Payroll Taxes and Labor Demand: Evidence from Colombian Manufacturing Industry

Sonia Alexandra Agudelo Ayala[1]

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Abstract

This study analyzes the impact of payroll taxes on employment decisions of Colombian manufacturing industry during the period 1974-2009. I consider two versions of a dynamic labor demand. One of them captures the overall effect of payroll taxes on employment while the other one captures the substitution effect between capital and labor. Both equations are estimated as an autoregressive distributed lag model by GMM. Given the use of a statutory payroll tax rate, this study has two advantages. First, it avoids econometric problems caused by using an effective tax rate. Second, the effect of payroll taxes can be broken down by the social security payroll tax (health and pension) and the *parafiscal* contributions. The main findings obtained are that (i) the long run labor demand elasticities with respect to payroll taxes are: 1.2% for social security and 2.3% for *parafiscal* contributions; and (ii) the long run elasticity of substitution employment with respect to the payroll tax rate is the same for social security and *parafiscal* contributions and they are close to 1.5% in the long run.

JEL *Classification*: J23, J32.

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[1]Departament d' Economia Aplicada. Universitat Autònoma de Barcelona. Edifici B, 08193. Bellaterra, Spain, tel: +34-93.581.27.39; email soniaalexandra.agudelo@e-campus.uab.cat.

1. INTRODUCTION

In the decade of the 90s, the Colombian economy began a process of structural reform of the labor market which encompassed, among other matters, the transformation of the Colombian Social Security System (Law 100 of 1993). The main aim of this reform was to expand the coverage in health and pension services by increasing social security payroll taxes (health and pension), affecting both the part paid by the employees and the employers. Ten years later, the Law 797 of 2003 established changes in pension schemes, which also led to significant increases in payroll taxes. As a result of this structural reform process, non-wage costs have grown significantly. They reached a rate of 61% over wages by 2009 (53% paid by employers) where the social security payroll tax rate was in total 28.5% (20.5%paid by employers).

Given this situation of high non-wage costs, some politicians have blamed them for destroying formal employment in the last two decades. Thus, in order to face this problem, the Colombian government issued a new law in 2010, which created some exceptions to the payment of *parafiscal* contributions. Nevertheless, In particular, in Colombia, payroll taxes have not been identified as main determinants of formal employment. There is a virtual lack of studies about tax incidence in Colombia and the international empirical evidence is far from reaching a consensus. It is very relevant therefore, to analyze the impact of payroll taxes (health, pension and *parafiscal* contributions) on labor demand up to 2009 to assess these changes.

I perform this analysis for the manufacturing industry because first, it is the only sector with panel data information with a long time dimension and containing data on wages. Second, the manufacturing industry generated a great share of the total urban employment, a 23% on average, by the period 1976-2009. And third, manufacturing industry is a specific sector where the institutional changes of the 1990s could have further destroyed employment levels. The Colombian manufacturing industry was characterized by significant job cuts, 2% on average.

In order to analyze the effect of payroll taxes on labor demand I consider two versions of a dynamic labor demand. In particular, I take as reference the approach of Karanassou *et al.* (2007) and Antràs (2004) and bring together three fundamental assumptions on payroll taxes, adjustment costs and technological change. One of the equations captures the overall effect of payroll taxes on labor demand while the other one captures the substitution effect between capital and labor. Both equations are estimated as an autoregressive distributed lag model by using GMM. Regarding methodological matters, I must highlight that, as I use statutory payroll tax rate, this study has two advantages: first, it avoids econometric problems by using an effective tax rate, such as the simultaneity in the determination of wages and payroll tax rates, and the spurious variability of payroll tax rate. Second, the effect of payroll taxes can be broken down by the social security payroll tax (health and pension) and the *parafiscal* contributions.

I must remark that previous works have focused on estimating the net employment effect, while I focus on labor demand. Take into account that the reduction on the level of employment is determinate by two opposing forces: i) the contraction of labor demand ii) a compensatory effect caused by wage cuts.

In general, previous literature has focused in two strategies: calibration and econometric models. Calibration is typical of the "Computable General Equilibrium Models" (CGE)[2]. They are no more than the numerical application of theoretical general equilibrium models. Some recent evidence for Colombia is provided by Botero (2011) and Hernández (2011). Both found that eliminating the *parafiscal* contributions will lead to increases in the level of formal employment.

On the other hand, most of the econometric approaches are based in partial equilibrium models[3] and include a wide variety of empirical works. However, there is only one study to be highlighted for the Colombian case, that conducted by Kugler and Kugler (2009) who showed that payroll tax increases have negative effects on formal employment and wages. The former results have been interpreted as evidence that there is partial shifting. That means, employers partially shift payroll tax burden to workers as lower wages, then there is a negative effect on the employment level. They argue this is because of the presence of downward wage rigidity which does not allow paid wages to decline enough to offset the effects on employment, as

[2] The main idea of a CGE model is simple: it is a computational representation of an economy which consists of economic agents who behave according to the principles of microeconomic optimization. The modeling of economic agents' behavior is necessary to assume specific functional forms; the value of the parameters is calculated using a process called calibration that uses information from a social accounting matrix and independent econometric estimates of elasticity's supply, demand and substitution factors. Finally, the calibrated model simulations can be performed to assess the impact of tax measures.

[3] Others are based in structural models which can arise from general equilibrium models.

economic theory predicts. Although, these results might be used as an argument to show the validity of employment policies that promote the reduction of labor costs; studies from other countries such as Cruces *et al*. (2010); Bennmarker *et al.* (2009); Bauer and Riphahn (2002); and Gruber (1997) found that reductions in payroll tax rates do not generate significant effects on employment.

Regarding my results I found: First, the long run labor demand elasticities with respect to payroll tax are: 1.21% for social security and 2.33% for *parafiscal* contributions. And second, the elasticity of substitution employment with respect to payroll tax rate is the same for social security and *parafiscal* contributions; they are approximately 1.5% in the long run.

These results suggest that the institutional changes brought by the government up to 2009 affected negatively the formal labor demand of the Colombian manufacturing industry. And, even more, they give empirical support to the policy implemented by the Colombian government in 2010. Because, (i) the reductions in *parafiscal* contributions rate might boost net job creation. And (ii), the *parafiscal* contributions rate might be a fiscal instrument more powerful than the social security payroll tax rate. Due to the demand for labor is approximately twice as sensitive to shifts in the *parafiscal* contributions rate than to shifts in the social security payroll tax rate.

