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Productivity in a Distorted Market: The Case of Brazil's Retail Sector

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Productivity in a Distorted Market: The Case of Brazil's Retail Sector[1]

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Abstract

In the Hsieh and Klenow (2009) [Hsieh, C., Klenow, P., 2009. Misallocation and Manufacturing TFP in China and India. Quarterly Journal of Economics 124:4] model of monopolistic competition with heterogeneous firms, distortions create a wedge between the cost and marginal revenue product of factor inputs. We use census data for Brazil's retail sector to study implications for aggregate productivity and relate distortions to regional variation in regulation using a differences-in-differences approach. We show the importance of distinguishing effects by firm size and type of distortion. Difficulty in access to credit creates distortions to capital for small firms, but has no discernible effects on medium and large-size firms. On the other hand, taxes on gross profits create distortions to output mainly for large firms. The potential gains from reallocation have not diminished during the 1996-2006 period, despite the process of services liberalization in the 1990s.
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1 Introduction

Latin America's disappointing economic performance after market-oriented reforms in the 1990s is receiving widespread attention. According to a more and more dominant view, slow resource reallocation is the main culprit of low growth in Latin America.[1] In an increasingly competitive market, resources are assumed to flow from low- to high-productive users, improving allocative efficiency. Pages et al. (2009) find that the contribution of resource reallocation to growth was negative in manufacturing industries of Latin America during the period after regulatory reforms. For Brazil's manufacturing sector, Menezes-Filho and Muendler (2007) find labor is flowing away from export industries because their labor productivity increases faster than their production. While output shifts to more productive firms labor is shed, adding to unemployment. Hence, reforms might be related with efficiency gains at the firm level[2], but not at the aggregate when idle resources result.

In contrast to manufacturing, little is know about the role of the services sector in Latin America's economic performance. This is surprising, because the sector accounts for over two-thirds of GDP and employment (Timmer and de Vries, 2009), and insight in the functioning of the services sector is crucial for understanding aggregate economic performance. Evidence suggests that reallocation only marginally contributed to growth in the services sector as well (de Vries, 2008). This raises the question, what is preventing the reallocation of resources toward the most efficient firms? This paper studies allocative efficiency in the retail sector of Brazil, and explores the relation between regulation and resource misallocation building upon the model of Hsieh and Klenow (Hsieh and Klenow (2009), HK hereafter).

Brazil opened up its retail sector in the World Trade Organization's 1995 General Agreement on Trade in Services, but also within MERCOSUL,[3] and between the MERCOSUL members and the European Union. Furthermore, the participation of foreign capital in Brazilian retail firms was freed from restrictions in the Sixth Constitutional Amendment of 1995 (World Bank, 2004). It was expected that these reforms would result in a retail revolution

[1] See for example Cole et al. (2005); Mukand and Rodrik (2005); Menezes-Filho and Muendler (2007); Pages et al. (2009).

[2] Studies typically find strong firm-level productivity improvements after trade liberalization. For the manufacturing sector in Brazil see: Hay (2001); Cavalcanti Ferreira and Rossi (2003); López-Córdova and Mesquita Moreira (2003); Muendler (2004); Schor (2004).

[3] Mercado Comum do Sul, the regional trade block consisting of Argentina, Brazil, Paraguay, and Uruguay.

characterized by productive reallocation through the expansion of modern retail chains and the growth of small successful retail businesses (Reardon et al., 2003).

This retail revolution happened in other countries. For example, in the US average annual labor productivity growth of 11 percent in the retail sector during the 1987-1997 period is for 90 percent due to new establishments from retail chains replacing independent mom-and-pop stores (Foster et al., 2006). A similar process, albeit at a lower scale, took place in the UK (Haskel and Sadun, 2007).[4]

The available evidence for Brazil's retail sector suggests a different development pattern. In Brazil, retail chains did not replace mom-and-pop stores during the period following reforms (de Vries, 2008). Instead, large chains both domestic and foreign typically acquired other existing (smaller-sized) chains. The share of small low-productive firms remained stable or even increased. The limited role of reallocation in Brazil's retail sector may explain its low labor productivity growth, averaging only 1 percent annually during 1996-2004 (de Vries, 2008). Limited reallocation of resources in Brazil's retail sector contradicts expectations from pro-competitive reforms.

Various policies and institutions contribute to resource misallocation. Despite the reforms, regulation in labor and product markets may have prohibited the start of a retail revolution in Brazil. For example, taxes are high and reach over 200 percent of gross profits in Rio de Janeiro (World Bank, 2006), reducing incentives for retail firms in other states to enter the market in Rio de Janeiro. Also, difficulties in access to credit and strict labor market regulations may prevent the growth of successful small retailers and worsen their competitiveness relative to informal retailers. Consistent with the idea that regulation in labor and product markets may forestall growth in Brazil's retail sector, Restuccia (2008) calibrated the implications of taxes and entry costs for the misallocation of resources in Latin American countries. He found that taxes and entry costs can easily generate large misallocation of resources and hence explain a lower aggregate total factor productivity level in Latin America as compared to the US. Stringent regulations may prevent allocative efficiency improvements in Brazil's retail sector, and thereby impede growth.

This paper measures distortions in the retail sector by comparing marginal

[4] Haskel and Sadun (2007) argue that lower growth in the UK retail sector relative to the US is due to retail chains opening up smaller new establishments because of size restrictions. In other words, growth in UK's retail sector originates from resource reallocation, but occurs at a slower pace because scale economies cannot be fully exploited by retail chains.

revenue products with the costs of factor inputs, following the tradition of models from Banerjee and Duflo (2005). We apply the Hsieh-Klenow (Hsieh and Klenow (2009) model to study changes in resource allocation in Brazil's retail sector during the period from 1996 to 2006. Distortions to output and capital are inferred from residuals in first-order conditions in a model of monopolistic competition with heterogeneous firms. Wedges are measured if there is a difference between the cost and the marginal revenue product of factor inputs. In turn, these wedges are used to derive implications for aggregate productivity.

We apply the HK model to a dataset of retail firms in Brazil. The principal data source is the annual census of retail firms from 1996 to 2006. This dataset offers detailed information on output, inputs, and location of retail firms (and their establishments). The findings suggest there are large potential output gains from the reallocation of resources to the most efficient retailers. More importantly, the potential aggregate productivity gains from resource reallocation have gone largely unexploited during the post-liberalization period. We find no allocative efficiency improvements for the total retail sector and for most Federal states of Brazil separately. These results are consistent with the view that allocative efficiency is the main culprit of low productivity growth in Latin America.

The implications of distortions for aggregate productivity are examined, and distortions to output and capital are related to regional variation in regulation using a differences-in-differences approach. Selective policy implementation and enforcement may create implicit or *de facto* differences in the business environment faced by small and large firms. For example, governments often find it impractical to collect taxes from small firms. Instead, governments are likely to set higher tax rates and enforce compliance only among larger firms (Tybout, 2000). In contrast, capital market imperfections might be a bigger constraint for smaller firms that lack sufficient collateral. Therefore, we allow the coefficients in our econometric model to vary by firm size. A novel aspect of the empirical approach is that we examine distortions to output and capital separately. HK examined the combination of distortions to output and capital. We show that separating both types of distortions is important due to opposing effects of regulation across size class and type of distortion.

We find that difficulty in access to credit results in distortions to capital for small and medium firms, but not for large firms. In contrast, taxes on gross profits create distortions to output for large firms, but do not significantly affect the output of small and medium firms. Hence, the results suggest that regulation results in distortions to output and capital, but the effects differ by firm size.

The remainder of this paper is organized as follows. Section 2 sketches the HK model and derives measures and implications of distortions for aggregate productivity. Section 3 describes the dataset. Potential gains and changes over time from productive resource reallocation are estimated in section 4. Thereafter, section 5 examines the relation between regulation and distortions to output and capital. Finally, section 6 provides concluding remarks.

2 Theoretical framework

This section illustrates the relation between aggregate productivity and the allocation of resources. Implications of the misuse of resources for aggregate productivity can be studied in a model of monopolistic competition with heterogeneous firms.[5] We follow the model introduced by HK. Based on the canonical model of Melitz (2003), HK introduced distortions to output and capital.[6] Here, we only discuss the core elements and present the competitive equilibrium of the model in a format which suits our empirical analysis.

Two firm-specific distortions are considered. First, a capital distortion τ_{Ksi}, which changes the marginal revenue product of capital relative to the marginal revenue product of labor. Second, an output distortion τ_{Ysi}, which distorts the marginal revenue product of capital and labor in equal proportions. The former leads firms to substitute labor for capital, while the latter results in a suboptimal size of the firm.

Following HK, assume aggregate output Y is the combination of goods Y_s in s retail industries under perfect competition in both the output and input market:

$$Y = \prod_{s=1}^{S} Y_s^{\theta_s}. \tag{1}$$

where the sum of industry shares $\sum_{s=1}^{S} \theta_s = 1$.[7] Output Y_s in industry

[5]Firms are heterogeneous with respect to marginal costs.

[6]Various authors focused on specific mechanisms that could result in resource misallocation. For example, Lagos (2006) studied the impact of labor market regulation on allocative efficiency; Buera and Shin (2008) examined implications of financial frictions, and Guner et al. (2008) developed a model to examine resource misallocation as a result of size restrictions.

