Universidad Externado de Colombia

FACULTAD DE ECONOMÍA

Tesis de Maestría en Economía

TAX DISTORTIONS, MISALLOCATION AND PRODUCTIVITY: THE CASE OF COLOMBIA

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DICIEMBRE

DE 2019

BOGOTÁ D.C.

Tax Distortions, Misallocation and Productivity: The case of Colombia

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Abstract

This paper presents a version of neoclassical growth model in which production is carried out by heterogeneous plants and calibrate it for Colombian data (Colombian Annual Manufacturing Survey (AMS) from 2016). The output tax and value-added tax (VAT) produce distortions that affect the size distribution of firms by labor and capital. Hence Total-factor productivity (TFP) and misallocation of resources are the most affected by these distortions that vary in their structure and size. The main results show that with both distortions with the same size, the VAT with rebate increases TFP and aggregate output 5 percent. Besides, an output tax policy decreases both measures 15 percent.

Este artículo presenta una versión del modelo de crecimiento neoclásico en el que la producción se lleva a cabo mediante plantas heterogéneas y se calibra para los datos colombianos (Encuesta Anual Manufacturera (EAM) de 2016). El impuesto a la producción y el impuesto al valor agregado (IVA) producen distorsiones que afectan la distribución del tamaño de las empresas por mano de obra y capital. Por lo tanto, la productividad total de los factores (PTF) y la mala asignación de recursos son los más afectados por estas distorsiones que varían en su estructura y tamaño. Los principales resultados muestran que ambas distorsiones con el mismo tamaño, el IVA con devolución aumenta la PTF y la producción agregada en un 5 por ciento. Además, una política de impuesto a la producción disminuye ambas medidas en un 15 por ciento.

Keywords: Policy distortions, taxes, manufacturing plants.

JEL Classification: O1, H2, L6.

*This is my M.A. Thesis. Email: jairoa.granados@uexternado.edu.co. I would like to thank both my supervisor Oscar Valencia Arana for his support and Edna Sastoque Ramírez for her advice and suggestions. For my family, that their memories are silent voices that I keep in my heart and my two beloved Valentinas who changed my life.

1 Introduction

A huge literature has studied the role of misallocation and productivity that are some of the factors that explain the cross country differences in per capita income. Moreover, the reallocation of factors of production across firms and sectors can be affected by the distortions. As a result, government policies that distort the relative prices faced by heterogeneous plants will influence the misallocation and thus generate considerable effects by the investment desitions, labor, and capital accumulation. These policies (Tax distortions) can be provided by several types of taxes, which in turn impacts the productivity and aggregate output. Motivated by this strand, our paper quantitatively examines the long-run effect of resource misallocation within an otherwise standard one-sector neoclassical growth model in which structure is carried by heterogeneous plants, characterized by both different taxes, that are subject to their size and structure.

The objective of the thesis is to analyze the impacts of direct taxation on the TFP through changes in TFP distribution, which is a barrier to entry in manufacturing plants. This work explores two different taxes (Output tax and VAT) as several sources of distortions that produce heterogeneity between plants then reallocate productive factors. Both policies distort the prices faced by producers and their impacts across heterogeneous production units. It shows that although the factor accumulation matters, the allocation of factors are determinants across plants.

This paper is closely related to Restuccia and Rogerson (2008, (RR)), this model considers a version of the neoclassical growth model that incorporates heterogeneous production units as in Hopenhayn (1992); Hopenhayn and Rogerson (1993). Our analysis differs from theirs in two aspects. First, we incorporate a VAT with a rebate related to firm size, which in turn captures the empirical features commonly observed in developing countries. For instance, the financing law[1] document within the tax benefits scheme discount a VAT fraction of capital goods investment and discount half of industry and commerce tax as several incentives to the investment by entrepreneurs to increase the productivity and competitiveness. Second, we incorporate a relationship of misallocation of resources and firm-level productivity by distortions analyzed in the Colombian context.

This study uses administrative records from the Annual Manufacturing Survey (From DANE) to determine the extent of misallocation of resources in Colombia. It estimates the amount of productivity and aggregate output loss due to the misallocation of resources and compares the tax system policies. This work proposes three simulation exercises implemented to study the sensitivity of productivity and output regarding policy distortions. In the first case, with the effective rate of

[1] Law 1943 of 2018 MFCP (2018)

taxes of output tax and benefit the plants with low productivity. This leads that the magnitude of the effect is about 4 percent decreasing productivity. Also, the misallocation of resources is considerably high, so the size of the subsidy to maintain the steady-state capital stock unaltered is in the range of 4 to 23 percent. It should be noted that benefit large plants does not modify the productivity and produce a misallocation of 1 percent.

In the second case, the effective rate of VAT and rebating the plants with low productivity. In this case, the maximum drop over productivity is 15 percent, and this policy benefits 79 percent of plants. Moreover, applying this benefit to large plants decreases 1 percent of productivity, 98 percent receive the rebate.

The third case, establish size-dependent tax policies, which both taxes with the same flat tax. Here, a policy that benefits small plants the maximum output tax decreases the productivity 19 percent, instead of the VAT increases 5 percent. Furthermore, with the policy that benefits large plants, the output tax reduces productivity 1 percent. In this sense, the effect of both taxes over productivity and output is contrary because the output tax reduces this measures, and VAT with rebate increases them.

1.1 Size Distributions and Life Cycle of plants

It will study the size distribution in a competitive environment, each plant characterized as the optimal size of the plant. Another is the time of plant in the market that makes it a dynamic problem for each one. The study of size distribution is important in macro research, especially with the work of Viner (1932) that in equilibrium, each firm produces at the minimum point in a U-shaped curve cost and firm entry-exit of plants adjust total industry production to the demanded quantity at zero profit. It focuses on the potential cost of policies directed against large plants. It is maintaining plants small in their most efficient scale, which must somehow balance against the gains from reducing monopoly inefficiency.

Several studies analyze the distribution of plants at a single point in time and show that firm growth is independent of their size. The behavior of the study is consistent with the empirical observation that the growth of plants, deviating from the predictions of the one-period Markovian process, exhibits strong serial correlation in the size changes of individual plants. It shows that it is a plausible assumption from the macroeconomic perspective on economic grounds with empirical findings and matches the postulated: there exist approximately constant returns to scale (Simon and Bonini (1958); Ijiri and Simon (1964)).

