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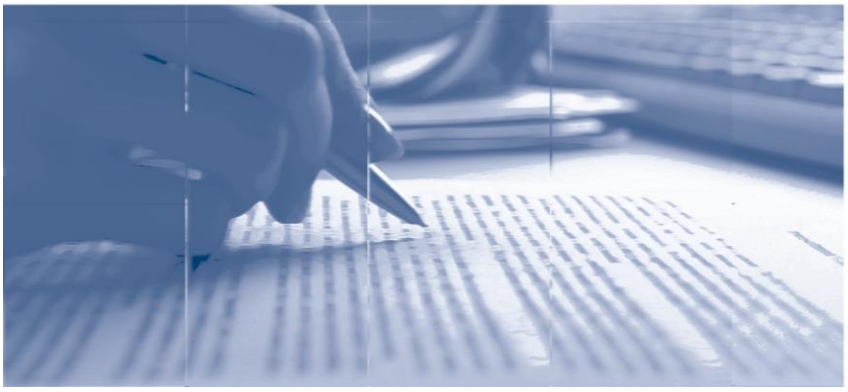

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Two Decades of Structural Shifts in the Brazilian Labor Market: Assessing the Unemployment Rate Changes through Stylized Facts on Labor Supply and Labor Demand

Andre de Queiroz Brunelli*

Abstract

This paper aims at dissecting how stylized facts of labor supply and labor demand may explain the aggregate unemployment rate developments from 1992 to 2012 using a household level data (PNAD/IBGE) for Brazil as a whole and for its six main metropolitan regions. The conclusions follow. The main stylized fact regarding labor supply is the aging process of the labor force. It lessened the aggregate unemployment rise during the 1990's by about 20% both in the entire country and in the metropolitan regions and strengthened the unemployment fall by about 30% in Brazil as a whole and by around 20% in the metropolitan regions during the 2000's. With respect to labor demand, the main stylized facts are that the relative prices have favored the non-tradable sectors, which in addition has shown the most significant rise of the marginal productivity of labor in the last two decades. We argue that it affected sectorial reallocation of employment, which in turn has a negative effect on aggregate unemployment rate conditional on GDP growth. It thus is consistent with the argument which states that employment migrated from tradable sectors towards non-tradable sectors, which are more labor intensive sectors. Besides conventional business cycle changes, which explain the bulk of the actual aggregate unemployment rate developments, the answer to why the aggregate unemployment rate has become so much lower in Brazil is that population has become older and also that the sectorial profile of employment has become increasingly non-tradable.

Keywords: labor market; unemployment rate; demography; economic sectors
JEL Classification: J11; J21; J82

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1. Introduction

This paper aims at dissecting how stylized facts of labor supply and labor demand may explain the aggregate unemployment rate developments from 1992 to 2012 in Brazil. Labor market in Brazil is widely monitored by the only comprehensive monthly survey, PME/IBGE, that comprises both formal and informal markets. However, it is restricted geographically by the six main metropolitan regions of the country. Thus, we include the metropolitan regions in our study in order to assess whether there are different patterns regarding labor market developments in relation to the whole country.

In the past twenty years, the aggregate unemployment rate had a substantial increase during the 1990's, which was followed by a remarkable fall during the 2000's that virtually gave back the unemployment rise in the previous decade. This observation raises the question on how much of the aggregate unemployment rate developments during the last twenty years is due to structural changes in the labor market and how much is due to conventional business cycle variations. We explored this question by assessing stylized facts of labor supply and labor demand.

Regarding stylized facts of labor supply, we follow Shimer (1999) in looking at workers' observable characteristics – age, schooling, sex and race – as an attempt to explain the unemployment rate developments. That is: we evaluate how demography affects aggregate unemployment rate by assuming that each group's unemployment rate is unaffected by the size of that group, which refers to an observable characteristic. To this respect, there are examples of alternative demographic adjustment for age, such as pointed out by Perry (1970) and Gordon (1982). They weight different groups by their members' total earnings and construct an alternative measure of unemployment using these weights.

An application of this type of analysis in Brazil is Barbosa Filho and Pessôa (2011), which decomposed the aggregate unemployment rate variation thorough an "unemployment effect" and a "composition effect" from 2001 to 2008 using the PNAD survey. They argued that the unemployment rate decomposition using the age profile of the labor force explained around 30% of the aggregate unemployment rate fall in this period. Nonetheless, this study does not explores the validity of the underlying hypothesis that the disaggregate unemployment rate is unaffected by their groups'

labor-force share, which may bias the results. In this sense, the main contribution of this study is to document an analysis of two decades (1992-2012) of structural shifts of labor supply and labor demand by using the PNAD/IBGE survey, which is the most comprehensive survey of labor market in Brazil. To this end, we set a couple of measures of demographic unemployment that aim to explore the limitations of the unemployment decomposition and its underlying hypothesis.

The main stylized fact regarding labor supply is the aging process of the labor force. The results that stem from the measures of demographic unemployment based on this stylized fact is that it lessened the aggregate unemployment rise during the 1990's by about 20% both in the entire country and in the metropolitan regions and strengthened the unemployment fall by about 30% in Brazil as a whole and by around 20% in the metropolitan regions during the 2000's.

In the meantime, the Brazilian economy has undergone through important changes in the past twenty years, as assessed by many authors, such as Bonelli and Fonseca (1998), Bonelli (2010) and Araujo and Lima (2007). We can cite the trade and financial openness and the price stabilization program in the early 1990's and the "macroeconomic tripod" in the late 1990's, which is a policy framework consisting of an inflation target regime, floating exchange rate and targets of fiscal discipline. Other authors analyzed the effect of structural changes in economy on the labor market during the 1990's, such as Barros et al. (1997) and Ramos and Reis (1997) and Camargo, Neri and Reis (2000). A more recent study is Pauli, Nakabashi and Sampaio (2012), which assessed how structural changes in the Brazilian economy during the 1990's and 2000's affected the labor demand for qualification among economic sectors.

Thus, with respect to stylized facts of labor demand, we apply Camargo, Neri and Reis (2000). We set a model of labor supply and labor demand in order to rationalize the main labor market developments in the last twenty years. By these means, we set an index of employment dispersion among economic sectors that follows Gonzaga and Reis (2000) which analyzes the importance of employment reallocation on unemployment rate using the PME/IBGE survey. This index is calculated similarly to that Loungani, Rush, and Tave (1990) and Loungani and Trehan (1997) apply to stock prices. In this sense, we empirically contribute to this methodology by applying a larger sample time and we also check robustness by calculating different versions of this index by using different sectorial aggregations. We then apply regressions on aggregate

unemployment rate utilizing this measure of sectorial employment dispersion as an attempt to capture whether the employment transition conditional on GDP growth matters for the aggregate unemployment rate changes in the past two decades.

With respect to labor demand, the main stylized facts are that the relative prices have favored the non-tradable sectors, which in addition has shown the most significant rise of the marginal productivity of labor in the last two decades. Hence, to some extent it affected the sectorial profile of employment, which is represented by the index of employment dispersion. It in turn has a negative effect on aggregate unemployment rate conditional on GDP growth as suggest the aggregate unemployment rate regressions. Therefore, it is consistent with the argument which states that employment migrated from tradable sectors towards non-tradable sectors, which are more labor intensive sectors.

However, despite the importance of structural factors for both the labor supply and labor demand, the results of the demographic unemployment and the aggregate unemployment rate regressions suggest that the business cycle changes explain the bulk of the aggregate unemployment rate developments, especially in the metropolitan regions.

Besides this introduction this paper is organized as follows: section 2 presents the data description. Section 3 refers to the motivation and methodology and section 4 discusses the results. The last section presents the concluding remarks.

2. Data Description

This study uses an annual household level data for the whole country (National Household Sample Survey – PNAD – Brazilian Institute of Geography and Statistics – IBGE) and for the six main metropolitan regions[2] to characterize the employment experience of different groups of workers and economic sectors[3]. The choice of the sample period is due to available data in the PNAD/IBGE and comprises the period

[2] It comprises the following metropolitan regions: Belo Horizonte, Porto Alegre, Rio de Janeiro, Recife, São Paulo and Salvador. These are the same areas comprised by the Monthly Employment Survey – PME, which is the main monthly survey regarding labor market in Brazil. Eventually, we compare the results of the metropolitan regions covered by PNAD with the ones that refer the PME as robustness check. The data in which the source is PME refers to September of each year in order to avoid seasonality factors for compatibility reasons with the PNAD, which is collected in September every year.

[3] The data in this paper are available from the IBGE website, http://www.ibge.com.br, except where noted otherwise. The specific series used are available upon request.

from 1992 to 2012 – the most recent year available. In the main counterfactual exercises with the unemployment rate, we split the sample in two decades (1992-2002 and 2002-2012) as our main comparison basis. It has the advantage that 2002 is in the neighborhood of the unemployment rate business cycle peak, so that the 1990's is marked by a continuous unemployment rate rise, whereas the 2000's experienced a continuous unemployment rate fall. We consider 10 years old people at least, according to the age that IBGE officially publishes as lower bound in labor market surveys.

All variables of labor market were assessed through four different sample cohorts regarding characteristics of labor supply and another that refers to labor demand (economic structure). As mentioned above, the chosen cohorts of workers are grouped by their observable characteristics – age, schooling, sex and race. The age and schooling profiles were split into three clusters each; the race profile was separated into white and non-white people and the sex profile is straightforward. This level of decomposition is the simplest one without limiting the generality of the results. Furthermore, different decomposition of sample cohorts is later carried out as robustness check.

The variable regarding the age is straightforward and its clusters were represented by young workers (10 to 24 years old), adult workers (25 to 49) and old workers (50 or more). The variable of schooling profile is years of schooling. It was split into people with less than 8 years of schooling (less skilled or unskilled – similar to less than primary education), between 8 and 10 years of schooling (average skilled – similar to primary education or lower secondary education) and more than 11 years of schooling (more skilled or skilled – similar to secondary education or higher, which includes, for example, post-secondary non-tertiary education, first stage of tertiary education and second stage of tertiary education). Both split among the age and schooling clusters are an attempt to adjust the concepts and definitions referred in the ILOSTAT Database (Statistical Database of the International Labour Organization) to the publication of data carried out by the IBGE.

The variable sector of occupation was split into four clusters: agriculture[4], industry[5], construction[6] and services. Both surveys follow the National Classification of

[4] It includes the following divisions (activities): agriculture, cattle farming, forestry and fishing.
[5] It includes the following divisions (activities): manufacturing, extraction, electricity and utilities.
[6] It includes the following division (activity): construction.

Economic Activities – CNAE adapted to households[7], which in turn adheres to the International Standard Industrial Classification of All Activities – ISIC. The aggregation of subsectors into agriculture, industry and construction is straightforward and follows the IBGE. The one associated to services sector is defined as the difference between the total and the others sectors[8]. In this sense, we follow the simplest sectorial aggregation represented by the GDP computed by the IBGE, which are: agriculture, industry and services. We additionally detached the construction sector from industry, since the former is more labor intensive and looks like a non-tradable sector. Furthermore, this sector experienced an economic boom during the 2000's such that the employment developments are quite different from the industry.

3. Motivation and Methodology

Brazil has established several macroeconomic reforms and has experienced considerable changes in the international scenario in the last two decades that have implied significant shifts in its economic structure. As examples of reforms, we can cite the trade and financial openness, the price stabilization program and the "macroeconomic tripod". In the wake of the institutional reforms and also of the commodity boom and high international liquidity, Brazil was able to accelerate the economic growth featuring a strong currency, which implied important developments in relative prices internally and in terms of trade. All these changes likely affected the labor market, especially the sectorial profile of employment.

During the early 1990's the fall of industrial employment following the trade openness and the stabilization program was compensated by the increase of the services employment. However, after 1995 this phenomenon finished, leading to a monotonic

[7] The CNAE-Household remains identical to the CNAE in more aggregated levels, except in respect to trade sector. In this case, there is no distinction between retail and wholesale, which are not captured accurately in household surveys.
For further details on PNAD/IBGE methodology, see:
ftp://ftp.ibge.gov.br/Trabalho_e_Rendimento/Pesquisa_Nacional_por_Amostra_de_Domicilios_anual/2012/Volume_Brasil/brasil_notas_tecnicas.pdf and
ftp://ftp.ibge.gov.br/Trabalho_e_Rendimento/Pesquisa_Nacional_por_Amostra_de_Domicilios_anual/2012/Volume_Brasil/pnad_brasil_2012.pdf.

[8] This definition is justified because we can also consider the sector 'other activities' as service sector, since these sectors are substantially correlated. 'Other activities' comprises the following subsectors: financial intermediation excluding insurance and pension plans, insurance and private pension, auxiliary activities to financial intermediation, real estate activities, rental of vehicles, machinery and equipment without operators and personal objects, IT services and related activities, research and development, services to enterprises, international organizations and institutions.

increase of the aggregate unemployment rate until 1999, which totaled up 350 basis points (hundredths of a percentage point), as shown in Figure 1. Following the "maxi-devaluation" of the currency and the floating exchange regime in 1999 and, more clearly since the business cycle peak in 2003, when Brazil started an accelerated pace of economic growth until 2010[9], we note a downward trend of the aggregate unemployment rate. It then gave back the rise experienced during the 1990's since it reached a 350 basis points fall in 2012. Interestingly, the employment boom was led by the non-tradable sector, but also widespread through all sectors[10]. Moreover, despite a steep deceleration of the economic growth starting in 2011, the downward trend of the aggregate unemployment rate has remained.

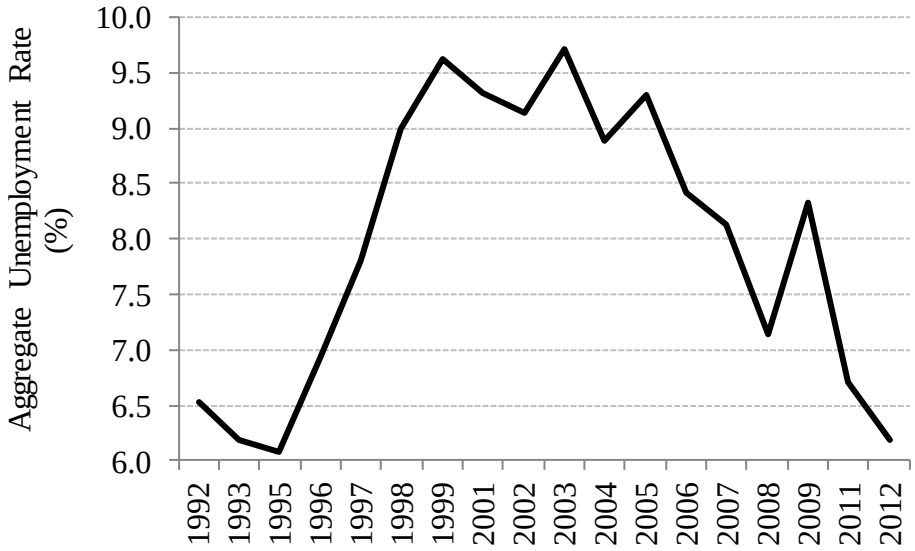


Figure 1: Aggregate Unemployment Rate in Brazil – PNAD (IBGE) – 1992-2012

In the meantime, the labor supply has experienced sorely transformations. Since mid-sixties Brazil has faced a falling fecundity rate, which has implied a noticeable demographic transition. It, in turn, has implied a continuous decline of the youth's share in the working age population during the 1990's and more pronouncedly during the 2000's. This phenomenon has been even more intensive with respect to the labor force if one considers the decreased participation rate of the youth attributed to quantitative improvements in education. In addition, it is perceptible that the labor market has been

[9] It was discontinued in 2009 due to the international financial crisis.
[10] With the exception of agriculture, which has experienced a structural process of workforce dismissal due to substantial improvements in productivity since the beginning of the 1990's.

more inclusive since the 1990's. There is a consistent upward trend regarding the participation of, for example, women and non-whites in the labor force.

All these stylized facts regarding both features of labor demand and labor supply raise the question on how much of the aggregate unemployment rate developments during the 1990's and the 2000's is due to structural changes in the labor market and how much is due to conventional business cycle variations.

In order to assess whether these structural shifts that are associated to the labor supply affected the aggregate unemployment rate developments, we propose a structural interpretation to the relationship between demographics and aggregate unemployment. For these means, with respect to features of labor supply, we documented the disaggregate unemployment rate of workers grouped by their observable characteristics – age, education, sex and race both in Brazil as a whole and in the main metropolitan regions.

Next we calculate how much of the 1990's rise and of the 2000's decline in aggregate unemployment rate is attributable to these demographic factors and how much of the decline would have happened if all demographic variables had remained constant. To perform this counterfactual exercise, we maintain the hypothesis that the unemployment rate of each group of workers is unaffected by demographics. Any change in unemployment for a group of workers would therefore have happened in the absence of demographic changes; it is a genuine change in unemployment. Any remaining changes in unemployment are demographic. Thus, we reaggregate the data to construct series for the demographic and genuine components of unemployment.

Then, in looking at the shifts of the labor demand, we document the determinants associated to business cycle and structural factors of the labor demand in economic sectors and how it interacts with labor supply in order to assess the aggregate unemployment rate developments. Although we assess stylized facts that refer to both labor supply and labor demand, in general, we call them in this section as developments of labor demand in order to distinguish from the labor supply characteristics that we assessed in the previous subsection and also because we focus on aspects related to the production structure, which is aggregated through economic sectors.

For these means we apply a simple model of labor supply and demand, which is consistent with the labor market operation as an attempt to rationalize these main developments regarding employment and real wages by economic sectors. To

compliment these rationalizations we assess determinants of labor demand, such as relative prices and marginal productivity of labor, which underlie labor demand shifts. Then we analyze how these developments affect the sectorial reallocation of employment and whether it matters for the aggregate unemployment rate changes in the past two decades. For this means we apply an index of employment dispersion that captures the incidence of sectorial shocks over time. Hence, we apply PNAD/IBGE data to specify different models by regressing the aggregate unemployment rate on a variable that represent the business cycle – GDP growth, and another that represents the structural (sectorial) shifts in employment – the index of employment dispersion, as an attempt to predict the aggregate unemployment rate developments.

4. Structural Shifts in the Labor market and Unemployment Rate Changes

4.1. Stylized Facts on Labor Supply

In this subsection we analyze the structural shifts of the labor supply by assessing how the observable characteristics of the labor force – age, education, sex and race – affect the aggregate unemployment rate developments in the past two decades.

4.1.1. Age

In this part we apply a demographic perspective to emphasize the outlines of the demographic transition of the Brazilian population and also how it affects the age profile of the labor supply.

4.1.1.1. Demographic Transition

Brazil has experienced a fast and sustainable fecundity decrease since mid-sixties, as many of the Latin American and developing countries (Alves, 2008; Carvalho and Wong, 2006). This fecundity drop has remained persistent throughout the years and led up to a deep change in the age distribution of the population.

This is clear by noting either end of the age scale. Table 1 shows a general picture of this process exhibiting usual indicators on demography for six decades, in

which four decades refer to past indicators and two decades are prospects, according to the Population Prospects of the IBGE[11]. There is a remarkable contrast in the trajectory of the population share between the age cluster representing the youth (from 0 to 14 years old)[12] and the one standing for the elderly (65 years old or more).

	1982	1992	2002	2012	2022	2032
Share of age profiles in the total population (%)	100	100	100	100	100	100
From 0 to 14 years old (A)	37.6	34.4	29.1	24.6	20.1	17.1
From 15 to 64 years old (B)	58.3	61.0	65.1	68.2	69.8	68.6
65 years old or more (C)	4.0	4.6	5.8	7.2	10.1	14.3
Dependency ratios (%)						
Total: [(A+C)/B]	71.4	63.9	53.6	46.6	43.3	45.7
Youth (A/B)	64.5	56.4	44.7	36.1	28.8	24.9
Elders (C/B)	6.9	7.5	8.9	10.5	14.5	20.8
Birth rate (births per 1000 inhabitants)	31.5	22.8	20.3	14.2	12.0	10.2
Fecundity rate (children *per* woman)	3.9	2.6	2.3	1.7	1.5	1.5
Life expectancy (years)	63.4	67.3	71.0	73.9	76.5	78.6

Table 1: Demographic Indicators in Brazil – 1982, 1992, 2002, 2012, 2022 and 2032 – Population Prospects (IBGE)

On the one hand, the youth cluster has faced a continuous declining since 1982, considering the time comprised in Table 1. It will be particularly intense throughout the 2010's since the youth share will account for 20.1% of the total population in 2022, from 24.6% in 2012. It is also reflected in a decreasing young-age dependency ratio[13]. The intensity of the youth share decrease throughout the 2010's is lead up by the fecundity rate in the previous decade. During the 2000's, Brazil faced a substantial

[11] The figures until 1992 refer to the 2008 review. From 2002 on, figures refers to the 2013 review, since data starts in 2000.
[12] This age clustering, from 0 to 14 years old, from 15 to 64 years old and 65 years old or more follows the clustering in the UN World population prospects – 2010 review (UN, 2010). Although, we will check later in this paper, we did a different clustering using the PME and PNAD surveys following the IBGE, it does not affect the consistency of our results.
[13] The young-age dependency rate is defined as the ratio between the cluster of the youth (from 0 to 14 years old) and the cluster of the adults (from 15 to 64 years old).

fecundity drop evidenced by both a fecundity rate decrease – 2.3 children *per* woman in 2002 to 1.7 in 2012 – and a birth rate fall – 20.3 births per 1000 inhabitants in 2002 to 14.2 in 2012.

On the other hand, the share of the elderly (65 years old or more) in the total population and the old-age dependency ratio[14] has risen at increasing rates. It will be particularly strong during the 2020's as a consequence of the fecundity level shift during the sixties and its ensuing downward trend. Furthermore, the life expectancy has increased continuously from 63.4 years in 1982 to 73.9 years in 2012 and it will reach 78.6 years in 2032, according to Table 1.

These facts altogether helps understanding the increasing trajectory of the adult share (from 15 to 64 years old) of the total population. It is noticed that even though the adult share has risen, it has been so at a decreasing pace since 1998 and it will remain so until mid-twenties[15]. Thereafter, both the adult share will fall and, accordingly, the total dependency ratio[16] will start to increase. That is: the demographic bonus[17] will start to taper off.

Lower birth rates and higher life expectancy transformed the age structure of the population by reducing the weight of children and young people and by increasing the weight of the adults, at first, and the weight of the elderly following a similar pattern with a natural lag. An alternative way to illustrate the aging process of the population is through population pyramids. Figure A.1 in the appendix uses the same sample period and data source referred in Table 1 and shows the way Brazilian population evolves in fifty years from a classic young population (triangle shape) in 1982 to an aged one in 2032 (rhombus shape).

4.1.1.2. Age Profile of the Labor Supply

The demographic transition that Brazil has experienced inevitably reflects in the labor market. One effect of the fecundity rate fall since mid-sixties is a steady decrease

[14] The old-age dependency rate is defined as the ratio between the cluster of the elderly (65 years old or more) and the cluster of the adults (from 15 to 64 years old).
[15] The turning point according to Population Prospects of the IBGE – 2013 review is 2022. The turning point in according to the United Nations data – 2012 review is 2020.
[16] The total dependency rate is defined as the ratio between the sum of the cluster of the youth (from 0 to 14 years old) and the cluster of the elderly over the cluster of the adults (from 15 to 64 years old).
[17] A demographic bonus is the situation in which the total dependency ratio is falling. That is: the share of the working age population in total population is increasing.

in the fraction of young workers in the labor force and, conversely, a continuous rise in the shares of adults and elderly workers since 1992. Figure 2 documents that the entire Brazil and the main metropolitan regions follow the same pattern regarding the fall in the fraction of young workers in the labor force in the past two decades – approximately 10 p.p (percentage points), reaching 20.1% and 17.4%, respectively in 2012.

