside the labor force (i)[12].

We assume that the instantaneous household utility associated with consumption is a function of the household income, and there is no saving or borrowing in the model, a common assumption in the search literature, which can be justified by market completeness[13]. Thus, the instantaneous utility of a household that comprises a father, a mother,

[10]We also relate to papers that estimate search models, in particular following Burdett and Mortensen (1998), such as Bontemps, Robin and Van den Berg (1999) and Van den Berg and Ridder (1998).

[11]Models based on cooperative or non-cooperative behavior may generate different income sharing, and the strategic household interaction may generate higher sensitivity of the labor supply decisions of one member about the other member labor market status [19]. Dey and Flinn (2008) also omit strategic interactions between members. Gemici (2011) is an exception and considers a life-cycle search model with intra-household bargaining.

[12]Unemployed workers search for jobs, whereas inactive workers do not.

[13]Dey and Flinn (2008) also ignore saving or borrowing and assume that all income is consumed in

and a child has the following form:

$$u = U(I)$$

in which I is the total household income, such as:

- $I = w_{1,s} + w_2 + Y$, if both the child and the mother work
- $I = w_{1,s} + b_2 + Y$, if only the child works
- $I = b_{1,s} + w_2 + Y$, if only the mother works
- $I = b_{1,s} + b_2 + Y$, if neither works

where: $w_{1,s}$ is the labor income of the child, w_2 is the labor income of the mother[14], $b_{1,s}$ is the non-labor income or the value of leisure of the child, b_2 is the non-labor income or the value of leisure of the mother[15], and Y is the father's labor income (exogenous)[16]. u$(\cdot)$ is the exponential utility with risk aversion parameter θ. The risk aversion implies a concave utility function. In this context, an increase in Y would imply a more than proportional decrease in the reservation wages of children or mothers and a higher job offer acceptance and employment.

We assume that the mother and child face mutually exclusive shocks in the labor market. In continuous time, the intervals between periods are infinitesimal, and it is possible that at most one shock affects the household in a period but that both members respond to this same shock. Dey and Flinn (2008) discuss the advantages and drawbacks of using a continuous time framework. These authors note that despite fiction, by using the continuous framework, we avoid the multiple equilibria problem and the arbitrariness

the same moment it is received. Garcia-Perez and Rendon (2012) develop a household search model in which the households are allowed to make savings decisions.

[14]Labor income is the usually received monthly income in the main job, that is, the wage before payment of social security contributions, but after labor income taxes.

[15]We do not distinguish the non-labor income or value of leisure of children and mothers, $b_{1,s}$ and b_2, for the situations of unemployment and inactivity. Instead, we have estimated the model in different subsamples of households by the education of mothers and the age group of children. In a future version of the study, we intend to do that, if the addition of the hypothesis about these values is not too restrictive. According to Fang and Shephard (2014), the continuous heterogeneity in leisure enriches the model's ability to capture heterogeneity in job acceptance behavior and smoothes the labor supply function that the firm is facing.

[16]Job opportunities for the father are determined outside the model, for simplicity. However, simulated wage shocks related to the labor market policies, such as the minimum wage policy, which affects the father's income may increase the opportunity cost of supplying labor of other household members.

of the choice of the decision period and time aggregation, which can affect estimates and inferences.

The transition rates and (exogenous) wage offer distributions are member- and schooling-specific. Job offers may arrive for children and mothers if they are unemployed ($\lambda^0_{1,s}$ and λ^0_2, respectively) or if they are employed ($\lambda^1_{1,s}$ and λ^1_2, respectively). Thus, we allow for the on-the-job search of members, which is another source of heterogeneity. Jobs may be exogenously destroyed at the rate $\delta_{1,s}$ for children and at δ_2 for mothers. The job destruction moves the household member from employment to unemployment.

Shocks that affect the mother impact the labor market decisions of children and vice versa. In particular, when both are unemployed and the mother accepts a job offer, the child may decide to become inactive. Then, we have endogenous quitting in the model. Additionally, if the child is unemployed and the employed mother faces a job destruction, the child may decide to search for a job, which is known as the added worker effect (instantaneous).

If a member is unemployed, he/she may decide stop searching for jobs and become inactive. The rate of discouragement or dropout (move from unemployment to inactivity) is $\beta_{1,s}$ for children and β_2 for mothers. Children encourage (move from inactivity to unemployment) at a rate $\alpha_{1,s}$, and mothers encourage at a rate α_2.

We assume that mothers and children do not draw from the same wage offer distributions. Thus, we denote the wage offer distribution faced by children as $F_{1,s}(w_{1,s})$ and the wage offer distribution faced by mothers as $F_2(w_2)$.

Shocks that affect the mother impact their children's decisions in the labor market and vice versa. In particular, if both are unemployed and the mother accepts a job offer, the child may decide to become inactive and vice versa. In addition, if the child is unemployed and the employed mother faces a job-destruction shock that sends her into unemployment, the child may decide to start looking for a job.

Following Bobba, Flabbi and Levy (2017) and Flinn and Mullins (2015), the model allows young people to optimally choose the level of education obtained before entering the labor market, therefore, we introduce an endogenous schooling decision for the member 1. Schooling decisions *ex-ante* have persistent effects on labor market outcomes and the youth workforce is more likely to be at the time of making that decision. Therefore, before entering the labor market, children make a *one-shot* decision about what level of education to acquire. This schooling decision is characterized by a discrete choice $s \in \{h, l\}$, where $s = h$ denotes a higher level and $s = l$ indicates a lower level of education.