Lucas (1967); Lucas and Prescott (1971), introduce a competitive equilibrium theory of industry evolution; the equilibrium shows a stochastic process of price, aggregate output, and investment in a homogeneous plant level. In the long-run equilibrium level, the main feature is the role of securities prices in informing plants of the market is a variable in a firm-level investment function for future demand.

In this seminal paper, Lucas (1978) proposes "managerial talent" to maximize output. He finds that the allocation of assets and employees, and the mechanism of classical studies predict the size-distribution of plants. Also, it defines restrictions in which average firm size varies across economies at several levels of development.

From this work, many important insights have been developed. With a partial solution to the dynamics of firm size and distribution of plants, the determinants in the decision of the firm to maintain in the market become the new paradigm in the theoretical work. In the first dynamic models of entry and exit, the plants have an identical size, and there is no entry and exit limit (Brock (1972); Smith (1974)).

The development of stationary equilibrium in this type of literature corresponds to the steady-state analysis of a dynamical system, as in Lippman and Rumelt (1982). Hopenhayn (1992) introduces a methodology to understand the changes in the structural characteristics of an industry that affects the turnover, growing plants, distribution-size, profits, and value of plants. This work shows that the dynamic decision does not only depend on the exit decision, or on the stopping time problem but also that it affects either investment decisions expanding the state vector in the dynamic problem or the conditional distribution for shocks.

Hopenhayn and Rogerson (1993) incorporate in a neoclassical growth model heterogeneous production units to examine the qualitative and quantitative impact of government policies upon the plants that force to adjust their employment levels. The results show that the effects of a tax on job destruction are costly, and they also find that firing taxes significantly reduce steady-state employment. The analysis is carried only at the steady-state, and the policies do not consider the short-run responses.

The flexible form of capital transitionary dynamics introduced by Veracierto (2001, 2008) solves the limitations of former authors because it allows analyzing the short-run effects of firing taxes and inserts the idiosyncratic productivity shocks. Thereby, he introduces two models, one with capital and, another without it. The paper shows that the steady-state effects of taxes are similar in both cases, and suggests that capital is not crucial for the understanding of the long-run effects of it distortion (taxes), but is crucial in the short-run effects.

1.2 Policy distortions and misallocation

Idiosyncratic and stochastic shocks can affect the size distribution of plants and the life cycle of plants, the mechanism to change the decision producer is in the way of TFP, technological change, research, and development (R&D), reallocation and different taxes (subsidies as negative taxes).

Recent literature explores the plant-level heterogeneity created by policy distortions in the aggregate outcome. The dispersion in marginal products potentially indicates misallocation (Bartelsman et al. (2013); Alfaro et al. (2008); Midrigan and Xu (2010); Da-Rocha et al. (2019)). The contribution of Hsieh and Klenow (2009, 2014) quantifies how significant is the cost associated with the misallocation of resources. It demonstrates that microeconomic distortions faced by plant-level have enormous macroeconomic consequences.

Restuccia and Rogerson (2008) take a different approach that explores in a model with heterogeneous plants that receive idiosyncratic distortions that affect their efficiency. They found that misallocation of resources across firms has essential effects on aggregate TFP. Subsidizing low productivity plants is a perversive policy in poor developing countries. In the context of their model, policies that subsidize high and low productivity plants also have adverse effects on output and TFP.

Other branch studies DSGE models to estimate changes in labor income and consumption. The decreases in this have sizeable effects on consumption and output, while a reduction in capital income tax favors investment and output in the medium run (Forni et al. (2009)) although other analyses show that the standard modeling strategy greatly overestimates the short-run impact of the changes that transform VAT in a weak fiscal instrument, especially for countries that are in severe recession (Voigts (2017)).

This paper is divided into seven sections with this introduction and related literature. Section 2 examines the importance of output tax and VAT in plants in Colombia. Section 3 presents the economic environment. Tax distortions in Section 4. The equilibrium of the model in Section 5. The calibration of the model with the Colombian Annual Manufacturing Survey in Section 6 and 7. Finally, Section 8 presents the main conclusions.

2 Stylized facts

The firm dynamics in Colombia have been studied well from several perspectives. Since the trade liberalization, the effect of input prices and plant output upon the firms has taken quantitatively importance (Fieler et al. (2018); Eslava et al. (2013, 2004)). Besides, the perspective of life-cycle growth in Colombia provides evidence of decomposing growth over a plant's life cycle attributable to fundamental sources of idiosyncratic growth-physical productivity, demand shocks (firm appeal), and input prices and distortions that weaken the link between those fundamentals and actual growth. These measured fundamentals explain around 75 percent of the variability of output relative, and the remaining 25 percent have an explanation by distortions Eslava and Haltiwanger (2017).

2.1 VAT in Colombia

The three most important items of tax revenue of the Government of Colombia are income tax 6,6 percent of GDP, the VAT 5,7 percent of GDP, and the TT 0,7 percent of GDP MFCP (2019).

Tab. 1: Trajectory of VAT rates

Law	General VAT (%)	Specific VAT (%)
Decree 3541 of 1983	10	4, 6, 8, 15, 20, 35
Law 49 of 1990	12	20, 35
Law 6 of 1992	14	8, 12, 20, 35, 45
Law 223 of 1995	16	8, 12, 20, 35, 45
Law 488 of 1998	15	8, 12, 20, 35, 45
Law 633 of 2000	16	8, 12, 20, 35, 45
Law 788 of 2002	16	2, 5, 7, 11, 20, 38
Law 1111 of 2006	16	2, 5, 7, 11, 20, 35
Law 1607 of 2012	16	5
Law 1819 of 2016	19	5

Although this is an easy tax to collect, the Colombian VAT has several problems and limitations since the side of the Government and the firms. The legislation considers three different regimes to apply the VAT at the firms.

1. Exclusions: Exist several types of goods and services that can be excluded from paying VAT. e.g., The import goods of capital by industries.