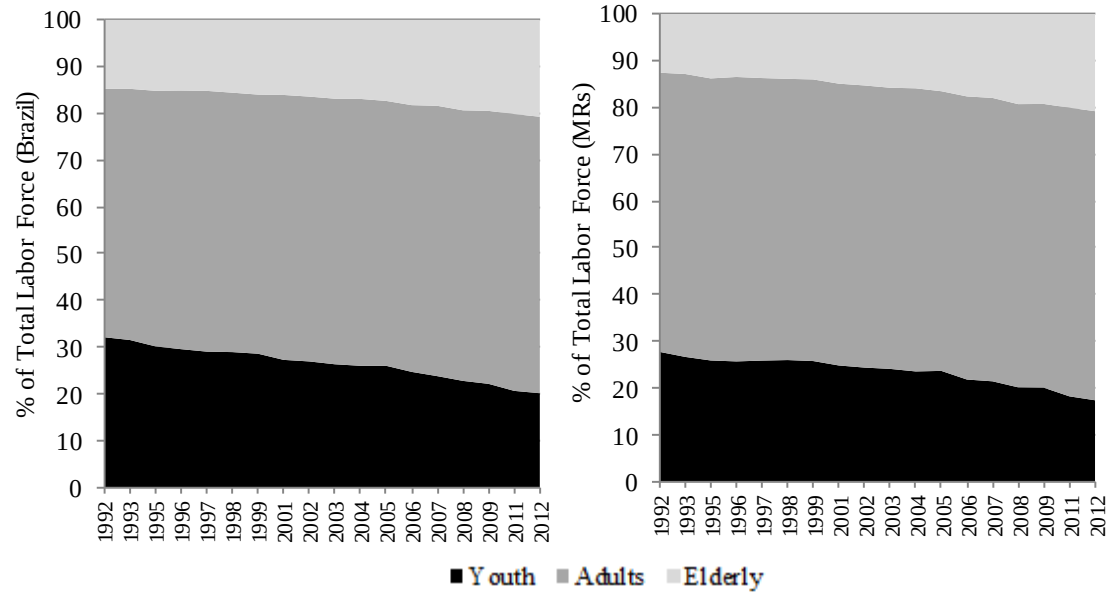


Figure 2: Labor-force Share by Age Clusters – Brazil and Metropolitan Regions (MRs) – 1992-2012 – PNAD (IBGE).

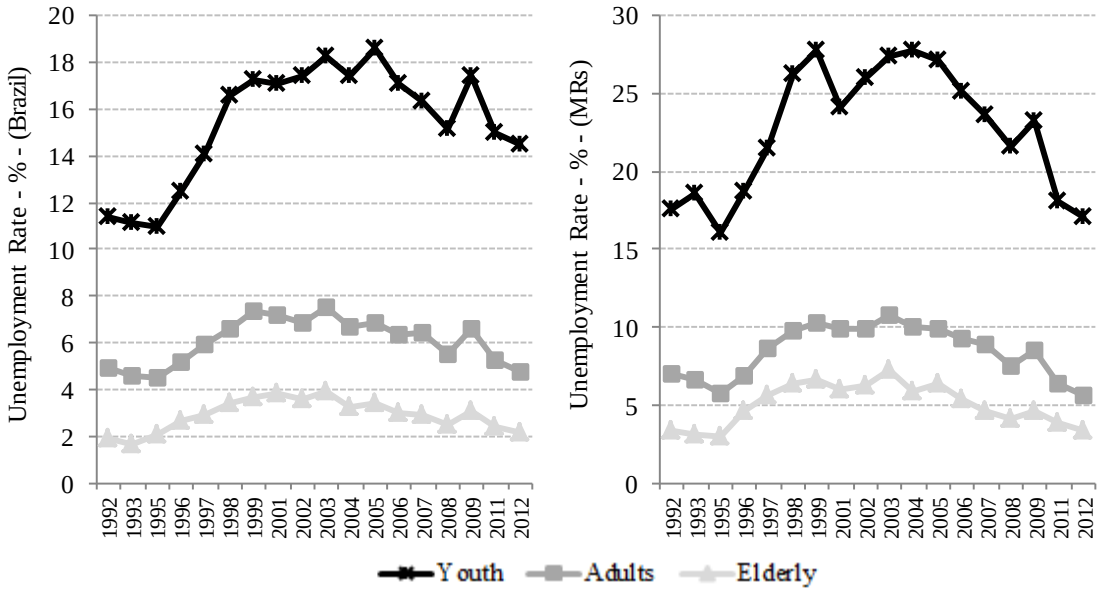


Figure 3: Unemployment Rate by Age Clusters – Brazil and Metropolitan Regions (MRs) – 1992-2012 – PNAD (IBGE).

These demographic changes are important for the aggregate unemployment rate. Since the unemployment rate of the youth cluster is persistently several times higher than the adults' unemployment rate, historical changes in the share of the youth cluster in the labor force are likely to have a significant effect on the aggregate unemployment rate. Figure 3 depicts graphically this fact. The order of the unemployment rates levels has been stable and remarkably consistent across clusters. Particularly, the unemployment rate of young workers is, in average, more than five times the unemployment rate of elderly workers and nearly three times as high the unemployment rate of adult workers and these measures do not vary significantly over time. Interestingly, the unemployment rate of each age cluster is higher in the metropolitan regions than in Brazil as a whole.

In order to assess quantitatively how changes in the age structure of the labor force affects the aggregate unemployment rate, we group the labor force into three clusters, as already mentioned in section 2: $I = \{\text{Youth, Adults, Elderly}\}$. Define D_t to be the number of unemployed workers; E_t is the number of employed workers and L_t is the labor force – each variable defined at time t. Let $\theta_{i,t} \equiv \frac{L_{i,t}}{\sum_i L_{i,t}}$ to denote the fraction of the labor force in cluster i at time t, such that $\sum_i \theta_{i,t} = 1 \; \forall t \in T$ and $T = [1992,2012]$. Additionally, let $u_{i,t} \equiv \frac{D_{i,t}}{L_{i,t}}$ to be the unemployment rate of cluster i at time t. Thus, the aggregate unemployment rate at time t is:

$$U_t \equiv \sum_i \theta_{i,t} u_{i,t} \qquad (1)$$

The aggregate unemployment rate might fall (increase) through two ways. First, the age structure of the labor force might shift towards clusters with lower (larger) unemployment rates, so that $\theta_{i,t}$ rises for i with small (large) $u_{i,t}$ and falls for i with large (small) $u_{i,t}$. Second, $u_{i,t}$, the unemployment rate of different clusters of workers might fall (increase).

We can assess how much of that change would have happened if demographics had remained the same. We will refer to this as genuine change in unemployment rate, following Shimer (1999). The underlying hypothesis is that if demographics had remained unchanged at some initial labor force shares θ_{i,t_0}, each cluster's unemployment rate would have followed the same path observed from t_0 to t_1. This

means that if there are less young workers, this gives rise to a proportional incentive to destroy jobs and has no effect on the rate that young workers find jobs. If the age-specific unemployment rate is unaffected by population dynamics, it makes sense to demographically adjust the unemployment rate for age. It then implies that the unemployment rate at time t_1 would have been the following if demographics had remained the same from t_0 to t_1:

$$U^{G}_{t_1,t_0} \equiv \sum_i \theta_{i,t_0} u_{i,t_1} \quad (2)$$

It is important to note that the calculation of the genuine unemployment rate, $U^{G}_{t_1,t_0}$, depends on the choice of the base year t_0. A natural candidate is 1992, as the aggregate unemployment rate level was similar to 2012 even though this is the demographically "worst" year in our survey, which means that $U^{G}_{t_1,1992} \geq U_{t_1}\ \forall t_1 \in T$.

Furthermore, $U^{G}_{t_1,t_0}$ may be affected by the cyclicality of labor market participation. For example, youth participation varies more with the business cycle. Young workers in general learn about their comparative advantage by experimenting. Thus, they necessarily endure many brief unemployment spells. Elderly workers, in turn, may postpone or advance the retirement decision conditional on the state of the economy and, therefore, labor participation is also more cyclical responsive. In contrast, prime-age workers are likely to be entrenched in more stable jobs[18].

On the one hand, during the 1990's, when the share of the youth in the population was already decreasing, youth participation in the labor market should have strengthened the negative changes in the weights θ_i, since the two effects move in the same direction during a not very vigorous decade in terms of economic growth. On the other hand, during the 2000's, a decade in which the economic growth was more thriving, this should have mitigated the negative changes in θ_i, since the secular decrease in the share of youth was offset by its cyclical increase in participation.

The labor market participation may also affect the genuine unemployment through a structural factor, which we will call *preference factors*. It refers to the interaction between the incentives structure and people's behavior, which might affect

[18] One way to quantify this is to look at the covariance between real GDP growth and labor-market participation growth for different age clusters. From 1993 to 2012, this covariance for young workers was 5.3 times the covariance for adult workers and 1.7 times the covariance for old workers.

their willing to participate in the labor market. For example, greater than average real gains in pensions to retirees might induce less job searching in this age cluster. Another example regards the rise of education provision, scholarships and better credit conditions given by the government to students, which might affect their (and family's) choices towards more qualification. A complementary issue that is related to the youth refers to any reason that might explain an eventual rise in the share of young people who neither are studying[19] nor are seeking a job[20]. The entry of the youth in the labor market might have been postponed by these factors as illustrates the decaying trend of the youth's participation rate since the beginning of the sample time in Brazil as a whole and since 2005 in the metropolitan region, according to Figure 4. Thus, it represents another factor that might strengthen the negative changes in the weights θ_i. It also contributes to reduce the aggregate unemployment, since it decreases the share of inexperienced workers, which has larger unemployment rates.

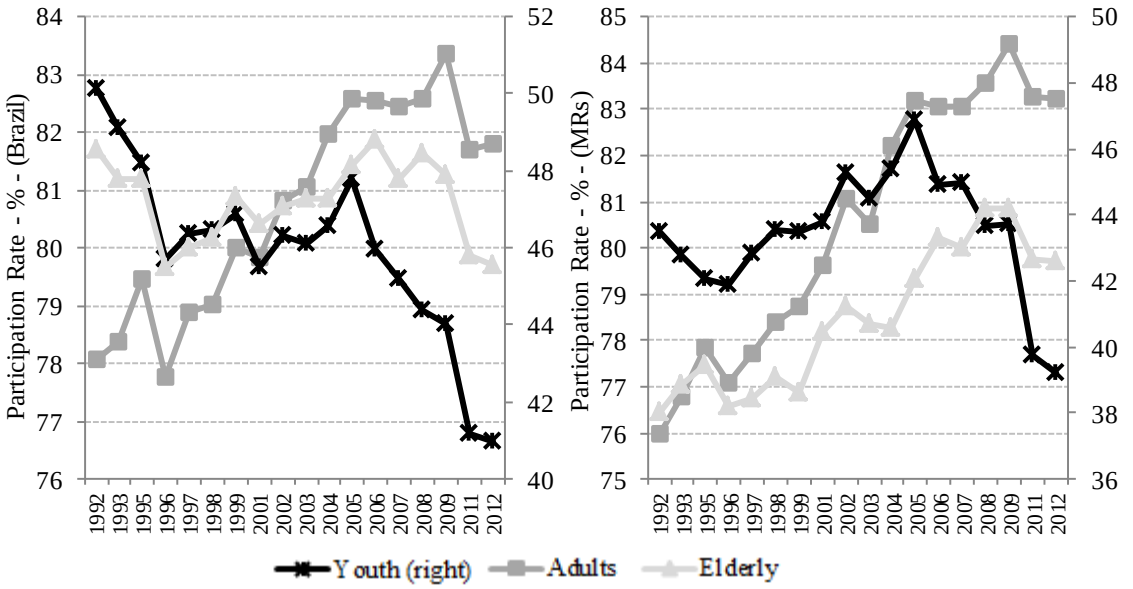


Figure 4: Participation Rate by Age Clusters – Brazil and Metropolitan Regions (MRs) – 1992-2012 – PNAD (IBGE).

[19] We mean someone studies if she is enrolled in formal education, such as, high school, technical school and universities.

[20] Regarding the explanation that refers to the youth share that does not study and does not seek a job, Monteiro (2013) argues that the youth share that does not study and does not seek a job in Brazil is not large by comparing with other developing countries and therefore does not represent an additional vector of labor market tightness. Menezes Filho, Cabanas and Komatsu (2013) agree and compliment by arguing that an inactive youth share is not unusual and it is due to a relatively high level of job-job and job-school transitions, which is typical in this age cluster. Furthermore, the disproportional incidence among poor and unskilled families is consistent with a higher employment turnover associated to precarious jobs and disenchantment with formal education relative to a higher attractiveness of unskilled real wages. In addition, Camarano and Kanso (2012) point out that in this cluster inactivity of women is double that of men due to household chores and early pregnancy.

To better assess the influence of the participation rate in the aggregate unemployment rate, we propose a variation of the genuine unemployment that incorporates the effects of the participation rate. In this case, we use a different decomposition of the aggregate unemployment. Define N_t to be the working age population. Let $p_{i,t} \equiv \frac{L_{i,t}}{N_{i,t}}$ to be the participation rate of cluster i at time t. In addition, let $h_{i,t} \equiv \frac{D_{i,t}}{N_{i,t}}$ to be the unemployed to working age population ratio of cluster i at time t. The fraction of the labor force in cluster i at time t_0, θ_{i,t_0}, is then multiplied by a term which is the inverse of the participation rate, such that: $\gamma_{i,t_0} \equiv \theta_{i,t_0}\left(\frac{1}{p_{i,t_0}}\right)$. Hence, the genuine unemployment rate controlled by participation rate is:

$$U_{t_1,t_0}^{G^p} \equiv \sum_i \gamma_{i,t_0} h_{i,t_1} \quad (3)$$

Figure 5 shows that the level of the aggregate unemployment rate, U_t, in the metropolitan regions is larger than in Brazil as a whole for all t, which suggests that the aggregate unemployment rate in urban areas is structurally larger than in non-urban areas. $U_{t_1,1992}^{G}$ rose by 322 basis points in the entire Brazil between 1992 and 2002, a period during which the U_t rose by 261 basis points. In the main metropolitan regions, $U_{t_1,1992}^{G}$ and U_t rose by 439 basis points and 373 basis points, respectively. Hence, genuine employment changes account for more than 100% of the aggregate unemployment rate rise during the 1990's. Therefore, the age profile of the labor force implied a negative effect on the U_t raise.

In contrast, from 2002 to 2012, $U_{t_1,1992}^{G}$ had a minor role in the unemployment developments. It accounts for 76% and 88% of the 294 basis points and 601 basis points decline in U_t, respectively, in the entire Brazil and in the metropolitan regions. It means that during the 2000's if not for the age factor (relatively less young workers in the labor force), the fall of the aggregate unemployment rate would have been lesser than the actual one. That is: $U_{t_1,1992}^{G}$ would be 7.5% in 2012 in Brazil as a whole and 8.6% in 2012 in the metropolitan regions, while U_t was 6.2% and 7.2%, respectively[21].

[21] This means $U_{t_1,1992}^{G}$ would be around 20% higher than U_t both in the entire country and the metropolitan regions.

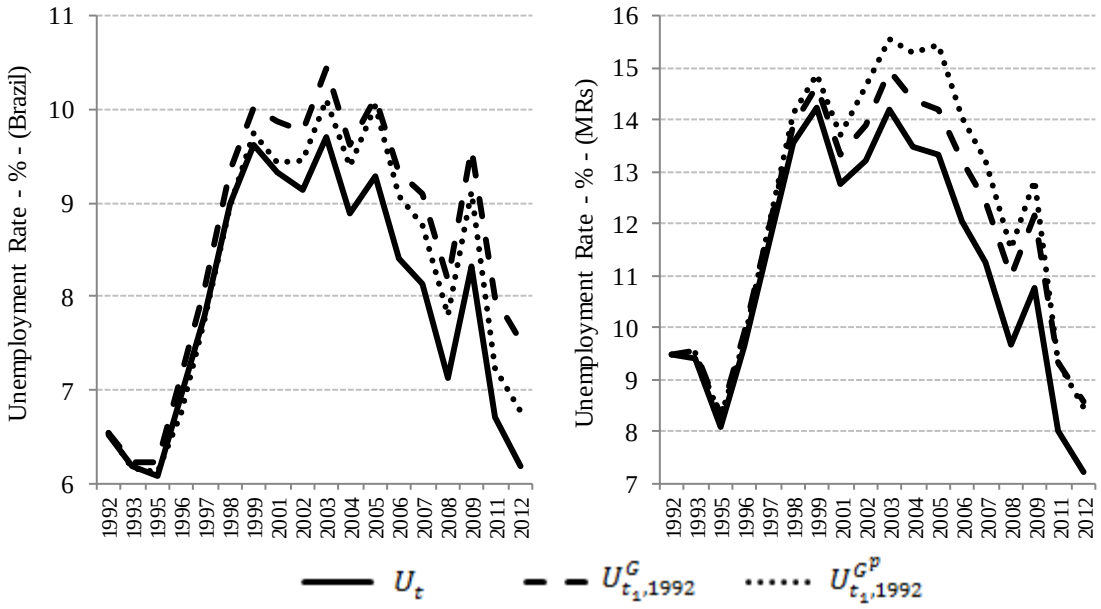


Figure 5: Aggregate Unemployment Rate, Genuine Unemployment Rate and Genuine Unemployment Rate Controlled by Participation Rate – Brazil and Metropolitan Regions (MRs) – 1992-2012 – PNAD (IBGE).

Regarding the influence of the participation rate in the aggregate unemployment rate, we note that whereas $U^{G^p}_{t_1,1992}$ mitigated $U^{\mathrm{G}}_{\mathrm{t_1},1992}$ ($U^{G^p}_{t_1,1992} \leq U^{\mathrm{G}}_{\mathrm{t_1},1992} \forall t_1 \in T$) in Brazil as a whole, in general it strengthened the genuine unemployment rate in the metropolitan regions during the two decades. In the entire country, it means that the participation rate strengthens the decline of the youth share of the labor force. For this reason the $U^{G^p}_{t_1,1992}$ raise is lower than $U^{\mathrm{G}}_{\mathrm{t_1},1992}$ raise during the 1990's and the $U^{G^p}_{t_1,1992}$ fall is greater than the $U^{G}_{t_1,1992}$ fall during the 2000's. This interpretation suggests that the importance of the *preference factors* have outweighed the attractiveness of the labor market especially to young workers in the entire country. In the metropolitan regions the opposite occurs, although to a lesser extent during the 2000's.

An alternative to the genuine unemployment rate is to assess how much of the aggregate unemployment rate changed due to demographics. Again we maintain the hypothesis that demographics do not affect disaggregate unemployment rates. Hence, if the only changes in the Brazilian economy from t_0 to t_1 were demographic, the unemployment rate in t_1 would be:

$$U^{D}_{t_1,t_0} \equiv \sum_i \theta_{i,t_1} u_{i,t_0} \qquad (4)$$

Changes in U^D are demographic unemployment rate changes. Similarly to the genuine unemployment rate, we can assess the influence of the participation rate in the aggregate unemployment rate. Then the demographic unemployment that incorporates the effects of the participation rate is:

$$U^{D^p}_{t_1,t_0} \equiv \sum_i \gamma_{i,t_1} h_{i,t_0} \quad (5)$$

However, these measures of demographic change have a drawback. If one defines $\left[\Delta U^D_{t+1,t_0} - \Delta U^D_{t,t_0}\right]$ or $\left[\Delta U^{D^p}_{t+1,t_0} - \Delta U^{D^p}_{t,t_0}\right]$ as changes in demographics from t to $t+1$, the result will depend on a choice of base year (t_0)[22]. To avoid this issue we can set a chain-weighted measure of demographic change in unemployment. For a given initial time t_0, such that $t_1 > t_0 \forall t \in T$:

$$\Delta^{CW} U^D_{t_1,t_0} = \sum_{t=t_0}^{t_1-1} \sum_i \left[\theta_{i,t+1} - \theta_{i,t}\right] \frac{u_{i,t+1}+u_{i,t}}{2} \quad (6)^{23}$$

Thus, $\left[\Delta^{CW} U^D_{t+1,t_0} - \Delta^{CW} U^D_{t,t_0}\right]$ is the chain-weighted change in demographics from t to $t+1$ and equation (6) represents the cumulative effect of chain-weighted demographic unemployment changes since time t_0.

$\Delta^{CW} U^D_{t_1,t_0}$ is not a perfect measure of demographic unemployment changes either, since it might also be affected by labor participation. Define $\mu_{i,t} \equiv \frac{N_{i,t}}{\sum_i N_{i,t}}$ to be the share of the working age population of cluster i at time t. Following Barbosa Filho and Pessôa (2011), we set a chain-weighted measure of demographic change in unemployment that incorporates the effects of the participation rate:

[22] For example, $U^{\mathrm{G}}_{\mathrm{t}_1,2002}$ accounted for 115% of the U_{t} rise in the entire country and 113% of the U_{t} rise in the metropolitan regions from 1992 to 2002. From 2002 to 2012, it accounted for, respectively, 76% and 85% of the U_{t} fall. Thus, $U^{\mathrm{G}}_{\mathrm{t}_1,2002}$ reached 7% in Brazil as a whole and 8.1% in the metropolitan regions in 2012. It is around 13% larger than U_{t}, instead of 20% larger than U_{t} if we set $U^{\mathrm{G}}_{\mathrm{t}_1,1992}$. Furthermore, labor participation would not have wielded a relevant influence on genuine unemployment rate, since $U^{G^p}_{t_1,1992}$ developments would be quite similar to $U^{\mathrm{G}}_{\mathrm{t}_1,1992}$ developments. Thus, $U^{\mathrm{G}}_{\mathrm{t}_1,1992}$ and $U^{G^p}_{t_1,1992}$ in Figure 4 would look different.

[23] For a complete derivation of equation (6), see Appendix B.

$$\Delta^{CW} U^{D^p}_{t_1,t_0} = \sum_{t=t_0}^{t_1-1} \sum_i \left(\mu_{i,t+1} - \mu_{i,t}\right) \left[\frac{h_{i,t+1}+h_{i,t}}{2} \frac{p_{t+1}+p_t}{2p_{t+1}p_t} - \frac{p_{i,t+1}+p_{i,t}}{2} \frac{h_{t+1}h_t}{p_{t+1}p_t} \frac{h_{t+1}+h_t}{2h_{t+1}h_t}\right] \quad (7)^{24}$$

Similarly to equation (3), h_t stands for total unemployed to working age population ratio and p_t denotes total participation rate. Then, $\Delta^{CW} U^{D^p}_{t_1,t_0}$ represents the cumulative effect of chain-weighted demographic unemployment changes controlled by participation rate from t_0 to t_1.

Table 2 indicates that the demographic unemployment changes controlled by participation mitigated the demographic unemployment changes in the two decades in Brazil as a whole $\left(\left|\Delta U^{D^p}_{t_1,t_0}\right| < \left|\Delta U^{D}_{t_1,t_0}\right|\right)$. Thus, it contradicts the argument that stems from the genuine unemployment rate, since it implies that the attractiveness of the labor market might have outweighed the *preference factors* especially to young workers. However, the genuine unemployment rate and the genuine unemployment rate controlled by participation rate are not robust to changes in the base year. For example, by changing the base year to 2002 and 2012, the results shift considerably because both the labor force shares and the clusters' participation rates change through the years due to business cycle and structural factors. Moreover, the demographic unemployment changes might also be sensitive to choice of the base year if the tendencies of the disaggregate unemployment rates and the unemployed to working age ratio of the age clusters vary substantially during the sample time[25].

It seems not to be exactly the case for the main metropolitan regions from 1992 to 2002. In this case, $\left|\Delta U^{D^p}_{t_1,t_0}\right| > \left|\Delta U^{D}_{t_1,t_0}\right|$ and this result is robust to changes in the base year[26]. This should have strengthened the argument which states that *preference factors* might have outweighed the attractiveness of the labor market. However, it is not entirely clear since the chained-weighted measures do not confirm it $\left(\left|\Delta^{CW} U^{D^p}_{t_1,t_0}\right| < \left|\Delta^{CW} U^{D}_{t_1,t_0}\right|\right)$ during this period. Moreover, $\left|\Delta^{CW} U^{D^p}_{t_1,t_0}\right| < \left|\Delta U^{D^p}_{t_1,t_0}\right|$, which reinforces that this result during the 1990's might have been obtained by construction. Note that, in

[24] For a complete derivation of equation (7), see Appendix B.

[25] The base year reported for $\Delta U^{D}_{t_1,t_0}$ and $\Delta U^{D^p}_{t_1,t_0}$ in Table 2 is 1992, which is the same we apply to genuine unemployment rate in Figure 5. That is: it refers to $U^{D}_{t_1,1992}$ and $U^{D^p}_{t_1,1992}$. However, $\left|\Delta U^{D^p}_{t_1,t_0}\right| < \left|\Delta U^{D}_{t_1,t_0}\right|$ is robust to changes in the base year. For example, for $U^{D}_{t_1,2002}$ and $U^{D^p}_{t_1,2002}$ or $U^{D}_{t_1,2012}$ and $U^{D^p}_{t_1,2012}$.

[26] For example, by choosing the base year 2002 or 2012.

calculating Δ^{CW}, we multiply the weights, $\theta_{i,t}$, by the current unemployment rate[27], which is higher during growth slowdowns like during the 1990's. This might moderate the changes in Δ^{CW}. We can reverse this argument to suggest that changes in Δ^{CW} are magnified during the 2000's. This may help explain why the simple demographically adjusted unemployment series, $\Delta U^{D}_{t_1,t_0}$ or $\Delta U^{Dp}_{t_1,t_0}$, changed by less than the chain-weighted series Δ^{CW} , especially in the 2000's.