[7]Under cost minimization $p_sY_s = \theta_s pY$, where p_s is the price of sales Y_s in industry s and $p \equiv \prod_{s=1}^{S}(\frac{p_s}{\theta_s})^{\theta_s}$ is the price of the final good sold (which is set the numéraire, so

s, is the combination of N_s differentiated products sold by all firms ($i = 1, ..., N_s$), which face a constant elasticity of substitution σ:[8]

$$Y_s = \left(\sum_{i=1}^{N_s} Y_{si}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}. \tag{2}$$

The Cobb-Douglas production function of each retailer selling a differentiated good in industry s is given by:

$$Y_{si} = A_{si} K_{si}^{\alpha_s} L_{si}^{1-\alpha_s}, \tag{3}$$

where Y_{si} denotes the retailer's value added, A_{si} productivity, K capital, and L labor. The capital share α_s and labor share $(1 - \alpha_s)$ are only allowed to vary across industries. Costs C_{si} for a retailer are given by:

$$C_{si} = wL_{si} + (1 + \tau_{Ksi})rK_{si}, \tag{4}$$

where w is the wage rate, r is the rental cost of capital, and the capital distortion τ_{Ksi} raises the cost of capital relative to that of labor. Cost minimization results in the optimal capital-labor ratio:

$$\frac{K_{si}}{L_{si}} = \left(\frac{\alpha_s}{1-\alpha_s} \right) \left(\frac{w}{r} \right) \left(\frac{1}{1+\tau_{Ksi}} \right). \tag{5}$$

Retailer's profits are given by:

$$\Pi_{si} = (1 - \tau_{Ysi}) p_{si} Y_{si} - wL_{si} - (1 + \tau_{Ksi}) rK_{si}, \tag{6}$$

where p_{si} is the price of the good sold by firm i in industry s, and τ_{Ysi} is the output distortion which affects the marginal products of capital and labor in equal proportions. Profit maximization results in the mark-up price over marginal cost, which is fixed because we assumed constant returns to scale in production, and is given by:

$$p_{si} = \left(\frac{\sigma}{\sigma-1} \right) \left(\frac{w}{1-\alpha_s} \right)^{1-\alpha_s} \left(\frac{r}{\alpha_s} \right)^{\alpha_s} \left(\frac{(1+\tau_{Ksi})^{\alpha_s}}{A_{si}(1-\tau_{Ysi})} \right). \tag{7}$$

$p = 1$). Throughout, quantities will be denoted by capital letters, and prices by lower-case letters.

[8] Firms sell a single type of good or variety. These varieties are symmetrically differentiated, with a common elasticity of substitution σ between any two variables. In addition, we assume the elasticity of substitution is time-invariant and does not differ across goods. We discuss the restrictiveness and examine the sensitivity of the results to these assumptions in section 4.

If retail industry output Y_s is maximized, we obtain the allocation of capital, labor, and firm output across firms. The allocation of labor is (see HK for details):[9]

$$L_{si} = c_1 \cdot \frac{(1-\tau_{Ysi})^{\sigma} A_{si}^{\sigma-1}}{(1+\tau_{Ksi})^{\alpha_s(\sigma-1)}}. \tag{8}$$

The allocation of capital is:

$$K_{si} = c_2 \cdot \frac{(1-\tau_{Ysi})^{\sigma} A_{si}^{\sigma-1}}{(1+\tau_{Ksi})^{\alpha_s(\sigma-1+\frac{1}{\alpha_s})}}. \tag{9}$$

And retailer's output is:

$$Y_{si} = c_3 \cdot \frac{(1-\tau_{Ysi})^{\sigma} A_{si}^{\sigma}}{(1+\tau_{Ksi})^{\alpha_s \sigma}}. \tag{10}$$

In equation 10, output across firms within industries may differ because of heterogeneity in productivity A_{si} (as in Melitz (2003)), and because of firm-specific output and capital distortions. Absent distortions, relative to other firms in the industry a more productive firm will be larger. If a firm faces higher tax (enforcement) on profits, its size will be smaller than in the absence of distortions. This might be particularly binding for large firms, since collecting taxes may involve fixed costs inducing authorities to enforce taxes on larger firms for which the effort has a positive payoff.

To the extent resource allocation in an industry is driven by distortions alongside firm productivity, this will result in differences in the marginal revenue products of capital and labor across firms. The marginal revenue product of labor is:

$$MRPL_{si} = \frac{p_{si} Y_{si}}{L_{si}} = \frac{w}{(1-\tau_{Ysi})} \left(\frac{\sigma}{\sigma-1}\right) \left(\frac{1}{1-\alpha_s}\right). \tag{11}$$

The marginal revenue product of capital is:

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[9] The parameter c_1, c_2, and c_3 are constant within industries and given by:
$c_1 = \left(\frac{\sigma-1}{\sigma}\right)^{\sigma} \left(\frac{(1-\alpha_s)}{w}\right)^{\sigma(1-\alpha_s+\frac{\alpha_s}{\sigma})} \left(\frac{\alpha_s}{r}\right)^{\alpha_s(\sigma-1)} I^{\sigma-1}\theta_s Y$;
$c_2 = \left(\frac{\sigma-1}{\sigma}\right)^{\sigma} \left(\frac{(1-\alpha_s)}{w}\right)^{\sigma(1-\alpha_s+\frac{\alpha_s}{\sigma}-\frac{1}{\sigma})} \left(\frac{\alpha_s}{r}\right)^{\alpha_s(\sigma-1+\frac{1}{\alpha_s})} I^{\sigma-1}\theta_s Y$;
$c_3 = \left(\frac{\sigma-1}{\sigma}\right)^{\sigma} \left(\frac{(1-\alpha_s)}{w}\right)^{\sigma(1-\alpha_s)} \left(\frac{\alpha_s}{r}\right)^{\alpha_s \sigma} I^{\sigma-1}\theta_s Y$;
where $I = \left(\sum_{i=1}^{N} p_{si}^{1-\sigma}\right)^{\frac{1}{1-\sigma}}$.

$$MRPK_{si} = \frac{p_{si}Y_{si}}{K_{si}} = \frac{r(1+\tau_{Ksi})}{(1-\tau_{Ysi})}\left(\frac{\sigma}{\sigma-1}\right)\left(\frac{1}{\alpha_s}\right). \tag{12}$$

The after-tax marginal revenue products of capital and labor are equalized across firms within industries because only distortions to output and capital are firm-specific. But before-tax marginal revenue products may differ depending on the distortions the firm faces. This has important implications for the firm's revenue productivity, which is an input share-weighted combination of the marginal product of capital and labor.

Solving for the equilibrium allocation of resources across industries, aggregate output can be expressed as (see HK for details):

$$Y = \prod_{s=1}^{S}\left(TFP_s K_s^{\alpha_s} L_s^{1-\alpha_s}\right)^{\theta_s}. \tag{13}$$

Next, to determine industry productivity TFP_s, it is useful to distinguish between the firm's revenue productivity, $TFPR_{si}$, and the firm's physical productivity, $TFPQ_{si}$. The use of a firm-specific deflator yields a 'pure' measure of productivity, termed physical productivity $TFPQ_{si}$. In contrast, if an industry deflator is used, firm-specific differences in prices are not taken into account. Using an industry deflator gives a 'contaminated' measure of productivity, which is termed revenue productivity $TFPR_{si}$. Both firm productivity measures ($TFPR_{si}$ and $TFPQ_{si}$) are relative to the industry average. Following Foster et al. (2008), physical and revenue productivity are defined as:[10]

$$\begin{aligned} TFPR_{si} &\equiv p_{si}A_{si} \equiv \frac{(p_{si}Y_{si}/\overline{p_sY_s})}{(rK_{si}/\overline{rK_s})^{\alpha_s}(wL_{si}/\overline{wL_s})^{1-\alpha_s}} \\ &= c_5 \cdot \frac{(1+\tau_{Ksi})^{\alpha_s}}{(1-\tau_{Ysi})}. \end{aligned} \tag{14}$$

$$\begin{aligned} TFPQ_{si} &\equiv A_{si} \equiv \frac{(Y_{si}/\overline{Y_s})}{(rK_{si}/\overline{rK_s})^{\alpha_s}(wL_{si}/\overline{wL_s})^{1-\alpha_s}} \\ &= c_4 \cdot \frac{(p_{si}Y_{si}/\overline{p_sY_s})}{(rK_{si}/\overline{rK_s})^{\alpha_s}(wL_{si}/\overline{wL_s})^{1-\alpha_s}}. \end{aligned} \tag{15}$$

[10] The parameters $c_4 = \frac{w^{1-\alpha_s}(p_sY_s)^{-\frac{1}{\sigma-1}}}{p_s}$ and $c_5 = \left(\frac{\sigma}{\sigma-1}\right)\left(\frac{1-\alpha_s}{1}\right)^{\alpha_s-1}\left(\frac{r}{\alpha_s}\right)^{\alpha_s}$ are constant within industries.

In comparison to HK, we improve the productivity estimates for $TFPR_{si}$ and $TFPQ_{si}$ by making them unit invariant (that is, dividing output and inputs by the industry averages for output and inputs). From equation 14, it follows that revenue productivity $TFPR_{si}$ only varies across firms within industries if firms face output and capital distortions. Firms with higher physical productivity $TFPQ_{si}$ demand more capital and labor up to the point where the higher output results in a lower price and thus the same $TFPR_{si}$ as the other firms.