Once the schooling decision is made, the children enter the labor market with an

education level of s, and both members face labor market shocks. Mother and child face mutually exclusive clashes. In continuous time, the intervals between periods are infinitesimal, and it is possible for only one shock to affect the family per period, but both members respond to that shock.

Finally, in this model, the steady state labor market is an assumption. In steady-state equilibrium, by combining the joint statuses of the two members in the labor market and the two possible levels of schooling of the children, we derive a system of eighteen equations for the inflow and outflow of families. The stock of families in which the child with education level s has status j and the mother, status k, for $j, k \in \{e, u, i\}$, must be constant; that is, the input and output flows of a given joint condition must equal, where: m_{jk} is a measure or stock of families in which the child has status j and the mother, status k; G_{jk} is the joint cumulative distribution function of wages and g_{jk} is the joint density of wages; and $\bar{F}_{1,s} = 1 - F_{1,s}$ and $\bar{F}_2 = 1 - F_2$.

3.2 Household value functions

The household labor market decisions are based on their value functions, which are defined recursively. Combining the three possible labor market states of the two members, there are nine household value functions for each state in which the household is. Thus, a value function W_{jk} is the lifetime income that a household has if the child is in state j and mother is in state k, for $j, k \in \{e, u, i\}$. The Bellman (1957) equation for the value functions defined at the household level are described below:

- Both the child and the mother are employed:

$$
\begin{aligned}
rW_{ee}(w_{1,s}, w_2, s) = {} & u(w_{1,s} + w_2 + Y) + \\
& \delta_{1,s}(W_{ue}(0, w_2, s) - W_{ee}(w_{1,s}, w_2, s)) + \delta_2(W_{eu}(w_{1,s}, 0, s) - W_{ee}(w_{1,s}, w_2, s)) + \\
& \lambda^1_{1,s} \int [\max[W_{ee}(x, w_2, s), W_{ei}(x, 0, s), W_{ee}(w_{1,s}, w_2, s)] - W_{ee}cw_{1,s}, w_2, s)] dF_{1,s}(x) + \\
& \lambda^1_2 \int [\max[W_{ee}(w_{1,s}, x, s), W_{ie}(0, x, s), W_{ee}(w_{1,s}, w_2, s)] - W_{ee}(w_{1,s}, w_2, s)] dF_2(x)
\end{aligned}
$$

where r is the discount rate. This value function, the discounted value that the family has if the child and the mother are both employed, is the sum of the instantaneous household utility (the wage of child plus the wage of mother added to the household non-labor income and other labor income, such as the wage of the father (Y)), and the option values of changing labor market state, that is, the risks and job opportunities in

the lifetime household income. First, with probability $\delta_{1,s}$, the employed child suffers job destruction. The employed mother may also suffer job destruction, which occurs at the rate δ_2. Job offers arrive to the mother while employed at the rate λ_2^1, and the household decides whether the mother should accept them by comparing the value of the current state with the value if the mother becomes employed at this new job. If the mother accepts a job offer, she draws a wage x from the distribution F_2, and if the mother does not accept it, she continues to receive the last wage, w_2, which is stationary.

- The child is employed and the mother is unemployed

$$
\begin{aligned}
rW_{eu}(w_{1,s},0,s) = {} & u(w_{1,s}+b_2+Y)+ \\
& \delta_{1,s}(W_{uu}(0,0,s)-W_{eu}(w_{1,s},0,s))+\beta_2(W_{ei}(w_{1,s},0,s)-W_{eu}(w_{1,s},0,s))+ \\
& \lambda_{1,s}^1\int \max\left[W_{eu}(x,0,s)-W_{eu}(w_{1,s},0,s),0\right]dF_{1,s}(x)+ \\
& \lambda_2^0\int \left[\max\left[W_{ee}(w_{1,s},x,s),W_{ie}(0,x,s),W_{eu}(w_{1,s},0,s)\right]-W_{eu}(w_{1,s},0,s)\right]dF_2(x)
\end{aligned}
$$

In this second value function, we have the discounted value that the household has if the child is employed and the mother is unemployed. In this case, the household instantaneous utility is the wage of child plus the value of leisure of the unemployed mother added to household non-labor income and the labor income of father, denoted by Y. Moreover, it is possible that the unemployed mother receives job offers at the rate λ_2^0, and the household decides whether the mother must accept or reject them by comparing the value of the current state with the value of being employed at this job. Job offer acceptance means to increase the household welfare. In addition, the unemployed mother may be discouraged and move to inactivity.

- The child is employed and the mother is inactive

$$
\begin{aligned}
rW_{ei}(w_{1,s},0,s) = {} & u(w_{1,s}+b_2+Y)+ \\
& \delta_{1,s}\max[W_{ui}(0,0,s)-W_{ei}(w_{1,s},0,s),W_{uu}(0,0,s)-W_{ei}(w_{1,s},0,s)]+ \\
& \alpha_2(W_{eu}(w_{1,s},0,s)-W_{ei}(w_{1,s},0,s))+ \\
& \lambda_{1,s}^1\int \max\left[W_{ei}(x,0,s)-W_{ei}(w_{1,s},0,s),0\right]dF_{1,s}(x)
\end{aligned}
$$

The third value function is similar to the second one, but the mother is in the inactive state and does not look for jobs or receive job offers. In this case, if the child suffers job destruction, it is possible that the mother starts looking for jobs and moves from inactivity to unemployment.