	$\Delta U_{t_1,t_0}$		$\Delta U^{D}_{t_1,t_0}$		$\Delta U^{Dp}_{t_1,t_0}$		$\Delta^{CW} U^{D}_{t_1,t_0}$		$\Delta^{CW} U^{Dp}_{t_1,t_0}$	
	b.p	%	b.p	%	b.p	%	b.p	%	b.p	%
Brazil										
$t_1: 2002$ $t_0: 1992$	261	100	-38	-14.7	-22	-8.4	-47	-18.0	-32	-12.4
$t_1: 2012$ $t_0: 2002$	-294	100	-57	19.3	-33	11.1	-85	28.8	-56	19.2
Metropolitan Regions										
$t_1: 2002$ $t_0: 1992$	373	100	-46	-12.2	-93	-24.8	-54	-14.5	-47	-12.6
$t_1: 2012$ $t_0: 2002$	-601	100	-94	15.6	-59	9.8	-121	20.2	-80	13.4

Table 2: Aggregate Unemployment Rate, Demographic Unemployment Rate, Demographic Unemployment Rate Controlled by Participation Rate, Chain-Weighted Demographic Unemployment Rate and Chain-Weighted Demographic Unemployment Rate Controlled by Participation Rate – Demographic Adjustment for Three Age Clusters – Brazil and Metropolitan Regions – Variations in Basis Points (b.p) and Percentage Points (%) – 1992-2002 and 2002-2012 – PNAD (IBGE).

Nevertheless, we argue that Δ^{CW} are better measures since they avoid the dependence of base year choice. Having these concerns in mind, the demographic unemployment, $\Delta^{CW} U^{D}_{t_1,t_0}$, accounts for -18% of the aggregate unemployment rise from 1992 to 2002 and 28.8% of the unemployment fall between 2002 and 2012 in the entire country. In the metropolitan regions, demographic unemployment wielded a less

[27] In the case of $\Delta^{CW} U^{Dp}_{t_1,1992}$, $\theta_{i,t}$ is multiplied by the weighted current unemployed to working age ratio subtracted by the weighted current participation rate. The weighted current unemployed to working age ratio is also higher and the participation rate is lower during growth slowdowns. Thus, the changes in Δ^{CW} tend to be even more moderated.

relevant impact, since it accounts for -14.5% and 20.2%, respectively in the two periods.

Therefore, demographic unemployment lessened the unemployment rise during the 1990's and it strengthened the unemployment fall during the 2000's. We can also argue that the demographic unemployment controlled by participation rate mitigated the demographic unemployment change in the last twenty years. That is: $\left|\Delta^{CW} U^{D^p}_{t_1,t_0}\right| < \left|\Delta^{CW} U^{D}_{t_1,t_0}\right|$. $\Delta^{CW} U^{D^p}_{t_1,t_0}$ accounts for -12.4% and -12.6% of the aggregate unemployment rise from 1992 and 2002, respectively, in Brazil as a whole and in the metropolitan regions. Between 2002 and 2012, it accounts for 19.2% of the aggregate unemployment fall in the entire country and 13.4% in the metropolitan regions. This suggests that the attractiveness of the labor market might have outweighed the *preference factors* during the two decades.

4.1.2. Schooling

In this subsection we analyze the increased education of the Brazilian labor force[28]. Figure 6 shows that since 1992 the share of skilled labor force has nearly doubled from 22% to 49% in Brazil as a whole and from 32% to 61% in the metropolitan regions. In contrast, the percentage of unskilled has virtually halved from 68% to 37% in the entire country and from 53% to 24% in the metropolitan regions. The share of average skilled labor force has risen from 11% to 15% in Brazil as a whole and has remained steady in the metropolitan regions in this period.

According to Figure 7, there are different patterns regarding the schooling profile of the labor market in the entire country and in the metropolitan regions. The disaggregate unemployment rate of skilled workers is lower than other clusters' in the metropolitan regions, which suggest a more qualified labor market in this localities. However, during the business cycle boom, since 2004, the unemployment rates of less qualified workers have fallen rapidly and have almost reached levels similar to those of the skilled workers. In Brazil as whole, the unemployment rate of unskilled workers has

[28] Throughout this subsection, we restrict analysis at 25^{+}-years-old workers. A 16-year-old who works while in high school is probably quite different than an adult who dropped out of high school many years before. Since most workers have completed their education by age 25, we avoid complex aggregation issues by focusing on these workers.

evolved along with the unemployment rate of skilled workers during the 1990's. However, since 2004 it has become the lowest disaggregate unemployment rate.

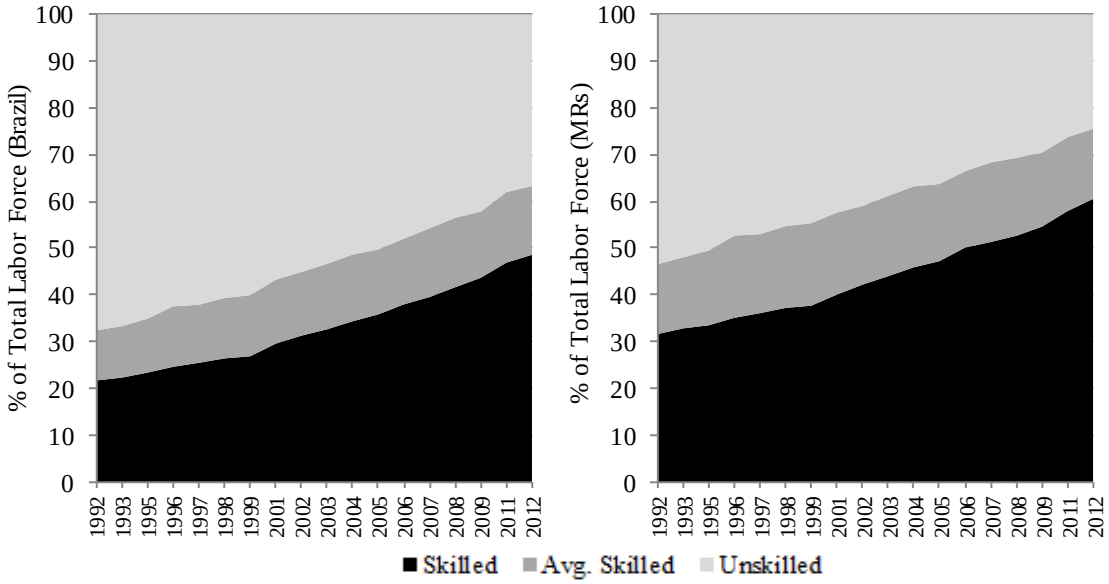


Figure 6: Labor-force Share by Schooling Clusters – Brazil and Metropolitan Regions (MRs) – 1992-2012 – PNAD (IBGE).

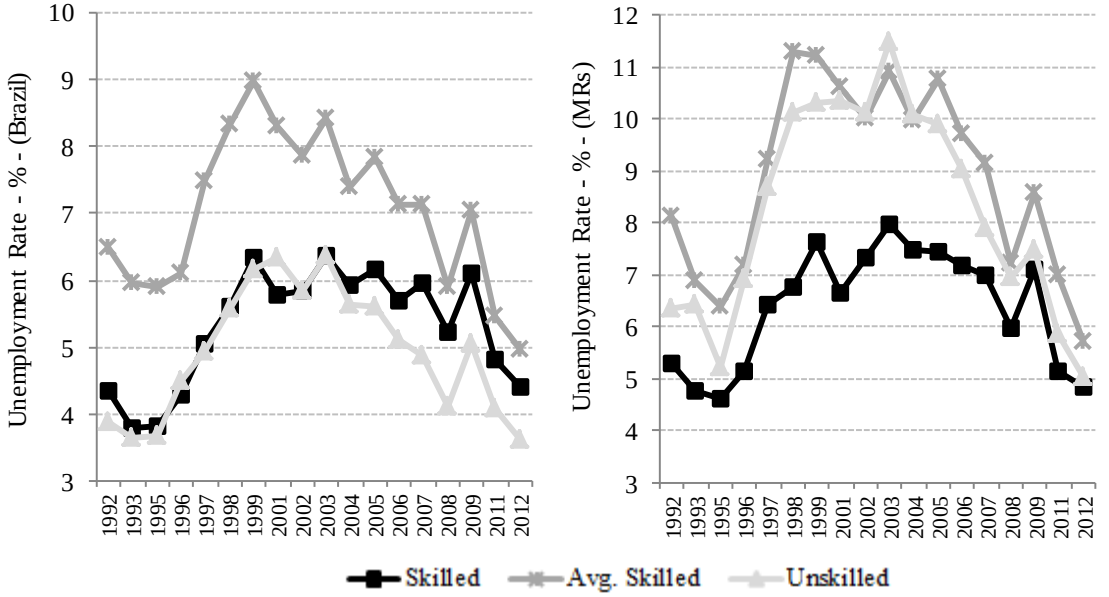


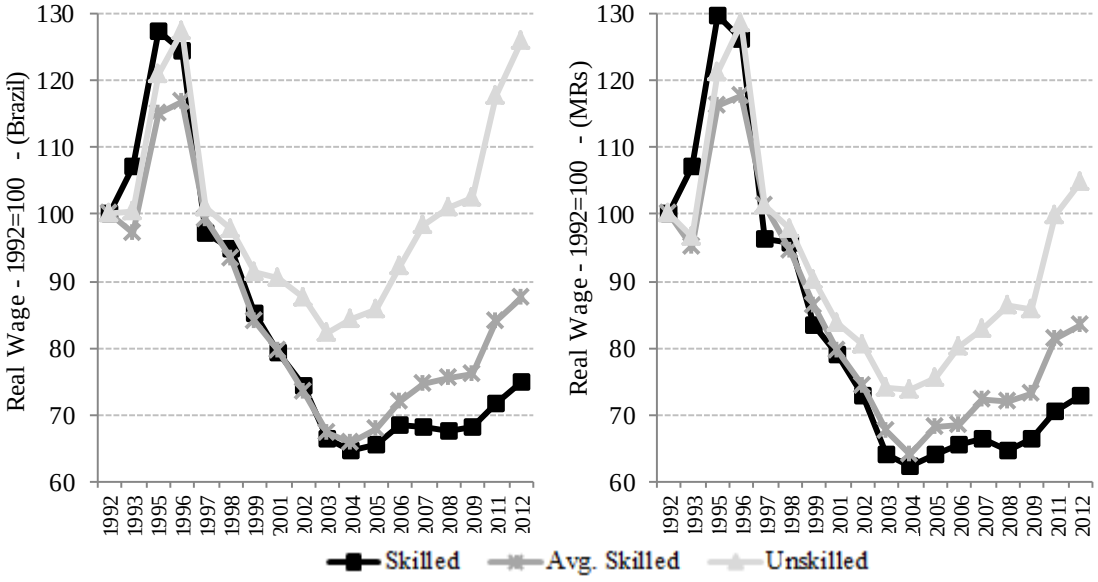
Figure 7: Unemployment Rate by Schooling Clusters – Brazil and Metropolitan Regions (MRs) – 1992-2012 – PNAD (IBGE).

Figure 8 suggests the real wages[29] follow the unemployment rate developments. However, it evolved differently among schooling clusters. It shows that real wages have

[29] Real wages are corrected by INPC/IBGE, which is a consumer price index. Although we distinguish between Brazil as a whole and the six main metropolitan regions, we do not distinguish the inflation

increased considerably after the stability program in 1994. Between 1996 and 2003 real wages fell pronouncedly following the unemployment rate raise during the 1990's and since 2004, real wages start to increase again following the business cycle boom. Interestingly, only the unskilled workers could recover the real wage fall during the 1990's, especially in Brazil as a whole. Furthermore, since 2004 the wages of both the less qualified clusters have risen faster than the ones referring the skilled workers.

In addition, according to Figure 9, the wage premiums[30] for both the average skilled and the skilled workers have fallen, especially in the entire country. The former has fallen since the beginning of the sample period and the latter since 1999. Therefore, the unemployment and wages developments suggest that there might be a mismatch of labor supply and labor demand for qualification by noting the increased supply of skilled labor that has not been absorbed proportionally by labor demand. It then implies that labor demand is still considerably based on economic sectors that uses less qualified workforce. This issue in particular, we will analyze in section 4.2.



correction among the two localities since we believe it does not invalid the overall results. The INPC is collected in eleven metropolitan and the IBGE publishes results for nine of them, including the six metropolitan regions we comprise in this paper. According to IBGE the remainder three metropolitan regions account for around 20% of total weight in 1996 and it remained similar in 2003. Furthermore, the average difference of the inflation level between the remainder three metropolitan regions and the six metropolitan regions comprised in the paper is 0.6 p.p in the whole sample period.

[30] We define wage premium as the marginal earning (in percentage terms) obtained by moving from cluster i to another cluster that represents more qualified workers. Therefore, it is the wage ratio of two immediate clusters in period t. For example, the wage premium of the average skilled cluster (in terms of the wages of unskilled workers) was 183% in 1992 and the wage premium of the skilled cluster (in terms of the wages of the average unskilled workers) was 214% in 1992.

Figure 8: Average Real wages by Schooling Clusters – Brazil and Metropolitan Regions (MRs) – 1992-2012 – PNAD (IBGE).

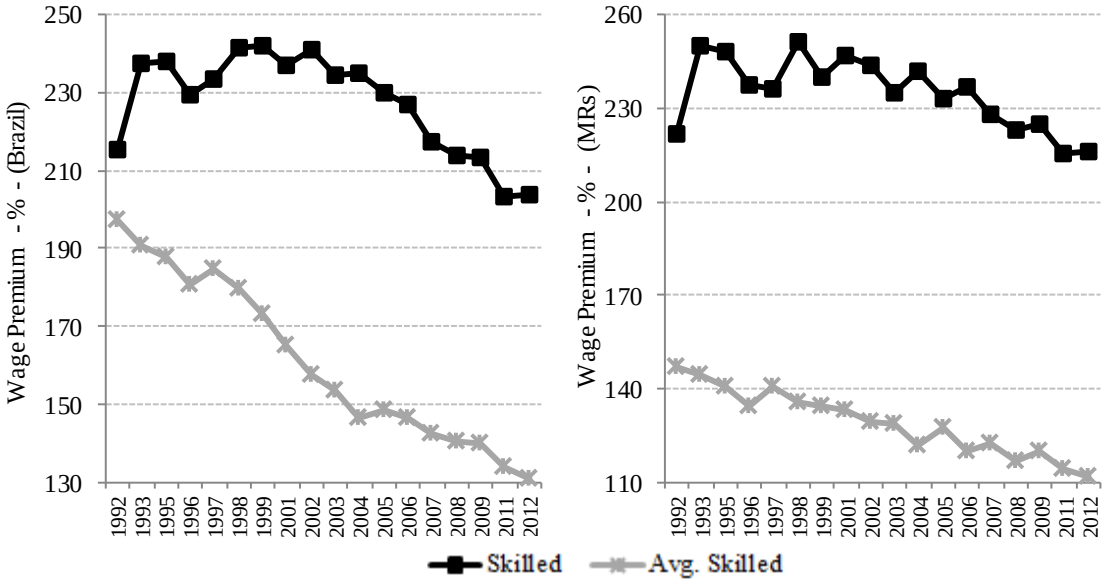


Figure 9: Wage Premium by Schooling Clusters – Brazil and Metropolitan Regions (MRs) – 1992-2012 – PNAD (IBGE).

We can assess how these developments affect the demographic unemployment by constructing the chain-weighted measures, Δ^{CW}, as in equation (6). We find that the demographic unemployment had not a substantial contribution to aggregate unemployment rate and shows ambiguous results in the entire country and the metropolitan regions, which is consistent to the findings of Barbosa Filho and Pessôa (2011). The behavior of U^{D}_{t,t_0} in equation (4) depends considerably on the choice of base year. For example, if we choose a year, like 1995, when skilled workers' unemployment rate is lower than unskilled workers' in the entire country, then U^{D}_{t,t_0} remains virtually stable during all sample period. In contrast, if we set the base year equals to 2005, when skilled workers' unemployment rate is higher than unskilled workers' in the entire country, then U^{D}_{t,t_0} monotonically increases. This highlights the disadvantage of U^{D}_{t,t_0} in the case in which the disaggregate unemployment rates and labor-force shares across clusters vary considerably over time. For this reason we use $\Delta^{CW}U^{D}_{t_1,t_0}$ as our primary measure of demographic unemployment.

Brazil	$\Delta U_{t_1,t_0}$		$\Delta^{CW} U^{D}_{t_1,t_0}$		Metropolitan Regions	$\Delta U_{t_1,t_0}$		$\Delta^{CW} U^{D}_{t_1,t_0}$	
	b.p	%	b.p	%		b.p	%	b.p	%
t_1: 2002 t_0: 1992	261	100	6	2.3	t_1: 2002 t_0: 1992	373	100	-37	-10
t_1: 2012 t_0: 2002	-294	100	14	-4.9	t_1: 2012 t_0: 2002	-601	100	-38	6

Table 3: Aggregate Unemployment Rate and Demographic Unemployment Rate – Adjustment for Schooling Clusters – Brazil and Metropolitan Regions – Variations in Basis Points (b.p) and Percentage Points (%) – 1992-2002 and 2002-2012 – PNAD (IBGE).

Table 3 shows that, by dividing workers up by the three schooling clusters, $\Delta^{CW} U^{D}_{t_1,t_0}$ rose 6 basis points between 1992 and 2002 and 14 basis points from 2002 to 2012 in Brazil as a whole. Then it accounts for 2.3% of the aggregate unemployment rate rise during the 1990's and -4.9% of the aggregate unemployment fall in the 2000's. Therefore, the schooling structure of the labor force implies a rise of the aggregate unemployment in the entire country, especially during the 2000's. In the metropolitan regions, $\Delta^{CW} U^{D}_{t_1,t_0}$ fell 37 basis points between 1992 and 2002 (-10.0%) and 38 basis points from 2002 to 2012 (6.3%). Hence, the schooling structure of the labor force implies a fall of the aggregate unemployment in the metropolitan regions.

The schooling structure of the labor force shifted towards skilled workers. The unemployment rate of this cluster, in turn, has exceeded the unskilled workers' since 2004 in Brazil as a whole. This is not true in the metropolitan regions. Although the unskilled workers experienced a fast decline in the unemployment rate, the skilled cluster has shown the lowest disaggregate unemployment rate during all sample period. This explains the opposite results regarding $\Delta^{CW} U^{D}_{t_1,t_0}$ in both localities. Furthermore, the schooling structure of the labor force shifted towards skilled workers. In Brazil as whole the unemployment rate of this cluster is relatively high, whereas in the metropolitan regions this cluster has the lowest disaggregate unemployment rate. This also suggests that the mismatch of labor supply and labor demand for qualification is more intensive in the entire country, which is consistent with the real wages developments.

One might be tempted to add the demographic changes reported here and the first part of this subsection in order to obtain the effects of the changes in the age and schooling composition of the labor force. In terms of $\Delta^{CW}U^{D}_{t_1,t_0}$, it accounts for a 41-basis-point (-20.3%) decline from 1992 to 2002, followed by a 71-basis-point (23.9%) fall between 2002 and 2012 in the entire country and a 91-basis-point (-24.5%) decline from 1992 to 2002, followed by a 159-basis-point (26.4%) fall between 2002 and 2012 in the metropolitan regions. Therefore, in the metropolitan regions the schooling composition of the labor force strengthened the effect of the age composition of the labor force since the two effects move in the same direction. Thus, the impact of demographic unemployment (age and schooling) becomes more relevant in this locality.

One might concern about the mix effects between age and education. However, it does not seem that important because in looking at education, we have restricted the set of workers to 25 years old or more. Empirically, the relationship between age and unemployment is weak for these workers, and so there is unlikely to be much overlap between the two demographic adjustments.

Nevertheless, one should be aware of the educational version of the demographic adjustment for age. That is: the hypothesis that the disaggregate unemployment rate is unaffected by the schooling composition of the labor force, as argued by Summers (1986). First, employers may care about relative education more than the absolute value of education. Hence, a raise in the fraction of skilled workers may simply lead employers to increase educational requirements of jobs. This implies that a shift in the education distribution may have no real effects. Second, educational choice is endogenous and correlated with ability, which is unobservable. Abler workers are likely to have a lower unemployment rate for a given level of education, and an increase in education reduces the ability of the average worker with a given level of education.

Therefore, this implies that an increase in education will tend to raise the unemployment rate conditional on education, even if it has little or no effect on aggregate unemployment rate. Thus, a demographic adjustment for education would be unwarranted or misleading, as claimed by Shimer (1999) and the results should be considered in light of these theoretical caveats.

4.1.3. Sex

Another observable characteristic of the labor force that might have explanatory power to aggregate unemployment rate changes is sex. However, female participation in the Brazilian labor market had an increase during the 1990's and has remained virtually steady since 2005, according to Figure 10. Additionally, Figure 11 shows that the gap between disaggregate unemployment rates has also slightly risen since the beginning of the sample period. All this suggests that the participation of women implied a demographic rise of the unemployment, but it cannot explain much of its change.

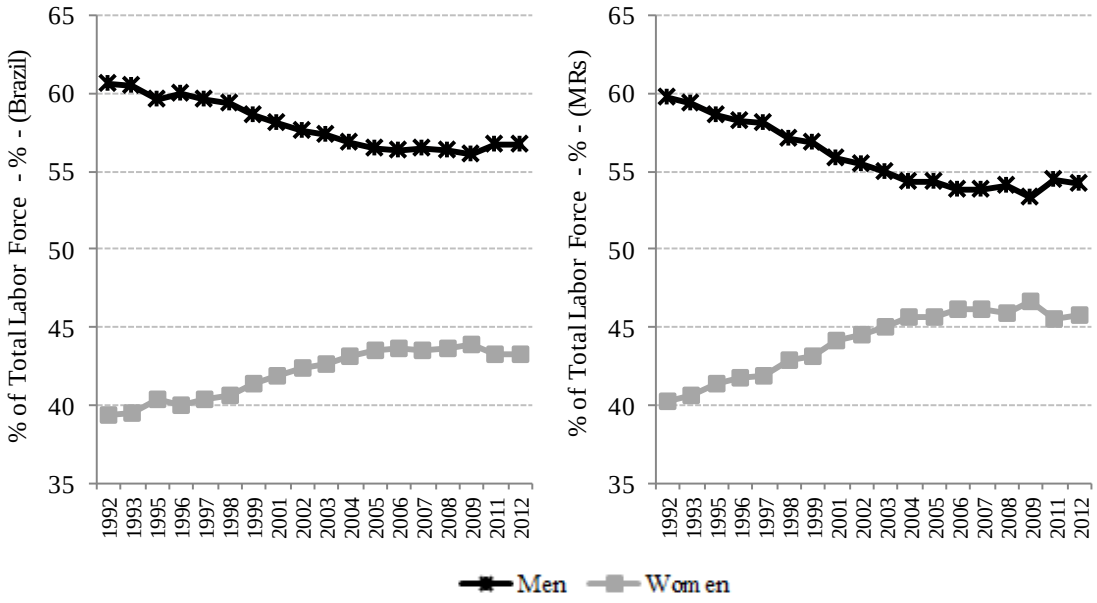


Figure 10: Labor-force Share by Sex – Brazil and Metropolitan Regions (MRs) – 1992-2012 – PNAD (IBGE).