Industry TFP_s can be shown to be:

$$TFP_s = \left(\sum_{i=1}^{N_s} \left\{ A_{si} \cdot \frac{\overline{TFPR_s}}{TFPR_{si}} \right\}^{\sigma-1} \right)^{\frac{1}{\sigma-1}}. \tag{16}$$

An important aspect of the expression for industry productivity is that if all firms face the same distortions, industry TFP_s will be unaffected. That is, if $\tau_{Ysi} = \tau_{Ys}$ and $\tau_{Ksi} = \tau_{Ks}$ for all i, the distortions disappear from the expressions for equilibrium industry TFP_s, and TFP_s is given by $\overline{A_s} = \left(\sum_{i=1}^{N_s} A_{si}^{\sigma-1} \right)^{\frac{1}{\sigma-1}}$. This property of the model allows us to isolate the effects of policies on TFP through resource misallocation. The property is due to inelastic factor demand with respect to the distortions. A change in average taxes only changes factor prices, such that the first-order conditions of all firms are satisfied with the same allocations.

Firm-level distortions cannot be observed from the empirical data and must be identified. Distortions to output and capital are estimated from:

$$(1 - \tau_{Ysi}) = \frac{\sigma}{\sigma - 1} \frac{(wL_{si}/\overline{wL_s})}{(1-\alpha_s)(p_{si}Y_{si}/\overline{p_sY_s})}. \tag{17}$$

$$(1 + \tau_{Ksi}) = \frac{\alpha_s}{1-\alpha_s} \frac{(wL_{si}/\overline{wL_s})}{(rK_{si}/\overline{rK_s})}. \tag{18}$$

Firm-specific output distortions are inferred from equation 17 (itself derived from equation 11), when the firm's labor share is low compared to the industry elasticity of output with respect to labor. Capital distortions are inferred from equation 18 when the firm's ratio of labor compensation to capital services is high relative to what one expects from the output elasticities of capital and labor of the industry.

An important parameter in inferring distortions to output and their implications for aggregate productivity is the elasticity of substitution σ between firm value added. Aggregate productivity gains from the removal of distortions are increasing in σ. HK assume a common σ across goods equal to $\sigma = 3$. Initially, we use $\sigma = 3$ as well, but the sensitivity of the results to the choice of σ will be considered.

To estimate the firm's productivity and its distortions to capital and output, a choice has to be made on the benchmark capital share α_s. Because the average capital distortion and the capital production elasticity in each industry cannot be separately identified, we use the industry shares for the Federal district Brasilia as the benchmark. HK use industry shares for the United States as the benchmark. We do not use the US as the undistorted benchmark, because US industry characteristics might not match those in the states of Brazil. That is, differences in institutions, market structure, and geography may induce input shares to differ across countries.

Instead, we assume Brasilia is comparatively undistorted. Our benchmark choice is motivated by the observations that GDP per capita is highest, overall business regulation is least restrictive (see next section), and state-specific estimates of the substitution elasticity σ (explained in the sensitivity analysis in section 4) suggests competition is strongest in Brasilia. Deviations of the firm's input cost shares from the median shares in that particular industry for Brasilia will show up as a distortion to output and/or capital for the firm.

3 Data

To derive measures of productivity and distortions, we use the annual census of retailers for the period from 1996-2006. The measures of distortions will be used to examine implications for aggregate productivity in section 4. In addition, the measures of distortions are related with indicators of regulation to examine whether taxes and difficulty in access to credit result in distortions to output and capital in section 5. This section describes the regulatory indicators and retail census data.

3.1 Regulation: Taxes and Access to Credit

Information on regulation is provided by the World Bank's Doing Business for Federal states in 2006 (World Bank, 2006). The indicators we use are paying taxes and getting credit. Taxes are considered, because the complex and burdensome tax system potentially distorts output. Getting credit is considered, because it is identified as one of the most important constraints on growth in Brazil (Rodrik, 2007). In particular, small firms are constrained

(World Bank, 2006), which may result in relatively larger distortions to capital for these firms.[11]

The indicator of paying taxes records all taxes paid by a medium-sized firm, which is dedicated to general commercial activities and services within the second year of operation. Taxes are measured at all levels of government, resulting in more than 25 different public, state, and municipal taxes. These taxes include among others corporate income taxes, turnover taxes, and value-added taxes. Importantly, labor taxes (such as payroll taxes and social security contributions) are not included. Hence, the indicator of paying taxes can be used to examine distortions to output as they are expected to proportionally affect the marginal revenue product of labor and capital.

The indicator on getting credit measures the time and cost to create and register collateral. The collateral agreement must be registered with the Registry of Deeds and Documents in the city of the debtor. These registries are not linked across regions, and often not digitalized. The cost to register a security includes official duties and notary fees.

Information on taxes and access to credit is provided in table 1. The cost of registering collateral (as a percent of loan value) ranges from 0.2 in Rio de Janeiro to 3.8 in Ceará. In comparison, the cost of registering collateral is 0.01 percent of loans in Canada and the United Kingdom. Taxes range from 89 percent of gross profits in the Amazone to 208 percent in Rio de Janeiro. Taxes in the United States are 45 percent of gross profits. Hence, although taxes and collateral registration procedures are essential for an economy to function, both appear burdensome in Brazil.

The first row of table 1 shows the final ranking of states in terms of business regulation (1 for the least regulated state, 13 for the most regulated state). This final ranking is a simple average of the ranking of a state on each indicator made by the World Bank.[12] The ranking suggests business regulation is least restrictive in Brasilia, while most restrictive in Ceará.

3.2 Retail-firm data

The principal data source of retail trade firms is the annual survey of distribution (Pesquisa Anual de Comercio, PAC) from 1996 to 2006. Firms registered in the Cadastro Nacional da Pessoa Jurídica (CNPJ) from the

[11] Another candidate would be labor market distortions. See Lagos (2006); Almeida and Carneiro (2007); and Petrin and Levinsohn (2008) for firm-level analysis of the effects of labor regulation in Latin America.

[12] A wider set of indicators is considered for the final ranking, also including starting a business, registering property, and enforcing contracts.

ministry of Economic Affairs and classified as wholesale and retail trade firms in the Cadastro Central de Empresas (CEMPRE) of the national statistical office (IBGE) are surveyed in PAC. The PAC dataset consists of two groups, namely a group of firms which surpass the threshold and are included by census, and another group of firms below the threshold included by sample only. The empirical analysis focuses on firms included by census, because we do not have appropriate weights to assure the sample reflects the population.

Firms with more than 20 employees or firms with less than 20 employees but with establishments in more than one Federal State are included in PAC by census.[13] For 1996 this amounts to 14,445 firms included by census. In 2006, the number of firms included by census has risen to 19,346. While firms included by census constitute a fairly small share of the total population of retail firms, they represent the major part of the sector in terms of sales (about 60 percent). Firms are linked across years using their identification numbers from the tax registry.

The census includes detailed information on output and inputs. Gross value added is obtained by subtracting purchases of goods sold and the costs of intermediate inputs from sales. Value added consists of compensation for labor and capital inputs. Labor input is measured by the firm's wage bill, which crudely controls for differences in human capital and hours worked (Hsieh and Klenow, 2009). Consistent with the flow measures of output and labor input, we measure capital services instead of capital stocks.[14]

Table 2 shows descriptive statistics for selected states and all states combined. Estimates of TFPR and TFPQ using equations 14 and 15 are close to one, because output and inputs are measured relative to the industry's average. Distortions to output are estimated from equation 17. Output distortions are negative on average, thus labor's share is high compared to what one would expect from the industry elasticity of output with respect to labor. The positive values for distortions to capital (estimated using equation 18) indicate that the ratio of labor compensation to the capital stock is high relative to what one would expect from the output elasticities with respect to capital and labor. Hence, both distortions suggest a relatively intensive use of labor compared to the benchmark. Distortions to capital are high in

[13] Firms in several northern states located outside the Federal States' capital are not included in the survey because of the high costs involved in collecting information for these firms. These states are: Rondônia, Acre, Amazonas, Roraima, Pará, Amapá, and Tocantins.

[14] Renting and leasing expenditures are excluded from costs of intermediate inputs and included in capital services.

Ceará, where access to credit is also most restrictive (see table 1), suggesting a positive relation between the two. Output and input data suggest that firm size in Rio de Janeiro is below average, which might be related with above average taxes distorting output more in this state than in others. We will formally examine the relation between regulation and distortions to output and capital in section 5.

4 Allocative efficiency in Brazil's retail sector

We consider the productivity distribution and the gains in aggregate productivity if distortions were to disappear. If there were no distortions (or all distortions were the same across firms within industries), the TFPR distribution would be equal to one, and there would be no potential gains in productivity from resource reallocation. Hence, the variance of the TFPR distribution reflects firm-specific distortions across states. One can estimate potential aggregate productivity gains by hypothetically removing these idiosyncratic distortions.