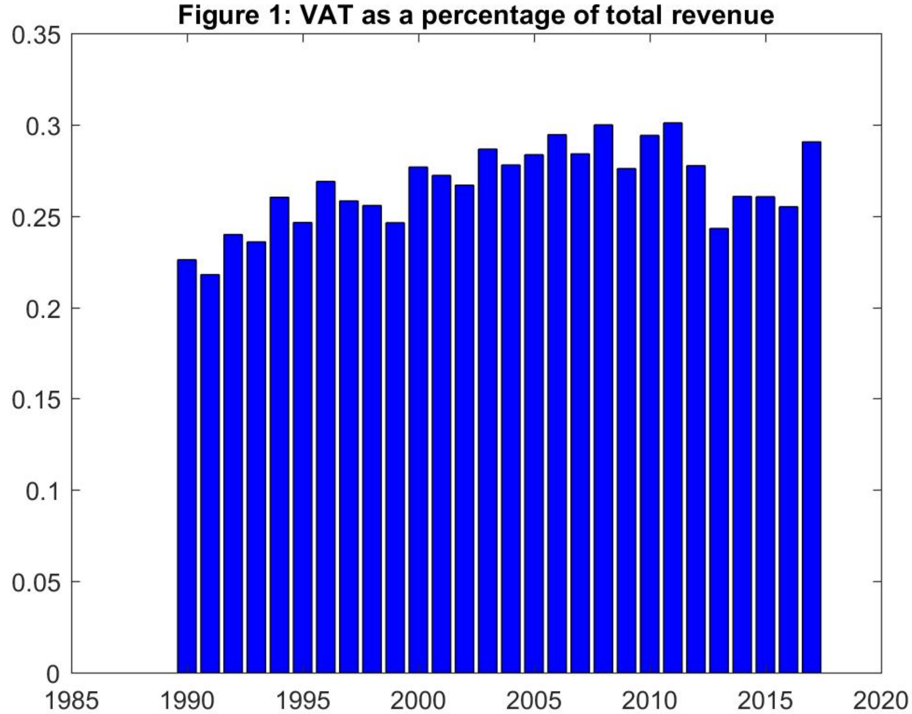
2. Exceptions: The firms have the discount right over the inputs that need to produce. This discount lets levy the value-added at each stage of production.

3. Differential rates: Table 1 shows the two types of VAT depending on the type of goods

The VAT in Colombia has had a growing trend (In the case of general VAT) over time, as reported in table 1 following the structure of developed economies as the OECD group that searches best governance practices. Moreover, the specific VAT converges to fewer rates that are applied to some goods of the basket of basic consumer goods.

Despite the income that represents this tax, their exclusions, exceptions, and differential rates represent fiscal costs of 5.3 (% of GDP), 1 (% of GDP), and 0.3 (% of GDP) in 2018, respectively MFCP (2019, 510). Figure 1[2] shows the revenue of VAT that increases because the economic activity has increased, and the mechanisms to avoid the evasion are effectiveness.

Figure 1: VAT as a percentage of total revenue

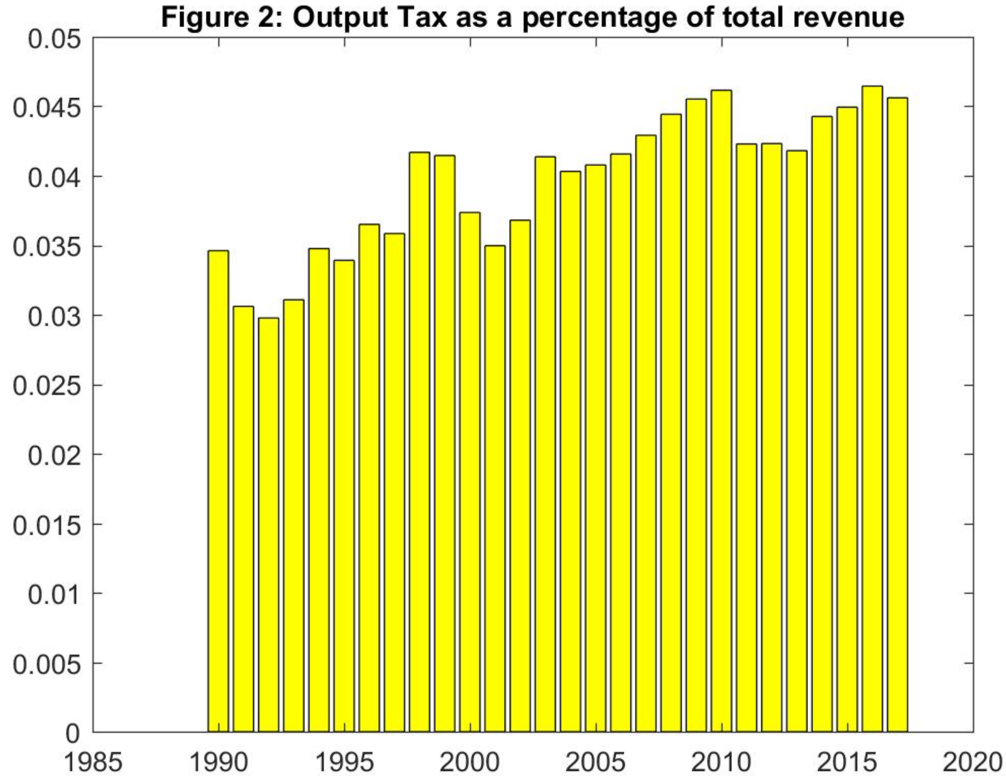


2.2 Output Tax in Colombia

In Colombia, the output tax (industry and commerce tax). This tax charge to industrial activities, businesses, and services. It is a municipal tax that differences their rates between economics activity and its selection criteria are defined by the International Standard Industrial Classification of All Economic Activities (ISIC). In Colombia, the heterogeneity in tariffs of this tax produces an incentive of reallocating the location of plants between municipals.

The evolution of industry and commerce tax in figure 2 corresponds to the share of this tax as a percentage of total government revenue. This share does not achieve more than 5 percent of total revenues, and the main reason is that the medium of this valid tariffs is 1.1 percent.

[2] Source: OECD Stats.



