PEDL Research Papers

This research was partly or entirely supported by funding from the research initiative Private Enterprise Development in Low-Income Countries (PEDL), a Foreign, Commonwealth & Development Office (FCDO) funded programme run by the Centre for Economic Policy Research (CEPR).

TFP Estimation at the firm level: Do Fiscal Pressure, the Legal Form, and the Local Competition Matter for Firm Performance in Senegal

Ibrahima Sarr Yaya Diallo Idrissa Diagne Amadou Asseloka Catherine Monoue [1]

Abstract

This paper reviews the state of the art in firm-level Total Factor Productivity (TFP) estimation by employing an unbalanced panel of 4,501 Senegalese firms in the Construction and Trade Services industries over the period 2008–2018. The three semi-parametric models considered are Olley and Pakes (1996)'s approach (OP hereafter), Levisohn and Petrin (2003)'s algorithm (LP hereafter) and Ackerberg et al. (2015)'s approach (ACF hereafter). Each of these estimators assumes different underlying properties for some inputs, which potentially affect the TFP measurements. We also analyze how corporate taxation, the legal form and the regional competition affect firm level productivity. Our findings are summarized as: (i) the ACF produces insignificant capital and labor coefficients for both Construction and trade services industries, while LP produces the best alternative within semi-parametric models and it is better than OP; (ii) tax pressure adversely affects TFP and the adverse effect is found to be severe in the groups of trades services firms, suggesting that the distortive nature of corporate tax affects disproportionately firms across the sectors. The results also suggest that the local economic environment plays a role on firm performance in the trade industry. The extent of local competition negatively affects the firm performances for both industries. The results indicate that medium-sized and large-sized firms also demonstrate an advantage over small ones. The effect of age of firm is positive but diminishes as firms become older.

JEL classifications: D22, D24, O3, 04

Keywords: Total factor productivity (TFP); Legal form; Firm performance; Senegal

---

[1] * Corresponding author : Ibrahima Sarr: (e-mail: ibrahimasarr3@gmail.com). This document is an output from the research initiave « Private Enterprise Development » (PEDL), a programme funded jointly by the Centre for Economic Policy Research (CEPR) and the Department for International Development (DFID), contract reference PEDL_LOA_8284_Sarr. The views expressed are not necessarily those of CEPR and DFID.

1 Introduction

Firm performance plays a central role in nations' economic growth and accelerates the process of economic development in Low Income Countries (LICs) and achieving the ambitious targets laid out in the Sustainable Development Goals (SDGs). After a decade of empirical research on economic growth, economists concluded that, although physical and human capital accumulation play a crucial role in accounting for economic progress in some countries, Total Factor productivity (TFP)— a measure of efficiency and technological change— explains most of the income and economic growth differences across countries (Easterly and Levine 2001). At the macro-level, TFP growth in the average country accounts for about 60 percent of the growth in output per worker. Further, recent empirical evidence shows that the typical Latin American country would have increased income per capita by 54 percent since 1960 if its TFP had grown at the same pace as its counterparts in the rest of the world (Pagés 2010). At the micro-level, recent studies have shown that large and persistent differences in productivity levels across businesses are ubiquitous (Syverson 2011).

These findings have shaped research agenda, and economists and policymakers are continuously concerned about understanding the key drivers of firm performance. The literature has documented fiscal pressure as one of the driving keys of firm level productivity (Bournakis and Mallick 2018; Gemmell et al. 2018). The legal form of a firm is also identified as a factor behind firm performance. Indeed, a firm's legal form which determines firm management and the corporate governance, affects firm's sales, survival rate and productivity (Harhoff, Stahl, and Woywode 1998; Abdo Ahmad and Fakih 2021; Škare and Hasić 2016). In addition, the local environment affects firm performance. For instance, the regional industrial structure affects firm performance as businesses generally face higher constraints, charges and competitions in these highly congested regions.

Even though these existing studies provide useful insights about the firm level productivity and its determinants, they are not without limitations. A central issue in exploring firm performances and its determinants obtaining reliable measures of TFP at the firm level (Bournakis and Mallick 2018). A second major limitation is the lack of enough data on some of the commonly analyzed factors, especially firm financial information and reliable information on the legal firm. Much less is also known about the effect of the local economic environment on firm performance in developing countries, especially African countries. This paper bridges this gap by estimating how the firm level productivity of firms in one of the Sub-Saharan African countries is determined. Using three semi-parametric models (Olley and Pakes (1996)'s approach, Levisohn and Petrin (2003)'s algorithm and Ackerberg et al. (2015)'s approach and employing an unbalanced panel of 4,501 Senegalese firms in the Construction and Trade Services industries over the period 2008–2018, we estimate the state of the art in firm-level Total Factor Productivity (TFP) on these firms. Each of these estimators assumes different underlying properties for some inputs, which potentially affect the TFP measurements. We also analyze the role of corporate taxation on firm and explore how the legal form and the regional competition affect firm level productivity.