- The child is unemployed and the mother is employed

$$
\begin{aligned}
rW_{ue}(0,w_2) = {} & u(b_1+w_2+Y)+ \\
& \beta_1(W_{ie}(0,w_2)-W_{ue}(0,w_2))+\delta_2(W_{uu}(0,0)-W_{ue}(0,w_2))+ \\
& \lambda_1^0\int \max\left[W_{ee}(x,w_2)-W_{ue}(0,w_2),0\right]dF_1(x)+ \\
& \lambda_2^1\int \max\left[W_{ue}(0,x)-W_{ue}(0,w_2),0\right]dF_2(x)
\end{aligned}
$$

The fourth function concerns the situation in which the child is unemployed and the mother is employed. In this case, the mother may suffer job destruction or may receive job offers when employed. Moreover, job offers arrive to the unemployed child, but the unemployed child may also be discouraged.

- Both the child and the mother are unemployed

$$
\begin{aligned}
rW_{uu}(0,0,s) = {} & u(b_{1,s}+b_2+Y)+ \\
& \beta_{1,s}(W_{iu}(0,0,s)-W_{uu}(0,0,s))+\beta_2(W_{ui}(0,0,s)-W_{uu}(0,0,s))+ \\
& \lambda_{1,s}^0\int \max\left[W_{eu}(x,0,s)-W_{uu}(0,0,s),0\right]dF_{1,s}(x)+ \\
& \lambda_2^0\int \max\left[W_{ue}(0,x,s)-W_{uu}(0,0,s),0\right]dF_2(x)
\end{aligned}
$$

This fifth value function is similar to the fourth, but the mother is also in the unemployment state and can move to employment or inactivity.

- The child is unemployed and the mother is inactive

$$
\begin{aligned}
rW_{ui}(0,0,s) = {} & u(b_{1,s}+b_2+Y)+ \\
& \beta_{1,s}(W_{ii}(0,0,s)-W_{ui}(0,0,s))+\alpha_2(W_{uu}(0,0,s)-W_{ui}(0,0,s))+ \\
& \lambda_{1,s}^0\int \max\left[W_{ei}(x,0,s)-W_{ui}(0,0,s),0\right]dF_{1,s}(x)
\end{aligned}
$$

For this sixth value function, we have the situation in which the child is unemployed; that is, he/she searches for a job and receives job offers, and the mother is in the inactive state and thus neither search for jobs nor receive job offers.

- The child is inactive and the mother is employed

$$
\begin{aligned}
rW_{ie}(0, w_2, s) = {} & u(b_{1,s} + w_2 + Y) + \\
& \delta_2 \max[W_{iu}(0,0,s) - W_{ie}(0, w_2, s), W_{uu}(0,0,s) - W_{ie}(0, w_2, s)] + \\
& \alpha_{1,s}(W_{ue}(0, w_2, s) - W_{ie}(0, w_2, s)) + \\
& \lambda_2^1 \int \max\left[W_{ie}(0, x, s) - W_{ie}(0, w_2, s), 0\right] dF_2(x)
\end{aligned}
$$

- The child is inactive and the mother is unemployed

$$
\begin{aligned}
rW_{iu}(0,0,s) = {} & u(b_{1,s} + b_2 + Y) + \\
& \alpha_{1,s}(W_{uu}(0,0,s) - W_{iu}(0,0,s)) + \beta_2(W_{ii}(0,0,s) - W_{iu}(0,0,s)) + \\
& \lambda_2^0 \int \max\left[W_{ie}(0, x, s) - W_{iu}(0,0,s), 0\right] dF_2(x)
\end{aligned}
$$

The seventh and eighth value functions above are similar to the presented third and fourth value functions, respectively, exchanging the states of mother and child and adding to the seventh function the possibility that the mother receives job offers while employed.

- The child and the mother are both inactive

$$
\begin{aligned}
rW_{ii}(0,0,s) = {} & u(b_{1,s} + b_2 + Y) + \\
& \alpha_{1,s}(W_{ui}(0,0,s) - W_{ii}(0,0,s)) + \alpha_2(W_{iu}(0,0,s) - W_{ii}(0,0,s))
\end{aligned}
$$

Finally, in the last value function, we have the discounted value for the household in which the child and the mother are both inactive. In this case, changes in the household status only occur due to encouragement.

Each worker's strategy has a reservation wage property; that is, there is a wage in which the agent is indifferent among states. The reservation wage or the minimum acceptable wage offer of one member potentially depends on the job status and the wage of the other family member. For example, when a job arrival shock arrives to a child and the mother is currently unemployed, the critical value is:

$$x^*: W_{eu}(x^*, 0, s) = W_{uu}(0, 0, s)$$

Value functions are strictly increasing in wages so that there exists one reservation wage for each pair of choices.