3 Environment

This paper introduces a standard version of the neoclassical growth model augmented along the lines of Restuccia and Rogerson (2008) with an infinitely- lived representative household with preferences over streams of consumption goods. The technology of plants has decreasing returns to scale[3], pay a fixed cost of entry in the first production stage, and a fixed cost of operation each production stage. There is an ongoing turnover rate in steady-state because plants may die stochastically and exogenously. This type of model abstracts plant-level productivity dynamics and assumes that plant-level productivity remains constant over time. Also, the competitive equilibrium plants take the wage rate and the rental rate of capital as given and make zero expected profits. The policy distortions affect factor prices faced by individual producers, the allocation of resources across plants, hence aggregate TFP.

[3] This assumption allows a non-degenerate stationary distribution in the long term. Without this assumption, we could double the production factors without being able to analyze the reallocation of resources. For instance see Lucas (1978)

3.1 Preferences

The supply of labor is inelastic; the agent does not define the hours of labor with a trade-off between labor and leisure, and so in equilibrium, total labor demand is equal unity that is the condition that determines the mass of entry. It is described by the utility function,

$$\sum_{t=0}^{\infty} \beta^t u(C_t), \text{ Where } 0 < \beta < 1$$

Where C_t is consumption at time t, and β is the discount factor. Households are endowed with $K_0 > 0$ units of capital stock at time 0.

3.2 Technology

The unit of production is the plant, and each plant is described by a production function $f(s, k, n)$ that combines capital services k, labor services n to produce output, and the parameter s capture the fact that technology varies across plants. The function f assumed decreasing returns to scale in both productive factors, and finally satisfy the usual Inada conditions. Focusing on the cross-sectional heterogeneity of plants, assume that the value of s is constant over time for a given plant.

$$f(s, k, n) = sk^{\alpha}n^{\gamma}, \ \alpha, \gamma \ \epsilon(0, 1), \ 0 < \gamma + \alpha < 1$$

It assumes that the only difference across plants is the level of TFP. Notably, the ratios capital/labor are the same across plants at equilibrium (with no distortions). c_f is the fixed cost of operation in units of output, hence if the plant wants to remain, it must pay this cost; otherwise, it ceases to exist.

3.3 Entry - Exit

In any given period after production takes place, each plant faces a probability of death (exit), λ. Also, assume that in each period, a new plant can be created by paying a cost of c_e in terms of output and after the parameter s for each plant is drawn from the distribution with cdf $H(s)$. (Draws from this distribution are iid across entering plants). E_t denotes the mass of entry in period t, and there is no restriction or limit for the number of potential entrants.

Aggregate feasibility constraint in the model requires

$$C_t + X_t + c_e E_t \leq Y_t - M_t c_{f,t}$$

Where X_t is the aggregate investment, E_t is aggregate entry, Y_t is aggregate output, M_t is the mass of producing plants, and C_t is the aggregate consumption.

The aggregate law of motion for capital is

$K_{t+1} = (1-\delta)K_t + X_t$

4 Tax Distortions

Different types of policies create idiosyncratic distortions to plant-level decisions and hence cause a reallocation of resources across plants. Expressly, it assumes that each plant faces its output tax. In this case, there are two different types of taxes. These policies can take three possible values: a positive value reflecting that a plant is being taxed, a negative value reflecting that the plant is being subsidized, and zero reflecting no distortion for the plant.

The first type is the output tax, τ^s. The value of the plant- level tax rate is revealed once the plant draws its value of s and before production takes place. It also assumes that the value of this tax rate remains fixed for the duration of the time for which the plant is in operation.

Different specifications of policy representing the probability that a plant with productivity s faces policy τ^s and also represents the possibility that the value of the plant-level tax rate may be correlated with the draw of the plant-level productivity parameter. A given distribution of plant-level tax and subsidies cannot lead to a balanced budget for the government.

The second policy is the tax rate of the VAT, τ^{VAT}. In the consumption tax model, the government levies a consumption on households, so tax changes directly affect output. In the model of Voigts (2017) introduced the effect of the VAT for the final good firm that would charge a VAT to consumers. Also, the producers can take a VAT rebate as a part of VAT levied by the government. This becomes effective only if the plant invests in capital goods. This second policy is the main difference and contribution respect to Restuccia and Rogerson (2008).

5 Equilibrium

The focus is exclusively on the competitive steady-state equilibrium of the model. In the state equilibrium, the rental prices for labor, w, and capital services, r, will be constant. The consumer problem will determine the steady-state rental rate of capital; with this condition, the zero-profit condition for the entry of plants will determine the steady-state wage rate. Labor is supplied inelastically, and at equilibrium, total labor demand must equal unity.

5.1 Consumer´s Problem

The consumer maximizes lifetime utility

$$\underset{\{c_t,k_{t+1}\}_{t=0}^{\infty}}{Max} \sum_{t=0}^{\infty} \beta^t u(C_t) \ [1]$$

Subject to a budget constraint

$$C_t + K_{t+1} - (1-\delta)K_t = r_t K_t + w_t N_t + \Pi_t - T_t \ [2]$$

where w_t and r_t are the period t rental prices for labor and capital measured relative to period t output, Π_t is the total profit of all plant operations, and T_t is the lump- sum taxes levied by the government. N_t is the total labor services supplied to the market, It is assumed is that $N_t = 1$ because the agents do not value leisure.

Using the first order condition (FOC) for this problem We have

$$\frac{\partial U}{\partial C_t} = \lambda_t = u\acute{}(C_t) \ [3]$$

$$\frac{\partial U}{\partial K_{t+1}} = \lambda_t = \beta[\lambda_{t+1}\{(1-\delta) + r_{t+1}\}] \ [4]$$

taking (3) and replacing in (4) we obtain (5)

$$\frac{u\acute{}(C_t)}{u\acute{}(C_{t+1})} = \beta\left[(1-\delta) + r_{t+1}\right] \ [5]$$

Hence the marginal utility of consumption at time t depends on the discount factor, the depreciation of capital, and the interest rate of time t+1. It is clear that the decision of consumption at time t depends on the cost of money in the next period.