4.1 The revenue productivity distribution

Table 3 shows statistics for the revenue productivity distribution. We estimated the distribution of TFPR for each Federal state separately and for all states combined. Output and factor inputs are relative to the industry mean, so the mean and median of the TFPR distribution approximate one. The dispersion of TFPR varies considerably across states. The variance ranges from 0.22 in Rondônia to 1.35 in Espíritu Santo. If we correlate the variance in TFPR with the ranking of states on the strictness of business regulation we find a positive but insignificant relation, which suggests a weak positive relation between regulation and dispersion in marginal revenue products across firms within states. Obviously, these results are indicative at best and will be further explored in the next section.[15]

4.2 Potential gains from resource reallocation

Potential gains in aggregate productivity across states are estimated by hypothetically removing distortions. If marginal products are equal across firms,

[15] The number of firms differs considerably across states (see table 3). The limited number of observations for several states may result in incorrectly measured TFPR distributions. In section 5 we consider the sensitivity of the relation between regulation and distortions to dropping states one at a time.

industry TFP is $\overline{A_s} = \left(\sum_{i=1}^{N_s} A_{si}^{\sigma-1}\right)^{\frac{1}{\sigma-1}}$. Potential gains are estimated from:

$$\frac{Y}{Y_{efficient}} = \prod_{s=1}^{S} \left[\sum_{i=1}^{N_s} \left\{ \frac{A_{si}}{\overline{A_s}} \cdot \frac{\overline{TFPR_s}}{TFPR_{si}} \right\}^{\sigma-1} \right]^{\frac{\theta_s}{(\sigma-1)}}. \tag{19}$$

For each industry, we calculate the ratio of actual TFP_s (equation 16) to the efficient level of TFP_s, and then aggregate this ratio across industries using the Cobb-Douglas aggregator (equation 1). Table 5 provides percentage TFP gains by state from fully equalizing TFPR across firms in each industry for the years 1996, 2001, and 2006. The potential gains are large. For example, for 1996 potential TFP gains are 217 percent in Brasilia (Distrito Federal), 239 percent in Rio de Janeiro, and 244 percent in São Paulo.

Estimates of potential gains in retailing are higher than estimated productivity gains from equalizing TFP within manufacturing industries. For China and India, gains in manufacturing range from 86 to 128 percent (Hsieh and Klenow, 2009). Estimates for the manufacturing sector in Latin America are not yet available, but preliminary evidence for Bolivian manufacturing suggests that it is roughly in the same ballpark as Chinese and Indian manufacturing (Machicado and Birbuet, 2008).

The approach to estimate potential gains is not without limitations, because 'non-neoclassical' features such as markups, adjustment costs, returns to scale, and fixed costs are also reflected in the gaps. The margin of error in estimated gains, which is further examined below, preclude us from stating that distortions are larger in São Paulo as compared to Rio de Janeiro, because potential gains are smaller in the latter (see table 5).

However, large potential gains are not out of line with estimates of TFP gaps in retail between the US and Brazil. Estimates indicate that productivity levels in Brazilian retailing are between 14 and 28 percent of the US productivity level (McKinsey (1998) Mulder (1999); Lagakos (2009)). Mulder (1999) finds that the relative productivity level dropped from 28 to 14 percent during the period from 1975-1995. This finding is consistent with the 14 percent level for food retailing in 1995 obtained by McKinsey (1998). Also, preliminary evidence based on differences in the size composition between the US and Brazil, suggests that resource allocation improvements may account for half of this retail TFP gap (Lagakos, 2009). Assuming larger firms have higher productivity levels, our estimates of the large potential TFP gains from resource reallocation are in line with these findings. That is, improvements in resource reallocation may improve TFP levels by a factor of two, which would bring productivity levels in Brazil's retail sector between 28 and 56 percent of the US productivity level.

More important is whether potential TFP gains from resource reallocation have been realized during the period following services liberalization. Changes in the opportunity for increasing aggregate productivity by removing distortions are examined by comparing the potential gains between 1996 and 2006. Figure 1 presents results for the total economy and three large Federal states (Rio de Janeiro, São Paulo, and Minas Gerais). The figure suggests potential gains from resource reallocation have gone largely unexploited despite liberalization of the retail sector since the 1990s.

In table 5, the last column shows the β-coefficient from an OLS regression where % TFP gains are regressed against time. A significant negative value indicates improvements in allocative efficiency. In most states, the coefficient is positive and insignificant. For some states we find a significant positive coefficient, but the change over time is small. This finding suggests slow resource reallocation following pro-competitive reforms as well.

Our finding of limited resource reallocation is consistent with earlier research attributing Latin America's disappointing performance after market-oriented reforms in the 1990s to the slow reallocation of inputs toward more efficient firms.[16] In particular, de Vries (2008) finds limited evidence of improvements in allocative efficiency after reforms in the retail sector of Brazil.[17]

4.3 Sensitivity analysis of the potential TFP gains

We examined the sensitivity of estimated potential aggregate TFP gains in various ways. The sensitivity analysis suggests that various adjustments affect the magnitude of potential TFP gains. However, changes over time in

[16] See for example Cole et al. (2005); Mukand and Rodrik (2005); Menezes-Filho and Muendler (2007); Pages et al. (2009); de Vries (2008).

[17] An alternative for considering the efficient allocation of resources is by focusing on the productivity distribution using the Olley and Pakes (OP) (Olley and Pakes, 1996) method. This method does not weight input movements using differences in the gaps between marginal revenue products and input prices, but measures whether resources are allocated efficiently in the cross section of firms by looking at the differences between weighted and unweighted productivity at a given moment in time. If distortions are present, the difference between unweighted productivity and cross-sectional efficiency is smaller. Applying this method to the retail sector in Brazil, we find the difference between weighted and unweighted log(TFPR) is 0.26 log points in 1996. This implies that aggregate productivity would be around 26 percent lower if resources were allocated randomly. We do not find an improvement in the OP cross term over time. Hence, the OP method suggests allocative efficiency did not improve, which is consistent with the findings using the HK model.

the opportunity for increasing aggregate productivity by removing distortions are hardly affected.

First, potential gains are increasing in σ, and HK argue that the 'estimated gains are highly sensitive to this elasticity' (p. 1425).[18] Therefore, we examined the sensitivity of TFP gains to the elasticity of substitution. Hopenhayn and Neumeyer (2008) show $\sigma = 3$ is a low value relative to what has been used in the literature.[19] The parameter ν ($\nu = 1/(\sigma - 1)$) is usually calibrated taking a value $\nu = 0.15 - 0.2$, which implies $\sigma = 6 - 7\frac{2}{3}$ (e.g. Atkeson and Kehoe (2005); Buera and Shin (2008); Guner et al. (2008)). In addition to the assumption of a low elasticity of substitution in HK ($\sigma = 3$ implies $\nu = 0.5$), the assumption of a common elasticity may not reflect differences in market circumstances.

More in line with calibration analysis of models with decreasing returns to scale and perfect competition (e.g. Restuccia and Rogerson (2008)), we let the elasticity of substitution vary between 3 and 7. Further, we relax the assumption of a common elasticity of substitution by allowing it to vary across states in Brazil. Substantial differences in market characteristics across the states of Brazil motivate this approach. The elasticity of substitution by state is estimated using indicators that capture the degree of substitutability between firm's value added in each state. Population and retail-firm density, in combination with demand factors are likely to increase competition. The variables considered are: population per km^2, number of retail firms per 1000 inhabitants, GDP per capita, female labor force participation (a higher participation rate shifts preferences toward one-stop shopping), and the share of households with a car. An unweighted average for the normalized values of these indicators determines the elasticity of substitution. Appendix table A.1 shows the indicators and the resulting σ. The elasticity of substitution between the output of firms is highest for Brasilia, and lowest for Pará.

The potential gains using state-specific σ's are shown in figure 2. The gains for the total economy are larger as compared to the benchmark estimates, which is mainly due to the higher estimates for São Paulo. This

[18] We considered other common elasticities of substitution (e.g. 5 and 7) as well. In general, gains increase in σ.

[19] In the absence of firm-specific distortions, there is an equivalence between aggregate productivity in the decreasing returns perfect competition economy (Restuccia and Rogerson, 2008) and the constant returns monopolistic competition economy (the HK model). Without distortions (or equal distortions across firms), TFP is:

$TFP_s^{RR} = \left(\sum_{i=1}^{N_s} A^{\frac{1}{\nu}} \right)^{\nu}$

$TFP_s^{HK} = \left(\sum_{i=1}^{N_s} A_{si}^{\sigma-1} \right)^{\frac{1}{\sigma-1}}$

Hence, for the parameter $\nu = 1/(\sigma - 1)$, aggregate productivity is similar in both models.

suggests that potential TFP gains from resource reallocation are sensitive to the choice of σ. However, if we use state-specific σ's there is no apparent improvement in allocative efficiency over time as well.

Second, we examined the influence of the tails of the TFPR distribution, because measurement error could influence the potential gains. We trimmed the 2.5 percent tails of TFPQ and the output and capital distortions.[20] We allow the elasticity of substitution to vary across states. Figure 2 shows these results as well. Hypothetical TFP gains fall, from 257 to 248 percent for all states combined. Hence, measurement error in the remaining 2 percent tails could matter, but if so it only partially accounts for the big gains from removing distortions. Changes in allocative efficiency are similar, and again suggest a limited role of resource reallocation to productivity growth.