3.3 Schooling choice

Following Bobba, Flabbi and Levy (2017) and Flinn and Mullins (2015), the model allows young people to optimally choose the level of education obtained before entering the labor market, therefore, we introduce an endogenous schooling decision for the member 1. Schooling decisions *ex-ante* have persistent effects on labor market outcomes and the youth workforce is more likely to be at the time of making that decision. Therefore, before entering the labor market, children make a *one-shot* decision about what level of education to acquire. This schooling decision is characterized by a discrete choice $s \in \{h, l\}$, where $s = h$ denotes a higher level and $s = l$ indicates a lower level of education. Children are heterogeneous in terms of their costs of acquiring education; therefore, the child who decides to obtain the level of education $s = h$ incurs an individual cost $c \sim H(c)$, where c summarizes monetary and disutility costs, and c is assumed to be uncorrelated with future labor market performance of both household members and constant over time; and if the child decides to obtain the level of education $s = l$, no costs are incurred. Once the schooling decision is made, the children enter the labor market with an education level of s, and both members face labor market shocks.

We assume that prior entering the labor force, the child is inactive and a large fraction of households is in the "inactive-inactive" state. Thus, the schooling level, s $\in \{l, h\}$, is solved by the following problem:

$$\max_s \{W_{ii}(0, 0, l), W_{ii}(0, 0, h) - c\}$$

There exists a unique optimal threshold cost of education c^* such that $W_{ii}(0, 0, h) - c^* = W_{ii}(0, 0, l)$, and c is drawn from an exponential distribution with parameter σ.

3.4 Firms and market equilibrium

We assume that wages of children and mothers are determined in separate markets and are denoted by 1 and 2, respectively. Therefore, in each market, firms are heterogeneous in their productivity $p^i \sim \Gamma^i(p)$, continuous, and $i \in \{1, 2\}$. The productivity can capture technology and price differences across firms.

We do not consider minimum wage as we do not distinguish between formal and informal employment. The firm solves

$$\max_{w_i} (p^i - w^i) l^i(w^i)$$

where $l^i(w^i)$ is the equilibrium size of a firm in the market i offering wage w^i.

The labor force size comes from the flow conditions in steady state. Normalizing the number of firms to one in each market, we have

$$l^i(w) = m_e^i \frac{dG_i(w)}{dF_i(w)}$$

where m_{jk} is the the measure of households in which the child is in state j and the mother is in state k, for $j, k \in \{e, u, i\}$, that must be constant; that is, the inflows and outflows to and from a given joint condition must be equal. In addition, $m_e^{1,s} = m_{ee} + m_{eu} + m_{ei}$, $m_e^2 = m_{ee} + m_{ue} + m_{ie}$, and $G_i(w)$ is the marginal distribution of wages obtained from integrating over the joint distribution of wages $G_{ek}(w_{1,s}, w_2)$, for children, and $G_{ke}(w_{1,s}, w_2)$ for the mothers, $k \in \{e, u, i\}$.

In equilibrium (following Bontemps, Robin and Van den Berg (1999)), $\Gamma^i(p) = F_i(w_i(p))$, where $w_i(p)$ solves the firms' profit maximization. That is,

$$w_i(p) = p - \frac{l(w_i(p))}{\frac{dl(w_i(p))}{dw_i(p)}}$$

4 Estimation and Identification

Based on the household search model, given r and the income of the father Y, we estimate:

$$\Theta = \{F_{1,s}, F_2, \delta_{1,s}, \delta_2, \lambda_{1,s}^0, \lambda_2^0, \lambda_{1,s}^1, \lambda_2^1, \alpha_{1,s}, \alpha_2, \beta_{1,s}, \beta_2, b_{1,s}, b_2, \theta, \sigma\}$$

where the parameters and distributions have been previously defined.

We estimate the model based on the Simulated Method of Moments (SMM) and

indirect inference. We search over the parameter vector Θ to find the combination that minimizes a distance criterion between the simulated, $m(\Theta)$ (simulated moments), and empirical moments, $\tilde{m}$.

Θ is solved by:

$$\hat{\Theta}_{MSM} = \arg\min_{\Theta} \left(m(\Theta) - \tilde{m}\right)^T W \left(m(\Theta) - \tilde{m}\right)$$

where W is a weighting matrix in which the diagonal elements are the inverse of the bootstrap variances and $\dim(m(\Theta)) = \dim(\tilde{m}) > \dim(\Theta)$.

We match 18 cross (or household) moments for the joint employment proportions by children's education level, and the following individual moments:

- 21 moments for wages: mean, standard deviation, 10th, 25th, 50th, 75th and 90th percentiles by children's education and for the mothers;
- 15 moments for transition probabilities based on a variation in occupation status between first and second interviews by children's education and for the mothers;
- One moment for the fraction of children with more than 9 years of schooling.

Therefore, we estimate 26 parameters with 55 moments. The model is estimated separately for 2003-06 and 2010-13.

Identification The transition parameters $(\delta, \lambda^0, \lambda^1, \alpha, \beta)$ are identified from the variation in individuals' job status between first and second monthly interviews. The distributions of wage offers ($F_{1,s}(w)$ and $F_2(w)$) are identified from the crossectional distribution of wages. Finally, by assuming strong monopsony power for the lowest income workers, the value of leisure for the child, $b_{1,s}$, can be identified by equating $W_{eu}(\underline{w}, 0) = W_{uu}$ and the value of leisure for the mother, b_2, by equating $W_{ue}(0, \underline{w}) = W_{uu}(\underline{w})$.