This paper is divided into six sections including this introduction. Section 2 provides the background on Colombian payroll taxation. Section 3 focuses on effects of payroll taxes on labor demand and provides an empirical implementation. Section 5 discusses the data and empirical issues. Section 6 presents the empirical results. And Section 6 concludes.

2. BACKGROUND ON COLOMBIAN PAYROLL TAXATION

In Colombia when a company hires a worker, according to labor law, it assumes the following mandatory payments besides of wages: a social security payroll tax (health insurance and pension schemes), *parafiscal* contributions, paid leaves, a severance payment, and occupational hazards, among others. The *parafiscal* contributions, which are only paid by employers, have been used to finance the Family Compensation System, the National Service of Learning (SENA by its acronym in Spanish) and the Colombian Family Welfare Institute (ICBF by its acronym in Spanish).

During the period 1970-1990, the Colombian Social Security System was characterized by institutional disintegration and low coverage. First, there were different institutions (private and public) providing separately the following services: pension schemes, savings, health insurances, occupational hazards and social solidarity services. And second, the employees formally linked to the labor market were unique members of the system and in some cases their family group. These features were identified as its main weaknesses due to the system could not ensure the welfare of the population. Hence, they carried out structural reform in 1993. A new social security system was conceived; it brought together all services: pension schemes, savings, health insurances, occupational hazards and social solidarity services.

As a result of the reform, the social security system was taken as a compulsory public service, and the contributions of both employers and employees were increased (see Table 1). The aim of these increases was to achieve greater health and pension coverage, through the solidarity system. In this way many citizens, who were not formally linked to the labor market or those that were not working, could enter and benefit from this system, particularly, the most unprotected population: elderly people, housewives and youth.

Table 1. Evolution of non-wage costs in Colombia

Year	Paid by employer						Paid by employee			Total
	Pension	Health	Parafiscal	Vacation	Others	Total	Pension	Health	Total	
1974	3.0	4,0	7,0	12,5	9.3	35,8	1.5	2.0	3,5	39,3
1980	3.0	4.7	7,0	12,5	9.3	36,5	1.5	2.3	3,8	40,3
1990	4.3	4.7	9,0	12,5	9.3	39,8	2.2	2.3	4,5	44,3
2000	10.1	8.0	9,0	12,5	11	50,7	3.4	4.0	7,4	58,0
2009	12.0	8.5	9,0	12,5	11	53,0	4.0	4.0	8,0	61,0

Source: Data obtained from the annual publication "*LEGIS, Cartilla laboral*", (1974-2009).
Notes: All variables are in percentages. Others include paid vacation, savings and occupational hazards.

Table 1 summarizes the evolution of the main non-wage costs in Colombia up to 2009, including those paid by employees and employers. The most important issue to state is the great growth of non-wage costs during the last two decades as a consequence of the reform. The main source of these increments was the rise in social security payroll tax (health and pension). Note that the non- wages costs reached a rate of 61% over wages by 2009 (53% paid by employers) and the social security payroll tax rate was in total 28.5% (20.5% paid by employers). The former values include the proportion that goes to the solidarity fund to provide pensions and health services to groups of people who are not formally linked to the labor market. On the other hand, note that the *parafiscal* contributions have almost remained unchanged. Their increases only have been 1% to SENA in 1982 and 1% to ICBF in 1988. Thus, the "*parafiscal* payroll tax rate" was 9% by 2009, where 4% went to Family Compensation System, 2% to SENA and 3% to ICBF.

Given this particular situation of high non-wage costs, some politicians have blamed them of destroying formal employment and boosting informal activity in the last two decades. Thus, in order to face this problem, the Colombian government issued a new law in 2010, which created some exceptions to the payment of *parafiscal* contributions.[4] As will be described in the next section, however, there is not enough empirical evidence to support this political decision. The effects of institutional changes of the Colombian labor market have not yet been assessed. Under this scenario, it is very relevant to analyze the impact of payroll taxes (health, pension and *parafiscal* contributions) on labor demand up to 2009, because it provides an evolution of these changes, and it is likely to shed light on the expected effects of the recent policy. The reason why I focus on health, pension and *parafiscal* contributions is that have been the main policy instruments used by Colombian government.

3. EFFECTS OF PAYROLL TAXES ON LABOR DEMAND

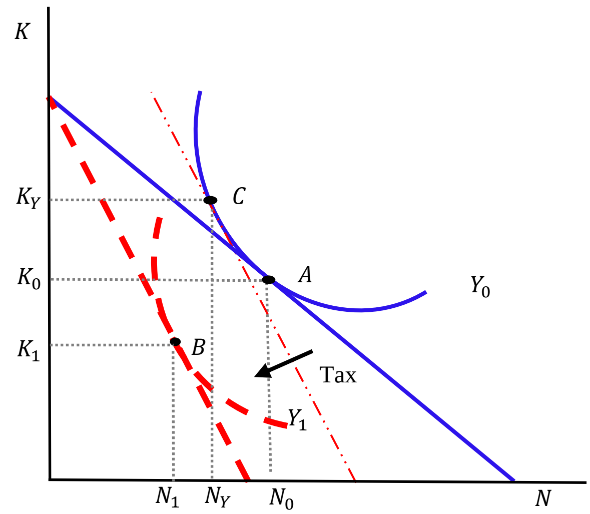
3.1. Intuition

Payroll taxes (paid by employers) are argued to have a negative impact on labor demand due to these taxes represent an extra labor cost for the employers. In the long-run, this impact can be explained as consequence of two effects: a substitution effect and a scale effect.

[4] Other arguments that have been used to justify the tax cuts are: first, the need of more competitive costs in order to face the competition that lies ahead with the signing of the free trade agreements (FTA). And second, the idea that some of the services that are financed by fiscal contributions and social insurance contributions are public goods whose responsibility should lie directly financing the public sector and not the business.

Both effects are widely analyzed in Hamermesh (1993) who uses them for explaining the labor demand elasticity with respect to real wage in the long-run. However, his qualitative conclusions can be applied in a context where government sets a payroll tax rate paid out by employers. Thus, these effects can be illustrated through Figure 1.