5 Regulation and distortions to output and capital

In an exploratory data analysis, we correlated the variables used in this paper. Correlations are shown in table 4. The relation between value added and productivity is positive suggesting larger firms are more productive, which is consistent with core models of the size-productivity distribution of firms (Melitz, 2003). The correlation between employment and distortions to output is positive. This may reflect larger firms facing larger distortions to output. In contrast, the relation between employment and distortions to capital is negative suggesting that smaller firms face larger distortions to capital, although the relation is not significant. Hence, distortions may differ with firm-size.

In this section we relate regulation to distortions using a particular form of a differences-in-differences (DD) approach, popularized by Rajan and Zingales (1998).[21] The advantage of this approach is that we are able to examine a causal relation between regulation and distortions as compared to a simple correlation between both.

The substantial variation in regulation across states (see table 1) allows us to examine the effects of regulations in a differences-in-differences approach. We examine how taxes and access to credit impact on distortions to output and capital. For taxes, we examine whether retail industries with higher commercialization margins will be more affected by higher sales taxes.[22] For

[20]In the benchmark estimations of TFP gains, we trimmed the 0.5 percent tails of TFPQ and the output and capital distortions.

[21]For recent applications, see Aghion et al. (2007), and Bruno et al. (2008).

[22]Commercialization margins, gross profits, are defined as resale revenues minus the

example, commercialization margins in the retail sale of household appliances, articles and equipment (CNAE 1.0 industry 5233) are higher than in specialized bakery and dairy stores (CNAE 1.0 industry 5221) (IBGE, 2006).[23] Therefore, retailers selling household appliances will be more affected by taxes as compared to retailers selling food, beverages, and tobacco. In turn, this will translate into higher distortions for high-margin firms in states with high taxes relative to low-margin firms in the same state.

For access to credit, we examine whether retail industries that depend more on external financing are more affected by difficulty in access to credit (Rajan and Zingales, 1998). Our measure for external financial dependence is expenditures related to outstanding debt (e.g. interest payments on loans). This measure should reflect the amount of desired investment that cannot be financed through internal cash flows generated by the same firm. Using this proxy suggests that the relative dependence on external finance is higher in more capital-intensive retail industries. For example, dependence on external finance is highest in hypermarkets (CNAE 1.0 industry 5211) and lowest in stores selling candy and chocolates (CNAE 1.0 industry 5222).

The differences-in-differences approach requires a relatively frictionless market. We use the Federal State Brasilia as the comparatively undistorted benchmark. Obviously, distortions are present in Brasilia as well, as suggested by the potential gains from resource reallocation we found in section 4. However, what matters is that the relative industry ordering of commercialization margins and external financial dependence in Brasilia corresponds to the ordering of natural commercialization margins and natural external financial dependence across industries, and that these orderings carry over to other states in Brazil (Klapper et al., 2006).

5.1 Model specification

For 2006, we regress distortions to output and capital on regulation interacted with an industry-specific indicator. Initially, we do not allow effects to vary by firm size (z), and therefore exploit three dimensions: (i) firm; (s) industry; and (r) region. If we label the regulatory variable (taxes or access to credit) as 'policy' and the related industry-specific factor as 'industry factor', the estimated specification is as follows:

cost of goods sold, remuneration, and intermediate expenditures, over sales.

[23] CNAE is Classificação Nacional de Atividades Econômicas, the national industry classification, which closely maps the International Standard Industrial Classification 3.1.

$$\gamma_{i,s,r} = \delta(policy_r \cdot industryfactor_s) + \sum_{r=1}^{R} \beta_r D_r + \sum_{s=1}^{S} \beta_s D_s + \epsilon_{i,s,r}. \quad (20)$$

The dependent variable, $\gamma_{i,s,r}$, is either a measure of the distortion to output (τ_{Ysi}) or capital (τ_{Ksi}), or a combination of both ($TFPR_{si}$). Region dummies, D_r, and industry dummies, D_s, are included to control for other market, technological, or regulatory factors not included in the regressions. This specification allows us to relate regulation with idiosyncratic distortions. Since the specification controls for region- and industry-specific effects, the only effects that are identified are those relative to the interaction term (the regulatory variable and the industry-specific factor) that varies both cross regions and cross industries. For example, for taxes we may examine whether differences in distortions to output between firms in industries with high or low commercialization margins are smaller in regions with lower taxes.

In the introduction, it is argued that the effects of taxes and difficulty in access to credit are likely to vary by firm size. The exploratory data analysis in this section suggested that distortions may vary with firm size as a result of regulation. Furthermore, Bartelsman et al. (2008) use the World Bank Investment Climate Surveys to examine the differential impact of policy factors on performance and growth prospects of firms of different size in Latin America. They present descriptive evidence that medium-size and, especially, large firms are more affected by high taxes and cumbersome tax administration than small firms. Medium and large businesses tend to be relatively less affected by lack of access to, and the cost of, financing. To allow for differential effects of policies, in a second specification we allow the effect to vary by firm size z:

$$\gamma_{i,s,r,z} = \sum_{z=1}^{Z} \delta_z(policy_r \cdot industryfactor_s) + \sum_{r=1}^{R}\sum_{z=1}^{Z} \beta_{r,z} D_{r,z} + \sum_{s=1}^{S}\sum_{z=1}^{Z} \beta_{s,z} D_{s,z} + \epsilon_{i,s,r,z}. \quad (21)$$

The employment-size categories distinguished are firms with z1 ($<$ 50 employees), z2 (51-100 employees), z3 (101-249 employees), and z4 (250 employees).[24]

A clear advantage of the DD approach compared to standard cross-state/cross-industry studies is that it allows to control for state and industry effects, thereby reducing problems with model misspecification and omitted variable bias. However, recent research has highlighted some disadvantages of the DD approach as well. Bertrand et al. (2004) argue that standard errors are biased due to autocorrelation if a long time series is considered. In our model set up, a single cross-section is considered, which is not susceptible to serial correlation problems. Donald and Lang (2007) show potential problems with grouped error terms, because the dependent variable differs across individuals while the policies being studied are constant among all members of a group. Failure to account for the presence of common group errors can generate biased standard errors as well. Therefore, we correct the standard errors using a robust covariance estimator, where state-industries are clustered. The large number of groups (13 states $\times$ 20 industries) is expected to result in an asymptotically normally distributed t-statistic.

5.2 Results

Table 6 shows results from estimating equation 20. Results show the average impact of regulation without differentiating by size. In the uneven columns, regional taxes on gross profits are interacted with the industry's commercialization margin. For the even columns, difficulty in access to credit is interacted with the industry's financial dependence. In columns (1)-(4), we consider the effects on revenue ($TFPR_{si}$) and physical ($TFPQ_{si}$) productivity. Recall that revenue productivity is a composite measure reflecting also distortions to output and capital, whereas physical productivity measures 'true' productivity of the firm only (see equations 14 and 15). Therefore, regulations are expected to be related with revenue productivity, and not with physical productivity.

Results in column (1)-(4) suggest that taxes and access to credit are positively related with distortions (higher revenue productivity) in industries with higher commercialization margins and dependence on external finance, although the relation is significant for access to credit only. However, a similar relation is observed between regulation and physical productivity (columns 3 and 4). This creates doubts on the accurateness of distinguishing TFPR and TFPQ, because distortions should solely be reflected in revenue

[24] Aghion et al. (2007), and Bruno et al. (2008) distinguish similar employment-size categories.

productivity. Both productivity measures are highly correlated and therefore TFPR may reflect distortions to output and capital as well as true productivity to some extent. Furthermore, revenue productivity is a composite measure of distortions, which may obscure channels by which regulation affects resource misallocation. Therefore, examining distortions to output and capital separately appears more appropriate.

Regressions for distortions to output and capital are shown in columns (5)-(8). Results suggest taxes are negatively related with distortions to output and positively related with distortions to capital. The opposing effects may explain why taxes are not significantly related with revenue productivity. Access to credit is positively related with both distortions to output and capital, which may explain why is it significantly related with revenue productivity.

A single coefficient for all firms may hide opposing affects across firm size. For example, distorting effects of difficulty in access to credit may be particular severe for small firms lacking sufficient collateral. Therefore, we allow the impact of regulation to vary by firm size. Results from estimating equation 21 are shown in table 7. Our interest centers on the relation between regulation and distortions to output and capital separately.

Results in table 7 suggest different patterns across firm size. In relative terms, taxes on gross profits act as an output subsidy for small firms $z1$ (because of the negative coefficient), have ambiguous effects for medium firms ($z2$ and $z3$), and distort output of large firms $z4$ (because of the positive coefficient, see column 1). Output distortions for large firms are higher in regions with higher taxes and in industries with higher commercialization margins. This finding is consistent with earlier literature (e.g. Gollin (2006); Guner et al. (2008)) and recent findings from interviews with CEO's of retail chains in Argentina (Sánchez and Butler, 2008). It may be due to higher enforcement for large firms if tax collection involves fixed costs, or a combination of both.