The results indicate that ACF approach produces insignificant capital and labor coefficients for both Construction and Trade Services industries, while LP estimator is the best alternative within the group of semi-parametric estimators as LP produces positive and significative coefficients for both sectors (except the capital for construction). The results suggest that tax pressure adversely affects TFP, and the adverse effect is found to be severe in the groups of Trades Services firms, suggesting that the distortive nature of corporate tax affects disproportionately the firms across different sectors. The findings also indicate that the local economic environment plays a role on firm performance in the trade industry. The extent of local competition negatively affects the firm performances for both industries. The results also indicate that medium-sized and large-sized firms demonstrate an advantage over small ones. This advantage ranges between 35 percent and 40 percent for construction industry, and between 43 percent and 118 percent for trade industry. The effect of age of the firm is also positive but diminishes as firms become older.

This paper contributes severally to the nascent literature on firm performance. This is the first study that uses semi-parametric methods and a census data to determine the factors that affect firm-level productivity on a Sub-Saharan country. We apply the semi-parametric methods to a sample of firms in Senegal, one of the Heavily Indebted Poor Countries (HIPCs) in the world. Since all the studies that use these approaches are on more developed and High-Income Countries, this provides a new setting to apply and further validate these semi-parametric methods. Second, we take into consideration the nature of data in use and more importantly to what extent the underlying assumptions of each method are compatible to the data generating process (DGP) and the Senegalese economy. We also exploit a richer and more comprehensive set of data than what have been used in the existing literature, which includes administrative census-type data of firms in Senegal covering all formal firm over the period 2008-2018.

The paper is organized as follows: Section 2 presents the methodology of TFP estimation. Section 3 presents the data. The TFP estimation results are presented in Section 4, and Section 5 investigates the determinants of firm performance. Section 6 concludes.

2 TFP estimation: methodology and measurement

We assume that the production function of a firm is a standard Cobb-Douglass production function, specified as follows:

$$\mathrm{Y_{it}} = \mathrm{A_{it}} \mathrm{K_{it}}^{\beta_k} \mathrm{L_{it}}^{\beta_l} \mathrm{M_{it}}^{\beta_m} \qquad (1)$$

Where $\mathrm{Y_{it}}$ is the production of firm i at year t. $\mathrm{A_{it}}$ stands for Hicks neutral technical change (TFP). $\mathrm{K_{it}}$, $\mathrm{L_{it}}$, and $\mathrm{M_{it}}$ are capital stock, labor input, and intermediate materials inputs of firm i at year t, correspondingly.

In order to recover the estimates of the parameters β_k , β_l, and β_m, the following log-linear form (letters in lower cases) of the production function (1) is considered:

$$y_{it} = \beta_0 + \beta_k k_{it} + \beta_l l_{it} + \beta_m m_{it} + \omega_{it} + \varepsilon_{it} \qquad (2)$$

Where $\ln(A_{it}) = \beta_0 + \omega_{it}$. β_0 is the average productivity while ω_{it} is firm productivity shock. The term ε_{it} is error term.

Equation (2) can be estimated by Ordinary Least Squares (OLS). Such estimates might suffer from two major issues: i) simultaneity and ii) selection bias.

Simultaneity arises because productivity is known to the profit-maximizing firms (but not to the econometrician) when they choose their input levels (Marschak and Andrews 1944). Following a positive productivity shocks, firms will increase their use of inputs and the OLS estimation would not take into consideration the unobserved productivity shocks, which would lead to biased parameter estimates.

Selection bias comes as a result of the relationship between productivity shocks and the probability of exit from the market. If a firm's profit is positively related to its capital stock, then a firm with a larger capital stock is more likely to stay in the market than a firm with a smaller capital stock even though the firm with more capital has a lower productivity shock as it is expected to produce greater future profits. The negative correlation between capital stock and probability of exit for a given productivity shock will cause the coefficient of the capital variable to be biased downward unless we control for this effect.

Semi-parametric methods are proposed as the novel approach to address the simultaneity and selection problems while estimating the production function parameters and firm-level productivity.