Figure 1. Substitution and scale effect



Point A represents the optimal choice of factors (N_0, K_0) where N_0 is the production function or isoquant. If the government sets a payroll tax rate τ, paid by the employer; it will increase labor costs. Given a wage W_0, labor cost increases to $W_0\ (1+\tau)$ then the slope of budget constraint (straight line) contracts and the optimal choice of factors is given by point B.

Note that the overall effect of the payroll tax on labor demand is given by the reduction from N_0 to N_1. This reduction arises from: First, the substitution effect that reflects how firms substitute capital for labor when face with a payroll tax, for a given level of output. This occurs because payroll taxes make labor factor is relatively more expensive than capital. This effect corresponds to movement from A to C or from N_0 to N_Y in the Figure 1. Second, the scale effect represents the fall in labor demand due to output reduction holding a production technology constant. Note that output reduces because increases in labor costs lead to higher output prices and therefore to lower sales. The idea behind this effect is that the real budget constraint is lower. This implies the firm can hire less capital and labor units with the same monetary unit. It is represented by the movement from C to B or N_Y to N_1.

The approach followed thus involves estimating two curves of demand for labor in order to capture the overall effect and the substitution effect. In particular, I will estimate two standard version of demand for labor but they will be extended by adding a payroll tax rate. The interpretation of coefficients will depend of the assumptions on labor and product market. These matters will be discussed in next section.

3.2. An Empirical Implementation

I obtain two empirical versions of a dynamic labor demand through the standard profit-maximization problem. This makes up one of the contributions of this paper because, first, I provide a straightforward derivation of the two labor demand equations with payroll taxes (paid by the employers). And second, I offer a consistent interpretation of coefficients of both equations. In particular, I take as reference the approach of Karanassou *et al.* (2007) and Antràs (2004) and bring together three fundamental assumptions. i) The payroll tax is modeled as ad valorem tax and proportional tax. ii) The employment adjustment costs are given in terms of training costs. iii) The technological change increases at a constant growth rate.

3.2.1. Overall effect

Following the approach of Karanassou *et al.* (2007), I assume that: first, a competitive labor market containing a fixed number f of identical firms with symmetric production and cost conditions, and monopoly power in the product market. The *i'th* firm has a Cobb Douglas production function: $q_{i,t}^{S} = A_t n_{i,t}{}^{\alpha} k_{i,t}{}^{1-\alpha}$, where $\mathrm{q}_{\mathrm{i,t}}^{\mathrm{S}}$ is output supplied, $\mathrm{n}_{\mathrm{i,t}}$ is employment, $\mathrm{k}_{\mathrm{i,t}}$ is capital stock, α $(0 < \alpha < 1)$ is a parameter accounting for relative influence of capital and employment, and $\mathrm{A}_{\mathrm{t}} = \mathrm{A}_0 \mathrm{e}^{\lambda \mathrm{t}}$ is the technological change type Antràs (2004) where λ is a growth rate. Second, firms have an employment adjustment cost or training cost $\xi_{i,t} = \left(\frac{n_{i,t}}{\rho n_{i,t-1}}\right)^{\delta}$ where $\delta > 0$ is a training cost coefficient and ρ is the employees' "survival rate".[5] Third, government sets a payroll tax rate τ which must be paid out by the employer.

[5] An extra assumption is given: the separation rate is sufficiently high (the survival rate is sufficiently low), so that $n_{i,t} > \rho n_{i,t-1}$. Thus the adjustment parameter may be interpreted in terms of training cost, see Karanassou et al. (2007).

Thus, solving the first order condition of the profit-maximization problem, defining aggregate employment as $N_t = n_{i,t}f$ and aggregate capital as $K_t = k_{i,t}f$ and aggregating across the firms, the aggregate dynamic labor demand is:

$$N_t = \left[\rho^{\delta} \alpha A_0 e^{\lambda t} \left(1 - \frac{1}{\varepsilon}\right)\right]^{\frac{1}{(1-\alpha+\delta)}} \left[\frac{W_t}{P_t}(1+\tau)\right]^{\frac{-1}{(1-\alpha+\delta)}} \; K_t^{\frac{(1-\alpha)}{(1-\alpha+\delta)}} \; N_{t-1}^{\frac{\delta}{(1-\alpha+\delta)}} \qquad (1)$$

Taking natural logarithms and introducing a white noise error $u_t \sim iid\ (0, \sigma_u^2)$ to capture supply and demand shocks the former equation can be rewritten as:

$$\ln N_t = \alpha_1 + \alpha_2 \ln N_{t-1} + \alpha_3 \ln \frac{W_t}{P_t} + \alpha_4 \ln K_t + \alpha_5 \ln(1+\tau) + \alpha_6\, t + u_t \qquad (2),$$

where $\alpha_1 = \frac{\ln\left[\rho^{\delta}\alpha A_0\left(1-\frac{1}{\varepsilon}\right)\right]}{(1-\alpha+\delta)}$, $\alpha_2 = \frac{\delta}{(1-\alpha+\delta)}$, $\alpha_3 = \frac{-1}{(1-\alpha+\delta)}$, $\alpha_4 = \frac{(1-\alpha)}{(1-\alpha+\delta)}$, $\alpha_5 = \frac{-1}{(1-\alpha+\delta)}$ $\alpha_6 = \frac{\lambda}{(1-\alpha+\delta)}$.

These coefficients can be interpreted as follows: the coefficient α_2 captures the persistence or inertia employment decisions. As, by definition, the training cost coefficient (δ) is positive, then α_2 will be positive as well.

The coefficient α_3 captures the labor demand elasticity with respect to real wage in the short run, whereas $\alpha_3/(1-\alpha_2)$ is the labor demand elasticity with respect to real wage in the long run. As shown in equation (8), α_3 is negative as well as $\alpha_3/(1-\alpha_2)$. In the same way the coefficients α_4 and $\alpha_4/(1-\alpha_2)$ represent the labor demand elasticities with respect to capital in the short run and in the long run, respectively; their signs are positive.

The coefficients α_5 and $\alpha_5/(1-\alpha_2)$ are the key parameters in this paper. They capture the overall effect of payroll taxes on the labor demand (given a wage level) in the short run and in the long run. A negative sign of α_5 indicates that the labor demand falls with taxes, unless $\alpha_5 = 0$ in which case the employer bases his demand decisions on net wages independently of the payroll tax. Then, the tax causes no fall in the effective labor demand. Note in equation (2) that $\alpha_3 = \alpha_5$ which means that a percentage change in the real wage or in the tax rate $(1+\tau)$ have the same impact on the labor demand.