It is showed that conclude that if there is a solution with r_t and C_t constant, it must be that

$$r = \frac{1}{\beta} - (1-\delta) \ [6]$$

where r is the steady- state of r_t and hence the corresponding real interest rate, denoted by R,

$$R = r - \delta = \frac{1}{\beta} - 1 \ [7]$$

5.2 The Plant´s Problem

The decision problem of a plant to hire capital and labor services is static since there is no link between decisions made in different periods. It means that the operation at a plant depends simply on hiring labor and capital, such as it can maximize its current period profits.

5.3 Incumbent Entrant

Consider a plant with productivity level s and different tax rates τ^s and τ^{VAT} that faces at the steady-state input prices of r and w. The maximum one period profit production $\pi(s, \tau^s, \tau^{VAT})$ satisfies

$$\pi(s,\tau^{s},\tau^{VAT}) = \max_{n,k\geq 0}\left\{(1-\tau_t^{s})(1+\tau_t^{VAT})sk_t^{\alpha}n_t^{\gamma} - (w_t n_t + r_t k_t(1+\tau_t^{VAT})) + r_t k_t \tau_t^{VAT}k(s) - c_{f,t}\right\}$$ [8]

The plant maximizes profits according to their labor, capital, and exogenous productivity, subject to the costs of hiring both productive factors and the cost of operation. Also, each plant has to pay the output tax (τ_t^s) of maintaining in the competitive market. This tax could be correlated with the productivity of maintaining the competitive market; this tax could be correlated with productivity. Because the model assumes the competitive equilibrium, the households pay the VAT that is charged by the final good producer in the output, and then it is discounted. This VAT affect the cost of hiring capital and has VAT restoration as a part of a VAT that depends on hiring capital goods that are determined for the size of each firm $k(s)$ represents different specifications of policy with various sets of (s,τ^{s},τ^{VAT}) , more specific, $dG(s,\tau^{s},\tau^{VAT}) = H(s)P(s,\tau^{s},\tau^{VAT})$.

Deriving the FOCs for capital

$\frac{\partial\pi}{\partial k_t} = k_t = \left[\frac{(1-\tau_t^{s})(1+\tau_t^{VAT})\alpha s n_t^{\gamma}}{r(1+\tau_t^{VAT})+k(s)r\tau_t^{VAT}}\right]^{\frac{1}{1-\alpha}}$ [9]

The optimal factor demand of labor derived from

$\bar{n}(s,\tau^{s},\tau^{VAT}) = \left[\frac{(1-\tau^{s})(1+\tau^{VAT})s\gamma}{w}\right]^{\frac{1}{1-\gamma}} k^{\frac{\alpha}{1-\gamma}}$ [10]

The marginal effect on demand of labor (10) of the plants of rise tax rates

$\frac{\partial\bar{n}}{\partial\tau^{s}} = \left(\frac{\alpha}{r(1+\tau_t^{VAT})+k(s)r\tau_t^{VAT}}\right)^{\frac{\alpha}{1-\alpha-\gamma}}\left[s(\frac{\gamma}{w})^{\frac{\alpha\gamma}{1-\alpha-\gamma}+1}\right]^{\frac{1}{1-\gamma}}\left[(1+\tau^{VAT})\right]^{\frac{1}{1-\alpha-\gamma}}\frac{(1-\tau^{s})^{\frac{\alpha+\gamma}{1-\alpha-\gamma}}}{1-\alpha-\gamma} < 0$ [11]

Replacing the optimal demand of labor (10) and isolating the productivity and taxes of the rest of parameters the conditional upon remaining in operation, optimal factor demand of capital for this plant is thus given by

$\bar{k}(s,\tau^{s},\tau^{VAT}) = (\frac{\alpha}{r(1+\tau_t^{VAT})+k(s)r\tau_t^{VAT}})^{\frac{1-\gamma}{1-\alpha-\gamma}}(\frac{\gamma}{w})^{\frac{\gamma}{1-\alpha-\gamma}}((1-\tau^{s})(1+\tau^{VAT})s)^{\frac{1}{1-\alpha-\gamma}}$ [12]

The effect on capital of rising taxes rates can be obtained deriving (12) with respect to each tax and is given by

$\frac{\partial\bar{k}}{\partial\tau^{s}} = (\frac{\alpha}{r})^{\frac{1-\gamma}{1-\alpha-\gamma}}(\frac{\gamma}{w})^{\frac{\gamma}{1-\alpha-\gamma}}\left[\frac{(1-\tau^{VAT})s}{(1+\tau^{T})}\right]^{\frac{1}{1-\alpha-\gamma}}\frac{(1-\tau^{s})^{\frac{\alpha+\gamma}{1-\alpha-\gamma}}}{(1-\alpha-\gamma)} < 0$ [13]

After deriving the effect of change output tax on (10) and (12) is negative upon the demand of labor and capital and shows that raise tax rates over time are negative in the decision of the plants of hire labor and capital. It means that in the long run, it affects the value-added of plants.

The discounted present value of an incumbent plant is given by

$W(s,\tau^{s},\tau^{VAT}) = \frac{\pi(s,\tau^{s},\tau^{VAT})}{1-\rho}$ [14]

Where $\rho = \frac{1-\lambda}{1+R}$ is the discount rate for the plant.

5.4 Entering Plant´s Problem

W_t represents the present discounted value of a potential entrant, this value is given by

$$W_t = \sum_{t=0}^{\infty} \max_{\bar{x}\epsilon\{0,1\}} \left[W(s,\tau^s,\tau^{VAT}),0\right] dG(s,\tau^s,\tau^{VAT}) - c_e \ \ [15]$$

It represents the potential entrant that will optimally decide whether to engage in production after observing their realize draw of (s,τ^s,τ^{VAT}) and $\bar{x}(s,\tau^s,\tau^{VAT})$ is the optimal entry decision with the convention that $\bar{x}=1$ which means that the plant enters and remains in operation.

$dG(s,\tau^s,\tau^{VAT})$ represents different specifications of policy with various sets of (s,τ^s,τ^{VAT}) , more specific, $dG(s,\tau^s,\tau^{VAT}) = H(s)P(s,\tau^s,\tau^{VAT})$.

In a stationary equilibrium with entry, $W_e = 0$ refers to the free- entry condition and is determined by the values of the endogenous variables w and r.