2.1 Olley and Pakes algorithm

One of the semi-parametric methods that have been suggested in the literature is the Olley and Pakes (1996) (hereafter OP) method . The OP approach assumes that firms decide at the beginning of each period whether to continue participating in the market or exit. If the firm exits, it receives a liquidation value and never appears again. If it continues, it chooses variable inputs (labor, material) and a level of investment, $\mathrm{I_{it}}$. The firm maximizes the expected discounted value of net future profits. Consequently, investment, $\mathrm{I_{it}}$, is a strict monotonic function of the capital stock, K_{it}, and the productivity shock, ω_{it}: $i_{it} = g(k_{it}, w_{it})$. Thus, the productivity shock, ω_{it}, is expressed as:

$$\omega_{it} = h(k_{it}, i_{it})$$

Equation (2) becomes:

$$\mathrm{y_{it}} = \beta_l \mathrm{l_{it}} + \beta_m \mathrm{m_{it}} + \psi(k_{it}, i_{it}) + \varepsilon_{it} \qquad (3)$$

Where $\psi(k_{it}, i_{it}) = \beta_0 + \beta_k \mathrm{k_{it}} + h(k_{it}, i_{it})$.

OP algorithm estimates equation (3) into two stages. In the first stage, an OLS is used to estimate equation (3) to get labour and materials coefficients. $\psi(k_{it}, i_{it})$ is approximated by a higher order polynomial function of k_{it} and i_{it}. In the second stage, OP algorithm runs a regression of $\mathrm{y_{it}} - \widehat{\beta_l}\mathrm{l_{it}} - \widehat{\beta_m}\mathrm{m_{it}}$ on $\hat{\psi}(k_{it}, i_{it})$. The capital stock is recovered by assuming that productivity ω_{it} follows a first order Markov process:

$$\omega_{it} = E(\omega_{it} \backslash \omega_{it-1}) + \theta_{it}$$

$$\omega_{it} = f(\omega_{it-1}) + \theta_{it}$$

where θ_{it} is an idiosyncratic error term of the productivity function.

More precisely, the following equations is estimated at the second stage:

$$\mathrm{y_{it}} - \widehat{\beta_l}\mathrm{l_{it}} - \widehat{\beta_m}\mathrm{m_{it}} = \beta_k \mathrm{k_{it}} + f\left(\hat{\psi}(k_{it-1}, i_{it-1}) - \beta_0 - \beta_k \mathrm{k_{it-1}}\right) + \theta_{it} \qquad (4)$$

From equation (3), the stock capital coefficient is recovered by using a non-linear estimation.

2.2 Levinsohn and Petrin algorithm

The second semi-parametric technique is the Levisohn and Petrin (2003)'s algorithm (LP hereafter) and this technique shares many similarities with the OP approach. To control for the correlation between the unobservable productivity shocks and the input levels, OP suggested using a firm's investment as a proxy variable for a firm's productivity. LP provided evidence from firm-level datasets that investment is very lumpy, meaning there are substantial adjustment costs. As firms face substantial adjustment costs, the investment variable may not be appropriate. Investment may not fully respond to changes in productivity, and it may become severely truncated at zero. This led LP to suggest an alternative approach that uses intermediate inputs rather than investments. LP showed that using intermediate materials has a benefit of being strictly data driven while it turns out that the investment proxy is only valid for plants reporting nonzero investment. The use of intermediate materials as a proxy also allows a simple link between the estimation strategy and the economic theory, primarily because intermediate inputs are not typically state variables. LP algorithm employs intermediate inputs, $\mathrm{m_{it}}$, as a proxy variable for unobserved productivity instead of $\mathrm{i_{it}}$. Intermediate inputs $\mathrm{m_{it}}$ are then expressed as a function of capital and productivity: $m_{it} = m(k_{it},\ w_{it})$. Consequently, $\omega_{it} = h(k_{it}, m_{it})$. Equation (3) leads:

$$\mathrm{y_{it}} = \beta_l \mathrm{l_{it}} + \beta_m \mathrm{m_{it}} + \psi(k_{it}, m_{it}) + \varepsilon_{it} \quad (5)$$

Similarly, LP algorithm uses the same strategy as OP algorithm to estimate parameters β_l, β_k, and β_m.