Finally, α_6 reflects the short run influence of technological change on labor demand and $\alpha_6/(1-\alpha_2)$ is the long run influence.

3.2.2. Substitution effect

In Antràs (2004), an aggregate labor demand is derived from a profit maximization problem where the real output Y_t of the economy is described by the following production function CES:

$$Y_t = \left[\theta\left(A_t^k K_t\right)^{\frac{\sigma-1}{\sigma}} + (1-\theta)(A_t^n N_t)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}},$$

where K_t is aggregate capital stock; N_t aggregate employment, σ the elasticity of substitution between capital and labor, $A_t^k = A_0^k e^{\lambda_k t}$ and $A_t^n = A_0^n e^{\lambda_n t}$ represent the technological change of capital and labor which grow at constant rates λ_k and λ_n and θ is a distribution parameter. I introduce two more assumptions: first, there is employment adjustment cost ξ_t as Karanassou *et al.* (2007) do and second, the government sets a payroll tax rate τ over wages which must be paid out by the employer. Thus, the first order condition with respect to labor yields the following aggregate dynamic labor demand:

$$N_t = \left[(1-\theta)\rho^{\delta}\right]^{\frac{\sigma}{(1+\delta\sigma)}}\left[A_0^n e^{\lambda_n t}\right]^{\frac{-(1-\sigma)}{(1+\delta\sigma)}}\left[\frac{W_t}{P_t}(1+\tau)\right]^{\frac{-\sigma}{(1+\delta\sigma)}} \; Y_t^{\frac{1}{(1+\delta\sigma)}} \; N_{t-1}^{\frac{\delta\sigma}{(1+\delta\sigma)}} \qquad (3)$$

Taking natural logarithms and introducing a white noise error $u_t \sim iid\ (0, \sigma_u^2)$ to capture supply and demand shocks, the equation (3) can be rewritten as:

$$\ln N_t = \beta_1 + \beta_2 \ln N_{t-1} + \beta_3 \ln \frac{W_t}{P_t} + \beta_4 \ln Y_t + \beta_5 \ln(1+\tau) + \beta_6\, t + u_t \qquad (4),$$

Where $\beta_1 = \frac{\ln\left[(1-\theta)^{\sigma}\rho^{\delta\sigma}A_0^{n(\sigma-1)}\right]}{(1+\delta\sigma)}$, $\beta_2 = \frac{\delta\sigma}{(1+\delta\sigma)}$, $\beta_3 = \frac{-\sigma}{(1+\delta\sigma)}$, $\beta_4 = \frac{1}{(1+\delta\sigma)}$, $\beta_5 = \frac{-\sigma}{(1+\delta\sigma)}$ $\beta_6 = \frac{-(1-\sigma)\lambda_n}{(1+\delta\sigma)}$.

Regarding the coefficients of equation (4), β_2 is the inertia employment coefficient. As, by definition, the training cost coefficient (δ) and the substitution elasticity (σ) are positive, then β_2 will be positive as well.

The β_3 is the short run elasticity of substitution between capital and labor, whereas $\beta_3/(1-\beta_2)$ is long run substitution elasticity. Their negative signs reflect that the firms substitute labor for capital when faced with an increase in wages, for a given level of output.

Regarding β_4 and $\beta_4/(1-\beta_2)$, these are the labor demand elasticities with respect to output in the short run and in the long run, respectively; their signs are positive.

The coefficients β_5 and $\beta_5/(1-\beta_2)$ are the crucial parameters. Nevertheless, as shown in equation (4), they do not measure the overall effect of payroll taxes on the labor demand; rather, they catch the substitution elasticity and their negative signs, therefore, show that the firms substitute labor for capital when faced with a payroll tax.

Finally, β_6 measures the short run influence of technological change on labor demand while $\beta_6/(1-\beta_6)$ captures its long run influence.

4. DATA AND EMPIRICAL ISSUES

The functional form of the equations to be estimated is based on the derived demand functions (2) and (4). I extend them in the following directions.

First, I control for the degree of economic openness as the trade liberalization of 1990s might have affected the labor demand in Colombian for manufacturing.

Second, I take the natural logarithm of all variables including the payroll tax rate. In particular I replace $\ln(1+\tau)$ by $\ln\tau$, so that, all the coefficients can be interpreted as elasticities. The resulting equations are:[6]

$$\ln N_t = \alpha_1 + \alpha_2 \ln N_{t-1} + \alpha_3 \ln\frac{W_t}{P_t} + \alpha_4 \ln K_t + \alpha_5 \ln\tau_t + \alpha_6\, t + \alpha_7 \ln op_t + u_t \qquad (5)$$

$$\ln N_t = \beta_1 + \beta_2 \ln N_{t-1} + \beta_3 \ln\frac{W_t}{P_t} + \beta_4 \ln Y_t + \beta_5 \ln\tau_t + \beta_6\, t + \beta_7 \ln op_t + u_t \qquad (6),$$

[6] Some authors consider extensions of equations (11) and (12) by adding price controls such as, for example, the price of capital. However, it is known that labor demand elasticities tend to be biased upwards when the price of other factors are considered in these type of equations.

where α_7 and β_7 measure the short run influence of the external trade on manufacturing industry labor demand, and $\alpha_7 /(1-\alpha_2)$ and $\beta_7 /(1-\beta_2)$ are long run influences. The new coefficients α_5 and β_5 have the same qualitative interpretation that in equations (2) and (4) but they are not quantitatively equal. This means that now the coefficient α_5 can be called the short run labor demand elasticity with respect to payroll tax and $\alpha_5/(1-\alpha_2)$ is its counterpart for the long run. They capture the overall effect of taxes on the labor demand for a given wage. Meanwhile, β_5 and $\beta_5 /(1-\beta_2)$ measure the substitution effect resulting from the change in the relative factor prices when firms face a payroll tax increase.[7] The other coefficients have the same interpretation and signs that those in the equations (2) and (4). For the estimation process it could be interesting to test the equality between α_3 and α_5, β_3 and β_5, and also between their respective long run counterparts.

Third, as I work with a two-dimensional panel data to estimate (5) and (6), I also add individual effects which allow me to control for unobserved heterogeneity among individuals.