5 Dataset and sample

The database for this study is the Monthly Employment Survey (PME) from the Brazilian Institute of Geography and Statistics (IBGE) for two periods 2003-2006 and 2010-2013. This survey is a longitudinal and monthly database and investigates the population resident in urban areas of six metropolitan areas: Recife, Salvador, Belo Horizonte, São Paulo, Rio de Janeiro and Porto Alegre. The PME is a household survey that collects

data on labor market activity of the population, including earnings, mobility decisions, occupational sector and formality status, and socioeconomic aspects such as schooling.

The sample used for descriptive analysis and to estimate the household job search model is selected from the original sample of households, and it comprises those households with a mother and the presence of at least one child aged 14-24[17]. The households can or cannot have children aged 0 to 13 years. Thus, we exclude the households in which the children live alone because we do not model the decision of children to leave the parents' house and the households with children aged over 24 years[18]. We exclude the households whose members have problems in the identification code or some inconsistent information throughout the panel [19]. Additionally, we exclude the households with fathers or mothers aged below 14 years and the households with two mothers or two fathers.

We observe that we estimate the household job search model for about 50% of all individuals aged 14 to 65 years old and for 36% of all households. We use the first and second interviews of each household, separated by one month, in our household job search estimations, for which we compute transition probabilities and wage changes. Thus, since we use transition information in our estimation process, we exclude the attrited households and the households whose children aged 14 to 24 years and/or mother have attrition or do not have information about labor market status in one of the two observations[20]. Applying these selection criteria, our subsample has 56,718 families in 2003-2006 and 51,087 families in 2010-2013. In this paper, we define a high level of education as high school or above.

6 Estimation results

This section presents the estimation results performed separately for 2003-2006 and 2010-2013, and subgroups of children based on schooling level – high education (around 56% of children in 2003-2006, and 60% in 2010-2013) or low education – and mothers.

[17]We do not exclude the households in which the father is not present, but we do not model marriage formation and dissolution.

[18]Camarano et al. (2003) show that in Brazil, the average age of children who leave their parents' house and become the head of a family is 26 years. Thus, we consider 24 years to be a general threshold for children to become a household head or a spouse.

[19]Inconsistency problems include the presence of more than one head or the absence of a head, which is not possible based on the PME's questionnaire.

[20]The father must be present in the two considered interviews if the father is a member of the household, and we allowed children aged below 13 years to suffer attrition.

6.1 Model fit

Tables 6 to 8 present the model fit for, respectively, aggregated stocks, wages, and transition probabilities. In these tables, we present a column for the data and the estimated counterparts, for the 2003-2006 and 2010-2013 periods.

We obtain a reasonable fit for the aggregated stocks (Table 6). This table presents the third set of columns for the change of stocks between the two analyzed periods, which allows us to observe the equality of signs and similar magnitudes of changes calculated with empirical data and estimated counterparts. The bottom of this table presents the employment and participation rates of children and mothers, calculated based on data and estimated stocks. These statistics are particularly relevant in our analysis since they reflect the aggregated trends of the labor market of secondary earners. Again, we observe a reasonable good fit. The employment rate is increasing for both members, but more for mothers. However, the participation rate is increasing for mothers and decreasing for children.

For wages (Table 7), we find a good fit for both periods, and it is even better for children with high education and mothers, in 2003-2006. Table 8 also reveals a reasonable fit for transition probabilities, but not so good as observed for stocks and wages, which is expected, since these are unrestricted moments.

Source: Elaborated by the authors based on model estimation using data from the PME for 2003-2006 and 2010-2013.

Table 6: Model fit - Aggregate stocks and change

Stocks	2003-2006		2010-2013		Change	
	Data	Estimated	Data	Estimated	Data	Estimated
m_{ee}	0.182	0.183	0.219	0.194	0.037	0.011
m_{eu}	0.013	0.021	0.009	0.018	-0.004	-0.003
m_{ei}	0.157	0.142	0.150	0.146	-0.007	0.004
m_{ue}	0.060	0.076	0.040	0.059	-0.020	-0.017
m_{uu}	0.010	0.008	0.004	0.005	-0.006	-0.003
m_{ui}	0.054	0.060	0.026	0.040	-0.028	-0.021
m_{ie}	0.273	0.265	0.328	0.300	0.055	0.034
m_{iu}	0.023	0.026	0.016	0.024	-0.007	-0.002
m_{ii}	0.228	0.218	0.207	0.215	-0.021	-0.003
Employment rate						
Children	0.352	0.346	0.378	0.358	0.026	0.012
Mothers	0.515	0.524	0.587	0.553	0.072	0.028
Participation rate						
Children	0.476	0.491	0.449	0.462	-0.027	-0.029
Mothers	0.561	0.579	0.616	0.600	0.056	0.020

Source: Elaborated by the authors based on model estimation using data from the PME for 2003-2006 and 2010-2013.

6.2 Main parameter estimates

In this section, we present the main parameter estimates for 2003-2006 and 2010-2013, and children with low and high education, and mothers. We estimate 26 parameters with 55 moments. We use bootstrap variances.