2.3 Ackerberg, Caves and Fraser algorithm

Ackerberg, Caves, and Frazer (2015) (ACF hereafter) argue that the OP and LP estimation strategies— particularly LP—may suffer from identification issues. Unless additional assumptions are made about the data-generating processes, they showed that the labor input may not vary independently of the non- parametric function that is being estimated using the low-order polynomial. This led ACF to suggest an alternative that avoids this functional dependence problem by estimating all the input coefficients in the second stage. Thus, ACF estimation procedure draws on some aspects of both the OP and LP two-stage procedures, however it estimates all the input coefficients including labor input at the second stage. Therefore, labour becomes an element of the demand function for intermediate inputs in period t: $m_{it} = m(k_{it},\ w_{it}, l_{it})$. This function is still invertible as long as m is strictly increasing in ω_{it} and $\omega_{it} = \psi(k_{it},\ m_{it}, l_{it})$. The first stage equation in ACF is defined as:

$$\mathrm{y_{it}} = \phi(k_{it}, m_{it}) + \varepsilon_{it} \quad (5)$$

Where $\phi(k_{it}, m_{it}) = \beta_l \mathrm{l_{it}} + \beta_k \mathrm{k_{it}} + \beta_m \mathrm{m_{it}} + \psi(k_{it}, m_{it}, \mathrm{l_{it}})$

The first stage estimation in ACF regresses output on a polynomial function of capital, intermediate inputs and labour. In the second stage, all production coefficients (β_l, β_k, and β_m) are recovered by using Generalized Method of Moments (GMM) with the following moment restrictions:

$$E(k_{it}\ \theta_{it}) = 0, \quad E(l_{it-1}\ \theta_{it}) = 0, \quad and\ E(m_{it}\ \theta_{it}) = 0 \qquad (6)$$

3 Data

In the framework of this study, we use data from the *Banque de Données Économiques et Financières* (BDEF) of the Senegalese National Statistics Office, ANSD. The dataset comes as a result of the aggregation of data provided by companies through statistical and tax declarations supplemented by estimates for those in activity for which accounting documents are not available. The dataset covers firms established in Senegal and are subject to the SYSCOA (West African accounting system) chart of accounts. Companies are classified into four groups according to their main activity: i) Construction, ii) Trades Services, iii) Manufacturing, iv) Services. The initial number of firms includes 16,403 firms for the period 2008–2018.

We measure $\mathrm{y_{it}}$ with revenue, which is calculated as total sales. We convert sales from BDEF into real values using the GDP deflator (2009: 100) taken from ANSD. The labor input is measured as the firm expenses in terms of personnel. The firm's capital is proxied by its fixed assets. The intermediate material expenditure is measured as a sum of the firm's expenditures on goods used in the production process. We also deflate material expenditures (m), fixed assets (capital input), and expenses in personnel (labor) with the GDP deflator.

Investment, the proxy for unobserved TFP shocks in OP algorithm is derived from rearranging the standard perpetual inventory formula:

$$I_{it} = \alpha K_{it+1} - (1-\delta)K_{it} \quad (7)$$

Where I_{it} is the investment level. K_{it} and K_{it+1} are the stock of capital for the current and future period, respectively. The parameter δ is the depreciation rate.

The depreciation (δ) is taken as equal to 20% as in Bournakis and Mallick (2018). This formula requires the value of the fixed assets for 2019 for the computation of investment values for 2018, which is the last year in the dataset. As the time series dimension of our panel reaches up to 2011, we extrapolate the 2012 values of fixed assets in order to obtain investment data for 2018. After this cleaning process, the resulting data set is an unbalanced panel of 11,554 firms for the period 2008–2018. In the framework of this study, we focus on firms in the sectors of Trade Services and Construction, resulting in a dataset of 4,505 firms for the period 2008–2018 (31,781 observations over the study period).

In general firms are unequally distributed across regions in Senegal, with the Dakar, which is economic capital, hosting a higher number of firms. Figure 1 provides the spatial distribution of the firms in 2018. The indicator is the business density per region, which is the number of firms per 1,000 inhabitants. More red the area is, the higher the business density is. Only Dakar, Saint Louis, and Thies have a density higher than 2 firms per 1,000 inhabitants. This low density reflects and leads to lower employment, investment, and exports. It deepens inequality and also adversely affects the nation's economic performance.

Figure 2 shows the evolution of firm production over time for the trade services and the construction industry. Production of trades services has been decreasing over the study period from 1475 million CFA to 1250 million CFA. The production of the industry sector has been decreasing from 2008 to 2013. From 2014 to 2018, the construction industry production had sloping upward. This can be explained by the *Plan Sénégal Émergent, (PSE)*, which constitutes the reference for economic and social policy in the medium and long-term. As the PSE planned the construction of socio-economic infrastructure aimed at improving access to basic social services for rural communities, it had been a huge opportunity for the construction industry.