5.5 Invariant Distribution of Plants

Let $\mu(s,\mathit{\Gamma})$ denote the distribution of producing plants at period t over the plant level characteristics. As the mass of entrants is E and the decision rule for production of entering plants is given by $\bar{x}(s,\tau^s,\tau^{VAT})$ the next period´s distribution of producers over (s,τ^s,τ^{VAT}) set, is denoted as follows by $\mu´$.

$$\mu´(s,\tau^s,\tau^{VAT}) = (1-\lambda)\mu(s,\tau^s,\tau^{VAT}) + \bar{x}(s,\tau^s,\tau^{VAT})dG(s,\tau^s,\tau^{VAT})E \ \ [16]$$

For all values of productivities and taxes, the first term represents the mass of incumbent plants that survive each period, and the second term represents the mass of entering plants that remain in operation. In the steady-state, the distribution μ will be constant over time, and an invariant distribution is defined by this

$$\hat{\mu}(s,\tau^s,\tau^{VAT}) = \frac{\bar{x}(s,\tau^s,\tau^{VAT})}{\lambda} dG(s,\tau^s,\tau^{VAT}) \ \ [17]$$

$\forall s,\tau^s,\tau^{VAT}$

5.6 Labor Market Clearing

An the steady- state, wage and capital rental rates determine the functions $\bar{k}(s,\tau^s,\tau^{VAT})$, $\bar{n}(s,\tau^s,\tau^{VAT})$, and $\bar{x}(s,\tau^s,\tau^{VAT})$ and the associated invariant distribution $\hat{\mu}$. Aggregate labor demand is given by

$$N(r,w) = E\sum_{t=0}^{\infty} \bar{n}(s,\tau^s,\tau^{VAT})\hat{\mu}(s,\tau^s,\tau^{VAT}) \ \ [18]$$

This equation (22) can be used to determine the steady-state equilibrium level of entry. Hence E satisfies

$E = \frac{1}{\sum\limits_{(s,\tau^s,\tau^{VAT})} \bar{n}(s,\tau^s,\tau^{VAT})\hat{\mu}(s,\tau^s,\tau^{VAT})}$ [19]

To see more clearly, if the taxes have a direct effect on the income of the government raising the taxes, but the decision of entering plants could be affected in the optimum demand for labor. The effect of taxes on the level of entry (19) with optimal entry decision $\bar{x} = 1$.

5.7 Definition of Equilibrium

Competitive steady-state competitive equilibrium with entry is defined by the wage rate w, the rental rate r, the lump-sum tax T, the aggregate distribution of plants $\mu(s,\tau^s,\tau^{VAT})$, a mass of entry E, value functions $W(s,\tau^s,\tau^{VAT})$, $\pi(s,\tau^s,\tau^{VAT})$, W_e policy functions $\bar{k}(s,\tau^s,\tau^{VAT},)$, $\bar{n}(s,\tau^s,\tau^{VAT})$, $\bar{x}(s,\tau^s,\tau^{VAT})$ for each plant, and aggregate levels of consumption (C) and capital (K):

- (Consumer optimization) $r = \frac{1}{\beta} - (1 - \delta)$
- (Plant optimization) Given prices (w, r), the functions π, W, and $W_e$solve incumbent and entering plant´s problems and $\bar{k}$, $\bar{n}$, $\bar{n}$ are optimal policy functions
- (Free- entry) $W_e = 0$
- Market clearing

$1 = \sum\limits_{t=0}^{\infty} \bar{n}(s,\tau^s,\tau^{VAT})d\hat{\mu}(s,\tau^s,\tau^{VAT})$ [20]

$1 = \sum\limits_{t=0}^{\infty} k(s,\tau^s,\tau^{VAT})d\hat{\mu}(s,\tau^s,\tau^{VAT})$ [21]

$C + \delta K + c_e E = \int_{(s,\tau^s,\tau^{VAT})} (f(s,\bar{k},\bar{n}) - c_f)d\hat{\mu}(s,\tau^s,\tau^{VAT})$ [22]

- (Government budget balance)

$T + \sum\limits_{t=0}^{\infty} (\tau^s,\tau^{VAT})f(s,\bar{k},\bar{n})d\hat{\mu}(s,\tau^s,\tau^{VAT}) = 0$ [23]

- (μ is an invariant distribution)

$\hat{\mu}(s,\tau^s,\tau^{VAT}) = \frac{\bar{x}(s,\tau^s,\tau^{VAT})}{\lambda} dG(s,\tau^s,\tau^{VAT})$ [24]

$\forall s,\tau^s,\tau^{VAT}$

6 Calibration

The model is calibrated using the data from Colombia (Colombian Annual Manufacturing Survey 2016[4] (AMS) from DANE). Economy without distortions corresponds to one year in that obtain the parameters of the distribution of plants in equilibrium. Specifically, we obtain the parameters using the first-order conditions and other quantitative parameters. Also, some parameters follow the standard procedures of Restuccia and Rogerson (2008), taking specific values in the calibration and other from Penn World Table version 9.1 (PWT) that procedures the growth model and determine the distribution of plants in equilibrium to the data observed in Colombia.

Using the first-order conditions of households, the real rate of return (7) of 11 percent implies a value for β of 0.89. Following the lines of Restuccia and Rogerson (2008), that assumes the extent of decreasing returns $(1-\alpha-\gamma)$ of 10 percent. This direct estimation of the plant-level production functions across establishments and calibration assesses in this parameter the quantitative implications of several values. It corresponds to the remaining share 1/3 capital and 2/3 of labor, implying $\alpha = 0.3$ and $\gamma = 0.6.$. The average depreciation rate of the capital stock of WPT for 2016 is $\delta = 0.04$.

Also, a key component is the range of plant-level productivity that determines the impact of reallocation in aggregate productivity by the reallocation of resources that the policies produce relative to the benchmark economy without distortions. Hence the plant-level employment match on the plant- level productivity because the benchmark economy there is a connection between plant-level productivity and employment.

The parameter $c_{f,t} = 0$ implies that all plants that receive draw of $s > 0$, which produce output and operate until time t. The value of the cost of creating a new plant normalized to one. It has implications in the steady-state with endogenous entry and exit that could be affected by distortions and then impact the invariant distribution of plants by productivity levels.