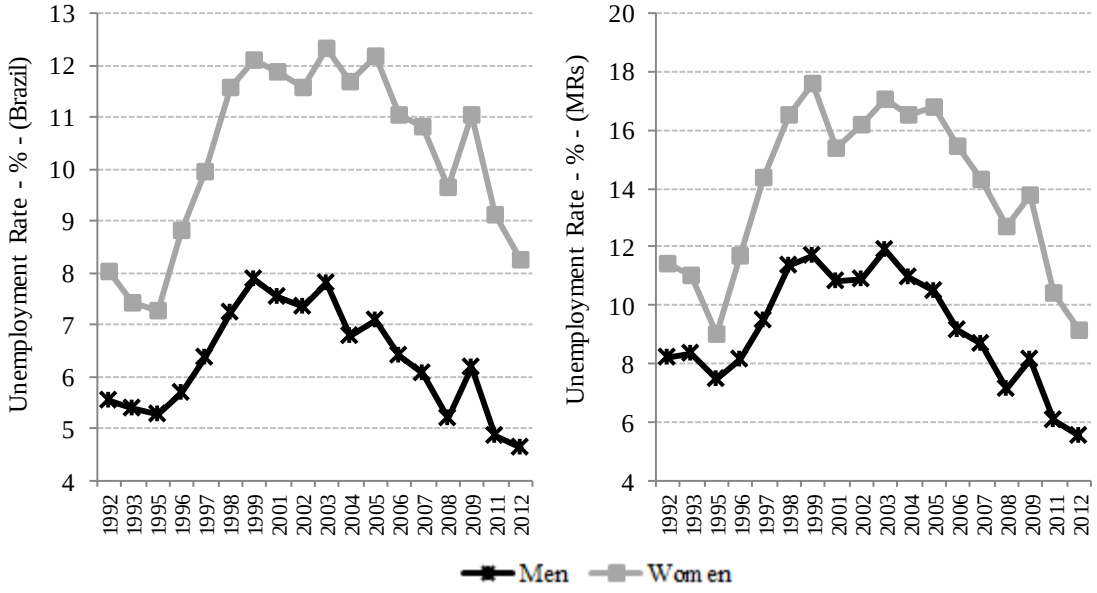


Figure 11: Unemployment Rate by Sex – Brazil and Metropolitan Regions (MRs) – 1992-2012 – PNAD (IBGE).

Table 4 shows that, by dividing workers up by sex, $\Delta^{CW}U^{D}_{t_1,t_0}$ rose 11 basis points between 1992 and 2002 and 4 basis points from 2002 to 2012 in Brazil as a whole. Then it accounts for 4.2% of the aggregate unemployment rate rise during the 1990's and -1.4% of the aggregate unemployment fall in the 2000's. In the metropolitan regions, $\Delta^{CW}U^{D}_{t_1,t_0}$ increased 18 basis points between 1992 and 2002 (4.8%) and 7 basis points from 2002 to 2012 (-1.2%). Note that $\left|\Delta^{CW}U^{D}_{2002,1992}\right| > \left|\Delta^{CW}U^{D}_{2012,2002}\right|$ and, in this case, it reflects the raise of female participation in the labor market during the 1990's. Nevertheless, unemployment rate adjustment for the sex composition of the labor force implies a diminutive rise in aggregate unemployment in the past two decades[31].

Brazil	$\Delta U_{t_1,t_0}$		$\Delta^{CW}U^{D}_{t_1,t_0}$		Metropolitan Regions	$\Delta U_{t_1,t_0}$		$\Delta^{CW}U^{D}_{t_1,t_0}$	
	b.p	%	b.p	%		b.p	%	b.p	%
t_1: 2002 t_0: 1992	261	100	11	4.2	t_1: 2002 t_0: 1992	373	100	18	4.8
t_1: 2012 t_0: 2002	-294	100	4	-1.4	t_1: 2012 t_0: 2002	-601	100	7	-1.2

Table 4: Aggregate Unemployment Rate and Demographic Unemployment Rate – Adjustment for Sex – Brazil and Metropolitan Regions – Variations in Basis Points (b.p) and Percentage Points (%) – 1992-2002 and 2002-2012 – PNAD (IBGE).

4.1.4. Race

Participation of non-white workers in the Brazilian labor market has increased slightly during the 1990's, since 1995, and this trend has accelerated during the 2000's, according to Figure 12. However, the gap between white and non-whites[32] unemployment has fallen, especially in the metropolitan regions during the 2000's, as

[31] Note that it might be incorrect to add the changes reported here and in the previous parts of this section if there are any mixed effects between sex and age or schooling. Thus, the rise of female participation may be double counted as a relative decrease of the participation of young workers or unskilled workers.

[32] The cluster of whites includes "yellow" skinned with Asiatic lineage. The non-whites cluster includes blacks, duns and indigenes.

shows Figure 13. Therefore, this gap should have had a small rise effect on demographic unemployment during the past two decades.

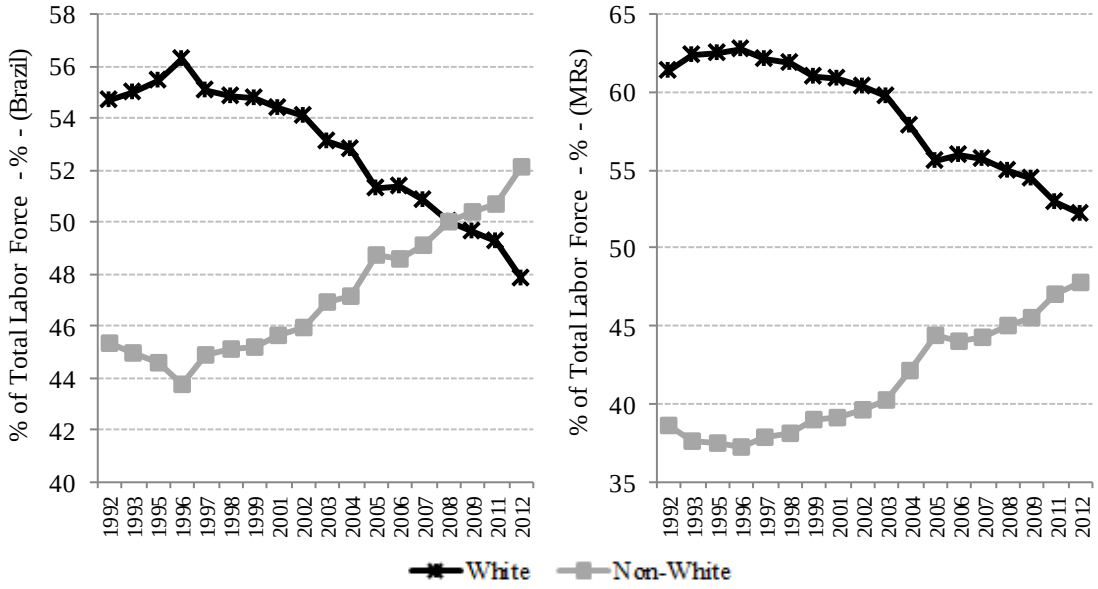


Figure 12: Labor-force Share by Race – Brazil and Metropolitan Regions (MRs) – 1992-2012 – PNAD (IBGE).

Figure 13: Unemployment Rate by Race – Brazil and Metropolitan Regions (MRs) – 1992-2012 – PNAD (IBGE).

Table 5 shows that, by dividing workers into white and non-white, $\Delta^{CW}U^{D}_{t_1,t_0}$ rose 2 basis points between 1992 and 2002 and 13 basis points from 2002 to 2012 in Brazil as a whole. Then it accounts for 0.6% of the aggregate unemployment rate rise

during the 1990's and -4.4% of the aggregate unemployment fall in the 2000's. In the metropolitan regions, $\Delta^{CW} U^{D}_{t_1,t_0}$ increased 7 basis points between 1992 and 2002 (1.8%) and 33 basis points from 2002 to 2012 (-5.5%). Therefore, non-white participation in the labor market also implies a slight rise in aggregate unemployment in the past two decades.

Brazil	$\Delta U_{t_1,t_0}$		$\Delta^{CW} U^{D}_{t_1,t_0}$		Metropolitan Regions	$\Delta U_{t_1,t_0}$		$\Delta^{CW} U^{D}_{t_1,t_0}$	
	b.p	%	b.p	%		b.p	%	b.p	%
$t_1: 2002$ $t_0: 1992$	261	100	2	0.6	$t_1: 2002$ $t_0: 1992$	373	100	7	1.8
$t_1: 2012$ $t_0: 2002$	-294	100	13	-4.4	$t_1: 2012$ $t_0: 2002$	-601	100	33	-5.5

Table 5: Aggregate Unemployment Rate and Demographic Unemployment Rate – Adjustment for Race – Brazil and Metropolitan Regions – Variations in Basis Points (b.p) and Percentage Points (%) – 1992-2002 and 2002-2012 – PNAD (IBGE).

One should not expect that race, itself, explains a higher level of non-whites's unemployment rate. Instead, it is likely to be observable variables such as poverty and quality of school and latent variables such as discriminatory hiring. To adjust the unemployment rate for the racial composition of the labor force would be misleading in the case the relationship between race, quality of school and wealth is changing over time. It is also inappropriate in the case of discriminatory hiring. If an increasing participation of non-white workers in the labor market does not give rise to a proportional incentive to create jobs, it then affects the rate that non-white workers find jobs in the case in which, in some extent, employers prefer hiring whites rather than non-whites.

4.2. Stylized Facts on Labor Demand

In this subsection we document the determinants associated to business cycle and structural factors of the labor demand in economic sectors and how it interacts with labor supply in order to assess the aggregate unemployment rate developments. For these means we apply a simple model of labor supply and demand, which is consistent with the labor market operation as an attempt to rationalize these developments. Then

we analyze whether the sectorial reallocation of employment matter for the aggregate unemployment rate changes in the past two decades.

4.2.1. Background: Macroeconomic Transformations

The Brazilian economy has undergone through important changes in the past twenty years. During the 1990's the state presence was reduced through a privatization process and a price stabilization program was established based on a currency peg regime backed by trade and financial openness. One effect of the stabilization program was a significant change in the relative prices in favor of sectors that produce non-tradable goods (especially the services sector) to the detriment of the tradable sectors (especially industry). During this time, Brazil still suffered from external vulnerability, so that the economic growth was more sensible to international crises, such as the Asiatic crises in 1997 and the international crises in 1998.

Other important changes took place in the following decade. Since 1999, an overall policy framework based on a "macroeconomic tripod" has consolidated. It consisted of an inflation target regime, floating exchange rate and targets of fiscal discipline. In the wake of these institutional reforms and also of the commodity boom and high international liquidity, Brazil was able to accelerate the economic growth featuring a strong currency, which gave conditions to push forward a growth model based on non-tradable sectors. During the 2000's this economic growth model featured a remarkable fall of the unemployment rate and raise of real wages that, together with the social programs of cash transfers, implied the ascension of more than 40 million families from poverty to the middle class, as pointed out by Neri (2010).

In addition, Brazil could accumulate a substantial amount of international reserves and became a net international creditor, so that it was able to deal with the challenges of the international crises in 2008 without major costs in terms of economic growth.

4.2.2. Economic Sectors and Interaction between Labor Supply and Labor Demand

These macroeconomic shifts affected the sectorial structure of the labor market. The employment likely migrated from tradable sectors (agriculture and industry) towards non-tradable sectors (construction and services) following the stabilization program in 1994 and the subsequent change in relative prices in favor of non-tradable sectors. According to Figure 14, this is even more evident in the metropolitan regions since there is a substantial contrast between employment in industry and agriculture[33] and employment in construction and services.

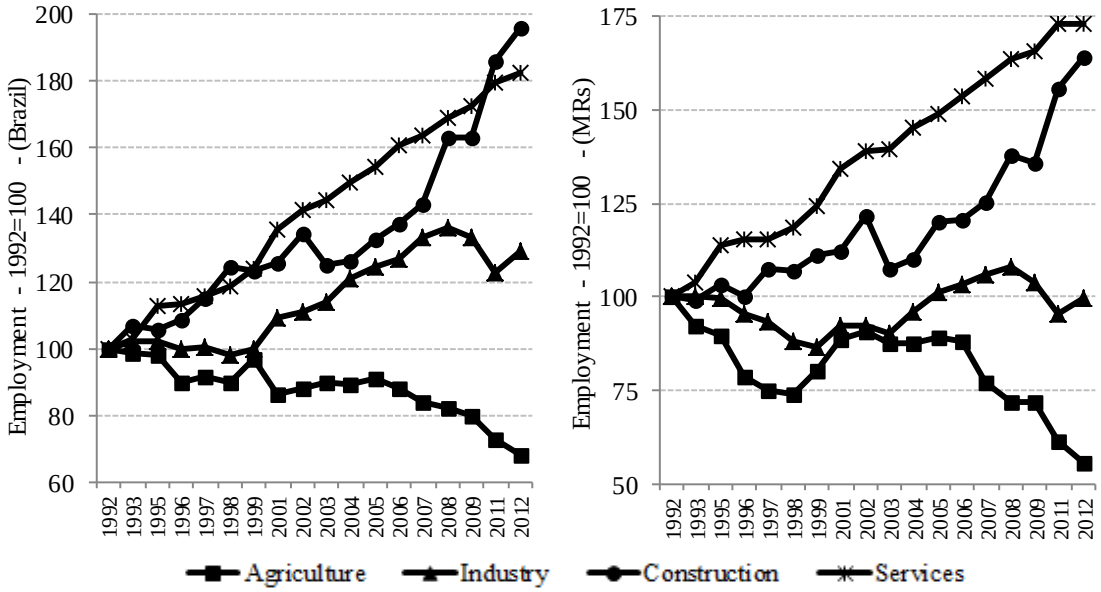


Figure 14: Employment Rate by Economic Sectors – Brazil and Metropolitan Regions (MRs) – 1992-2012 – PNAD (IBGE).

The evolution of the sectorial share of employment confirms that economy has consolidating a non-tradable profile with respect to employment, as illustrates Figure 15. In the entire country, while the share of agriculture and industry totaled around 44% in 1992 and monotonically declined until reaching 28% in 2012, the share of construction and services has risen each year. It totaled 56% in 1992 and reached 2012 with 72% of total employment. In the metropolitan regions, we note a similar pattern, but with a lesser share of tradable sectors (agriculture and industry) and consequently a larger share of non-tradable sectors (construction and services) due to a diminutive share of agriculture.

[33] Employment and wages in the agriculture should be taken with caution in the metropolitan regions, since they are more likely to be subject to measurement errors due to its diminutive representativeness in total employment in this locality.

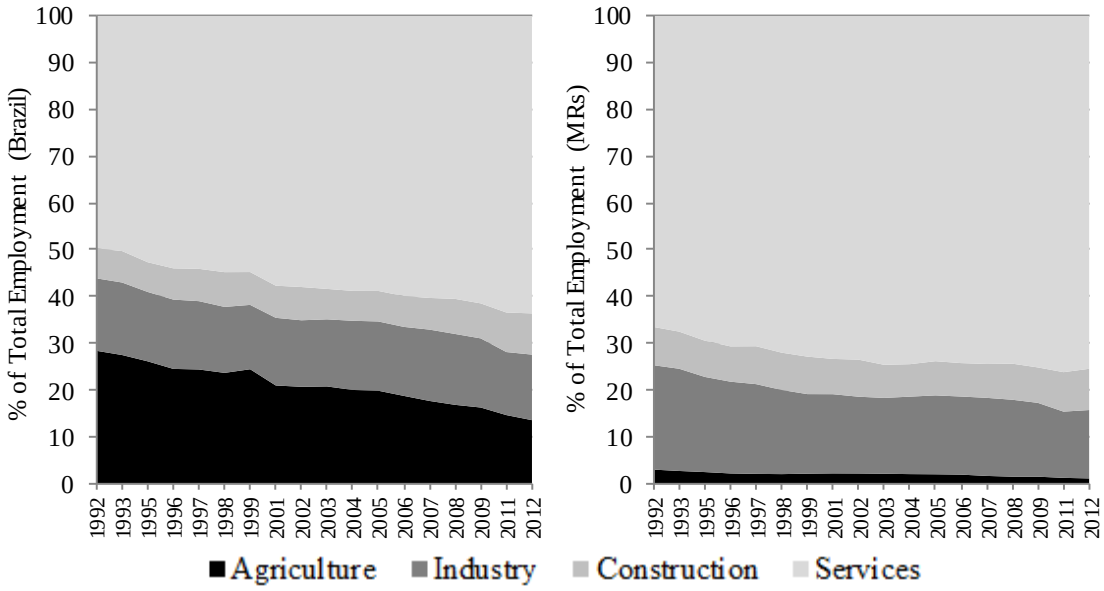


Figure 15: Shares of Total Employment by Economic Sectors – Brazil and Metropolitan Regions (MRs) – 1992-2012 – PNAD (IBGE).

The sectorial real wages[34] follow the evolution of the aggregate unemployment rate over the two decades. According to Figure 16, between 1992 and 1995 real wages rose systematically and reversed this trend when the economy started to slowdown and then the aggregate unemployment rate began to increase from 1996 to 2003. Interestingly, we note that an important part of the adjustment of the labor market to the economic slowdown during this period occurred through a reduction of real incomes, which avoided an even greater increase in the aggregate unemployment rate. Then, since 2004, when economic activity started to boom, the aggregate unemployment rate began to fall and real wages rose again, especially in the non-metropolitan areas, since the employment increase was relatively more intensive in the entire country. Therefore, we distinguish three different periods regarding employment and real wages trends both in the entire country and in the metropolitan regions: from 1992 to 1995, from 1996 to 2003 and from 2004 to 2012.

During the first period, real wages have increased relatively less in industry and agriculture. In part, it reflects a slight decline of employment and a rise of real labor

[34] Sectorial real wages represent the average real wage in a specific economic sector and are corrected by INPC/IBGE – a consumer price index, in September of each year, which is the month in which the PNAD is collected.

costs[35] until the "maxi-devaluation" of the Real in 1999, unlike the other sectors (construction and services), according to Figure 17. That is: during this period, there was an income transfer from workers and employers in tradable sectors for companies in non-tradable sector.

Between 1996 and 2003, the raise of employment in non-tradable sectors and the slight employment increase in tradable sectors was not enough to avoid the jump of the aggregate unemployment rate. Thus, real wages start to fall in all economic sectors. The "maxi-devaluation" of the Real temporarily favored the relative prices of tradable sectors and then these sectors had a larger decline in the real labor costs.

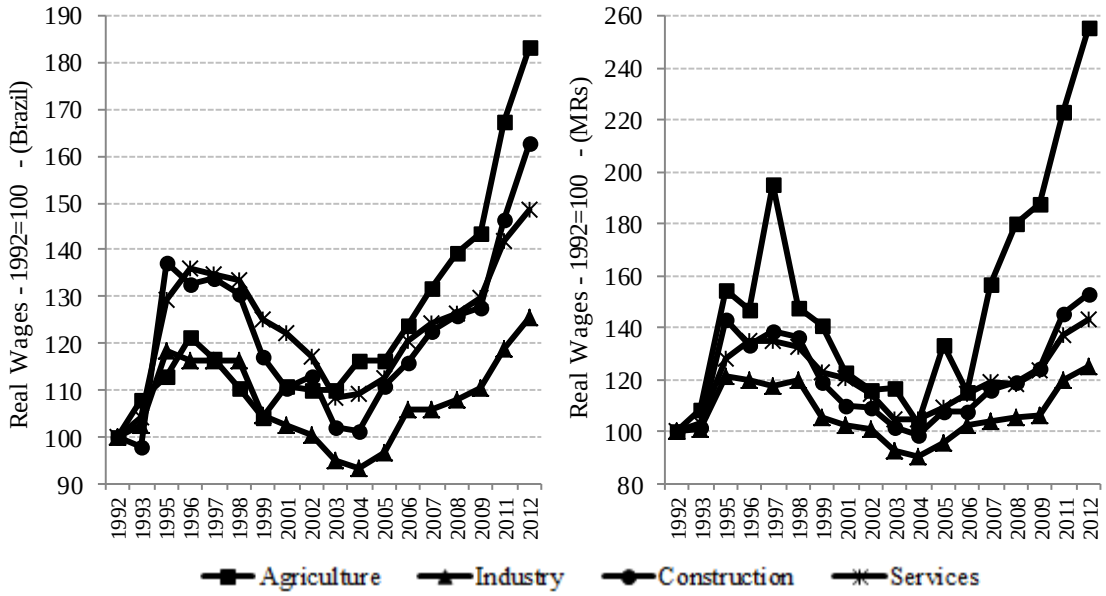


Figure 16: Average Real Wages by Economic Sectors – Brazil and Metropolitan Regions (MRs) – 1992-2012 – PNAD (IBGE).

[35] We define real labor cost as the sectorial nominal wage corrected by the sectorial producer price index (Agriculture: IPA-agriculture/FGV; Industry: IPA-Industry/FGV and Construction: INCC/FGV), as Camargo, Neri and Reis (2000). In the absence of such an index for the services sector in Brazil, we apply a consumer price index applied to service sector (IPCA/IBGE), which is computed by the Central Bank of Brazil. In this case, we include consumer taxes and other costs in the index applied to services sector. However, we do not believe its dynamics remarkably differs from what would be a producer index for this sector and it does not affect the general argument. We started the sample period in 1995, which is after the price stabilization program.

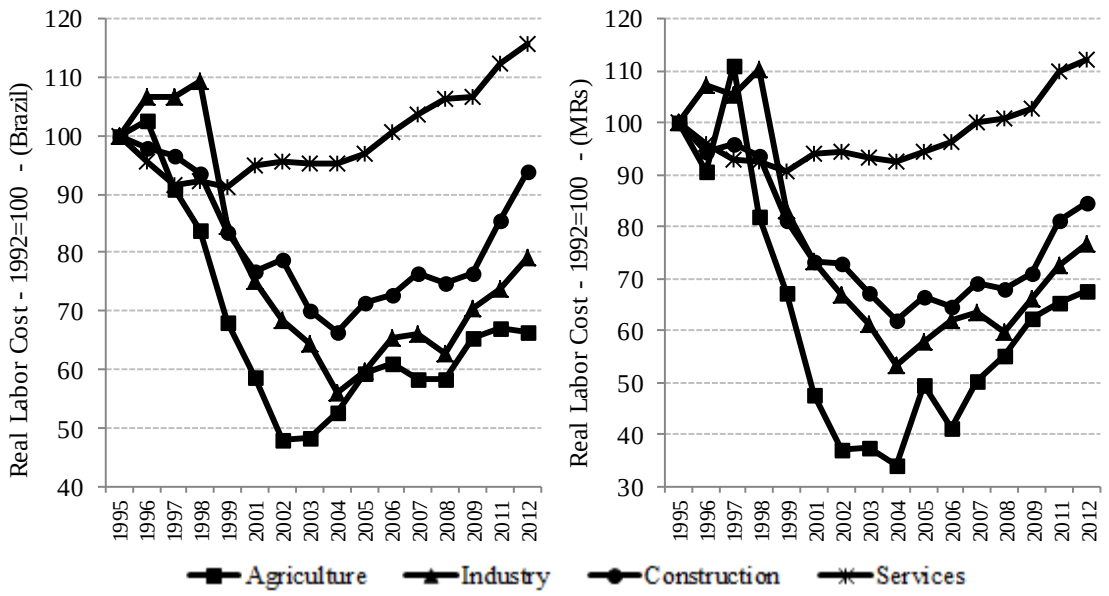


Figure 17: Real Labor Costs by Economic Sectors – Brazil and Metropolitan Regions (MRs) – 1992-2012 – PNAD (IBGE).

In the third period employment rose considerably (especially in construction and services), except in agriculture, which continued to reduce employment. This sector registered the most intensive raise of real wages, which means it underwent a continued process of modernization of cultivation and harvesting techniques, such that labor productivity has grown systematically[36]. Furthermore, the commodities boom in this period and the raise of the relative prices which refer to agriculture allowed the workers to take advantage of this favorable period by achieving high real earnings. Industry, however, had the weakest employment and real wages increase. It suggests that this sector has faced some difficulties during this period, in which economic growth featured a strong currency. For example, it has competed with relatively cheaper imported goods and also has experienced a competitive labor market in which the non-tradable sectors offer high wages. In this sense, the real labor costs show an increasing trend following the economic boom since 2004. Construction and services have relatively higher levels of real labor costs. This suggests together with the employment and real wages rises that these sectors were the most heated ones during this period.

4.2.2.1. A Simple Model of Labor Supply and Demand and Labor Market Developments During the 1990's and 2000's

[36] The Figure A.3 in the appendix C illustrates an outstanding trajectory of the productivity in agriculture.

Following the descriptions of the main sectorial developments in the labor market in the last two decades, we apply a simple model of labor supply and demand, which is consistent with the labor market operation as an attempt to rationalize these developments. This is an application of the methodology that Camargo, Neri and Reis (2000) use with data on metropolitan regions based on the PME/IBGE survey during the 1990's.

In this model, the basic underlying hypothesis is that the labor demand curve is determined by the firms' profit maximization. This means that, in the long run, it only hires a new worker in the case her productivity is equal or higher than her hiring cost, which implies a negative slope in the demand curve. Regarding the labor supply curve, the basic hypothesis is that the worker optimizes her time allocation among different available alternatives, which implies a positive slope in the supply curve.

We can summarize the main stylized facts regarding employment and real wages in the last two decades by grouping the main trend regarding tradable sectors (agriculture and industry) and non-tradable sectors (construction and services)[37]. The first period (1992-1995) featured real wages rise in all economic sectors, employment remained nearly steady in agriculture and industry and it rose in construction and services. In the second period (1996-2003), real wages fell in all economic sectors and employment increased, especially in non-tradable sectors. In the third period (2004-2012), real wages and employment rose in all economic sectors, except in agriculture, which continued to dismiss workers.