In Table 10, we observe that the estimated job destruction parameter for high education children ($\delta_{1,h}$) and mothers (δ_2) decreased between 2003-2006 and 2010-2013, reflecting better labor market conditions for these members. On the other hand, the job destruction parameter for low education children ($\delta_{1,l}$) is increasing in the period. Low education children also present a lower job arrival rate when unemployed ($\lambda^0_{1,l}$), but it is increasing between 2003-2006 and 2010-2013, whereas it is decreasing for high education children ($\lambda^0_{1,h}$) and mothers (λ^0_2). Comparing these two groups of workers – mothers and high education children – mothers present a worse job arrival rate when unemployed. Mothers also present the worst on-the-job arrival rate.

It is important to note that the estimated encouragement rates (move from inactivity

Table 7: Model fit - Wages

Wages	2003-2006		2010-2013	
	Data	Estimated	Data	Estimated
Children - high ed.				
$P10$	6.019	5.390	6.411	5.481
$P25$	6.308	6.232	6.672	6.269
$P50$	6.603	6.683	6.879	6.789
$P75$	6.972	6.993	7.181	7.129
$P90$	7.344	7.280	7.529	7.382
Mean	6.783	6.707	7.021	6.830
Std. Dev.	6.267	6.129	6.318	6.210
Children - low ed.				
$P10$	5.186	5.417	5.730	5.480
$P25$	5.831	6.241	6.310	6.269
$P50$	6.256	6.686	6.695	6.788
$P75$	6.570	6.993	6.882	7.129
$P90$	6.840	7.279	7.119	7.382
Mean	6.324	6.709	6.698	6.830
Std. Dev.	5.843	6.123	5.997	6.210
Mothers				
$P10$	5.656	5.687	6.189	5.999
$P25$	6.203	6.195	6.619	6.545
$P50$	6.568	6.781	6.861	6.990
$P75$	7.033	7.291	7.286	7.361
$P90$	7.663	7.801	7.802	7.721
Mean	6.900	7.054	7.123	7.156
Std. Dev.	6.757	6.842	6.753	6.806

Source: Elaborated by the authors based on model estimation using data from the PME for 2003-2006 and 2010-2013.

to unemployment) for both children ($\alpha_{1,l}$ and $\alpha_{1,h}$) decrease in the period, whereas the discouragement/dropout rates for these members ($\beta_{1,l}$ and $\beta_{1,h}$) increase. For mothers, we have an increase in the encouragement and discouragement rates, but with a predominance of the latter.

Therefore, the employment and participation rates, and changes of these two labor market aggregates between 2003-2006 and 2010-2013, presented in Table 7, are resulted from the observed changes in the main parameter estimates (Table 10). The increase in the employment rate of children is the result of better labor market conditions, a worse

Table 8: Model fit - Transition probabilities

Transitions	2003-2006		2010-2013	
	Data	Estimated	Data	Estimated
Children - high ed.				
E→E'	0.024	0.083	0.016	0.066
E→U	0.030	0.070	0.018	0.040
U→E	0.125	0.171	0.159	0.199
U→I	0.282	0.263	0.336	0.291
I→U	0.129	0.133	0.080	0.076
Children - low ed.				
E→E'	0.033	0.058	0.022	0.067
E→U	0.037	0.061	0.025	0.045
U→E	0.124	0.109	0.144	0.112
U→I	0.370	0.309	0.408	0.337
I→U	0.048	0.035	0.027	0.031
Mothers				
E→E'	0.010	0.026	0.006	0.021
E→U	0.009	0.007	0.007	0.007
U→E	0.138	0.064	0.156	0.079
U→I	0.337	0.113	0.327	0.132
I→U	0.036	0.014	0.029	0.016

job arrival rate for mothers, and an increase in mothers' flow out of inactivity. Higher participation of mothers in the labor market may allow greater investment in the education of children and a higher level of children's employment due to returns to education. These mechanisms overcome the children's flow out of inactivity and the increase in the income of fathers, which could contribute to diminishing the employment of children.

On the other hand, the participation of children is decreasing and the mechanisms behind this trend could be a decrease in the flow out of inactivity and an increase in the income of fathers, despite an improvement in their labor market conditions, an increase in mother's flow out of inactivity and a fall into mother's job finding rate.

For mothers, both the employment and participation rate are increasing as a result of better labor market conditions, and a higher mother's flow out of inactivity that overcomes other mechanisms such as a higher flow into inactivity, a decrease in the job arrival rate, and an increase of father's income.

Table 9: Main parameter estimates

Parameters	Description		2003-2006		2010-2013	
			Estimate	Std. Error	Estimate	Std. Error
$\delta_{1,h}$		child - high ed.	0.152	0.012	0.082	0.011
$\delta_{1,l}$	E→U: job destruction	child - low ed.	0.105	0.017	0.115	0.025
δ_2		mother	0.030	0.003	0.022	0.003
$\lambda^0_{1,h}$		child - high ed.	0.490	0.033	0.430	0.043
$\lambda^0_{1,l}$	U→E: job arrival 0	child - low ed.	0.272	0.025	0.282	0.044
λ^0_2		mother	0.439	0.023	0.368	0.035
$\lambda^1_{1,h}$		child - high ed.	0.434	0.038	0.339	0.047
$\lambda^1_{1,l}$	E→E': job arrival 1	child - low ed.	0.205	0.031	0.300	0.043
λ^1_2		mother	0.094	0.017	0.081	0.022
$\alpha_{1,h}$		child - high ed.	0.266	0.019	0.168	0.019
$\alpha_{1,l}$	I→U	child - low ed.	0.080	0.007	0.056	0.006
α_2		mother	0.053	0.004	0.057	0.007
$\beta_{1,h}$		child - high ed.	0.743	0.018	0.747	0.034
$\beta_{1,l}$	U→I	child - low ed.	0.734	0.023	0.756	0.025
β_2		mother	0.628	0.024	0.703	0.025
σ	Cost of education dist.	household	8.77E-06	2.06E-06	9.58E-06	7.05E-06

Source: Elaborated by the authors based on model estimation using data from the PME for 2003-2006 and 2010-2013.