Finally, due to the relevance of adjustment costs in labor demand decisions, I also add lags of explanatory variables. Therefore the equations (5) and (6) will be estimated as an autoregressive distributed lag (ARDL) model that takes the following general form:

$$\ln N_{it} = \alpha_i + \lambda \sum_1^S LN_{i,t-s} + \beta X_{it} + \beta \sum_1^V X_{i,t-v} + u_{i,t} , \qquad u_{it} \sim iid\ (0, \sigma_i^2) \qquad (7),$$

where the subscripts i and t denote, sector and time index, respectively, s and v represent the dynamic structure of the model, N is the dependent variable, α is a sectorial cross-section intercept, λ is the inertial (or persistence) coefficient, X is a vector of explanatory and control variables, where β is a set of parameters that reflects their influence on dependent variables, and u_{it} is the error term.

4.1. Data: Description, sources and treatment

The definition of variables and its sources is provided in Table 2. This shows that the main source of the database is the Annual Survey of Manufacturing (EAM by its acronym in Spanish) which is supplied by the National Administrative Department of Statistics (DANE by its acronym in Spanish). From this survey I take data on a set of variables: employment (paid

[7] Take into account that this substitution effect is not the one in Hamermesh (1993).

and unpaid), wages, output and net capital stock. This data is available from 1974 to 2009 and is disaggregated by 19 sectors according to the International Standard Industrial Classification (ISIC) revision 3.AC. It is important to state some details about these variables.

Table 2. Definitions of variables

	Variables	Sources	Sub-indices
Y_{it}	Real output	EAM	$i = 1, \ldots, 19\ sectors$
K_{it}	Net real capital stock	EAM	$t = 1, \ldots, 36\ years$
${N^f}_{it}$	Formal employment	EAM	
W_{it}/P_t	Average real wage	EAM	
${\tau_t}^p$	Statutory parafiscal contributions rate	LEGIS	
${\tau_t}^{ss}$	Statutory social security payroll tax rate	LEGIS	
op_t	Openness $\left(\frac{exports+imports}{output}\right)$	DANE	
t	Linear time-trend	Constructed	

Note: All nominal variables are deflated with price index of manufacturing (base: June 1999)

First, the average real wages are calculated as real wage bill over total paid employment. Second, I use the value of real fixed assets[8] as a proxy for net capital stock. To test if this is a good proxy, I checked that the series normalized for the variation of real fixed assets and real net investments were correlated and quantitatively close. Third, I use as output the real value added. And fourth, the employment variable includes paid employment which I recall as formal employment.

Regarding payroll tax rates I have available two types of data. The first one is the non- wage costs obtained from EAM and the second one is the statutory payroll tax taken from LEGIS. In the first case, I could calculate payroll tax rate as total non-wage costs over wage bill. However, non-wage costs include concepts such as: severance payment, settlement, paid vacations, and other kinds of payment, which by definition cannot be considered strictly as payroll taxes. The problem is that it is not possible to break down each of these costs and, as a consequence, a correct payroll tax rate per sector it cannot be calculated. In this context, a possible solution would be to estimate a standard labor demand which includes the variable

[8] Fixed assets include office equipment, transport equipment, industrial equipment, buildings and structures, constructions in progress and lands.

wages plus non-wage costs; however, in that case, I would not be able to identify the individual effect of payroll taxes, which is disappointing given the purpose of this paper. Therefore, I do not use this data.

The second option, which I use in the estimation process, is the statutory tax rate. This data is uniform for all sectors and has two main advantages. First, it avoids econometric problems by using an effective tax rate. In particular, the simultaneity in the determination of wages and payroll tax rates and the spurious variability of payroll tax rate are not an issue. Second, I can break down the effect of payroll tax by type of tax: social security (health and pension) and *parafiscal* contributions. Likewise, using statutory payroll tax has a weakness: the little variability of data might lead to multicollinearity problems.

On the other hand, to measure the degree of openness I take data from DANE. Finally, all nominal variables are deflated with the price index of manufacturing (base: June 1999).

In summary, I work with a panel model with a cross-section dimension of $N = 19$ sectors and a time dimension of $T = 35$ years covering the period 1974-2009.

Table 3 provides descriptive information on the crucial variables of interest. This information corresponds to aggregate averages of Colombian manufacturing industry for the relevant period of analysis.

Table 3. Economic scenario in the Colombian manufacturing industry.

Years	ΔY_t	ΔK_t	$\Delta W_t/P_t$	$\Delta {N^f}_t$	$\Delta \frac{Y_t}{{N^f}_t}$	${\tau_t}^{ss}$	${\tau_t}^{p}$	op_t
1974-1979	6.23	-2.74	3.32	2.25	3.97	7.44	6.67	18.44
1980-1989	3.55	3.98	0.90	-0.05	3.59	8.33	7.90	22.04
1990-1999	1.87	17.21	5.12	-2.00	3.87	15.52	9.00	28.78
2000-2009	5.28	2.33	1.20	1.15	4.12	22.07	9.00	35.65
1974-2009	4.23	5.19	2.64	0.34	3.89	13.34	8.14	26.22

Notes: Δ is the difference operator and indicates average growth rates. All variables are expressed in percent.

Real growth of the Colombian manufacturing industry was around 4.23% on average since the mid-1970s until 2009. The main source of growth in the last three decades was capital investment which was benefited from the trade and financial openness process started in the late 1980s. Note, for example, in the 1990s there was a high capital investment growth (17.21%) and at the same time there was a high external trade flow (28.78%).

Although, the manufacturing industry grown; the net formal job creation was low 0.34%. Even more, the 1980s and 1990s were mainly characterized by formal job cuts (-0.05% and -2.00%) and lower output growth (3.55% and 1.87%). This situation could reflect the slowdown of the Colombian economy in the early 1980s and the second half of 1990s. The first one was due to the debt crisis and the second one due to the financial crisis. Nevertheless, part of the employment decrease could also be explained as a result of the payroll tax increases.

As a final point, in 2000-2009, the manufacturing industry was characterized by the deepening economic openness rate (35.61%), the improvement on labor productivity (4.12%), and the growth of social security costs (from15.52% to 22.07%).

4.2. Panel Unit Root Tests and Panel Cointegration Tests

As I have a dynamic panel, I must ensure there is a long run equilibrium relationship among the variables. In other words, to determinate if there might be causal relationships. That implies testing that all variables will be stationary I (0). If two or more variables are non-stationary but integrated of order I (1); I must check their cointegration to avoid the peril of having spurious relationships.