Benchmark Calibration to Colombian Data			
Parameter	Value	Target	Source
γ	0.3	Capital income share	RR
β	0.89	Real rate of return	PWT
δ	0.04	Investment to output ratio	PWT
λ	0.1	Annual exit rate	RR
sRange	[1, 2.46]	Relative plant sizes	RR
$H(s)$	see fig. 1	Size distribution of plants	Own construction based on RR

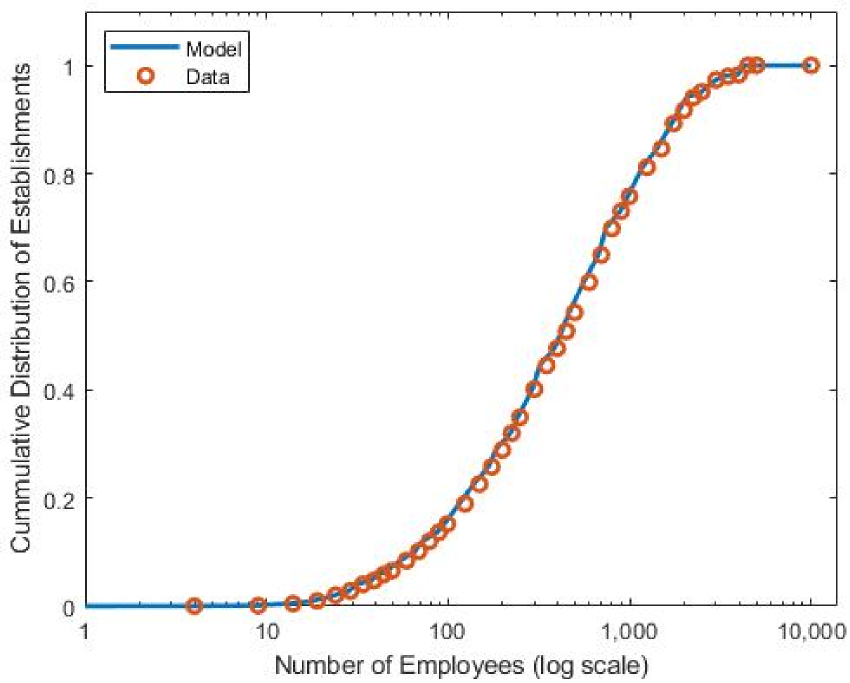
The distribution of plant size across employment levels, H, matches the data from the Colom-

[4] It is based on Rossi-Hansberg and Wright (2007) The sample size involves the ranges of the number of workers per plant is 1 to 4,080.

bian Annual Manufacturing Survey 2016. The probability of death (10 percent) is independent of productivity, the ratios of plants in the invariant distribution μ are identical as the distribution H. The data provides the number of plants for a set of employment ranges. The plants are uniformly distributed in this range so that the cumulative distribution function is a linear interpolation across the point in the data. Figure 1 documents the approximated distribution H and the cumulative distribution across average plant size in the data. This distribution matches according to the size distribution of plants in Colombia (2016).

Notice "that is a close connection between elasticity of the plant-level factor demand functions with respect to taxes and the elasticity of these functions with respect to plant-level TFP" Restuccia and Rogerson (2008, 16). It means that associate the range of TFP values, and the elasticity of the plant-level factor demands respect to taxes. It implies then that increase the productivity of plants the response regard to taxes is small.

Figure 1: Distribution of Plants by Employment - Model vs. Data



7 Type of Distortions: Output Tax and VAT in Colombia

This section analyses the quantitative impact of distortions for both output tax and VAT in the steady-state. In both cases, the taxes/subsidizes of heterogeneous plants are assess when these distortions are correlated with plant-level productivity. There are two types of correlation (i) Positive correlation tax the plants with low productivity (benefit large plants). (ii) Negative correlation tax the plants with high productivity (benefit small plants). It considers the case where plants with low TFP receive a subsidy, and plants with high TFP are taxed. Tables show the case of output tax if the half of plants are taxed and the others are subsidized and their effect on several variables of interest.

The first row reports the level of output relative to the distortion-free economy. The second row is also the level of aggregate TFP relative to the distortion-free economy. The third row reports the level of entry relative to the distortion-free case. The final three rows report statistics related to the distortions. The variable Y_s/Y is the output share of plants that are receiving a subsidy, the variable S/Y is the total subsidies paid out to plants receiving subsidies as a fraction of output, and the variable τ_s is the size of the subsidy required to generate a steady-state capital stock equal to that in the distortion-free economy. In the case of tables of VAT, the latest row represents the share of plants that receive the rebate of VAT depending on their productivity for investment in capital goods. The first two rows are the same by construction because aggregate inputs of productive factors (labor and capital) are the same in the economy.

7.1 Output tax

This subsection discusses how to benefit small plants that have the potential to be distorted more than large plants. Table 2 compiles the effects of the output tax when benefit small plants with plant-level productivity considering taxes of 0.6, 2.6, 4.6, and 6.6 percent as four types of policy. As the distortion increases, the share of output accounted for by subsidized firms increases, as do the subsidy rate and the total payment of subsidies relative to output. In each case, the net effect of the size of subsidies on the steady-state capital accumulation is zero, and so does not affect the benchmark of entry-exit since this perspective of idiosyncratic distortions[5]. Contrary to the literature on the role of capital accumulation that emphasizes the impact of policy distortions on the return to capital investments and capital accumulation, but TFP is exogenous and constant (Chari et al. (1996); Mankiw et al. (1992)). The literature of idiosyncratic distortions across plant heterogeneity establishes a link between capital accumulation and TFP measures being the key to assessing distortions.

The relative effect of distortions in TFP decreases not significantly; the maximum effect through this channel is 4 percent. Moreover, with a 6.6 percent output tax rate, the output share of subsidized firms is equal to 37 percent. In the same order, the maximum resources to finance the distortion is 23 percent. Although the maximum drop in TFP is relatively small (4 percent), it is also interesting to note that more resources are required to finance this distortion (23 percent of output are required).