Note: Bootstrap standard errors based on 100 replications reported.

6.3 Simulations

In these counterfactual simulations, we replace the entire set of parameters in the first period (2003-2006) with the parameters in the second period (2010-2013), keeping one parameter fixed at a time. The objective is to analyze if new estimates converge to the estimates of the predicted change (between the two analyzed periods) in stocks and employment and participation rates. Thus, we can conclude the contribution of these parameters to the trends in employment and participation observed in this decade. Table 13 presents the counterfactual simulations of the parameters.

We verify that most of the observed increase in children's employment rate is explained by an improvement in their labor market conditions, despite a negative contribution to children's employment of the increase in father's income and of movements of children out of the labor force. Also, most of the observed fall in children's participation rate is

explained by movements of children in and out of the labor force and improvement in their labor market conditions. However, we find evidence for the added worker effect: (i) an increase in the father's income reduces participation (and employment) of children, and (ii) the mother's lower job finding rate attenuates the fall in the participation rate of children.

For the observed increase in mothers' employment and participation rates, the main determinant is an improvement in their labor market conditions, but we also find evidence for the added worker effect for this family member: an increase in the father's income reduces the employment and participation of mothers. In addition, the increase in the encouragement of mothers – reflecting a higher entry of mothers into the labor force – impacted both participation and employment rates.

Table 10: Counterfactual simulations

Results	Predicted Change	Children		Mother				Father
		δ_1	α_1	δ_2	λ_2^0	α_2	β_2	Y
		Job dest.	I→U	Job dest.	Job arrival	I→U	U→I	Income
Employment rate								
Children	0.012	**-0.071**	**0.081**	0.009	**0.003**	**0.003**	0.009	**0.019**
Mother	0.028	0.028	0.028	**-0.051**	**0.068**	**0.005**	**0.053**	**0.037**
Aggregate	0.030	0.002	0.053	0.003	0.040	0.020	0.037	0.035
Participation rate								
Children	-0.029	**-0.091**	**0.054**	-0.033	**-0.037**	**-0.037**	-0.030	**-0.025**
Mother	0.020	0.017	0.022	**-0.046**	**0.055**	**-0.001**	**0.046**	**0.031**
Aggregate	0.007	-0.015	0.035	-0.017	0.016	-0.003	0.015	0.012

Source: Elaborated by the authors based on model estimation using data from the PME for 2003-2006 and 2010-2013.

7 Conclusions and final remarks

In this study, we develop a household job search model in which we allow for secondary earners' labor market decisions (children and mothers). The model distinguishes between unemployment and inactivity of mothers and children and we also add one important long-term benefit: parental investment in child education, since an ex-ante schooling decision for children is allowed to be endogenous. Our model does a reasonable job of fitting stocks, employment and participation rates, and wages.

Our estimation results show that the increase in the employment rate of children is the result of better labor market conditions, a worse job arrival rate for mothers, and an increase in mothers' flow out of inactivity. Higher participation of mothers in the labor market may allow greater investment in the education of children and a higher level of children's employment due to returns to education. These mechanisms overcome the children's flow out of inactivity and the increase in the income of fathers, which could contribute to diminishing the employment of children. On the other hand, the participation of children is decreasing and the mechanisms behind this trend could be a decrease in the flow out of inactivity and an increase in the income of fathers, despite an improvement in their labor market conditions, an increase in mother's flow out of inactivity and a fall into mother's job finding rate.

For mothers, both the employment and participation rate are increasing as a result of better labor market conditions, and a higher mother's flow out of inactivity that overcomes other mechanisms such as a higher flow into inactivity, a decrease in the job arrival rate, and an increase of father's income.

In our counterfactual simulations, we verify that most of the observed fall in children's participation rate is explained by (i) movements of children in and out of the labor force and (ii) improvement in labor market conditions. We also find evidence for the added worker effect: (i) an increase in the father's income reduces employment and participation of children and mothers, and (ii) the mother's lower job finding rate attenuates the fall in the participation rate of children.

For the observed increase in mothers' employment and participation rates, the main determinant is an improvement in their labor market conditions, but we also find evidence for the added worker effect for this family member: an increase in the father's income reduces the employment and participation of mothers. In addition, the increase in the encouragement of mothers – reflecting a higher entry of mothers into the labor force – impacted both participation and employment rates. Finally, we verify that important cross-effects are underestimated if we ignore endogenous schooling. Therefore, our results strengthen the argument about the relevance of household search behavior in the labor supply decisions of secondary earners in families and about how using individual job search models to understand aggregate employment and participation can be misleading.

Finally, the future agenda of the paper includes heterogeneity analysis based on age group and gender of children, and differentiation of value of leisure for unemployed and inactive workers.