Table 4. Panel Unit Root Test

	${N^f}_{it}$	Y_{it}	K_{it}	W_{it}/P_t	${\tau_t}^p$	${\tau_t}^{ss}$	$\frac{minw_t}{P_t}$	op_t
Statistic	27.74	48.60	31.37	47.59	0.13	0.09	0.06	0.11
p-value	(0.865)	(0.116)	(0.768)	(0.137)				

Notes: All variables are expressed in logs. The 5% of critical value of KPSS test is 0.146 using intercept and trend, and testing in first differences.

In order to check the order of integration of the variables, I perform a series of unit root test. These tests are different depending on the type of variables to be dealt with. In particular, I use the KPSS unit root test[9] for the variables that are common across sectors; while, I used the AD Fisher unit root test for the variables that are sectorial-specific.

I used the AD Fisher unit root test, since, as Maddala and Wu (1999) point out, this test is simple and straightforward to use and is a better test than the Levin and Lin (1993) and the Im, Pesaran and Shin (2003) tests. The test has two attractive characteristics: first, it does not restrict the autoregressive parameter to be homogeneous across sector under the alternative of stationary. And second, the choice of the lag length and of the inclusion of a time trend in the individual ADF regressions can be determined separately for each sector.

Table 4 shows the tests. The test statistic and the p-value are provided for the AD Fisher test, while for KPSS test only the test statistic is provided. The results indicate that all variables follow a unit root process. Therefore, I test if there are cointegrating relations among variables. Specifically, I use the Johansen Fisher panel cointegration test which is shown in Table 5.

Table 5. Panel Cointegration

Hypothesized No. of CE(s)	Equation (K_{it})				Equation (Y_{it})			
	Fisher Statistic (from trace test)	*p-value*	*Fisher Statistic (from max-eigen test)*	*p-value.*	*Fisher Statistic (from trace test)*	*p-value*	*Fisher Statistic (from max-eigen test)*	*p-value.*
None	355.04	0.00	219.72	0.00	278.62	0.00	225.83	0.00
At most 1	165.94	0.00	107.38	0.00	105.82	0.00	83.51	0.00
At most 2	82.63	0.00	65.06	0.00	45.73	0.18	39.75	0.39
At most 3	38.38	0.45	33.94	0.66	22.27	0.98	17.42	0.99
At most 4	22.95	0.97	17.92	0.99	17.72	0.99	15.21	0.99
At most 5	23.68	0.97	23.68	0.98	18.37	0.99	18.37	0.99

Note: All variables are expressed in logs. Test computed using intercept and trend

These results indicate that the existence of a single cointegrating vector cannot be rejected. Actually, the first equation has three cointegrating relations and the second one has two. This means there is at least a long run relationship between the variables included in each specification for formal employment.

[9] See Kwiatkowski, Phillips, Schmidt and Shin (1992) for details.

4.3. Estimation method

Given the panel structure of my database, I will estimate the respective versions of specification (7) as a dynamic one-way fixed effect model (FE). However, these estimates are likely to be biased due to two main problems. First, the potential endogeneity caused by the introduction of a lagged dependent variable. And second, the well-known simultaneity of wages and capital (or output).

In particular, Nickell (1981) points out that when T is small and N is large, specifically when $T < N$, the within or fix effect estimator will be biased and inconsistent even if there is no serial correlation of the error term. Nevertheless, Álvarez and Arellano (2003) show that when $N \rightarrow \alpha$, $T \rightarrow \alpha$ and T grows fast enough with respect to N, the FE estimator will be consistent. This is relevant for me because I work with a large T, large N, and $T > N$ for formal employment. Therefore, I expect a reduced bias in the FE estimator. In contrast, for informal employment I work with a medium T, large N, and $T < N$, therefore I expect the FE estimator will be significantly biased. To deal with this problem I will estimate the respective equations by the Generalized Method of Moments (GMM) or Arellano and Bond (1991) estimator. The advantages of using GMM are that I can obtain consistent estimates and at the same time I can take into account the endogeneity of wages and capital (or output).

Thus, as a first step and for comparison purposes, I estimate the formal employment specifications by FE and GMM assuming wages and capital (or output) as exogenous variables, and then I estimate by GMM endogenizing these variables.

Additionally, with the aim to raise the efficiency of the FE estimator, I compute white cross-section standard errors (clustering by period) correcting for the possible presence of cross-section specific heteroskedasticity. I also compute a white covariances matrix whose estimates are robust to arbitrary heteroskedasticity and within cross-section serial correlation. In the case of the GMM estimator, I control for arbitrary heteroskedasticity and within cross-section serial correlation.

5. ESTIMATES AND RESULTS

Equations (5) and (6) are estimated for formal employment by a dynamic one-way FE model, GMM one-step (assuming wages and capital or output as exogenous) and GMM one-step (assuming wages and capital or output as endogenous).

Table 7 displays the results for formal employment. The estimated specifications are similar across models –equations (5) and (6) – and methodologies –FE and GMM one-step–. All explanatory variables are highly significant except output in the GMM estimations of equation (6). I am not concerned about this because, if I estimate a re-parameterization of both equations, the output becomes significant at common confidence levels, 1%, 5% and 10% (see the appendix, Table A). Note that all the variables have the expected signs and their coefficients have magnitudes that are economically plausible. In addition, as shown in Table 8 the long run elasticities are higher than the short run elasticities, which accords with economic theory.

Comparing estimates by FE and GMM one-step in which wages, capital, output, taxes, and openness are assumed as exogenous; I should not expect large differences in the estimated coefficients, as they turn out to be (see Table 6). Nevertheless, given the potential heterogeneity bias, there are unavoidable differences between both sets of estimates which, in turn, yield significant differences in the long run elasticities, especially in the equations that include the output as explanatory variable (see Table 6 and 7).

Likewise, if I put together the two estimations made by GMM, I realize that endogenizing wages and capital (or output) does not generate a high variability in the estimated coefficients but it does in the long run elasticities. Therefore, given that these differences among the three estimations might arise from the heterogeneity bias and the simultaneity of some regressors, I take as reference the results of the second estimation by GMM (third column in Table 6) since they combine the characteristics of dynamic panel data estimation and endogeneity control.[10]

[10] I also resorted to other panel data techniques such as Two Stage Least Square (2SLS) and Three Stage Least Square (3SLS) in order to control for the endogeneity of wages and capital (or output). But these did not yield reasonable results.