To explore the estimated impact of taxes on distortions to output we follow the approach outlined in Aghion et al. (2007). We estimate the difference in distortions to output between firms in industries with high commercialization margins (90^{th} percentile of distribution in Brasilia) and firms in industries with low commercialization margins (10^{th} percentile of the same distribution) in the region with the highest taxes compared to the region with the lowest taxes:

$$\delta_z[(Margin_{90th} - Margin_{10th})(Taxes_{max} - Taxes_{min})]. \qquad (22)$$

Using the coefficients in column (1), the impact of taxes on distortions to output is -0.02 for small firms and 0.19 for large firms. The differential impact is 0.21, which is about 12 percent of the sample mean distortion to output, suggesting that taxes have a modest but non-negligible impact on output distortions.

Difficulty in access to credit results in distortions to capital for small and medium firms, but not for large firms (column 4). In other words, difficulties in access to credit induce small and medium firms to substitute labor for capital. Smaller firms are more likely to face borrowing constraints because of limited liability and imperfections in the enforcement of debt repayment (Albuquerque and Hopenhayn, 2004). Therefore, small firms in industries that depend relatively more on external finance are more likely to employ labor instead of capital. In a similar fashion as for the effect of taxes, we examine the estimated impact of access to credit on distortions to capital. The differential impact between small and large firms is 0.57, suggesting that difficulty in access to credit has a substantial impact on distortions to capital at the sample mean.

5.3 Sensitivity of the results

The sensitivity of the main result, namely that the effects of regulations differ by firm size and type of distortion, are examined along different dimensions. Overall, the results are robust, but the sensitivity analysis uncovers several other interesting findings. First, regressions might be affected by the hierarchical setup of the model specification. That is, distortions measured at the firm-level are related with region-industry indicators. Although region-industry clusters were used to adjust the standard errors, an alternative approach might be to include firm-specific variables as explanatory variables (also using clustered standard errors). In columns (1) and (2) of table 8, regressions are shown where the firm's employment is included. Employment was considered, because it proxies for firm size. Therefore, we examine whether the results are driven by differences in profit margins and dependence on external finance between industries across size classes and not by independent size effects. Including a firm-specific variable does not change the distortionary effects of taxes and access to credit across firm size.

Second, we considered the sensitivity of the results to the elasticity of substitution varying by firm size. It may be argued that the elasticity of substitution is higher for small firms, perhaps because of customer-binding marketing strategies and the broader assortment of large firms, and less fixed costs in small firms. As a crude proxy, we allow the elasticity to vary between

7 and 3 for the different size groups instead of letting it vary between states. Results from regressing the different measures of distortions to output and capital are shown in columns (3) and (4). For difficulties in access to credit, the relation with distortions to capital is similar. However, for taxes we no longer find a significant distortionary influence on output for large firms. This suggests competition reduces the effect of tax policies on distortions.

Finally, we examined the sensitivity of the results to changes in the sample. We re-estimated the main regression of interest (columns (5) and (8) in table 6) removing one region at a time from the sample. This approach is motivated by substantial differences in the number of observations between states. Appendix figure A.1 and A.2 present the estimated coefficients differentiated by size classes. The first set of results (figure A.1) suggests the amplitude of the coefficient for taxes interacted with commercialization margins is insensitive to the regions included in the sample. In particular, the distorting effect of taxes for large firms is stable across the different regressions, although the effect is at the 5 percent border of significance if Rio Grande do Sul (UF 43) is excluded from the sample. The second set of results (figure A.2) indicates that the results for difficulty in access to credit interacted with financial dependence are affected by the exclusion of certain regions. In particular, excluding Minas Gerais, the state where access to credit is least difficult, affects the coefficient for large firms. Nevertheless, the sensitivity analysis still indicates substantial different effects across size classes irrespective of the exclusion of regions one at a time.

6 Concluding remarks

An increasingly dominant view holds the limited role of allocative efficiency as the main culprit of low growth following reforms in Latin America since the 1990s. So far, this view has been largely based on evidence from the manufacturing sector. In this paper, we extended the analysis by examining allocative efficiency in the retail sector of Brazil. A novel methodological approach, following Banerjee and Duflo (2005), which uses the gaps between marginal revenue products and input prices to measure resource allocation, was followed.

We applied the HK model to a detailed census dataset of retail firms. Wedges between the opportunity cost and marginal product of factor inputs were measured and implications for aggregate productivity were imputed. The results indicate large potential productivity gains from the reallocation of resources toward the most efficient retailers. The potential TFP gains appear larger for the retail sector found in this study than that of the manufacturing sector found by others, but comparative evidence for the manufacturing sector in Brazil and the retail sector of other countries is still missing.

Importantly, we find no evidence for improvements in allocative efficiency. Potential output gains from resource reallocation have not been realized during the 1996 to 2006 period as the gap remained more or less constant. This finding is in line with the view that the absence of productive reallocation is underlying low growth in Latin America following reforms.

After obtaining measures of distortions at the firm level and examining its implications for aggregate productivity, we related these distortions with regional variation in regulation using a differences-in-differences approach. Selective policy implementation and enforcement may create implicit or *de facto* differences in the business environment faced by small and large firms. Therefore, we allowed the coefficients in our econometric model to vary by firm size. We find that difficulty in access to credit results in distortions to capital input for small and medium firms, but not for large firms. In contrast, taxes on gross profits create distortions to output for large firms, but do not significantly affect the output of small and medium firms. Hence, the results suggest that regulation results in distortions to output and capital, but the effects differ by firm size.

The approach in this paper to measure distortions and their implications for aggregate productivity is theoretically a preferable measure of aggregate productivity with firm-level data (Petrin and Levinsohn, 2008). However, the approach is not without limitations, because 'non-neoclassical' features such as markups, adjustment costs, returns to scale, and fixed costs are also reflected in the gaps. Results in this paper therefore await further comparisons to potential TFP gains in the services sector of other developed and developing countries. In addition, future research may address what specific distortions generate greater dispersion in marginal products.

Despite liberalization of the services sector in the 1990s, allocative efficiency in Brazilian retailing did not improve. Our results suggest that regulations are positively related to distortions in output and input choice, and may have prevented improvements in allocative efficiency. In particular, our results call for a closer examination of the differential impact of various regulations on firms of different sizes (see also Syverson (2010)).

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Figure 1: Potential aggregate productivity gains from resource reallocation