References

[1] Becker, G. S. A theory of marriage: Part II. *Journal of Political Economy 82*, 2 (1974), S11–S26.

[2] Becker, G. S. *A Treatise on the Family*. NBR Books, 1981.

[3] Béland-O'keefe, L. An examination of the added-and the discouraged-worker effects in canada at the end of the millennium.

[4] Bellman, R. *Dynamic programming*. Princeton University Press, 1957.

[5] Benati, L. Some empirical evidence on the 'discouraged worker'effect. *Economics Letters 70*, 3 (2001), 387–395.

[6] Blundell, R., Pistaferri, L., and Saporta-Eksten, I. Consumption inequality and family labor supply. *American Economic Review 106*, 2 (2016), 387–435.

[7] Bobba, M., Flabbi, L., and Levy Algazi, S. Labor market search, informality and schooling investments, iza discussion papers 11170. *Institute for the Study of Labor (IZA)* (2017).

[8] Bontemps, C., Robin, J., and VAN DEN BERG, G. J. An empirical equilibrium job search model with search on the job and heterogeneous workers and firms. *International Economic Review 40*, 4 (1999), 1039–1074.

[9] Burdett, K., and Mortensen, D. Labor supply under uncertainty. Tech. rep., Northwestern University, Center for Mathematical Studies in Economics and Management Science, 1977.

[10] Burdett, K., and Mortensen, D. T. Wage differentials, employer size, and unemployment. *International Economic Review 39*, 2 (1998), 257–73.

[11] Cabanas, P., Komatsu, B., and MENEZES FILHO, N. O crescimento da renda dos adultos e as escolhas dos jovens entre estudo e trabalho. *INSPER Policy Paper*, 13 (2015).

[12] Camarano, A. A., Pazinato, M. T., Kanso, S., and Vianna, C. A transição para a vida adulta: novos ou velhos desafios? *Mercado de trabalho: conjuntura e análise* (2003), 53–66.

[13] Conti, G., Ginja, R., and Narita, R. The value of health insurance: a household job search approach.

[14] Cunningham, W., and Maloney, W. F. Measuring vulnerability: who suffered in the 1995 mexican crisis? *World Bank mimeo* (2000).

[15] Dey, M., and Flinn, C. Household search and health insurance coverage. *Journal of Econometrics 145*, 1 (2008), 43–63.

[16] Duryea, S., Lam, D., and Levison, D. Effects of economic shocks on children's employment and schooling in Brazil. *Journal of Development Economics 84*, 1 (2007), 188–214.

[17] Fang, H., and Shephard, A. Joint household labor supply and health care reform. *Work in Progress, University of Pennsylvania* (2014).

[18] Fernandes, R., and Felício, F. d. The entry of the wife into the labor force in response to the husband's unemployment: a study of the added worker effect in brazilian metropolitan areas. *Economic Development and cultural change 53*, 4 (2005), 887–911.

[19] Flabbi, L., and Mabli, J. Household search or individual search: does it matter? evidence from lifetime inequality estimates.

[20] Flinn, C., and Mullins, J. Labor market search and schooling investment. *International Economic Review 56*, 2 (2015), 359–398.

[21] García-Pérez, J. I., and Rendon, S. Family job search and wealth: The added worker effect revisited. *Quantitative Economics 11*, 4 (2020), 1431–1459.

[22] Gemici, A. Family migration and labor market outcomes. *Manuscript, New York University* (2011).

[23] Guner, N., Kulikova, Y., and Valladares-Esteban, A. Labor market ddynamics of married couples. Preliminary, 2015.

[24] Jaimovich, N., Pruitt, S., and Siu, H. E. The demand for youth: Explaining age differences in the volatility of hours. *American Economic Review 103*, 7 (2013), 3022–44.

[25] Jaimovich, N., and Siu, H. E. The young, the old, and the restless: Demographics and business cycle volatility. *American Economic Review 99*, 3 (2009), 804–26.

[26] Kell, M., and Wright, J. Benefits and the labour supply of women married to unemployed men. *The Economic Journal 100*, 400 (1990), 119–126.

[27] Long, C. D., et al. The labor force under changing income and employment. *NBER Books* (1958).

[28] Lundberg, S. The added worker effect. *Journal of Labor Economics 3*, 1, Part 1 (1985), 11–37.

[29] Mankart, J., and Oikonomou, R. Household search and the aggregate labor market. *The Review of Economic Studies 50* (2016), 1–63.

[30] Mankart, J., and Oikonomou, R. Household search and the aggregate labour market. *The Review of Economic Studies 84*, 4 (2017), 1735–1788.

[31] Skoufias, E., and Parker, S. W. Job loss and family adjustments in work and schooling during the mexican peso crisis. *Journal of Population Economics 19*, 1 (2006), 163–181.

[32] Tansel, A., and Ozdemir, Z. A. Unemployment invariance hypothesis, added and discouraged worker effects in canada. *International Journal of Manpower* (2018).

[33] VAN DEN BERG, G., and Ridder, G. An empirical equilibrium search model of the labor market. *Econometrica 66*, 5 (1998), 1183–1222.

[34] Vieira, C. S., Menezes-Filho, N., and Komatsu, B. K. Como as mudanças no trabalho e renda dos pais afetam as escolhas entre estudo e trabalho dos jovens? *Pesquisa e Planejamento Econômico 46*, 3 (2016), 33–61.