Figure 18 shows all the possible combinations that roughly illustrate these stylized facts using a simple model of labor supply and demand departing from an initial equilibrium represented by point a (E_0, W_0). Table 6 groups these possible combinations into different economic sectors and different periods.

[37] The dynamics of employment and real wages is quite similar in the metropolitan regions and in Brazil as a whole such that it is not necessary to distinguish the analysis in both localities.

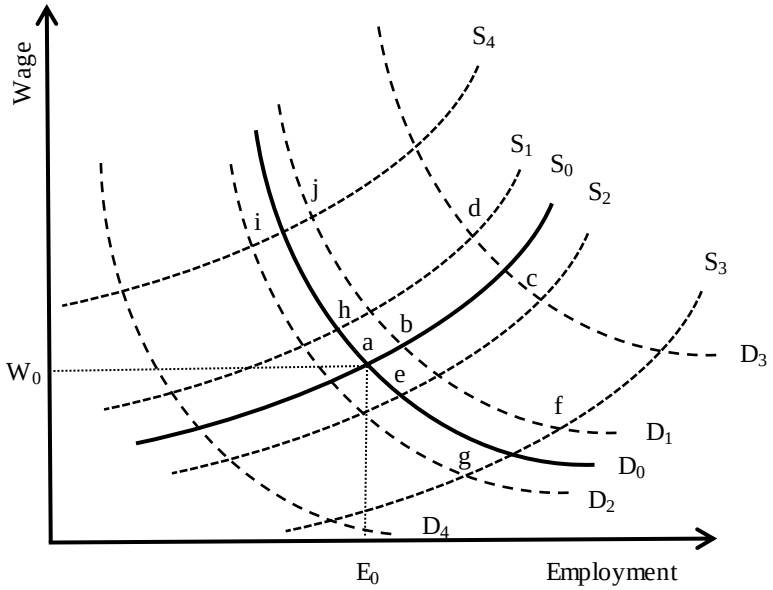


Figure 18: Illustration of Stylized Facts of Wage and Employment in Economic Sectors by a Model of Labor Supply and Demand.

We note that from 1992 to 1995 the real wages rose in all economic sectors. Since employment fell slightly in agriculture and industry, the model of labor supply and demand may describe these facts through three possible combinations by grouping agriculture and industry as tradable sectors as follows: (*i*) the demand curve does not move, whereas the supply curve shifts to the left (point h); (*ii*) the demand curve shifts to the left and the supply curve shifts more than proportionally to the left (point i) and (*iii*) the demand curve shifts to the right and the supply curve shifts more than proportionally to the left (point j). That is: the labor supply declines for any real wage level. Construction and services show a raise in both real wages and employment. This is consistent with three different situations by grouping construction and services sectors as non-tradable sectors: a shift of the demand curve to the right while supply curve does not move (point b); a shift of the demand curve more than proportionally to the right and a shift of the supply curve to the right (point c), a shift of the demand curve more than proportionally to the right and a shift of the supply curve to the left (point d). This means that the labor demand necessarily increased in this period.

Since adults' participation shows a slight raise, according to Figure 4 in subsection 4.2, labor supply in construction and services might have shifted to the right, which is consistent to point c. From 1992 to 1995 it seems that disaggregate

participation rate has wielded a nontrivial role in labor supply regarding especially the decline in young participation as suggest Figure 4. The participation rate of the elderly and youth decreased, whereas adults' participation slightly rose. However, it is not clear how the decline in participation of the youth is distributed among economic sectors. Thus, adults' participation seems to better reflect the business cycle participation in order to reduce demographic influence.

The labor supply developments in this period may be explained by technologic changes in the industrial sector and the relative prices favoring the non-tradable sectors, as we will assess in the next part of this subsection. First, following the trade openness of the economy and the price stabilization program in the early 1990's many workers were unable to deal with the technologic changes applied to the production process in tradable sectors. Since the technologic changes are less frequent in the non-tradable sectors and many workers were likely not able to qualify in order to deal with the new technologies, they offer their labor force in the non-tradable sector. Second, the relative price changed in favor of the non-tradable sectors, which implied a raise in real labor costs in tradable sectors, as shown previously by Figure 17. Nominal wages incorporate non-tradable prices, while tradable prices depend on imported prices. Thus, the tradable sectors (especially industry) could not afford real wage rises such as the non-tradable sectors did.

Economic Sectors	1992-1995	1996-2003	2004-2012
Agriculture and Industry	h, i, j	e, f, g	h[1/], i[1/], j[1/], b[2/], c[2/], d[2/]
Construction and Services	b, c, d	e, f, g	b, c, d

1/ Refers only to Agriculture.

2/ Refers only to Industry.

Table 6: Possible Combinations of Wage and Employment Represented by a Model of Labor Supply and Demand and Grouped in Economic Sectors and Periods.

During the period between 1996 and 2003 the real wages fell and employment rose in all economic sectors. This is consistent with three different combinations according to the model of labor supply and demand: (*i*) the demand curve does not move, while the supply curve shifts to the right (point e); (*ii*) the demand curve shifts to the right and the supply curve shifts more than proportionally to the right (point f) and

(*iii*) the demand curve shifts to the left and the supply curve shifts more than proportionally to the right (point g). It follows that all combinations imply the labor supply rises for any real wage level. Moreover, this argument is strengthened by the increasing trend of adults' participation, as illustrates Figure 4.

In 1999, following the "maxi-devaluation" of the Real, the relative prices had an inflection in favor of the tradable sectors such that the demand curve in these sectors might have shifted to the right, which is consistent to point f. In contrast, the labor demand curve in the non-tradable sectors might have shifted to the left or might have remained steady, which is represented by points g and e, respectively. However, the increase in labor demand in tradable sectors was not enough to absorb the labor force that has likely migrated from non-tradable sectors since it was a period of economic growth slowdown and aggregate unemployment raise. Although the tradable sectors were favored by relative prices in this period, when a worker moves to other economic sector it usually take some time to understand the operation of the new market in order to find a new job and to fill further qualification requirements, especially in tradable sectors, where technologic changes are more frequent. Furthermore, evidence suggests that tradable sectors are relatively less labor intensive[38].

From 2004 to 2012 both real wages and employment rose in all economic sectors, except agriculture which continued to dismiss workers. The following combinations in the model of labor supply and demand can describe these facts in agriculture: (*i*) the demand curve does not move, whereas the supply curve shifts to the left (point h); (*ii*) the demand curve shifts to the left and the supply curve shifts more than proportionally to the left (point i) and (*iii*) the demand curve shits to the right and the supply curve shifts more than proportionally to the left (point j). That is: all combinations imply the labor supply fell for any real wage level. Since there has been a continued process of job destruction in agriculture and by considering the real wages developments in the period, the combination represented by point i, in which both labor demand shifts to the left and by point j, in which labor demand shifts to the right seem credible descriptions of the model. The decision on whether labor demand increased or

[38] See appendix C for further evidence on labor intensity and productivity by economic sectors. We note that according to PAS, PAIC and PIA (IBGE), industry is relatively less labor intensive and more productive since labor costs accounts for a lesser share of total costs and the added value to total employment ratio is higher in comparison to construction and services. However, during the 2000's according to the National Accounts System (IBGE) the added value to total employment in industry shows a downward trend.

declined will be done in the next part of this subsection by assessing the determinants of the labor demand.

In industry and especially in construction and services, since both real wages and employment rose, the possible combinations represented by the model of labor supply and demand are similar to that observed in construction and services between 1992 and 1995. That is: points b, c and d, which means the labor demand increased in this period. Moreover, since 2004 adults' participation has slightly risen. Adding this to the fact that industry was not as thriving as construction and services with respect to real wages and employment, we believe that point b (supply curve does not move) and c (supply curve shifts to the right) match reasonably this situation for industry and construction/services, respectively. Furthermore, given that the relative prices trend has favored non-tradable sectors since 2004, industry has experienced difficulties to afford real wages raises similar to those in the non-tradable sectors.

Nevertheless, the choice of the combinations regarding the labor demand in the three periods is an empirical decision to be done in the following part of this subsection.

4.2.2.2. Labor Demand: Relative Prices and Marginal Productivity

The shifts of the labor demand curve in an economic sector depend on two variables: the relative prices and the marginal productivity of labor. Define $W_{i,t}$ to be the average nominal wage in sector i; $PPI_{i,t}$ is the producer price index of sector i and ${MP^L}_{i,t}$ is marginal productivity of labor in sector i – each variable defined at time t. Thus, in a firm that maximizes profits, it follows that:

$$W_{i,t} = PPI_{i,t}{MP^L}_{i,t} \tag{8}$$

By dividing equation (8) by a consumer index price (CPI_t), we have:

$$\frac{W_{i,t}}{CPI_t} = \frac{PPI_{i,t}}{CPI_t}{MP^L}_{i,t} \tag{8.1}$$

Hence, by taking the derivative of equation (8.1) in logarithm, the change of nominal wages in sector i (in terms of a consumer price index) is, approximately, the

sum of the change in its relative prices and the change of its marginal productivity of labor:

$$\Delta\left(\frac{W_{i,t}}{CPI_t}\right) = \Delta\left(\frac{PPI_{i,t}}{CPI_t}\right) + \Delta MP^L{}_{i,t} \quad (9)$$

That is: a rise (fall) of either the relative price or of the marginal productivity means a shift of the labor demand curve to the right (left). A relative price change is a cyclical factor that depends on the economic growth pace and also on the exchange rate level. For example, a demand curve in tradable sectors may shift due to a devaluation of the exchange rate. The marginal productivity of labor, in turn, depends on the level of physical and human capital in each economic sector and then it is considered a structural factor.

One effect that follows the program of price stabilization in 1994 was a remarkable change of relative prices trends in favor of non-tradable goods until at least 1999, when the "maxi devaluation" of the Real was established. Then the trends of the relative prices were inverted in favor of tradable sectors[39] until 2003, according to Figure 19[40]. When economic growth has started a thriving period since 2004, the valorization of the Real, the consequent increasing external competition and then the slowdown in external demand following the international financial crises in 2008 implied a slight decrease in relative price in industry, while the relative prices in construction and services (non-tradable sectors) had a raise.

[39] The relative price tendency in agriculture has reflected the commodities price boom since 1996.

[40] We follow the relative price definition in equation (8.1): $\left(\frac{\mathrm{PPI_{i,t}}}{\mathrm{CPI_t}}\right)$, where $\mathrm{CPI_t}$, the consumer price index, is the INPC/IBGE – the index used to correct the nominal wages for inflation. $\mathrm{PPI_{i,t}}$ is the producer price index in sector i – Agriculture: IPA-agriculture/FGV; Industry: IPA-Industry/FGV and Construction: INCC/FGV). In the absence of such an index for the services sector in Brazil, we apply a consumer price index applied to service sector (IPCA/IBGE), which is computed by the Central Bank of Brazil. In this case, we implicitly include consumer taxes and other costs in the index applied to services sector. However, we do not believe its dynamics remarkably differs from what would be a producer index for this sector and it does not affect the general argument. We started the sample period in 1994 due to data availability.

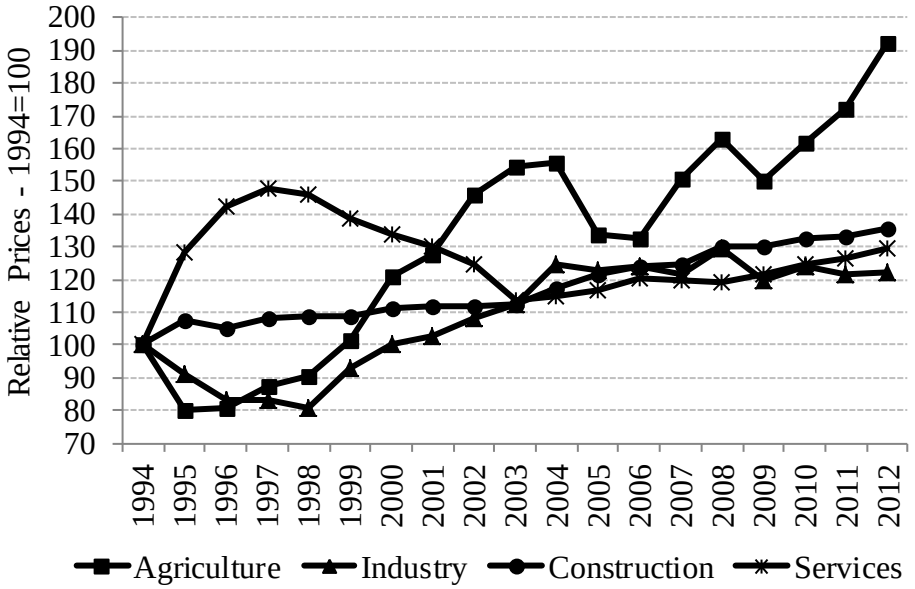


Figure 19: Relative Prices by Economic Sectors – Brazil – 1994-2012 – IBGE and FGV.

Between 1994 and 1995 the raise of the consumer price index was 20% higher than the prices in agriculture and 10% higher than the prices in industry. In contrast, the raises in the construction and services prices were, respectively, 7% and 29% higher than the consumer prices. The relative price developments in this period suggest that the labor demand curve might have shifted to the left in tradable sectors and to the right in non-tradable sectors.

From 1996 to 2003, the sectorial prices rose 93% and 24% more than consumer prices, respectively, in agriculture and industry, whereas prices in construction rose 5% more than consumer prices, which, in turn, rose 11% more than prices in services sector. This period suggests the opposite regarding demand curve shifts: to the right in tradable sectors and to the left in non-tradable sectors.

Since 2004 relative prices in agriculture continued to have an increasing trend. The prices in this sector rose 24% more than consumer prices. However, industrial prices rose 2% less than consumer prices. This period seems to be positive to relative prices again in non-tradable sectors since prices in construction and services rose, respectively, 16% and 13% more than consumer prices. It then means that the labor demand curve might have shifted to the right both in tradable and non-tradable sectors.

The other factor that might have determined labor demand shifts is the marginal productivity of labor. Indicators of marginal productivity are not easy to obtain. In this

study we propose the evolution of the schooling profile of employment in each economic sector as a proxy of productivity gains. Table 7 shows that the shares of skilled workers raised in all economic sectors, whereas the opposite occurred with the share of unskilled workers both in the entire country and in the metropolitan regions.

Brazil	1992	1995	2003	2012	Metropolitan Regions	1992	1995	2003	2012
Agriculture	100	100	100	100	**Agriculture**	100	100	100	100
Unskilled	94.7	94.2	87.9	76.6	Unskilled	88.2	85.9	77.3	70.9
Avg Skilled	3.2	3.6	8.0	12.6	Avg Skilled	6.6	7.2	13.9	11.8
Skilled	2.1	2.2	4.1	10.8	Skilled	5.2	6.9	8.7	17.3
Industry	100	100	100	100	**Industry**	100	100	100	100
Unskilled	64.3	61.0	43.8	26.9	Unskilled	56.1	52.7	33.2	19.5
Avg Skilled	16.9	18.1	21.1	20.3	Avg Skilled	19.9	21.7	21.7	17.8
Skilled	18.8	21.0	35.1	52.9	Skilled	24.0	25.6	45.0	62.7
Construction	100	100	100	100	**Construction**	100	100	100	100
Unskilled	83.6	84.1	70.5	54.3	Unskilled	80.4	80.0	64.9	49.9
Avg Skilled	9.4	9.1	16.8	21.7	Avg Skilled	9.3	10.1	18.3	21.0
Skilled	7.0	6.8	12.7	23.9	Skilled	10.3	9.9	16.8	29.0
Services	100	100	100	100	**Services**	100	100	100	100
Unskilled	55.0	52.5	37.6	24.3	Unskilled	48.5	45.3	31.6	19.5
Avg Skilled	15.9	16.7	18.3	16.8	Avg Skilled	17.7	18.8	18.5	15.9
Skilled	29.1	30.8	44.2	58.9	Skilled	33.8	36.0	49.8	64.6

Table 7: Schooling Profile of Employment by Economic Sectors (%) – Brazil and Metropolitan Regions – 1992, 1995, 2003 and 2012 – PNAD (IBGE).

Between 1992 and 1995, the share of skilled workers employed in agriculture increased from 2.1% to 2.2% and in industry it raised from 18.8% to 21% in the entire country. Thus, it is likely to have offset the fall in relative prices in the period, such that the demand curve has not moved. By considering the employment and real wage developments shown in the previous part of this subsection (Figures 14 and 16), the situation that better explain these developments in the model of labor supply and demand in Figure 17 is point h. Furthermore, the share of skilled workers had a slight decrease in construction (from 7% to 6.8%) and a raise in services sector (from 29.1%

to 30.8%), which suggests that the marginal productivity of labor moved in the same direction of relative prices in the non-tradable sectors and then it confirms that the labor demand increased in these sectors (point c). In the metropolitan regions the developments of the marginal productivity of labor follow a similar pattern. Therefore, the stylized facts on labor supply and labor demand in tradable sectors and non-tradable sectors are illustrated by points h and c, respectively.

From 1996 to 2003, the variation of the share of skilled workers in agriculture (from 2.2% to 4.1%) and industry (from 21% to 35.1%) moved in the same direction of the sectorial relative prices, which suggests that labor demand rose in these sectors in the entire country[41]. Thus, it confirms that point f is a credible representation of these developments through the model of labor supply and demand. However, the variation of the share of skilled workers in construction (from 2.2% to 4.1%) and services (from 21% to 35.1%) moved in the opposite direction of the sectorial relative prices. It then is likely to have offset the fall in relative prices in the period, such that the labor demand curve did not move, which is represented by point e. Thus, the labor market developments in tradable sectors and non-tradable sectors can be represented, respectively, by points f and e.

Between 2004 and 2012, the relative prices in agriculture moved in the same direction of marginal productivity of labor, since the share of skilled workers more than doubled (from 4.1% to 10.8%) in the entire country. This indicates point j as a credible representation of the labor market developments. That is: labor demand rose (shifted to the right) whereas labor supply fell. The explanation for the labor supply decline might be related to the fact agriculture has the largest share of unskilled workers, who have been unable to deal with the technologic changes applied to the production process and, therefore, might have largely migrated to non-tradable sectors where technological changes are less frequent to offer their labor force.

The developments of marginal productivity of labor seem to have outweighed the fall in relative prices in industry since the share of skilled workers increased from 35.1% to 52.9%. Thus, labor demand is likely to have increased, while labor supply remained steady, which confirms point b as the best representation of the employment and real wage developments among the three possible scenarios. This argument is

[41] The developments of marginal productivity of labor follow a similar pattern in all periods in the metropolitan regions.

strengthened by the fact that labor supply declined in agriculture and rose in construction and services, once one considers that adult's participation rate had a slight raise.

In construction and services the relative price and marginal productivity of labor moved in the same direction, since the share of skilled workers rose, respectively, from 12.7% to 23.9% and from 44.2% to 58.9% in Brazil as a whole. By considering the remarkable raise in employment and real wages, the representation of the model of labor supply and demand that better matches these developments is point c, in which both curves of labor demand and labor supply shifted to the right. Therefore, the stylized facts on labor supply and labor demand in tradable sectors and non-tradable sectors are explained by points j (agriculture) and b (industry) and c (construction and services), respectively.

Table 7 also shows that industry and services are the sectors in which its shares of skilled workers have been the largest since 1992. However, in agriculture and construction we note that the raise of this share of workers shows the fastest pace. The marginal productivity gains in agriculture and construction are more expressive and this is a structural fact that explains the long run gains of real wages. Hence, one should expect a declining gap of real wages between agriculture and construction sectors and industry and services, which show the highest wage levels, according to Table 8. This argument is strengthened by the cyclical factor represented by the relative prices developments, which has favored especially the agriculture.

Interestingly, the unskilled workers have the largest gains of real wages in relative terms, especially from 2003 to 2012 in agriculture and construction, which are the sectors with the largest shares of unskilled workers. During the whole sample time, it is noticeable an opposite trend between real wages growth associated to unskilled workers and those associated to skilled workers in both the entire country and the metropolitan regions. The real wages of unskilled workers had a substantial rise especially in agriculture and construction, whereas real wages of skilled workers declined[42], especially in industry. As we assessed in subsection 4.1.2, the share of unskilled workers declined, while the share of skilled workers rose in the last two

[42] The only exception is the services sectors, in which the real wages of skilled workers registered a slight rise.

decades. These facts altogether reinforces the labor demand has mismatched the schooling profile of the labor supply in the Brazilian economy.

Brazil	1992	1995	2003	2012	Metropolitan Regions	1992	1995	2003	2012
Agriculture	**300**	**338**	**330**	**549**	**Agriculture**	**264**	**408**	**308**	**675**
Unskilled	253	289	273	423	Unskilled	236	358	255	433
Avg Skilled	784	607	431	634	Avg Skilled	401	855	471	852
Skilled	1,684	2,002	1,354	1,343	Skilled	1,242	2,665	1,670	2,403
Industry	**1,182**	**1,401**	**1,189**	**1,486**	**Industry**	**1,383**	**1,678**	**1,392**	**1,727**
Unskilled	740	847	641	905	Unskilled	953	1,097	795	1,062
Avg Skilled	1,141	1,278	840	1,067	Avg Skilled	1,276	1,447	978	1,242
Skilled	2,731	3,121	1,894	1,943	Skilled	3,111	3,800	2,274	2,400
Construction	**796**	**1,093**	**899**	**1,295**	**Construction**	**904**	**1,299**	**986**	**1,386**
Unskilled	645	894	658	1,038	Unskilled	769	1,079	745	1,159
Avg Skilled	845	1,183	750	1,114	Avg Skilled	823	1,316	853	1,202
Skilled	2,515	3,423	1,742	2,043	Skilled	2,793	4,384	2,216	2,272
Services	**1,040**	**1,346**	**1,218**	**1,475**	**Services**	**1,241**	**1,595**	**1,426**	**1,707**
Unskilled	596	715	582	827	Unskilled	734	879	679	930
Avg Skilled	933	1,106	768	975	Avg Skilled	1,095	1,262	870	1,042
Skilled	1,940	2,550	1,736	2,006	Skilled	2,340	3,085	2,033	2,354

Table 8: Real Wages by Economic Sectors (%) – In Reais (R$) of September 2012 – Brazil and Metropolitan Regions – 1992, 1995, 2003 and 2012 – PNAD (IBGE).

4.2.3. Sectorial Dispersion of Employment and Variations of the Aggregate Unemployment Rate

The main stylized facts with respect to labor demand that arises from the previous two subsections are that the relative prices have been in general favored in non-tradable sectors, which in addition has shown a more significant rise of the marginal productivity of labor in the last two decades. To some extent it implied an employment migration from tradable sectors towards non-tradable sectors. In this subsection we evaluate how these stylized facts reflect a sectorial reallocation of employment. Then we analyze whether this reallocation affect the variations of

aggregate unemployment rate. To this end, we use an index of employment dispersion, ED, that captures the incidence of sectorial shocks over time as used by Gonzaga and Reis (2000) and Camargo, Neri and Reis (2000), which analyzes the importance of employment reallocation on unemployment rate using the PME/IBGE survey. This index is calculated similarly to that Loungani, Rush, and Tave (1990) and Loungani and Trehan (1997) apply to stock prices and uses the annual growth rates in employment weighting them by the share of each sector in total employment. We include the four economic sectors comprised in this study: agriculture, industry, construction and services.

Define $E_{i,t}$ to be the employment in sector i and $EG_{i,t}$ to be the growth rate[43] of employment in sector i; EG_t is the growth rate of total employment and $\delta_{i,t} \equiv \frac{E_{i,t}}{\sum_i E_{i,t}}$ is the employment share of sector i – each variable defined at time t. Thus, it follows that:

$$ED_t = \sum_i \delta_{i,t} \left(EG_{i,t} - EG_t\right)^2 \qquad (10)^{44}$$

The raise of the index of employment dispersion during the 1990's, as shown by Figure 20, can be associated to one relevant structural change that might have led to an increasing importance of reallocation shocks on unemployment. The price stabilization program established in 1994 and the trade and financial openness, which started in the early 1990's. As we assessed in subsections 4.2.2.1 and 4.2.2.2, in the early 1990's while in tradable sectors the labor demand was likely steady and labor supply declined, in the non-tradable sectors both labor demand and labor supply increased. Furthermore, in this period the relative prices favored the non-tradable sectors. These facts altogether probably implied an employment reallocation from tradable sectors to non-tradable sectors.

[43] The growth rate is calculated in Log.