Table 6. Estimated labor demand for formal employment, 1974-2009.

Dependent variable: $\Delta N^{f}{}_{it}$

	FE		GMM one-step *		GMM one-step **	
	K_{it}	Y_{it}	K_{it}	Y_{it}	K_{it}	Y_{it}
C	0.24 (0.67)	0.11 (0.76)				
$N^{f}{}_{it-1}$	-0.08 (0.00)	-0.07 (0.00)	-0.10 (0.00)	-0.08 (0.03)	-0.09 (0.00)	-0.07 (0.03)
K_{it}	0.04 (0.00)		0.04 (0.07)		0.03 (0.06)	
Y_{it}		0.04 (0.01)		0.02 (0.56)		0.02 (0.61)
ΔY_{it}		0.17 (0.00)		0.15 (0.00)		0.17 (0.00)
W_{it}/P_t	-0.15 (0.00)	-0.11 (0.00)	-0.12 (0.01)	-0.06 (0.02)	-0.12 (0.00)	-0.05 (0.00)
$\Delta\left(W_{it}/P_t\right)$	0.14 (0.00)		0.13 (0.00)		0.16 (0.00)	
$\tau_t{}^{ss}$	-0.09 (0.00)	-0.06 (0.00)	-0.11 (0.00)	-0.09 (0.00)	-0.11 (0.00)	-0.10 (0.00)
$\tau_t{}^{p}$	-0.19 (0.00)	-0.12 (0.03)	-0.22 (0.00)	-0.13 (0.02)	-0.22 (0.01)	-0.13 (0.00)
t	0.01 (0.00)	0.01 (0.00)	0.01 (0.00)	0.01 (0.00)	0.01 (0.00)	0.01 (0.00)
op_t	-0.17 (0.01)	-0.06 (0.14)	-0.15 (0.01)	-0.07 (0.09)	-0.15 (0.01)	-0.07 (0.12)
Δop_t	0.35 (0.00)	0.27 (0.00)	0.35 (0.00)	0.30 (0.00)	0.36 (0.00)	0.32 (0.00)
Δop_{t-1}	0.17 (0.00)	0.16 (0.00)	0.17 (0.02)	0.16 (0.03)	0.17 (0.02)	0.16 (0.03)
Obvs.	646	646	627	627	608	608
ADF Fisher Test	116.56 (0.00)	134.74 (0.00)	407.04 (0.00)	405.25 (0.00)	395.23 (0.00)	392.08 (0.00)
Sargan Test			498.35 (0.20)	484.33 (0.35)	486.30 (0.30)	477.00 (0.41)

Notes:
All variables are expressed in logs. p-values in brackets.
FE: Fixed Effects.
GMM one-step: Generalized Method of Moments or Arellano and Bond (1991) estimator.
* All regressors, except $N^{f}{}_{it-1}$, are assumed as exogenous.

Instruments in model with K: [$N^{f}{}_{i1}, N^{f}{}_{i2}, \dots, N^{f}{}_{it-2},\ K_{it},\ W_{it-1}/p_t,\ W_{it-1}/p_{t-1},\ \tau_t{}^{ss},\ \tau_t{}^{p},\ t,\ op_t,\ op_{t-1},\ op_{t-2}$].

In model with Y: [$N^{f}{}_{i1}, N^{f}{}_{i2}, \dots, N^{f}{}_{it-2}, Y_{it},\ Y_{it-1},\ W_{it-1}/p_t,\ W_{it-1}/p_{t-1},\ \tau_t{}^{ss},\ \tau_t{}^{p},\ t,\ op_t,\ op_{t-1}$].

** $W_{it},\ Y_{it}$ *and* K_{it}, are assumed as endogenous.

Instruments in model with K: [$N^{f}{}_{i1}, N^{f}{}_{i2}, \dots, N^{f}{}_{it-2},\ K_{it-2},\ W_{it}/p_{t-2},\ W_{it}/p_{t-3},\ \tau_t{}^{ss},\ \tau_t{}^{p},\ t,\ op_t,\ op_{t-1},\ op_{t-2}$].

In model with Y [$N^{f}{}_{i1}, N^{f}{}_{i2}, \dots, N^{f}{}_{it-2}, Y_{it-2},\ Y_{it-3},\ W_{it}/p_{t-2},\ \tau_t{}^{ss},\ \tau_t{}^{p},\ t,\ op_t,\ op_{t-1},\ op_{t-2}$].

ADF Fisher Test computed using intercept and trend.

Table 8 presents the crucial elasticities (short run and long run) for my analysis. Recall that the overall effect of payroll taxes on the labor demand and the wage elasticity are obtained from equation (5) while the substitution effect of payroll taxes and the standard elasticity of substitution are obtained from equation (6). So qualitatively, the three estimation methods deliver a similar picture but quantitatively they do not. The main difference is in the long run elasticity of substitution estimates. To check the robustness of the GMM estimator from equation (6) (third column in Table 7), I take as reference some estimates of the labor demand in the Colombian manufacturing industry similar to equation (12) and I compare the long run substitution elasticity. For example, Arango and Rojas (2003) and Vivas *et al*. (1998) found that the substitution elasticity is around -0.7. Likewise, Robert and Sckofias (1997) found that it is -0.42 for skilled workers, and -0.63 for unskilled.

Table 7. Estimated labor demand elasticities for formal employment, 1974-2009.

Elasticity		FE		GMM one-step*		GMM one-step *	
		K_{it}	Y_{it}	K_{it}	Y_{it}	K_{it}	Y_{it}
Parafiscal contribution	SR	-0.19	-0.12	-0.22	-0.13	-0.22	-0.13
	LR	-2.37	-1.69	-2.18	-1.65	-2.33	-1.77
Social Security (health and pension)	SR	-0.09	-0.06	-0.11	-0.09	-0.11	-0.10
	LR	-1.18	-0.86	-1.14	-1.13	-1.21	-1.43
Real Wage	SR	-0.15		-0.12		-0.12	
	LR	-1.89		-1.18		-1.31	
Substitution	SR		-0.11		-0.06		-0.05
	LR		-1.53		-0.72		-0.67

Notes: SR- Short run- and LR -Long run-

Given these results and the preference for the second econometric GMM estimate, I conclude that, first, there is a high level of persistence in employment decisions and, in turn, a low sensitivity of the demand for labor to wage shifts and payroll tax shifts in the short run.