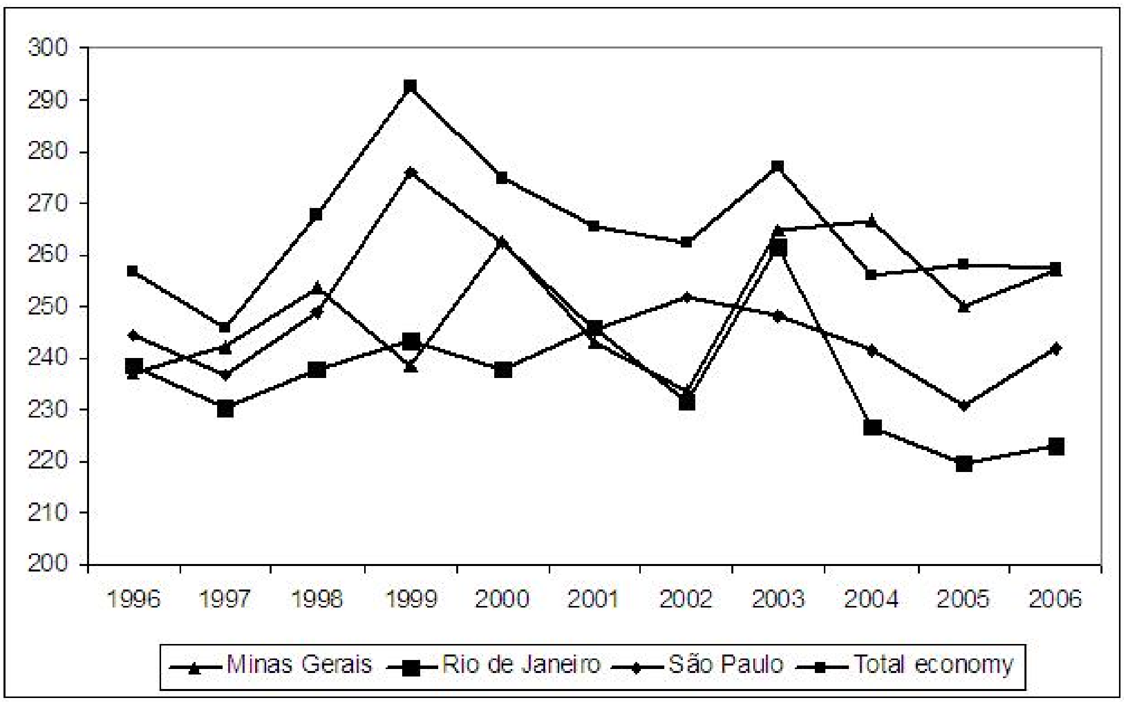


Figure 2: Potential aggregate productivity gains from resource reallocation

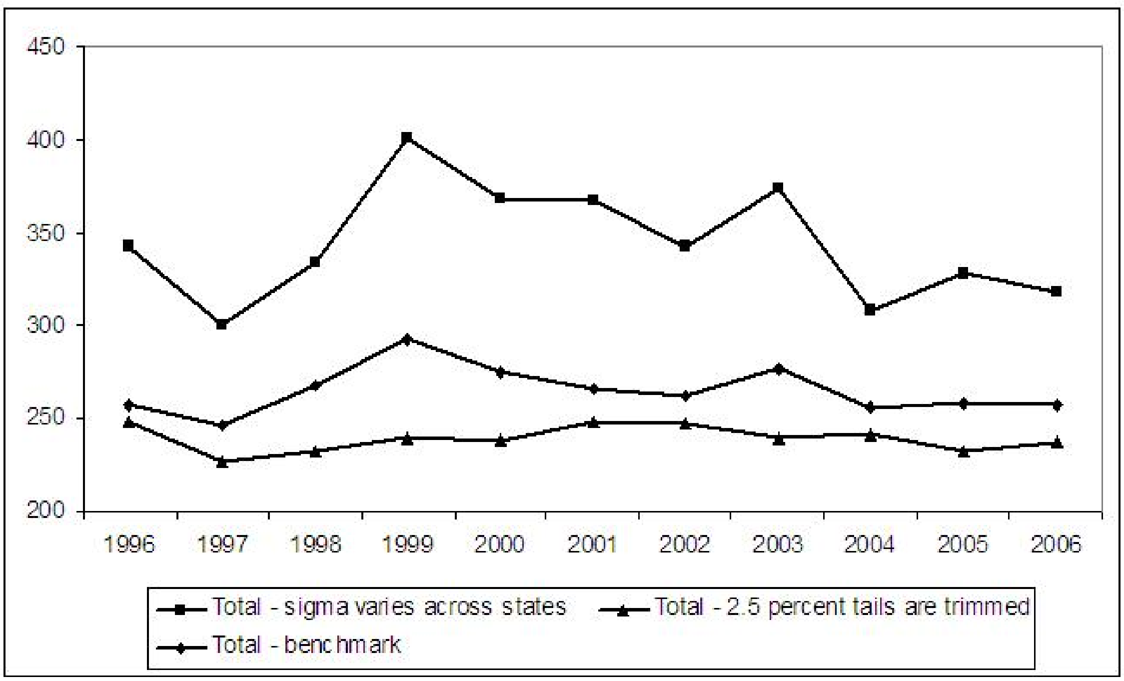


Table 1: Business regulations across the Federal states of Brazil, 2006

Federal state		Federal district	Amazonas	Minas Gerais	Rondônia	Maranhão	Rio Grande do Sul	Mato Grosso do Sul
Final Rank		1	2	3	4	5	6	7
Getting credit	Time to create collateral	45	6	2	30	4	25	30
	Cost to create collateral	0	2	1	2	1	1	1
Paying taxes	Total tax payable	149	89	150	146	147	153	146
	Number of payments	12	23	23	12	12	12	12
Federal state		**Rio de Janeiro**	**Santa Catarina**	**Bahia**	**São Paulo**	**Mato Grosso**	**Ceará**	
Final Rank		8	9	10	11	12	13	
Getting credit	Time to create collateral	27	25	26	na	23	40	
	Cost to create collateral	0	3	2	na	3	4	
Paying taxes	Total tax payable	208	144	144	148	146	137	
	Number of payments	12	23	12	23	23	23	

Notes: Time to create collateral in days, cost to create collateral in percentage of loan value, total tax payable as percentage of gross profits. Number of payments per year. Source: Doing Business in Brazil (World Bank, 2006).

Table 2: Descriptive statistics for retail firms, 2006

	All states	Ceará (UF=23)	Rio de Janeiro (UF=33)	Brasilia (UF=53)
Sales	14.44	14.70	13.91	14.75
	1.55	*1.63*	*1.38*	*1.60*
Value added	12.96	12.95	12.75	13.28
	1.25	*1.47*	*1.15*	*1.38*
Remuneration	12.67	12.49	12.47	12.85
	1.11	*1.29*	*1.05*	*1.19*
Capital services	11.24	11.25	11.23	11.69
	1.36	*1.60*	*1.29*	*1.49*
TFPR	1.16	1.22	1.11	1.23
	0.81	*1.11*	*0.59*	*1.10*
TFPQ	1.04	1.08	0.98	1.14
	1.00	*1.37*	*0.75*	*1.15*
τ_{Ysi}	-1.71	-2.29	-1.32	-1.65
	2.61	*3.57*	*1.63*	*2.56*
τ_{Ksi}	0.15	0.15	-0.09	0.11
	1.70	*1.40*	*1.08*	*1.58*
Observations	19346	396	2607	413

Notes: The mean values (in natural logarithmic form) for Sales, Value added, Remuneration, and Capital services are in current Reais. The standard deviation is below in italics. TFPR is estimated using equation 14, TFPQ is estimated using equation 15, output distortions are estimated from equation 17, and capital distortions are estimated from equation 18. Source: Pesquisa Anual de Comercio (IBGE, 2006).

Table 3: TFPR distribution, 2006

Federal state	n	mean	median	variance
Rondônia	69	1.06	1.02	0.22
Acre	51	1.06	0.97	0.29
Amazonas	198	1.04	0.72	1.03
Roraima	31	1.00	0.88	0.26
Pará	182	1.08	0.90	0.56
Amapá	45	1.04	0.91	0.50
Tocantins	37	1.28	1.00	1.11
Maranhão	193	1.11	0.90	1.02
Piauí	163	1.10	0.87	0.77
Ceará	396	1.22	0.94	1.22
Rio Grande do Norte	265	1.18	1.04	0.55
Paraíba	185	1.22	0.97	0.83
Pernambuco	573	1.20	0.96	1.11
Alagoas	165	1.07	0.75	1.21
Sergipe	157	1.12	1.00	0.47
Bahia	917	1.17	0.91	1.04
Minas Gerais	2148	1.16	0.99	0.53
Espírito Santo	499	1.20	0.96	1.35
Rio de Janeiro	2607	1.11	0.99	0.35
São Paulo	5451	1.24	1.10	0.53
Paraná	1432	0.98	0.91	0.29
Santa Catarina	821	1.25	1.01	0.94
Rio Grande do Sul	1104	1.11	0.97	0.61
Mato Grosso do Sul	299	1.04	0.90	0.66
Mato Grosso	394	1.23	1.01	0.80
Goiás	551	1.15	0.93	1.06
Distrito Federal	413	1.23	0.94	1.21
Total economy	19346	1.16	1.00	0.65

Notes: TFPR is estimated using equation 14, TFPQ is estimated using equation 15, output distortions are estimated from equation 17, and capital distortions are estimated from equation 18.

Table 4: Correlation between variables, 2006

	Value added	Employment	Capital services	TFPR	TFPQ	τ_{Ysi}	τ_{Ksi}
Value added	1						
Employment	0.94	1					
Capital services	0.84	0.82	1				
TFPR	0.02	-0.01^{c}	-0.01^{b}	1			
TFPQ	0.13	0.09	0.05	0.89	1		
τ_{Ysi}	0.04	0.02^{a}	0.02^{b}	0.42	0.37	1	
τ_{Ksi}	-0.02	-0.01^{c}	-0.03	0.25	0.14	-0.22	1

Note: Pearson correlation coefficients. All pairwise correlations are significant except for [a] Significant at 5 percent level, [b] Significant at 10 percent level, and [c] not significant.

Table 5: TFP Gains from equalizing TFPR within industries

Federal state	1996	2001	2006	beta-coefficient
Rondônia	190	196	204	-1.524
Acre	231	187	214	1.909
Amazonas	188	216	235	2.933**
Roraima	212	236	229	0.722
Pará	204	212	218	1.190
Amapá	226	216	217	1.730
Tocantins	239	262	238	-0.481
Maranhão	179	196	238	2.829
Piauí	204	220	230	1.573*
Ceará	218	226	244	1.971*
Rio Grande do Norte	211	221	227	3.153**
Paraíba	224	227	237	1.561
Pernambuco	233	262	235	1.066
Alagoas	197	228	250	4.125***
Sergipe	203	223	206	0.567
Bahia	245	255	264	1.893
Minas Gerais	237	243	257	1.750
Espírito Santo	242	239	274	2.332*
Rio de Janeiro	239	246	223	-1.127
São Paulo	244	246	242	-1.121
Paraná	243	231	235	-1.397
Santa Catarina	235	247	254	1.842
Rio Grande do Sul	237	250	274	2.930
Mato Grosso do Sul	232	251	260	2.523
Mato Grosso	241	248	267	2.651*
Goiás	229	243	269	3.814***
Distrito Federal	217	239	250	4.454***
Total economy	257	266	257	-0.257

Notes: TFP Gains from equalizing TFPR within industries, elasticity of substitution is 3. The last column shows the β-coefficient from an OLS regression where % TFP gains are regressed against time. A significant negative value indicates improvements in allocative efficiency. * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 6: Productivity and distortions regressions, no allowance for size effects of regulation

Dependent variable=	TFPR	TFPR	TFPQ	TFPQ	τ_{Ysi}	τ_{Ysi}	τ_{Ksi}	τ_{Ksi}
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Taxes * Commercialization margins	0.094		0.037		-0.007		0.667	
	(1.09)		(0.60)		(0.05)		(2.74)***	
Credit * Financial dependence		0.144		0.180		0.126		0.131
		(1.98)**		(2.57)**		(1.14)		(1.29)
Observations	15010	9559	15010	9559	15010	9559	15010	9559
R-squared	0.05	0.04	0.08	0.08	0.06	0.07	0.16	0.11