[44] Gonzaga and Reis (2000) define in equation (10) the employment share of sector i at time $t-1$: $\delta_{i,t-1}$. We set the employment share of sector i at time t because the PNAD/IBGE survey is not published in the years 1994, 2000 and 2010. Thus, we avoid ambiguity in the interpretation of the employment dispersion index, ED_t, since in 1995, 2001 and 2011, actually $\delta_{i,t-1}$ would be $\delta_{i,t-2}$. This specification implied virtually no change in the average and variance of the ED_t in comparison to the original specification, since the employment share of each sector does not change considerably from one year to another. The average and variance of ED_t using the original specification are, respectively, $[1.41 \times 10^{-3}]$ and $[3.76 \times 10^{-6}]$ in the entire country and $[7.95 \times 10^{-7}]$ and $[6.45 \times 10^{-7}]$ in the metropolitan regions. In our specification the average and variance become, respectively, $[1.36 \times 10^{-3}]$ and $[3.19 \times 10^{-6}]$ in the entire country and $[7.61 \times 10^{-7}]$ and $[5.75 \times 10^{-7}]$ in the metropolitan regions.

The index of employment dispersion during the 2000's reflects a remarkable decline of employment in agriculture and the international financial crisis in 2008. Employment in agriculture and industry has fallen following the international crisis, while employment in services and especially in construction has increased. This might have reflected the fact that the labor demand slightly rose and labor supply declined in tradable sectors, whereas both labor demand and labor supply increased in non-tradable sectors. With exception of agriculture, which has led a job destruction process, the relative prices have favored non-tradable sectors since 2004. These facts also reinforce a likely reallocation of employment from tradable sectors to non-tradable sectors during this period.

The changes in the structure of the labor market with the opening of trade and the price stabilization program were analyzed by Barros et al. (1997) and Ramos and Reis (1997). They noted that together with the opening process, technological innovations occurred, triggering a process of economic restructure following institutional changes and the increased competition from imported products. Therefore, the absorption capacity of labor force in tradable sectors, historically major employers, has decreased considerably. There is even a reduction in the number of jobs in agriculture both in the entire country and the metropolitan regions and in industry in the metropolitan areas[45]. This employment decline in tradable sectors was due to trade liberalization, which has been the keynote economic policy of the 1990's and that favors adjustments that generate productivity gains to increase their international competitiveness. During the 2000's this trend continues in the tradable sectors, while the opposite occurred in the services and construction sectors. Productivity adjustments in these sectors were not that favored as in the tradable sectors since they did not suffer much from international competition.

[45] Figure 14 illustrates it.

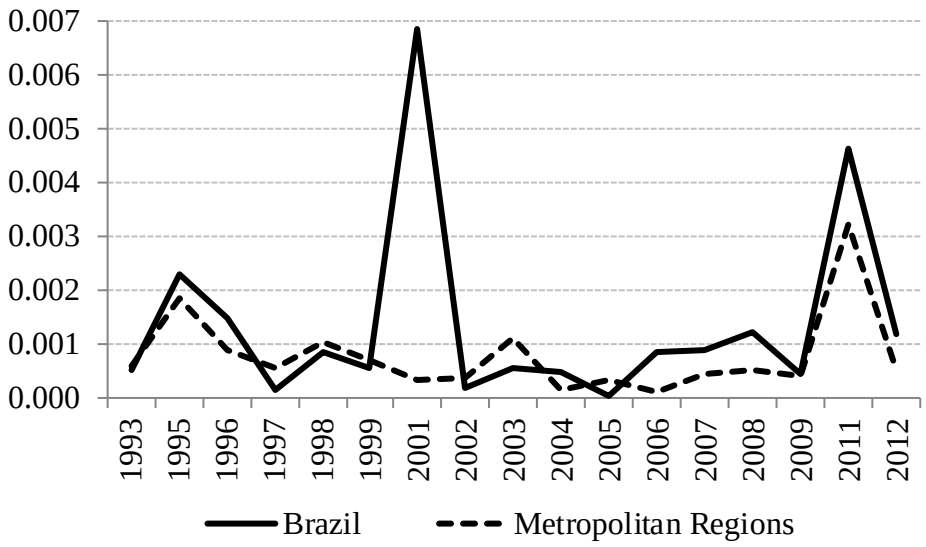


Figure 20: Index of Employment Dispersion – Four Sectors – Brazil and Metropolitan Regions – 1993-2012 – PNAD (IBGE).

The raise of employment dispersion, ED_t, in 1995 was led by structural changes associated to employment movements from agriculture in the entire country and industry in the metropolitan regions towards the services sector. This pattern remained in Brazil as a whole in 2001 and is strengthened by a substantial decline of employment in agriculture, unlike the other sectors, which experienced an increase in employment. In 2011, there was a considerable decline in employment both in agriculture and industry, while the services and especially the construction sector experienced a remarkable raise in employment. Moreover, this contrast of employment growth between tradable and non-tradable sectors strengthens the level rise of ED_t by considering that since 2009 total employment has decelerated substantially[46].

According to Camargo, Neri and Reis (2000), until the 1990's the aggregate unemployment rate had a more cyclical behavior, which followed the production cycle. When the economy entered a recession, the aggregate unemployment rate increased, reverting to the low levels of the end of the economic growth period at end of the next cycle. These developments of the aggregate unemployment suggest a high degree of flexibility of the labor market (employment and real wages) relative to the size of the shocks experienced by the economy. During the last two decades the unemployment rate presents a new trend that is not solely associated with cyclical movements of the

[46] Total employment growth decelerated from 2% in annual average between 1992 and 2009 to 0.7% between 2009 and 2012.

product. In this sense, a new component stems from the structural (sectorial) changes that might have led to an increasing importance of reallocation shocks on unemployment.

The effects of cyclic variations of the product and reallocation shocks on aggregate unemployment rate are obtained by the estimation[47] of the aggregate unemployment rate in Table 9. The aggregate unemployment rate, U_t, is estimated using as explanatory variables the lagged aggregate unemployment rate, annual variations of GDP[48], GDP_t, calculated by IBGE, in log, as a measure of product variations and the employment dispersion index, ED_t.

The data is annual from 1993[49] to 2012 and since there are gaps in the PNAD/IBGE survey between the years 1993-1995, 1999-2001 and 2009-2011, the variation of GDP_t in 1995, 2001 and 2011 are accumulated in two years in order to be consistent to variations of the aggregate unemployment rate and the employment dispersion index. We use first differences in levels to the formalization of time trends, when applicable.[50] The regressions inevitably deal with degree of freedom problems due to the sample size. However, some insights can be useful, especially the comparison of different specifications and to use the employment dispersion index and GDP growth to predict the aggregate unemployment rate.

The results show that in our baseline model, (1), the aggregate unemployment rate fluctuates in relation to its lagged values, as attest its coefficients, which are significant at 1% and 5% in the entire country and in the metropolitan regions, respectively. Furthermore, we attested that the lagged values of the employment dispersion index, ED_t, are significant[51]. This is consistent with the argument which states that workers that move from one economic sector to another take some time to

[47] The estimation is by OLS (Ordinary Least Squares). Additionally, to deal with heteroskedasticity and serially correlated errors we use the Newey-West (1987) - HAC estimator (heteroskedasticity and autocorrelation consistent) - to estimate the long-run variance matrix and we use a Barlett Kernel-based estimator to compute the weights for autocovariances. There is no unique method for the bandwidth choice. We also test different bandwidths and the results do not change remarkably. Regarding the Jarque-Bera statistics, the chi-squared approximation of the Jarque-Bera test statistics for small samples is overly sensitive, often rejecting the null hypothesis when it is in fact true - large Type I error rate. In this case, it uses a table derived from Monte Carlo simulations in order to interpolate p-values. For more details on these approximations, see Lawford (2004).

[48] The GDP source is the National Accounts System (SCN/IBGE).

[49] It starts in 1993 because the sample time starts in 1992. Hence, the first observation of ED_t starts one year ahead by construction.

[50] We assume the preliminary adjustments based on the Augmented Dickey-Fuller (ADF) test at 5% level to attest series are stationary $(\mathrm{I}(0))$.

[51] With exception of ED_{t-5} in the metropolitan regions.

understand the operation of the new market in order to find a new job and to fill further qualification requirements. The lagged values of employment dispersion index, ED_t, are negatively significant at 1% and 5% in Brazil as a whole and at 10% in the metropolitan regions. This might suggest that the reallocation shocks on employment conditional on GDP growth have a negative effect on the aggregate unemployment rate[52], especially in Brazil as a whole, where the employment destruction in agriculture is more pronounced. This, in turn, might suggest that the bulk of the employment reallocation – from tradable sectors to non-tradable sectors – implied an economy that is structurally more labor intensive.

Brazil				Metropolitan Regions			
Explanatory Variable	(1)	(2)	(3)	Explanatory Variable	(1)	(2)	(3)
C	1.77 [7.11]***	0.93 [2.45]**	-0.07 [-0.17]	C	4.28 [5.19]***	5.19 [0.22]	0.50 [0.73]
U_{t-1}	-0.78 [-5.10]***	0.15 [0.40]	-0.23 [-0.59]	U_{t-2}	-0.52 [-2.61]**	-2.61 [0.71]	0.48 [1.38]
GDP_t	-24.4 [-13.71]***	-26.77 [-8.35]***	-	GDP_t	-51.80 [-14.28]***	-14.28 [-4.46]***	-
GDP_{t-1}	-29.21 [-4.47]***	-1.23 [-0.12]	-	GDP_{t-1}	-22.50 [-3.20]**	-3.20 [-0.29]	-
ED_{t-3}	-66.76 [-4.56]***	-	-59.62 [-0.68]	GDP_{t-2}	-42.85 [-2.81]**	-2.81 [1.11]	-
ED_{t-5}	-57.26 [-3.43]**	-	-91.19 [-1.00]	ED_{t-1}	-559.23 [-2.41]*	-	-458.85 [-1.61]
				ED_{t-5}	-596.84 [-1.61]	-	-1,122.65 [-1.95]*
Jarque-Bera	0.73	0.90	0.37	Jarque-Bera	1.44	0.65	0.06
R^2	0.94	0.66	0.16	R^2	0.92	0.75	0.20
Adjusted R^2	0.90	0.57	-0.15	Adjusted R^2	0.83	0.64	-0.09

Note: t-statistic in brackets. [.]***, [.]** and [.]* denote 1%, 5% and 10% marginal significance level, respectively.

Table 9: Regressions on Aggregate Unemployment Rate – Brazil and Metropolitan Regions – 1992-2012 – PNAD (IBGE) and SCN (IBGE).

The baseline model also shows that the GDP variations are highly significant with a negative signal, as expected. The significance of GDP_t is also robust to changes

[52] This result should be considered with caution, as we will see in the robustness check in the next section.

in the model specification, as we notice in model (2) both in the entire Brazil and the metropolitan regions, in which it does not include the employment dispersion index. However, the exclusion of the GDP_t variations, especially, and the exclusion of the employment dispersion index cause important changes in terms of the regression adjustment, as we note by the declines of the R^2 and the adjusted R^2 in specifications (3) and (2) in comparison to the baseline model.

An alternative way to depict the importance of the reallocation shock and the business cycle fluctuations in the 1990's and 2000's is illustrated by Figure 21, which shows the actual aggregate unemployment rate, U_t, and the forecasted values one period ahead through the estimation of models (1), (2) and (3). That is: $F_t(1)$[53] considers both the effects of the sectorial shocks, ED_t, and GDP variations on aggregate unemployment rate; $F_t(2)$ only considers the effects of the GDP variations and $F_t(3)$ only considers the effects of the sectorial shocks.

The forecasted aggregate unemployment rate represented by model (2), $F_t(2)$, seems to underestimate the aggregate unemployment rate until 1999[54], which is in accordance with the finds in Camargo, Neri and Reis (2000) with the PME/IBGE survey in the early 1990's. It suggests that the sectorial shocks in this period are positively correlated with the raise of the aggregate unemployment rate. This is consistent with a period of GDP slowdown and also the argument about a slow market adjustment to the employment reallocation from tradable sectors to non-tradable sectors that followed the price stabilization program in 1994. However, during the 2000's $F_t(2)$ does not clearly underestimate or overestimate U_t.

In model (3), the forecasted aggregate unemployment rate, $F_t(3)$, seems to overestimates the aggregate unemployment rate since 2007[55], which suggests the GDP variations are positively correlated with the decline of the aggregate unemployment rate. This is consistent with the thriving GDP growth experienced in the country in the period. Furthermore, by considering the remarkable fall of the aggregate unemployment rate, it might be that rather than sectorial shocks, it is the absorption of unemployed

[53] $F_t(1)$ denotes the aggregate unemployment rate forecasted by specification (1) at time t.
[54] In the entire country, it underestimates U_t in 60 basis points, in average from 1996 to 1999. In the metropolitan regions, it underestimates U_t in 90 basis points, in average from 1997 to 1999.
[55] With exception of 2009 due to the international financial crises in 2008 and its lagged effects on unemployment. In the entire country and in the metropolitan regions, it overestimates U_t, respectively, by 30 basis points and 40 basis points, in annual average from 2006 to 2012.

workers led by the economic growth that better predicts the unemployment decline in the period.

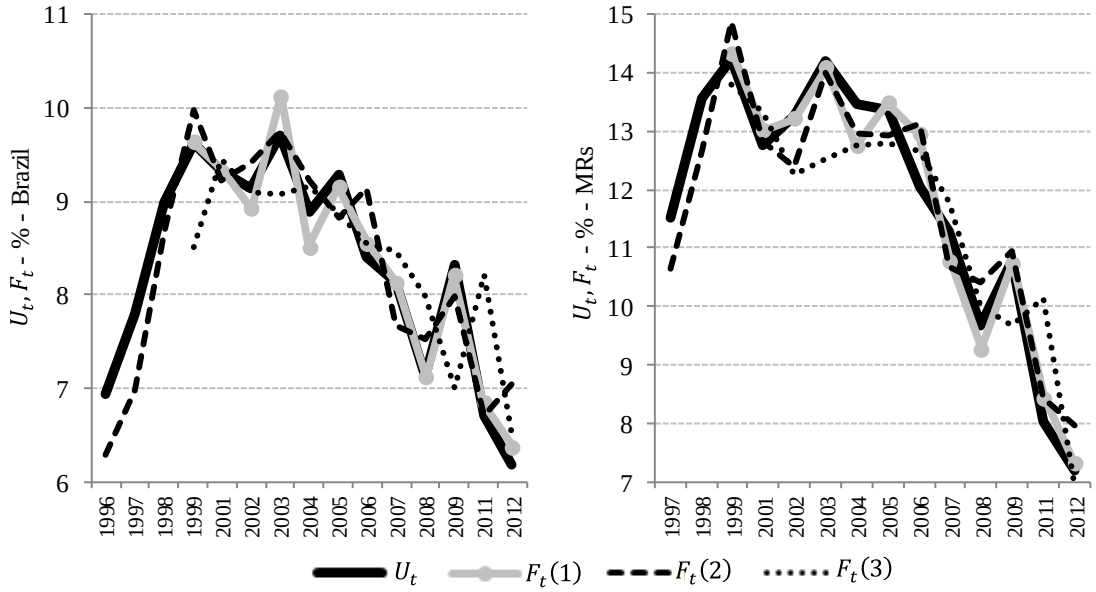


Figure 21: Actual Unemployment Rate and Forecasted Aggregate Unemployment Rates – Brazil and Metropolitan Regions (MRs) – 1996-2012 and 1997-2012 – PNAD (IBGE).

The baseline model, $F_t(1)$, has the best fit to the actual aggregate unemployment rate attested by the adjusted R^2, and the best forecasts among the three specifications, as suggested quantitatively by a root mean squared error (RMSE) of U_t. Define $e_t = U_t - F_t$ to be the in-sample forecast error at time t. Thus, it follows that:

$$RSME = \sqrt{\frac{\sum_{t=t_0}^{t_1} (e_t)^2}{(t_1 - t_0)}} \tag{11}$$

The RMSE from 1999 to 2012[56] is 2 basis points by $F_t(1)$, 4.4 basis points by $F_t(2)$ and 7.9 basis points by $F_t(3)$, respectively, in Brazil as a whole. In the metropolitan regions, the average quadratic loss is 4.1, 5.2 and 9.5 basis points, respectively by $F_t(1)$, $F_t(2)$ and $F_t(3)$. Hence, the RMSE is larger by taking the GDP out of the baseline model in (3), instead of taking out the employment dispersion index in (2).

[56] It means that $t_0 = 1999$ and $t_1 = 2012$. It starts in 1999 because the baseline model starts this year both in the entire country and in the metropolitan regions due a loss of degree of freedom by the inclusion of the lagged employment dispersion index, ED_{t-5}.

Therefore, the baseline model indicates that both GDP variations and the sectorial shocks matter for the aggregate unemployment rate changes. However, despite the importance of structural factors for both the supply and demand for labor, the results suggest that the business cycle changes seem to explain the bulk of the aggregate unemployment rate developments.

4.3. Robustness Check

To discuss robustness of our main results, we include two exercises regarding the stylized facts of labor supply applied to the age profile of the labor force in subsection 4.1.1 and one exercise that refers to labor demand, which uses the aggregate unemployment rate estimations in subsection 4.2.3.

4.3.1. Age Profile of the Labor Supply and Aggregate Unemployment Rate Changes

Empirically, changes in the age composition of the labor force account for the bulk of the demographic changes in aggregate unemployment under the maintained hypothesis with respect to the observable characteristics of the labor supply. Other demographic changes do not have as much explanatory power. Thus, this subsection focuses exclusively on age.

The first exercise refers to aggregation of age clusters, which may bias demographic adjustments. It reduces the measured demographic changes since it is strictly the differences in disaggregate unemployment rates and the changes in labor-force shares that result in demographic adjustments. As we mentioned in the data description section, the decomposition of the age profile of labor force into three age clusters – young workers, adult workers and old workers – is the simplest one, such that we could raise some stylized facts regarding age without limiting the generality of the results. One way of assessing whether this is true is by dividing the population into more age clusters. Logic and evidence suggest that we would attribute more of the unemployment variations to the changing age structure of the labor force.

	$\Delta U_{t_1,t_0}$		$\Delta^{CW} U^{D}_{t_1,t_0}$		$\Delta^{CW} U^{D^p}_{t_1,t_0}$	
	b.p	%	b.p	%	b.p	%
Brazil						
t_1: 2002 t_0: 1992	261	100	-51	-19.4	-27	-10.5
t_1: 2012 t_0: 2002	-294	100	-86	29.2	-67	22.9
Metropolitan Regions						
t_1: 2002 t_0: 1992	373	100	-84	-22.5	-44	-11.8
t_1: 2012 t_0: 2002	-601	100	-128	21.3	-89	14.8

Table 10: Aggregate Unemployment Rate, Chain-Weighted Demographic Unemployment Rate and Chain-Weighted Demographic Unemployment Rate Controlled by Participation Rate – Demographic Adjustment for Eight Age Clusters – Brazil and Metropolitan Regions – Variations in Basis Points (b.p) and Percentage Points (%) – 1992-2002 and 2002-2012 – PNAD (IBGE).

In light of this caveat, under the maintained hypothesis, table 10 confirms it. We divide the population into eight age clusters[57] using Δ^{CW} as our primary measures since they do not rely on base year choice, as mentioned. However, in general, the figures are quite similar to the ones in Table 2. $\Delta^{CW} U^{D}_{t_1,t_0}$, accounts for -19.4% of the aggregate unemployment rise from 1992 to 2002 and 29.2% of the unemployment fall between 2002 and 2012 in the entire country. In the metropolitan regions, it accounts for -22.5% and 21.3%, respectively in the two periods. Moreover, $\Delta^{CW} U^{D^p}_{t_1,t_0}$ accounts for -10.5% and -11.8% of the aggregate unemployment rise from 1992 and 2002, respectively, in Brazil as a whole and in the metropolitan regions. Between 2002 and 2012, it accounts for 22.9% of the aggregate unemployment fall in the entire country and 14.8% in the metropolitan regions. Therefore, the raise on demographic changes, in absolute terms, is small and therefore does not modify the conclusions that arise of Table 2 in subsection 4.1.1.

[57] From 10 to 14 years old; from 15 to 19 years old; from 20 to 24 years old; from 25 to 29 years old; from 30 to 39 years old; from 40 to 49 years old; from 50 to 59 years old and from 60 years old or more.

The chain-weighted measures of demographic unemployment from 2002 to 2012[58] specifically in the metropolitan regions shows similar results by using the PME/IBGE survey, as shows Appendix D.

The second exercise is an attempt to assess whether the underlying assumptions related to demographic adjustments to the unemployment rate are appropriate. Regardless of the theoretical reasons why demographic adjustments to the unemployment rate may or may not be appropriate, ultimately this is an empirical question. If changes in a cluster's labor-force share, $\theta_{i,t}$, do not affect any disaggregate unemployment rate, $u_{i,t}$, then $U^{G}_{t_1,t_0}$ is an accurate measure of what the unemployment rate would be at time t_1 if the demographics look what they did in period t_0. The difference $U_{t_1} - U^{G}_{t_1,t_0}$ measures how much the unemployment rate increased due to demographics. Similarly, $U^{D}_{t_1,t_0}$, is an accurate measure of what the aggregate unemployment rate would be if the only changes had been demographic. Thus, $U^{D}_{t_1,t_0} - U_{t_0}$is another measure of how much the unemployment rate increased due to demographics. To the extent that $U_{t_1} - U^{G}_{t_1,t_0} \neq U^{D}_{t_1,t_0} - U_{t_0}$, the quantities U^{G} and U^{D} are poor measures of genuine and demographic unemployment. Hence, it follows that:

$$\begin{aligned}\left(U_{t_1} - U^{G}_{t_1,t_0}\right) - \left(U^{D}_{t_1,t_0} - U_{t_0}\right) &= \sum_i \left[\theta_{i,t_1} - \theta_{i,t_0}\right]\left[u_{i,t_1} - u_{i,t_0}\right] \\ &= \sum_i \left[\theta_{i,t_1} - \theta_{i,t_0}\right]\left\{\left[u_{i,t_1} - U_{t_1}\right] - \left[u_{i,t_0} - U_{t_0}\right]\right\} \qquad (12)\end{aligned}$$

If this number is positive, clusters that increase their labor-force share tend to have relative increases of their disaggregate unemployment rate. The problem with using this as a measure of the quality of demographic adjustments is that if demographic changes or relative unemployment-rate changes are small, this covariance will be small. Therefore, Shimer (1999) constructs a measure that normalizes by the size of these changes. It is analogous to a correlation, such that $\rho \in [\text{-}1,1]$. Rather than deviations between the labor-force shares and disaggregate unemployment rates at time t and their means, it measures the deviations of these variables from time t_0 to time t_1:

[58] The PME/IBGE survey comprises the same metropolitan regions that we analyze by using the PNAD/IBGE survey and starts in 2002.

$$\rho = \frac{(\vec{\theta}_{t_1} - \vec{\theta}_{t_0}) \cdot (\vec{u}_{t_1} - \vec{u}_{t_0})}{|\vec{\theta}_{t_1} - \vec{\theta}_{t_0}||\vec{u}_{t_1} - \vec{u}_{t_0}|} \quad (13)$$

where $\vec{\theta}$ and $\vec{u}$ are vectors of labor-force share and disaggregate unemployment rates, and the vertical bars indicate the Euclidean length of the indicated vectors. If ρ is positive, then there is a relatively large increase (decrease) in unemployment for clusters that grow (diminish) relatively more. If ρ is negative, then clusters that grow (diminish) more had a relative decline (increase) in unemployment. Only if $\rho = 0$ do U^G and U^D have the desired interpretations.

Table 11 shows the value of ρ obtained by dividing the population into eight age clusters[59]. These estimates are reasonably robust to changes in the time period or to changes in the number of age clusters. For example, changing the initial or terminal time by one year or changing the number of age cluster to three, following subsection 4.1.1, does not change the sign of any of the entries.

From 1992 to 2002, age clusters that diminished in size had a correspondingly larger increase in unemployment since $\rho = -0.30$ in both the entire country and in the metropolitan regions. This result was led specially by the cluster from 15 to 19 years old, which represents young workers. However, from 2002 to 2012, there was positive correlation between changes in labor-force share and unemployment, especially in the metropolitan regions ($\rho = 0.34$), since in the entire country the magnitude is much smaller ($\rho = 0.07$), and is exactly zero for the interval 2001-2011. This means that it makes sense to demographically adjust the unemployment rate for age in the entire country from 2002-2012. That is: the age-specific unemployment rate was virtually unaffected by population dynamics. The results in this period was led again by the decline of age clusters corresponding to young workers, including one more cluster, from 20 to 24 years old, which is consistent with the argument which states that the schooling expansion has affected positively the decline of the youth labor-force share. However, since this period featured an economic boom, the unemployment rate of these clusters had a disproportional decline, especially in the metropolitan regions.