Second, the overall effect (in the long run) of social security payroll taxes and *parafiscal* contributions are respectively -1.21 and -2.33. That is, a 1% increase in the social security payroll tax rate will cause a 1.21% reduction in the demand for formal labor, while a 1% increase in the *parafiscal* contributions rate will cause a 2.33% reduction in the demand for formal labor. This means that demand for formal labor in the Colombian manufacturing industry is approximately twice as sensitive to a 1% shift in *parafiscal* contributions rates than to a 1% shift in social security payroll tax rate.

Third, the long run substitution effects or substitution elasticities resulting from the change in the relative factor prices when firms face a payroll tax increase are -1.43 for the social security payroll tax rate and -1.77 for the *parafiscal* contributions rate. Nevertheless, as shown in the empirical derivation section, they are expected to be equal. Therefore, I check this hypothesis using a Wald-test and I cannot reject the equality in the short run and long run. This means the elasticity of substitution employment with respect to the payroll tax rate is the same for the social security and the *parafiscal* contributions. Quantitatively, they are approximately two point five times the standard elasticity of substitution.

As a final point, I also tested the equality of the labor demand elasticities with respect to real wages and with respect to the social security payroll tax (for the short and long-run). I could not reject the null hypothesis of equality which means that firms respond in the same way to a 1% increase in wages or to a 1% increase in social security payroll tax rate.

6. CONCLUDING REMARKS

In this study, I have analyzed the impact of payroll taxes on the labor demand to assess the effects of institutional changes of the Colombian labor market on the employment decisions taken in manufacturing industry (up to 2009). Through the standard profit maximization problem, I have obtained two empirical versions of dynamic labor demands, which incorporate the payroll tax rate. These labor demand equations have been estimated as autoregressive distributed lag models by GMM.

The results obtained suggest that the institutional changes brought by the government in last decades (up to 2009) affected negatively the formal labor demand of the Colombian manufacturing industry. And, even more, they have two main implications in terms of the 2010 measures of economic policy. First, assuming that there is not full shifting as Kugler and Kugler (2009) pointed out, the reductions in *parafiscal* contributions rate issued by the Colombian government in 2010 might boost net job creation in the manufacturing industry, especially in the long run due to slow labor demand adjustment process. Second, the *parafiscal* contributions rate seems to be a fiscal instrument more powerful to create new jobs due to the fact that the demand for formal labor is approximately twice as sensitive to shifts in the *parafiscal* contributions rate than to shifts in the social security payroll tax rate. This result validates the policy implemented by the Colombian government.

To further validate this conclusion, it is necessary that future studies estimate a dynamic multi-equation labor market system, which allows to simultaneously capture the effect of payroll taxes on wages and employment. It would also be interesting to break down this employment effect into: a labor demand effect and a compensation effect. In addition, adding more sectors of the economy could yield a more accurate picture on the total effect on employment and wages. Controlling the type of employment (for example, by permanent and temporal personal or by production and administrative personal) could improve the estimates as there might be differentials of wages which might make firms react differently to changes in payroll taxes. Finally, two major challenges are: first, to design an approach to capture simultaneously the effects of taxation in the formal and informal sectors (for example through a CGE model), because Colombia is characterized by high and persistent levels of informal activity (around 50%). Second, to design a model that also captures the effects of these policies on government revenue.

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APPENDIX

Table A. Estimated labor demand for formal employment, 1974-2009.

Dependent variable: $\Delta N^{f}{}_{it}$	GMM one-step *	GMM one-step **
	Y_{it}	Y_{it}
C		
$N^{f}{}_{it-1}$	-0.08 (0.03)	-0.07 (0.03)
K_{it}		
Y_{it}	0.17 (0.00)	0.18 (0.00)
Y_{it-1}	-0.15 (0.00)	-0.16 (0.00)
W_{it}/P_t	-0.06 (0.02)	-0.05 (0.00)
$\Delta\left(W_{it}/P_t\right)$		
$\tau_t{}^{ss}$	-0.09 (0.00)	-0.10 (0.00)
$\tau_t{}^{p}$	-0.13 (0.02)	-0.13 (0.00)
t	0.01 (0.00)	0.01 (0.00)
op_t	-0.07 (0.09)	-0.07 (0.12)
Δop_t	0.30 (0.00)	0.32 (0.00)
Δop_{t-1}	0.16 (0.03)	0.16 (0.03)
$Obvs.$	627	608
ADF Fisher Test	405.25 (0.00)	392.08 (0.00)
Sargan Test	484.33 (0.35)	477.00 (0.41)

Notes:
All variables are expressed in logs. P-values in brackets.
FE: Fixed Effects.
GMM one-step: Generalized Method of Moments or Arellano and Bond (1991) estimator.
* All repressors, expect $N^{f}{}_{it-1}$, are assumed as exogenous.

Instruments in model with K: [$N^{f}{}_{i1}, N^{f}{}_{i2}, \ldots, N^{f}{}_{it-2}$, K_{it}, W_{it}/p_t, W_{it-1}/p_{t-1}, $\tau_t{}^{ss}$, $\tau_t{}^{p}$, t, op_t, op_{t-1}, op_{t-2}].

In model with Y: [$N^{f}{}_{i1}, N^{f}{}_{i2}, \ldots, N^{f}{}_{it-2}$, Y_{it}, Y_{it-1}, W_{it}/p_t, W_{it-1}/p_{t-1}, $\tau_t{}^{ss}$, $\tau_t{}^{p}$, t, op_t, op_{t-1}].

** W_{it}, Y_{it} and K_{it}, are assumed as endogenous.

Instruments in model with K: [$N^{f}{}_{i1}, N^{f}{}_{i2}, \ldots, N^{f}{}_{it-2}$, K_{it-2}, W_{it-2}/p_{t-2}, W_{it-3}/p_{t-3}, $\tau_t{}^{ss}$, $\tau_t{}^{p}$, t, op_t, op_{t-1}, op_{t-2}]. In model with Y [$N^{f}{}_{i1}, N^{f}{}_{i2}, \ldots, N^{f}{}_{it-2}$, Y_{it-2}, Y_{it-3}, W_{it-2}/p_{t-2}, $\tau_t{}^{ss}$, $\tau_t{}^{p}$, t, op_t, op_{t-1}, op_{t-2}].

ADF Fisher Test computed using intercept and trend.