Tab. 2: output-Tax plants with high productivity

	τ_t			
Variable	0.6%	2.6%	4.6%	6.6%
Relative Y	0%	−1%	−2%	−4%
Relative TFP	0%	−1%	−2%	−4%
Y_s/Y	14%	23%	30%	37%
S/Y	1%	3%	6%	8%
τ_s	4%	13%	19%	23%

The aggregate impact of distortions depends on the quantity of plants that are taxed. An

[5] This type of policies considers do not rely on changes in aggregate capital accumulation and aggregate relative prices, although these policies have substantial effects on aggregate output and measured TFP.

analogizing is if 10 percent of the plants are subsidized and 90 percent taxed (Only in the case of the output tax), the impact of a 6.6 percent tax reduces the output and TFP 13 percent. Interestingly, the resources to produce this reallocation is 91 percent.

In this case, the most productive plants receive the output subsidy. Table 3 generally exposes that the output and the TFP remain unchanged despite the distortions. With the initial policy: 50 percent of the plants with high productivity receive a subsidy while the rest are taxed. The drop in TFP measure converges to zero, as do the subsidy rate. Despite the distortion, the output and TFP not decrease; it requires an amount of reallocation of 1 percent.

Tab. 3: output-Tax plants with low productivity

	τ_t			
Variable	0.6%	2.6%	4.6%	6.6%
Relative Y	0%	0%	0%	0%
Relative TFP	0%	0%	0%	0%
Y_s/Y	89%	90%	92%	92%
S/Y	0%	0%	0%	1%
τ_s	0%	0%	0%	1%

Applying the latest case of benefit small plants (10 percent of the plants are subsidized, and 90 percent taxed), the impact of output tax is marginally decreasing the output and TFP 1 percent. It generates a maximum misallocation of 7 percent.

7.2 VAT

Now, consider that the mechanism of VAT affects capital accumulation trough increases (decreases) in the TFP and output. Table 4 shows the policies that benefit small firms that receive a VAT discount, as discussed earlier. In this case, the effect of VAT with rebate with a rate of 19 decreases 11 percent of the TFP and output, and there reduces maximum this measure 15 percent.

Tab. 4: VAT-Rebate plants with low productivity

	τ_v			
Variable	19%	21%	23%	25%
Relative Y	−11%	−12%	−14%	−15%
Relative TFP	−11%	−13%	−14%	−15%
Y_r/Y	68%	72%	76%	79%
τ_s	34%	35%	36%	36%

In the case of table 5, the large firms receive the rebate of acquiring capital goods. This channel only reduces the TFP and output 1 percent, and the needed resources to finance the maximum value of this distortion is 2 percent. Although the high productivity plants take advantage of the VAT rebate, the loss of resources is significant than the decreasing productivity.

Tab. 5: VAT-Rebate plants with high productivity

	τ_v			
Variable	19%	21%	23%	25%
Relative Y	−1%	−1%	−1%	−1%
Relative TFP	−1%	−1%	−1%	−1%
Y_r/Y	97%	97%	97%	98%
τ_s	1%	1%	1%	2%

We suppose that remove the VAT rebate hence all rate is levied all plants are forced to be efficiently. Therefore, in this economy, 31 percent of plants exit and the most competitiveness increasing the productivity by 9 percent with 19 percent of the tax, and the minimum increasing is 7 percent with a VAT of 25 percent. On the output side, the maximum drop is 8 percent. It indicates that the decreasing returns to scale decrease the entry of plants. As the VAT size is larger regarding output tax, the VAT distortion can affect more output and productivity. It establishes that the comparative assess not only depends on the mechanism of each tax. Also, the size of each type of policy is an important factor in facing both distortions.

7.3 Distortions with the same size

An interesting and important counterfactual exercise is to compare both taxes to asses what distortion impacts more productivity and output. In the model, the transmission channel of each tax is different, and one necessary element to compare these taxes must be the same size. With a tax path of 19, 21, 23, and 25 percent for both taxes and half of the plants have a subsidy (rebate), and the other half is taxed. The case of small plants that take benefit of this policy: The fall in output and productivity is much higher with the output tax that decreases the productivity up to 19 percent maximum with a tax of 25 percent, and the VAT increases 5 percent with a tax of 19 percent.

The case of large plants that take benefit of this policy: Generally, the effect of both taxes is insignificant due to the most productive plants assign their resources optimally include being subsidized. Only with the output tax, the productivity and output reduce 1 percent. In this sense, the net effect of both distortions studied has several consequences over the productivity of correlated plants with the ownership structure of each distortion. In a comparative approach, the output tax has a mechanism that affects the plants according to their size. Instead of the VAT rebate mechanism increases the capital accumulation of each plant, it also increases the productivity and aggregate output. In this order, this work can discriminate what type of policy might be less harmful to productivity despite both of these produce a misallocation of resources. The VAT rebate policy can increase productivity and output, especially in small plants.

Since the point of view of fiscal policy in Colombia, the mechanism of VAT has better effects on productivity and output than the output tax. Also, figure 1 shows higher government revenue capacity than the output tax that has more distorting effects in the economy. A possible advance that might be useful to the distortions that are created, especially to increase the aggregate capital accumulation, is constructing a model that emphasizes the impact of policy distortions on the returns of capital investment, capital accumulation, and TFP.

8 Concluding Remarks

This paper analyzed two types of distortions that reallocate resources across heterogeneous production units in a developing economy. The results indicate that the impact of this both distortions with the same tax rates on aggregate output and TFP might be negatively in the output tax than VAT. While the distortions that benefit small plants, the VAT increases productivity 5 percent; the output tax decreases in 15 percent. Moreover, when the latest policy benefits large plants, the effect in productivity and output is reduced by 1 percent. Nevertheless, with the tax rates from Colombia, the output tax has a negative impact when benefit of small plants than large plants. Given the several policies to increase productivity and output, reallocation of resources across plants is significant in developing countries, especially when the small plants are benefited.

Although this literature is relatively new has had progress identifying the role of misallocation and specific channels. Apply these methodologies in the developing economies become a reason for the development of this literature. It also is relevant for future researches to explore how several causes of misallocation can affect the firm dynamics since the direct and indirect approach explained by Restuccia and Rogerson (2017). Another type of element to study since this literature could be the influence of R&D and the role of creative destruction in his indirect effect on growth (Restuccia and Rogerson (2013); Hsieh and Klenow (2018); Akcigit and Kerr (2018)).

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