[59] The same age clusters comprised in Table 10.

	Correlation	
	Age	
Year	Brazil	Metropolitan Regions
1992-2002	-0.30	-0.30
2002-2012	0.07	0.34

Table 11: Measures of the Correlation between a Cluster's Growth in Labor-Force Share and its Relative Growth in Unemployment – Brazil and Metropolitan Regions – 1992-2002 and 2002-2012 – PNAD (IBGE).

Given the ambiguous results in the two decades, the maintained hypothesis that changes in age structure do not affect disaggregate unemployment rates does not seem enlightening. During the economic slowdown in the 1990's, the decline of the young labor-force share implied an increase in youth unemployment. Thus, estimates like ΔU^D and $\Delta^{CW} U^D$ understate the size of the demographic unemployment change since our underline hypothesis is that demographics do not affect disaggregate unemployment rates. During the thriving economic growth in the 2000's, the decline of young workers caused the opposite situation. That is: the youth unemployment fell and ΔU^D and $\Delta^{CW} U^D$ overstate the size of the demographic unemployment decline, especially in the metropolitan regions. From these ambiguous results in the two decades, two issues arise. First, it might be that the correlation measure is only reflecting the greater employment turnover, which is typical among young workers, and the fact that it strengthens the business cycle changes of youth unemployment rate. The second issue refers to the lack of observations. Since we have only two decades of data, we cannot assess regularity of demographic adjustment across business cycles fluctuations.

4.3.2. Sectorial Dispersion of Employment and Aggregate Unemployment Rate Estimations

The employment dispersion index, ED_t, which is a explainable variable in the aggregate unemployment estimations is calculated based on the four economic sectors,

which we refer in this study. Thus, aggregation also reduces the measured employment changes, such as the aggregation regarding demographic changes in unemployment, since it is precisely the differences between the deviations of disaggregated (sectorial) employment growth relative to total employment growth that defines ED_t.

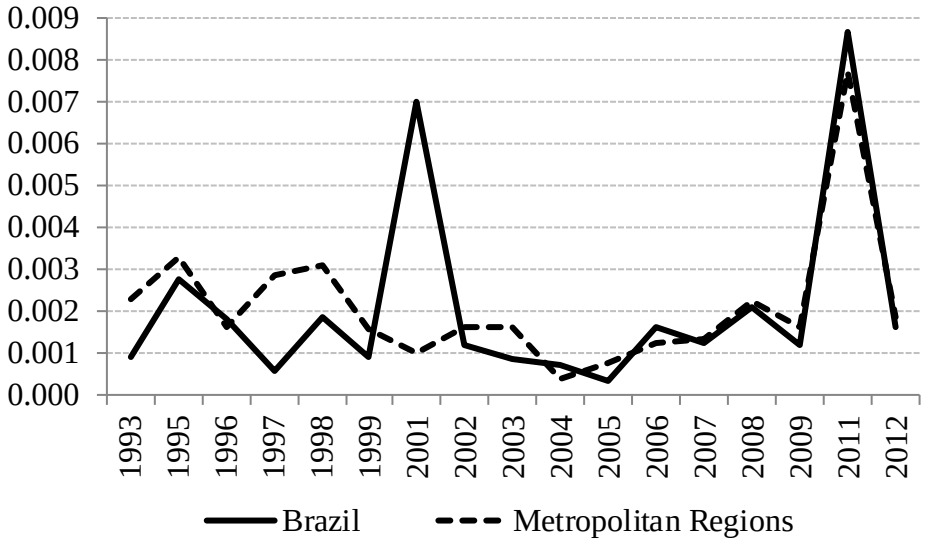


Figure 22: Index of Employment Dispersion – Eleven Sectors – Brazil and Metropolitan Regions – 1993-2012 – PNAD (IBGE).

Therefore, we assess possible intra-sectorial employment reallocation, especially in the services sector since, as pointed out by Corseuil and Servo (2006), this sector experiences a higher level of employment reallocation due to lower capital requirements relative to industry, for example. Thus, we calculated ED_t' by dividing the economy into eleven sectors[60]. We define two industrial sectors and we split the services sector into seven subsectors. Logic and evidence, illustrated by Figure 22, confirm that the average and the variance of ED_t' increased[61] with respect to ED_t. Furthermore, the peak of the series in Brazil as a whole becomes 2011, instead of 2001 as suggested by Figure 19. In 2011, in addition to the employment reallocation observed previously, which refers to a decline in employment both in agriculture and industry and raises in employment in the services and construction sectors, ED_t' captures a decline in the sectors of education,

[60] The sectors are: agriculture; manufacturing; other industrial activities; construction; retail and reformation; food and lodging; transport, warehouse and communication; public administration; education, health and social services; household chores; other services.

[61] In Brazil as a whole the average and the variance of $ED_t'$are $[5.15 \times 10^{-6}]$ and $[2.07 \times 10^{-2}]$, respectively. In the metropolitan regions, they are, respectively, $[2.72 \times 10^{-6}]$ and $[2.11 \times 10^{-2}]$.

health and social services and especially in domestic services in the metropolitan regions.

The use of ED'_t instead of ED_t does not imply much change in the previous baseline models, (1), used in the regressions on aggregate unemployment rate, according to Table 12. In Brazil as a whole it caused virtually no change in terms of the regression adjustment, whereas in the metropolitan regions it slightly worsens the regression adjustment. However, especially in the metropolitan regions the employment reallocation within the service sector improved the forecasts of the baseline model since 2011. That is: ED'_t can capture the fact that workers in the sectors of education, health and social services and domestic services have likely migrated to other non-tradable sectors, which are more labor intensive. It, in turn, is consistent with the remarkable decline of the aggregate unemployment rate recently.

Explanatory Variable	Brazil (1)	Explanatory Variable	Metropolitan regions (1)
C	1.81 [7.16]***	C	3.35 [3.39]**
U_{t-1}	-0.79 [-5.50]***	U_{t-2}	-0.47 [-2.17]*
GDP_t	-24.4 [-13.82]***	GDP_t	-51.53 [-7.60]***
GDP_{t-1}	-29.00 [-4.60]***	GDP_{t-1}	-17.47 [-2.32]*
ED'_{t-3}	-53.90 [-3.98]***	GDP_{t-2}	-29.11 [-2.38]*
ED'_{t-5}	-65.30 [-4.91]***	ED'_{t-1}	-182.57 [-5.98]***
		ED'_{t-5}	-58.26 [-0.28]
Jarque-Bera	0.97	Jarque-Bera	0.07
R^2	0.94	R^2	0.89
Adjusted R^2	0.90	Adjusted R^2	0.75

Note: t-statistic in brackets.
[.]***, [.]** and [.]* denote 1%, 5% and 10% marginal significance level, respectively.

Table 12: Regressions on Aggregate Unemployment Rate – Baseline Model – Brazil and Metropolitan Regions – 1992-2012 – PNAD (IBGE) and SCN (IBGE).

Figure 23 confirms the improvements in terms of unemployment rate forecast recently, which is formally shown by the RMSE. In the entire country, it has declined in average since 1999 from 2 basis points by the baseline model forecast, $F_t(1)$, in which ED_t comprises 4 economic sectors, to 1.7 basis points by the baseline model forecast, $F_t(1)$ - robustness, in which ED_t' comprises 11 economic sectors. In the metropolitan regions, the RMSE by $F_t(1)$ registered 4.1 basis points in average since 1999, while by $F_t(1)$ - robustness it was 2.8 basis points.

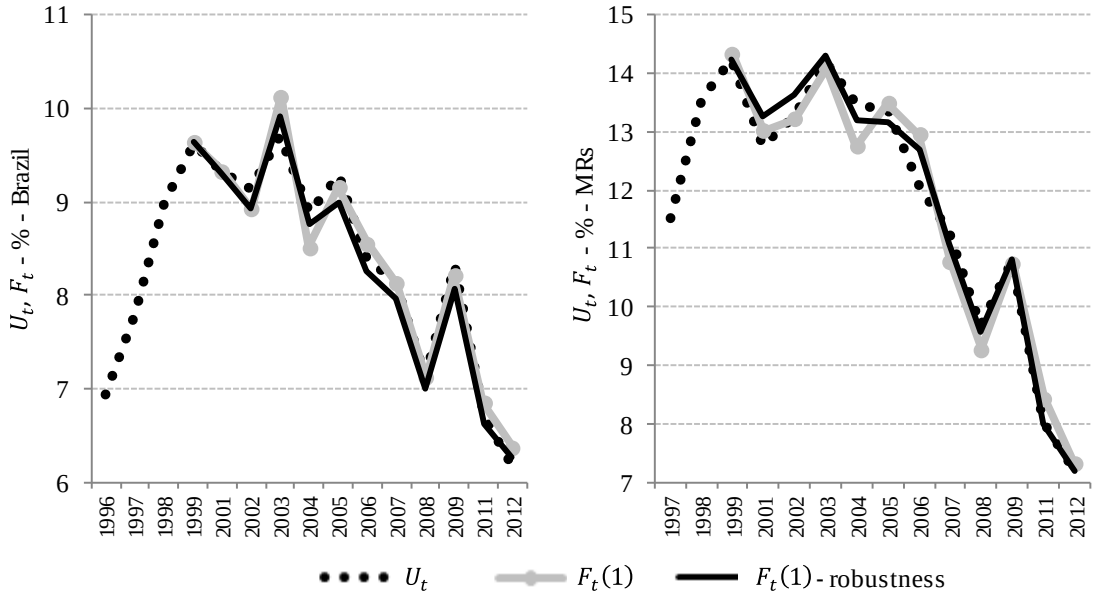


Figure 23: Actual Unemployment Rate and Forecasted Aggregate Unemployment Rates – Baseline Model – Brazil and Metropolitan Regions (MRs) – 1996-2012 and 1997-2012 – PNAD (IBGE).

We can do an additional exercise of robustness check that refers to the results of the regressions in Table 9 specifically associated to the metropolitan regions. Appendix D shows similar results by applying the aggregate unemployment rate regressions in the PME/IBGE survey.

4.4. Caveats and Possible Extensions

Before we conclude on the results that we have drawn so far, there are some additional concerns we need to keep in mind.

Regarding the stylized facts of labor supply, an important point that needs to be raised is the lack of a solid theoretical support and empirical evidence to attest the

underlying hypothesis relating the demographic adjustment of the aggregate unemployment rate for education and especially for age. In our study we follow Shimer (1999) to argue that the age-specific unemployment rate is unaffected by population dynamics. It means that, for example, if there are less (more) young workers and if this gives rise to a proportional incentive to destroy (create) jobs; it has no effect on the rate that young workers find jobs. However, the ambiguous results of the correlation measure of disaggregate unemployment and labor force shares in Table 11 are an indicative that the demographic adjustments for age should be better comprehended. To this respect, we left open issues that are worthy to be further investigated. First is the question on whether the measures of demographic adjustment under our hypothesis indeed bias the demographic unemployment rate. If the answer is yes, an immediate question that arises is by how much.

In this sense, future endeavors on, for example, modelling job loss, the relationship between unemployment and age and demographic adjustment might contribute to a solid explanation of the importance of stylized facts regarding the labor supply for the developments of the aggregate unemployment rate in Brazil. In this sense, variations of alternative demographic adjustment for age, such as pointed out by Perry (1970) and Gordon (1982) might be fertile. They weight different groups by their members' total earnings and construct an alternative measure of unemployment using these weights.

The following comments regard the stylized facts of labor demand. In the aggregate unemployment rate regressions, as we mentioned, we faced some challenges such as the gaps in the series that refers to PNAD/IBGE and the stringent time length. Although it presents typical degree of freedom problems, the signal of the lagged unemployment and GDP and lagged GDP are widely robust to chances in the model specification[62]. However, the signal of the employment dispersion index is sensitive to the precise specifications since it turned positive in a couple of model specifications.

The sample time comprises only two decades during which employment reallocation might have ambiguous effects on unemployment since the sample time does not covers enough time such that the effects of sectorial structural shifts in employment are crystallized. During periods of thriving economic growth, such as the

[62] It refers to some variation using the same variables comprised in the baseline models. We included variables with different lags that are statistically significant, such that it does not harm considerably the regression adjustment.

2000's, the migration of workers from agriculture to industry and especially to services and construction might affect negatively the aggregate unemployment rate since non-tradable sectors are in average more labor intensive and require less qualification. However, there can be some employment reallocation within economic sectors that might not matter for the aggregate unemployment rate developments. Additionally, during the slowdown in economic growth in the 1990's the rise of employment in non-tradable sectors were not enough to compensate the employment fall in tradable sectors, such that the aggregate unemployment rate increased. In this sense, to apply the employment dispersion index in more extensive series of employment, such as the PED/DIEESE[63] may contribute to this discussion.

Nonetheless, the estimations should be considered in light of these concerns. We also emphasize that as far we are concerned of there is a lack of empirical studies that aim to explain the effects of sectorial employment dispersion on unemployment developments in Brazil[64]. Therefore, different methodologies and alternative data sources applied to this matter may shed some light on the understanding of the unemployment rate variations by assessing aspects that refer to labor demand.

Another possible extension refers to assessments on changes in the nonaccelerating inflation rate of unemployment (NAIRU). If one has a model connecting equilibrium unemployment and inflation in mind, then to look at changes in the actual unemployment rate is likely to be almost equivalent. If the actual unemployment rate requires a demographic adjustment, then so surely must the unemployment rate associated with no wage-push inflation. Conversely, if demographics have no effects on unemployment, then they should have no effect on the NAIRU, in the absence of some other channel connecting demographics and inflation. Shimer (1999) shows that his demographic adjustment of the unemployment rate is remarkably similar to Staiger, Stock and Watson's (1997) nonstructurally estimated series for the NAIRU.

One can take into account demographic and other structural changes in the labor force for calculating the NAIRU using the Phillips Curve framework, such as Wiener (1993). The author calculates different natural unemployment rates for different labor

[63] Although the series starts in 1985, it comprises only the metropolitan region of São Paulo.

[64] Such as Menezes-Filho and Scorzafave (2013). They found a high persistence in the process of employment creation in the 2000's. It is relatively higher in the services sector and among the less qualified workers.

force groups (age, gender and race). Weighting the group natural rates by labor force shares generates the overall natural rate series. Measures of demographic unemployment rate and NAIRU that consider demographic and other structural shifts are more powerful, for example, to monetary policy purposes. However, as argued by Silva Filho (2010), NAIRU estimations carry sizeable parameter uncertainty and are sensitive to the particular method used. This imprecision reflects the challenges involved in the natural rate's estimation and there seems to be much room available for theoretical and empirical improvements.

5. Conclusion

This papers analyzes how stylized facts of labor supply and labor demand may explain the aggregate unemployment rate developments both in Brazil as whole and in the metropolitan regions. The substantial raise of the aggregate unemployment rate during the 1990's was followed by a remarkable fall during the 2000's. In the entire country, the actual aggregate unemployment rate increased 261 basis points from 1992 to 2002 and had a 294 basis points decline between 2002 and 2012. In the metropolitan regions, the actual aggregate unemployment rate is higher and shows a 373 basis points raise and a considerable decline of 601 basis points, respectively, during the two decades. This observation raises the question on how much of the aggregate unemployment rate developments during the 1990's and 2000's is due to structural changes in the labor market and how much is due to conventional business cycle variations. We explore this question by assessing stylized facts of labor supply and labor demand.

With respect to labor supply, the change in the age composition of the labor force, which is associated to the demography transition and the schooling improvements, is the main stylized fact and account for the most of demographic changes in aggregate unemployment. The underlying hypothesis for this conclusion claims that the level of an age cluster's unemployment rate is unaffected by the size of that cluster. Other demographic changes do not have as much explanatory power.

The results regarding demographic unemployment are more expressive in the entire country than in the metropolitan regions, since it accounts for slightly less than -20% and 30% of the change of the aggregate unemployment rate in Brazil as whole and

around -20% and 20% in the metropolitan regions, respectively, during the 1990's and the 2000's. Therefore, it means that the demographic unemployment, which reflects the decline of the youth labor-force share, lessened the aggregate unemployment rise during the 1990's and strengthened the unemployment fall during the 2000's. However, the maintained hypothesis regarding the demographic unemployment is not completely resolved since an empirical assessment that uses the correlation between the changes of the labor-force shares and changes of disaggregate unemployment rates indicates that this hypothesis understates the size of the demographic unemployment during the 1990's and overstates it during the 2000's.

Thus, from a labor supply perspective we conclude that the bulk of the aggregate unemployment rate developments in the last two decades actually reflects the disaggregate unemployment rate developments, which are associated to business cycle fluctuations. It accounts for around 120% during the 1990's and from 70% to 80% during the 2000's. This is consistent with the result which shows that demographic changes controlled by the participation rate mitigated the demographic unemployment change. It, therefore, is a direct result of the attractiveness of the labor market, which reflects the business cycle fluctuations.

Although schooling improvements do not have as much explanatory power for the aggregate unemployment, by considering the interaction between labor supply and labor demand some indications about the relationship between education and unemployment in Brazil in the past twenty years arise. First, the skilled labor-force share rose remarkably, while the unskilled labor-force share declined. Second, the cluster of unskilled workers achieved the lowest disaggregate unemployment rate level and had the largest real wages gains in all economic sectors. Therefore, there might be a mismatch of labor supply and labor demand for qualification, which suggests that despite the increased skilled labor-force share, the labor demand is still considerably based on economic activities that require less qualified workforce.

Meanwhile, the Brazilian economy has undergone through important changes in the past twenty years. In the early 1990's the price stabilization program and the trade and financial openness was established. Since 1999, an overall policy framework based on a "macroeconomic tripod" has consolidated consisting of an inflation target regime, floating exchange rate and targets of fiscal discipline. In the wake of the institutional reforms and also of the commodity boom and high international liquidity, Brazil was

able to accelerate the economic growth featuring a strong currency, which favored the relative prices of the non-tradable sectors (services and construction). In tradable sectors, technological innovations occurred, triggering a process of economic restructure. Especially in industry it followed the increased competition from imported products and also from the labor market by considering a boosted non-tradable sector, which was able to afford high real wage gains. Therefore, the absorption capacity of the labor force in tradable sectors, historically major employers, has decreased considerably, especially in agriculture, whose growth of labor productivity has been remarkable.

Following the description of the main sectorial developments in the labor market in the last two decades, we apply a simple model of labor supply and demand, which is consistent with the labor market operation as an attempt to rationalize these developments. We conclude that the main stylized facts with respect to labor demand are that the relative prices in general have favored the non-tradable sectors, which in addition has shown the most significant rise of the marginal productivity of labor in the last two decades. Hence, to some extent it affected an employment migration from tradable sectors towards non-tradable sectors. To assess whether sectorial reallocation of employment affect the variations of aggregate unemployment rate, we set and index of employment dispersion that captures the incidence of sectorial shocks over time. Regressions on aggregate unemployment rate show that the index of employment dispersion conditional on GDP growth matters for aggregate unemployment rate changes. Its coefficient shows a negative signal, which is consistent with the argument which states that employment migrated from tradable sectors towards non-tradable sectors, which are more labor intensive sectors.

In addition, the (baseline) model specification that utilizes both the index of employment dispersion and GDP growth better predicts the aggregate unemployment rate developments in the last twenty years among other specifications that uses only one of these explainable variables. To this respect, the forecast error becomes larger and the regression adjustment becomes worse by taking the GDP growth out of the baseline model, instead of taking out the employment dispersion index. Moreover, by taking the index of employment dispersion out of the baseline model in the metropolitan regions it affected less the forecast error and the regression adjustment than in the entire country. By considering also that the demographic unemployment explain less of the decline of

the actual aggregate unemployment rate in this localities during the 2000's, it means that the GDP growth carry more explanatory power for the aggregate unemployment rate developments in the metropolitan regions.

Therefore, indications about the relevance of both GDP variations and the sectorial shocks for the changes of the aggregate unemployment rate stem from the regressions. Nonetheless, data limitations should encourage further endeavors at trying to get alternative data sources and different methodologies in order to shed some light on the understanding of the unemployment rate variations by assessing aspects that refer to labor demand.

Despite the importance of structural factors for both the labor supply and labor demand, the results regarding the demographic unemployment and the aggregate unemployment rate regressions suggest that the business cycle changes explain the bulk of the actual aggregate unemployment rate developments in the past twenty years. Equivalently, besides conventional business cycle variations, the answer to why the aggregate unemployment rate has become so much lower in Brazil is that population has become older and also that the sectorial profile of employment has become increasingly non-tradable.

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Appendix

Appendix A: Demographic Transition – Population Pyramids in Brazil

The pyramid in 1982 had a triangle shape, representing a classic young population – a wide base and an extremely narrow top. However, in 2012 we notice that the age groups representing the adults increased as so the age groups representing the elderly. This process becomes even clearer in 2032, when the age structure of the population has a rhombus shape that moves towards a rectangle and the percentage of elderly almost reaches the percentage of children, particularly in the case of women.

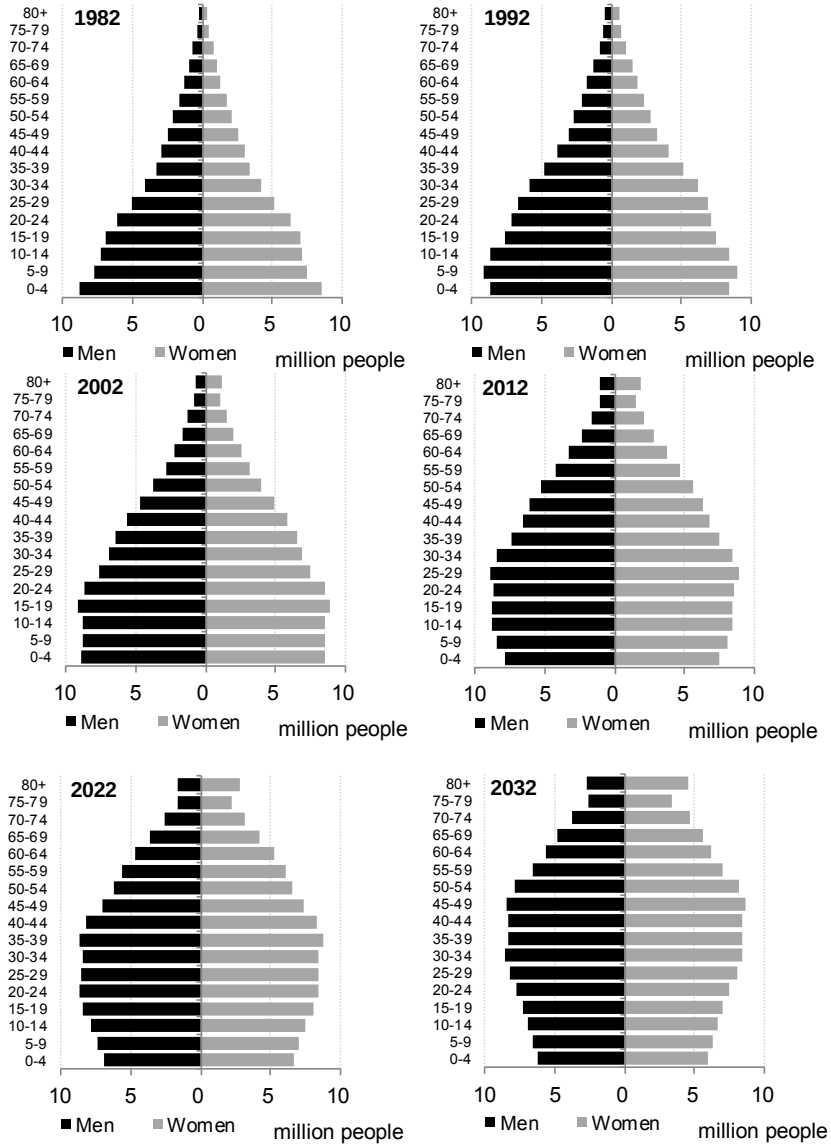

Figure A.1: Population Pyramids in Brazil – Population Prospects (IBGE) – 1982, 1992, 2002, 2012, 2022 and 2032

Appendix B: Equations of Chain-Weighted Demographic Unemployment

This part of the appendix is based on Shimer (1999) and Barbosa Filho and Pessôa (2011).

- Equation (6): Cumulative effect of chain-weighted demographic unemployment changes since time t_0.