Notes: OLS regressions, robust standard errors in brackets, region and industry dummies are included (not shown), clusters by region-industry. Number of observations for regressions where access to credit is interacted with financial dependence is smaller because no information on access to credit is available for São Paulo. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table 7: Productivity and distortions regressions, allowance for size effects of regulation

Dependent variable=	τ_{Ysi}	τ_{Ysi}	τ_{Ksi}	τ_{Ksi}
	(1)	(2)	(3)	(4)
Taxes * Commercialization margins * z1	-0.041		0.606	
	(0.30)		(2.51)**	
Taxes * Commercialization margins * z2	0.147		1.019	
	(0.69)		(3.36)***	
Taxes * Commercialization margins * z3	-0.175		0.748	
	(0.87)		(2.89)***	
Taxes * Commercialization margins * z4	0.350		0.484	
	(2.29)**		(2.04)**	
Credit * Financial dependence * z1		0.368		0.304
		(1.54)		(1.37)
Credit * Financial dependence * z2		0.153		0.546
		(0.56)		(1.77)*
Credit * Financial dependence * z3		-0.161		0.077
		(0.95)		(0.49)
Credit * Financial dependence * z4		0.016		-0.068
		(0.42)		(1.99)**
Observations	15010	9559	15010	9559
R-squared	0.06	0.07	0.16	0.11

Notes: OLS regressions, robust standard errors in brackets, size-specific region and industry dummies are included (not shown), clusters by region-industry. The employment-size categories distinguished are firms with z1 ($<$ 50 employees), z2 (51-100 employees), z3 (101-249 employees), and z4 (250 employees). Number of observations for regressions where access to credit is interacted with financial dependence is smaller because no information on access to credit is available for São Paulo. * significant at 10%, ** significant at 5%, *** significant at 1%.

Table 8: Productivity and distortions regressions, sensitivity analysis

	τ_{Ysi} (1)	τ_{Ksi} (2)	τ_{Ysi} (3)	τ_{Ksi} (4)
Taxes * Commercialization margins * z1	-0.041		-0.067	
	(0.30)		(0.51)	
Taxes * Commercialization margins * z2	0.147		0.099	
	(0.69)		(0.49)	
Taxes * Commercialization margins * z3	-0.175		-0.305	
	(0.87)		(1.44)	
Taxes * Commercialization margins * z4	0.350		0.090	
	(2.29)**		(0.51)	
Credit * Financial dependence * z1		0.301		0.353
		(1.36)		(1.51)
Credit * Financial dependence * z2		0.545		0.590
		(1.77)*		(1.84)*
Credit * Financial dependence * z3		0.078		0.113
		(0.49)		(0.70)
Credit * Financial dependence * z4		-0.070		-0.060
		(2.52)**		(1.70)*
Observations	15010	9559	15041	9581
R^2	0.06	0.11	0.04	0.11

Notes: OLS regressions, robust standard errors in brackets, size-specific region and industry dummies are included (not shown), clusters by region-industry. The employment-size categories distinguished are firms with z1 ($<$ 50 employees), z2 (51-100 employees), z3 (101-249 employees), and z4 (250 employees). Number of observations for regressions where access to credit is interacted with financial dependence is smaller because no information on access to credit is available for São Paulo. * significant at 10%, ** significant at 5%, *** significant at 1%. Columns (1) and (2) include firm's employment; columns (3) and (4) show results from estimating the model with alternative capital services estimates; columns (5) and (6) show results when the elasticity of substitution is allowed to vary across size groups.

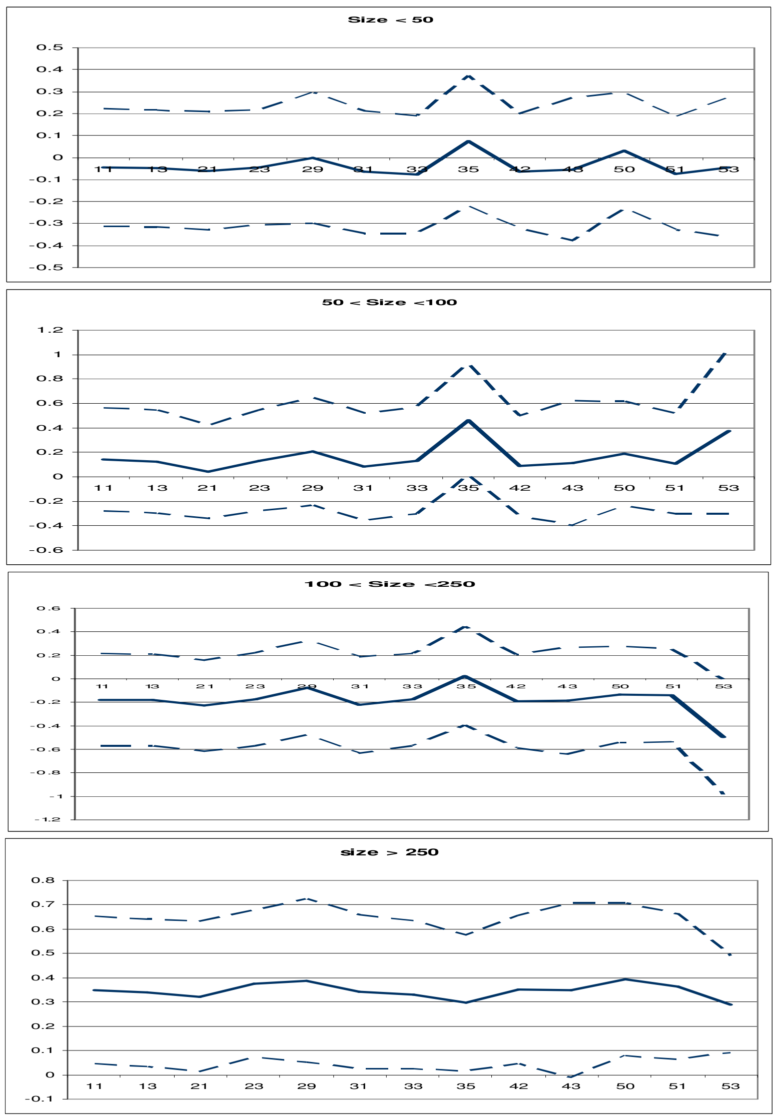
A Appendix table and figures

Table A.1: Elasticities of substitution by Federal state

Federal State	UF	population per km^2	retail firms per 1000 inhabitants	GDP per capita	female labor force participation	share of households with a car	σ
Acre	12	3.66	1.86	3.91	0.40	14.13	3.37
Alagoas	27	101.46	3.22	2.80	0.39	13.51	3.64
Amazonas	13	1.79	1.38	6.02	0.42	12.40	3.50
Amapá	16	3.34	2.77	5.15	0.42	15.66	3.62
Bahia	29	23.16	3.64	3.76	0.44	15.37	3.82
Ceará	23	51.00	4.99	3.10	0.39	15.56	3.75
Distrito Federal	53	353.53	6.45	21.37	0.54	52.05	7.00
Espírito Santo	32	67.26	5.25	6.86	0.48	31.22	4.78
Goiás	52	14.71	5.60	5.88	0.46	34.37	4.58
Maranhão	21	17.03	2.69	2.19	0.38	7.79	3.16
Minas Gerais	31	30.50	7.13	5.73	0.45	32.98	4.71
Mato Gr. do Sul	50	5.82	5.15	5.81	0.46	33.13	4.46
Mato Grosso	51	2.77	4.84	6.58	0.43	28.24	4.24
Pará	15	4.96	0.49	3.25	0.38	9.93	3.00
Paraíba	25	61.12	3.94	2.94	0.39	17.62	3.66
Pernambuco	26	80.37	3.44	3.59	0.41	18.37	3.81
Piauí	22	11.31	4.01	2.11	0.39	13.74	3.43
Paraná	41	47.99	6.92	7.43	0.48	43.35	5.14
Rio de Janeiro	33	328.59	4.97	9.58	0.45	33.79	5.42
Rio Gr. do Norte	24	52.32	4.06	3.52	0.38	20.33	3.71
Rondônia	11	5.81	0.99	4.45	0.42	19.72	3.51
Roraima	14	1.45	4.32	5.41	0.49	24.90	4.36
Rio Gr. do Sul	43	37.90	9.38	8.35	0.51	45.72	5.65
Santa Catarina	42	56.21	7.22	8.28	0.51	51.73	5.55
Sergipe	28	81.25	3.11	4.20	0.42	17.53	3.86
São Paulo	35	149.22	7.09	11.01	0.48	49.61	5.73
Tocantins	17	4.17	0.66	3.80	0.43	17.25	3.47

Notes: population per km^2 in 2000, GDP per capita in 1000 reais in 2006, female labor force participation in 2000, and the share of households with a car in 2000 from IPEA (www.ipeadata.gov.br). Number of retail firms per 1000 inhabitants from Pesquisa de Comercio (IBGE, 2006). The elasticity of substitution σ is obtained as the unweighted average of the normalized values from these variables and allowed to range between 3 and 7.

Figure A.1: Taxes and distortions to output, excluding one state at a time



Note: solid line shows β-coefficient, while dotted lines are the 95 % confidence intervals.

Figure A.2: Difficulty in access to credit and distortions to capital, excluding one state at a time

Note: solid line shows β-coefficient, while dotted lines are the 95 % confidence intervals.