We can decompose the changes of the unemployment rate into two components: one is attributable to demographics and the other is an unexplained component that reflects the disaggregate unemployment rate levels. Thus, $\forall t \in T$ it follows that:

$$U_{t+1} - U_t = \sum_i \left(\theta_{i,t+1} u_{i,t+1} - \theta_{i,t} u_{i,t}\right) \qquad (A.1)^{65}$$

$$U_{t+1} - U_t = \frac{1}{2}\sum_i \left(\theta_{i,t+1} u_{i,t+1} - \theta_{i,t} u_{i,t}\right) + \frac{1}{2}\sum_i \left(\theta_{i,t+1} u_{i,t+1} - \theta_{i,t} u_{i,t}\right) \qquad (A.2)$$

By adding and subtracting $\theta_{i,t+1} u_{i,t}$ in the first term and by adding and subtracting $\theta_{i,t} u_{i,t+1}$ in the second term of equation $(A.2)$, we have:

$$U_{t+1} - U_t = \frac{1}{2}\sum_i \left[\theta_{i,t+1}\left(u_{i,t+1} - u_{i,t}\right) + u_{i,t}\left(\theta_{i,t+1} - \theta_{i,t}\right)\right] + \frac{1}{2}\sum_i \left[\theta_{i,t}\left(u_{i,t+1} - u_{i,t}\right) + u_{i,t+1}\left(\theta_{i,t+1} - \theta_{i,t}\right)\right] \qquad (A.3)$$

Hence, it is straightforward that:

$$U_{t+1} - U_t = \sum_i \left[\theta_{i,t+1} - \theta_{i,t}\right] \frac{u_{i,t+1} + u_{i,t}}{2} + \sum_i \left[u_{i,t+1} - u_{i,t}\right] \frac{\theta_{i,t+1} + \theta_{i,t}}{2} \qquad (A.4)$$

The first component is the chain-weighted measure of the change in unemployment attributable to demographics. The second term is the unexplained component that reflects the disaggregate unemployment rate levels.

[65] See subsection 4.1.1.2 for definitions.

Thus, by focusing only on the demographic component of equation $(A.4)$, for a given initial time t_0, such that $t_1 > t_0 \forall t \in T$, it follows that the cumulative effect of changing demographics since period t_0 is the equation (6):

$$\Delta^{CW} U^{D}_{t_1,t_0} = \sum_{t=t_0}^{t_1-1} \sum_i \left[\theta_{i,t+1} - \theta_{i,t}\right] \frac{u_{i,t+1}+u_{i,t}}{2}.$$

- Equation (7): Cumulative effect of chain-weighted demographic unemployment changes that incorporates the effects of the participation rate since time t_0.

As we did in equation (6), we can decompose the changes of the unemployment rate that incorporates the effects of the participation rate into two components: one is attributable to demographics and the other is an unexplained component that reflects the disaggregate unemployment rate levels. Again, we focus in the demographic component. Thus, the aggregate unemployment rate can be alternatively represented by the ratio of h_t and p_t[66], such that $U_t \equiv \frac{h_t}{p_t}$. Thus, $\forall t \in T$ it follows that:

$$U_{t+1} - U_t = \frac{h_{t+1}}{p_{t+1}} - \frac{h_t}{p_t} \qquad (A.5)$$

$$U_{t+1} - U_t = \frac{h_{t+1}p_t - h_t p_{t+1}}{p_{t+1}p_t} \qquad (A.6)$$

Let's call the numerator of equation $(A.6)$ by $A \equiv h_{t+1}p_t - h_t p_{t+1}$. Similarly to equation $(A.2)$, it follows that:

$$A = \frac{1}{2}\sum_i (h_{t+1}p_t - h_t p_{t+1}) + \frac{1}{2}\sum_i (h_{t+1}p_t - h_t p_{t+1}) \qquad (A.7)$$

Hence, we can follow similarly the steps in equation$(A.3)$, by adding and subtracting $\frac{h_{t+1}p_{t+1}}{2}$ and $\frac{h_t p_t}{2}$ in equation$(A.7)$ such that:

[66] See subsection 4.1.1.2 for definitions.

$$A = (h_{t+1} - h_t)\frac{p_{t+1}+p_t}{2} - (p_{t+1} - p_t)\frac{h_{t+1}+h_t}{2} \qquad (A.8)$$

Thus, by plugging A in equation $(A.6)$, it follows that:

$$U_{t+1} - U_t = \frac{1}{p_{t+1}p_t}\left[(h_{t+1} - h_t)\frac{p_{t+1}+p_t}{2} - (p_{t+1} - p_t)\frac{h_{t+1}+h_t}{2}\right] \qquad (A.9)$$

We can decompose h_t and p_t into age clusters, such that $h_t \equiv \mu_{i,t}h_{i,t}$ and $p_t \equiv \mu_{i,t}p_{i,t}$. Then, by substituting out h_t and p_t in equation $(A.9)$ and by applying the chain-weighted measure of equation $(A.4)$ to the change in h_t attributable to demographics and $h_{i,t}$ levels, it follows that:

$$U_{t+1} - U_t = \frac{1}{p_{t+1}p_t}\sum_i\left(\mu_{i,t+1} - \mu_{i,t}\right)\left[\frac{h_{i,t+1}+h_{i,t}}{2}\frac{p_{t+1}+p_t}{2} - \frac{p_{i,t+1}+p_{i,t}}{2}\frac{h_{t+1}+h_t}{2}\right] +$$
$$\frac{1}{p_{t+1}p_t}\sum_i\frac{(\mu_{i,t+1}+\mu_{i,t})}{2}\left[\left(h_{i,t+1} - h_{i,t}\right)\frac{p_{t+1}+p_t}{2} - \left(p_{i,t+1} - p_{i,t}\right)\frac{h_{t+1}+h_t}{2}\right] \qquad (A.10)$$

Or alternatively:

$$U_{t+1} - U_t = \sum_i\left(\mu_{i,t+1} - \mu_{i,t}\right)\left[\frac{h_{i,t+1}+h_{i,t}}{2}\frac{p_{t+1}+p_t}{2p_{t+1}p_t} - \frac{p_{i,t+1}+p_{i,t}}{2}\frac{h_{t+1}h_t}{p_{t+1}p_t}\frac{h_{t+1}+h_t}{2h_{t+1}h_t}\right] +$$
$$\sum_i\frac{(\mu_{i,t+1}+\mu_{i,t})}{2}\left[\left(h_{i,t+1} - h_{i,t}\right)\frac{p_{t+1}+p_t}{2p_{t+1}p_t} - \left(p_{i,t+1} - p_{i,t}\right)\frac{h_{t+1}h_t}{p_{t+1}p_t}\frac{h_{t+1}+h_t}{2h_{t+1}h_t}\right] \qquad (A.11)$$

The first component is the chain-weighted measure of the change in unemployment attributable to demographics. The second term is the unexplained component that reflects the disaggregate unemployment rate levels.

We focus only on the demographic component of equation $(A.11)$, which explains the change in the aggregate unemployment rate due to the age composition of the working age population, which is represented by the terms multiplied by $\left(\mu_{i,t+1} - \mu_{i,t}\right)$ in the equation. Each term is weighted by the average number of unemployed workers in each age cluster controlled by the disaggregate participation rate. That is: it is represented by $\left[\frac{h_{i,t+1}+h_{i,t}}{2}\frac{p_{t+1}+p_t}{2p_{t+1}p_t} - \frac{p_{i,t+1}+p_{i,t}}{2}\frac{h_{t+1}h_t}{p_{t+1}p_t}\frac{h_{t+1}+h_t}{2h_{t+1}h_t}\right]$. An age cluster in which there are many unemployed workers, that is, a large value for $\frac{h_{i,t+1}+h_{i,t}}{2}$, but its

disaggregate participation rate is high, that is, a large value for $\frac{p_{i,t+1}+p_{i,t}}{2}$, it weakens the cluster's demographic effect in the aggregate unemployment rate.

It is then straightforward that for a given initial time t_0, such that $t_1 > t_0 \forall t \in T$, the cumulative effect of chain-weighted demographic unemployment changes controlled by participation rate from t_0 to t_1 is the equation (7):

$$\Delta^{CW} U^{D^p}_{t_1,t_0} = \sum_{t=t_0}^{t_1-1} \sum_i \left(\mu_{i,t+1} - \mu_{i,t}\right) \left[\frac{h_{i,t+1}+h_{i,t}}{2} \frac{p_{t+1}+p_t}{2p_{t+1}p_t} - \frac{p_{i,t+1}+p_{i,t}}{2} \frac{h_{t+1}h_t}{p_{t+1}p_t} \frac{h_{t+1}+h_t}{2h_{t+1}h_t}\right].$$

Appendix C: Indicators on Labor Productivity in Brazil

For the cost indicators by economic sectors in Figure A.2, we refer to the following surveys collected from enterprises in 2011: Annual Survey of Services (PAS), Annual survey of Construction Survey (PAIC) and Annual Survey of Industry (PIA). There is no survey of Agriculture such that we could compare with the other surveys. These surveys have the advantage of illustrating a picture of the economic sectors by using the same sectorial classification (CNAE 2.0) that is used by the computation of the GDP in the National Accounts System (IBGE).

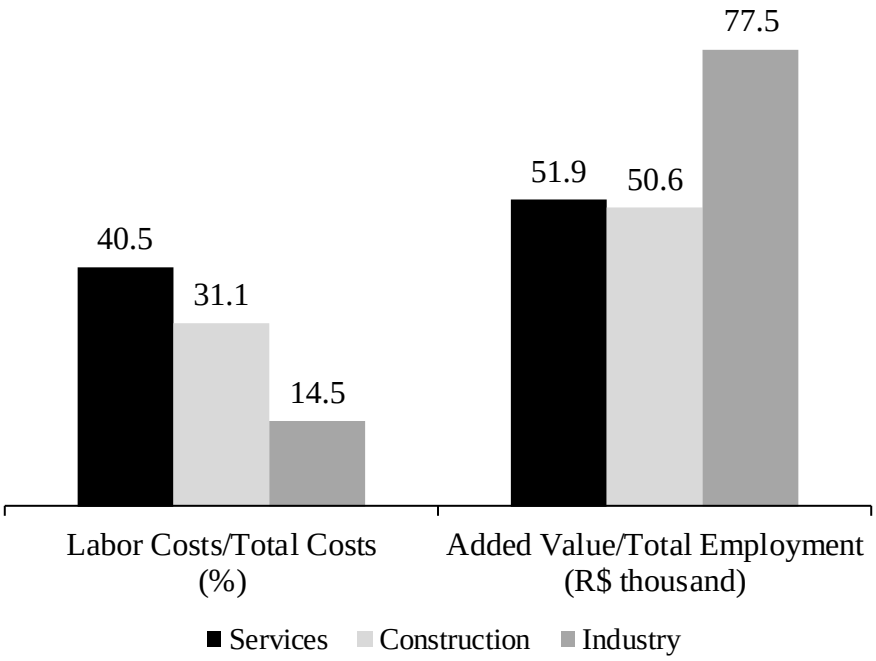

Figure A.2: Labor Productivity Indicators by Economic Sectors – PAS, PAIC and PIA (IBGE) – 2011

With respect to labor productivity, data from the Synoptic Tables of the National Accounts System (IBGE) from 2000 to 2009 depicts the dynamics of labor productivity and average real wages in the 2000's. This base was chosen because of the uniformity presented along the period analyzed, which starts in 2000. For example, the employment series in the PNAD survey differ from the employment series in the Synoptic Tables of the National Accounts System because probably the National Classification of Economic Activities – CNAE adapted to households is not exactly the same used by the CNAE 2.0 in the National Accounts System. The labor productivity is

defined as the added value to employment ratio. The added value is calculated as the volume change of the gross added value at basic prices based on the added value of 2000. The industrial sector does not comprise the construction sector. The average nominal wages are corrected by the INPC - price index.

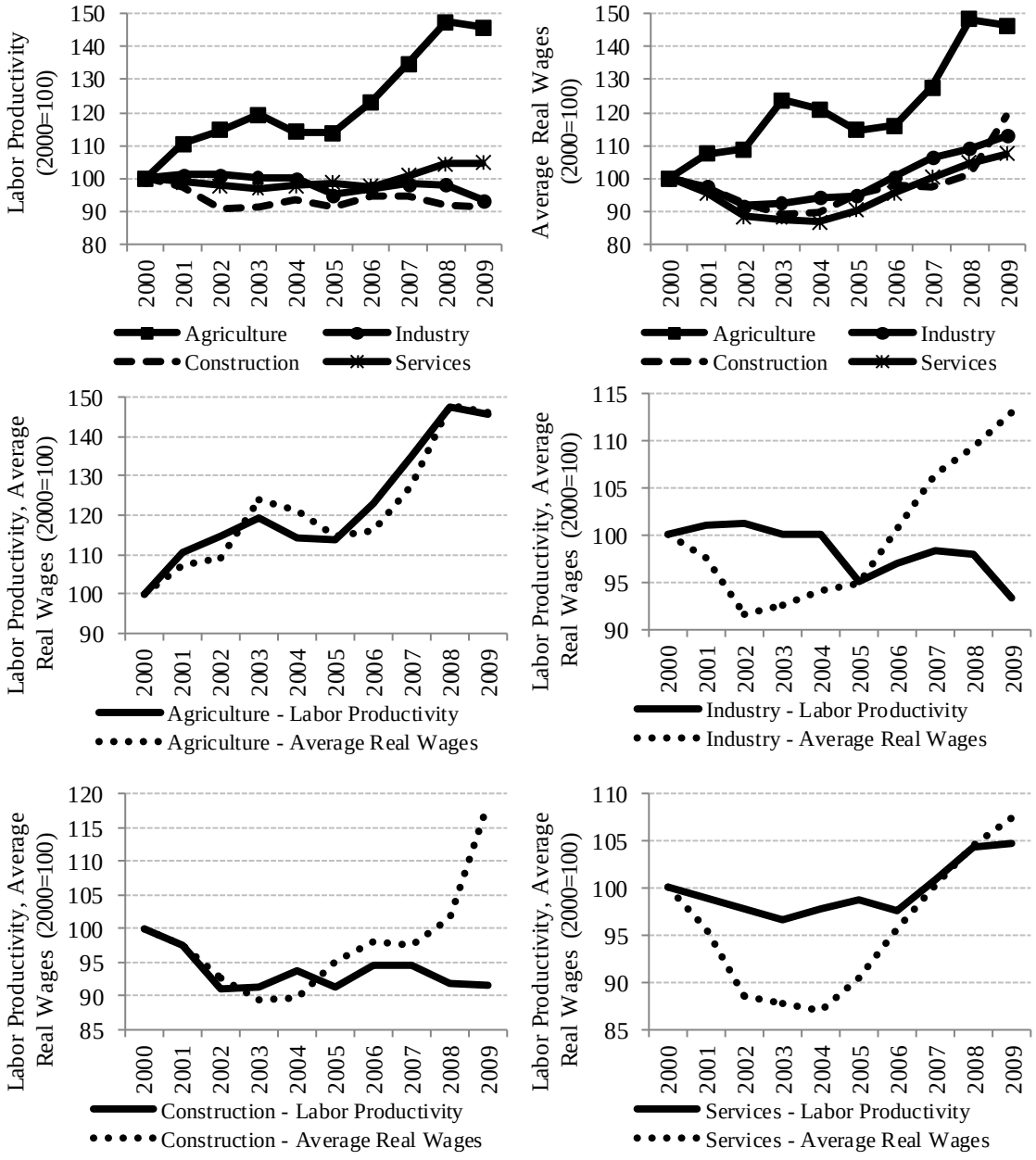

Figure A.3: Labor Productivity and Average Real Wages by Economic Sectors – Synoptic Tables of the National Account System (IBGE) – 2000-2009.

Appendix D: Robustness Check on Metropolitan Regions – PME/IBGE

- Age Profile of the Labor Supply and Aggregate Unemployment Rate Changes

We can reinforce even more the results specifically regarding the changes of the aggregate unemployment rate in the metropolitan regions from 2002 to 2012 in Table 2. By using the PME/IBGE survey, which comprises the same metropolitan regions and starts in 2002[67], we found similar results to that of the PNAD/IBGE. Although the level of the aggregate unemployment rate computed by the PME/IBGE is lesser than the one computed by the PNAD/IBGE, the fall of the aggregate unemployment rate[68] and the demographic measures of unemployment change are quite similar. According to Table A.1 the change of the aggregate unemployment rate, $\Delta U_{t_1,t_0}$, between 2002 and 2012 is -608 basis points, of which $\Delta^{CW} U^{D}_{t_1,t_0}$ accounts for 17.1% and $\Delta^{CW} U^{D^p}_{t_1,t_0}$ accounts for 12.6%.

	Metropolitan Regions						
	U_t	$\Delta U_{t_1,t_0}$		$\Delta^{CW} U^{D}_{t_1,t_0}$		$\Delta^{CW} U^{D^p}_{t_1,t_0}$	
	%	b.p	%	b.p	%	b.p	%
PNAD t_1: 2012 t_0: 2002	7.2 13.2	-601	100	-121	20.2	-80	13.4
PME t_1: 2012 t_0: 2002	5.4 11.5	-608	100	-104	17.1	-77	12.6

Table A.1: Aggregate Unemployment Rate, Chain-Weighted Demographic Unemployment Rate and Chain-Weighted Demographic Unemployment Rate Controlled by Participation Rate – Demographic Adjustment for Three Age Clusters –

[67] For more details see the footnote number 2. We use the same age clusters of Table 2, which were represented by young workers (10 to 24 years old), adult workers (25 to 49) and old workers (50 or more).

[68] The aggregate unemployment rate obtained by PME/IBGE is in average 223 basis points higher than the one obtained by the metropolitan regions using the PNAD/IBGE. The change of aggregate unemployment rate between 2002 and 2012 is -52.9% in PME/IBGE, while the one obtained by PNAD/IBGE is -45.5%.

Metropolitan Regions – Variations in Basis Points (b.p) and Percentage Points (%) – 2002-2012 – PNAD (IBGE) and PME (IBGE).

- Sectorial Reallocation of Employment and Aggregate Unemployment Rate Estimations

We can strengthen the results of the regressions in Table 9 that refers to the metropolitan regions by using the PME/IBGE survey, such as we did in the first part of the robustness check. Data is quarterly from the last quarter of 2002[69] to the last quarter of 2012. Following Camargo, Neri and Reis (2000), we group data as quarterly arithmetic average of the monthly series of the PME/IBGE survey. GDP growth refers to the quarterly growth calculated by IBGE. In addition to the usual explanatory variables, we include seasonal dummies, SD, for each quarter. Models specifications follow the same methodology applied in Table 9.

Table A.2 shows that the time of the lagged explanatory variables in the baseline model, (1), are quite similar to the explanatory variables in the models in Table 9. The coefficients of the lagged unemployment rate, GDP growth and the employment dispersion index[70], ED_t'', have all the expected signals and are statistically significant in (1). The coefficients of the dispersion index confirm the negative signals obtained in the models in Tables 9 and 11. The exclusion of GDP_t variations and the employment dispersion index do not cause important changes in terms of the regression adjustment, as we note by the declines of the R^2 and the adjusted R^2 in specifications (3) and (2) in comparison to the baseline model.

Figure A.4 illustrates and the RMSE quantitatively confirms that the baseline model forecast, which includes both the GDP growth and the employment dispersion index, have a lesser RMSE with respect to models (2) and (3). The RMSE of the baseline model since the third quarter of 2005 is 5.7 basis points, while specifications (2) and (3) registered, respectively, 6.2 basis points and 6.9 basis points.

[69] The PME/IBGE series starts in 2002. For more details on the PME/IBGE survey, see footnote 2.

[70] The employment dispersion index, ED_t'', comprises the following eight economic sectors: industry and production and distribution of electricity, gas and water; construction; retail, vehicles services and personal and household servicing; financial intermediation, real estate services and business services; public administration, defense, social security, education, health and social services; household chores; other services; other activities.

Metropolitan Regions			
Explanatory Variable	(1)	(2)	(3)
U_{t-7}	-0.28 [-2.04]*	-0.31 [-2.26]**	-0.25 [-1.93]*
GDP_t	-10.43 [-5.75]***	-11.01 [-5.39]***	-
GDP_{t-6}	-8.93 [-2.23]**	-2.79 [-0.88]	-
GDP_{t-10}	-5.12 [-1.71]*	-3.94 [-1.58]	-
ED_t''	-0.06 [-2.36]**	-	-0.05 [-1.85]*
ED_{t-9}''	-0.08 [-2.09]**	-	-0.08 [-2.39]**
SD_1	1.89 [6.37]***	1.12 [5.60]***	1.86 [9.11]***
SD_2	0.34 [2.13]**	-0.10 [-0.78]	-0.29 [-1.52]
SD_3	-0.45 [-1.96]**	-0.78 [-3.59]***	-0.27 [-1.35]
SD_4	0.45 [0.77]	0.36 [-1.09]	-0.37 [-1.37]
Jarque-Bera	1.85	0.79	1.10
R^2	0.95	0.93	0.91
Adjusted R^2	0.93	0.90	0.89

Note: t-statistic in brackets.
[.]***, [.]** and [.]* denote 1%, 5% and 10% marginal significance level, respectively.

Table A.2: Regressions on Aggregate Unemployment Rate – Metropolitan Regions – 2002.Q4-2012.Q4 – PME (IBGE) and SCN (IBGE).

In model (3), the forecasted aggregate unemployment rate, $F_t(3)$, confirms the observation that arises of Figure 19 that it overestimates the aggregate unemployment rate since 2007[71] and reinforces the relevance of the business cycle to predict the fall of the aggregate unemployment rate. Furthermore, since 2011 the three models have overestimated the aggregate unemployment rate, which suggest that there might be a fall of the aggregate unemployment rate that is neither explained by GDP changes nor

[71] In the metropolitan regions, it overestimates U_t by 60 basis points in average each quarter from the first quarter of 2007 to the last quarter of 2012.

by the employment dispersion index. Although one can observe a similar pattern in Figure 20 since 2011 and models overestimate less pronouncedly the aggregate unemployment rate; degree of freedom problems suggest that the estimations should be taken with caution and this matter deserves more investigation.

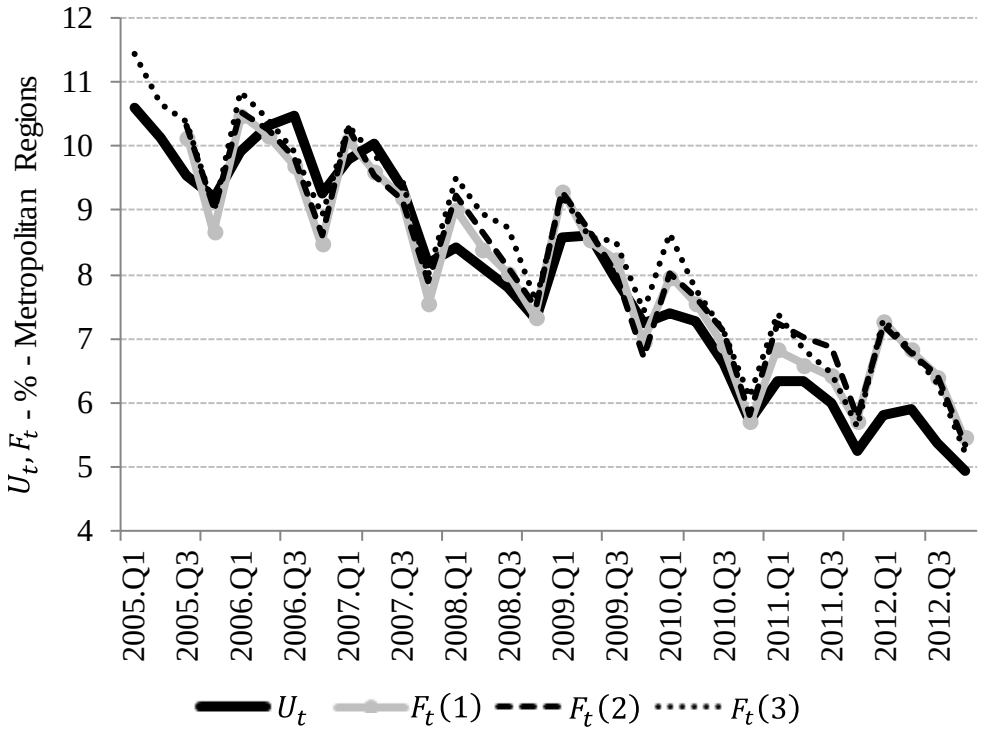

Figure A.4: Actual Unemployment Rate and Forecasted Aggregate Unemployment Rates – Metropolitan Regions – 2005.Q1-2012.Q4[72] – PME (IBGE) and SCN (IBGE).

[72] The time length 2005.Q1-2012.Q4 denotes the first quarter of 2005 to the fourth quarter of 2012.