Table 1 provides summary statistics of the variables of interest.

Table 1: Summary statistics of variables of interest (log)

	Obs	Mean	St Dev	Min	Max
Construction sector					
y	5,600	18.59	2.07	10.34	26.03
k	5,600	17.74	2.38	11.06	27.63
l	5,599	16.37	2.00	8.43	23.50
m	5,597	18.38	2.11	10.32	25.90
Trade services					
y	23,406	18.94	1.75	9.97	26.77
k	23,406	16.91	1.95	8.35	25.24
l	23,397	15.73	1.56	6.98	23.06
m	23,325	18.86	1.74	9.83	26.74

Note: The data are at annual frequency. An observation is year-firm.

4 Production estimates and TFP estimates

The estimates from the semi-parametric estimators are shown in Table 2. Columns (1), (2), and (3) show the results for OP, LP and ACF models for the Construction industry respectively. Similarly, the three rightmost columns show the results for the Trade Services.

For the construction sector, the three models indicate that capital is not significant at the risk of 5%, unlike labor input and intermediate materials input. The estimated coefficient of labor in LP is similar to estimates in OP and ACF. An increase of 1% of labor input in this sector has a smaller impact than a similar increase of the intermediate material input for the three approaches of measurement of the TFP estimates: that is to say 15 % vs. 85 % according to the OP approach, 14% vs 90 % according to that of LP and finally 16 % vs 85 % according to that of ACF. Moreover, the Wald test indicates that this sector has constant returns to scale for the three approaches.

For the Trade sector, only LP produces a statistically significant for capital, labor, and intermediate materials coefficients. Both OP and LP algorithms provide significant coefficients for the labor input and material input at a risk of 5%. Like the construction sector, production for the trade services industry is more sensitive to an increase in intermediate material than to labor input. More precisely, the production increases by 95% when the material increases by 1% vs 4 % for labor input according to the OP model. On the other hand, an increase of 1% in intermediate materials has smaller effect on production according to the LP algorithm (68%). In addition, LP indicates that the capital is significant and when it varies by 1 %, the production increases by 10 %. This could be seen in the sense that trades services companies, by increasing their capital which corresponds to fixed tangible assets (land, buildings, transport vehicles, etc.), can acquire greater storage capacity which can reduce certain costs and therefore, implicitly, increase their production. Moreover, the Wald test indicates that this sector has a constant return to scale for OP and ACF algorithms.

Given that ACF produces a statistically insignificant capital and labor coefficients for both sectors, and also the OP uses investment proxy which is valid for only firms reporting nonzero investments[2], we could argue that the LP estimator is the best alternative within the group of semi-parametric estimators as LP produces positive and significative coefficients for both sectors (except the capital for construction).

---

[2] Levinsohn and Petrin (2003a) (LP) point to the evidence from firm-level datasets that suggest investment is very lumpy (that is, that there are substantial adjustment costs). If this is true, the investment proxy may not smoothly respond to the productivity shock, violating the consistency condition.

Table 2: Production estimates

	Construction			Trade services		
	OP	LP	ACF	OP	LP	ACF
	(1)	(2)	(3)	(4)	(5)	(6)
k	-0.005	0.003	0.001	-0.005	0.101**	-0.004
l	0.151***	0.141***	0.156	0.042***	0.043***	0.107
m	0.850***	0.900***	0.841***	0.955***	0.680***	0.863***
Test						
Wald	0.877	0.5778	0.994	0.53	0.025	0.705

Following the estimates in Table 2, TFP estimates are derived and shown in Table 3, while Table 4 provides correlation between TFP measures.

$$\hat{\omega}_{it} = \mathrm{y}_{it} - \hat{\beta}_k \mathrm{k}_{it} - \hat{\beta}_l \mathrm{l}_{it} - \hat{\beta}_m \mathrm{m}_{it} \quad (8)$$

Table 3: TFP estimates (in log) for different methods

	Construction			Trade services		
Year	OP	LP	ACF	OP	LP	ACF
2008	0.62	-0.30	0.58	0.37	3.74	1.08
2009	0.60	-0.31	0.56	0.36	3.74	1.07
2010	0.57	-0.34	0.52	0.35	3.72	1.06
2011	0.60	-0.32	0.55	0.36	3.72	1.07
2012	0.59	-0.32	0.55	0.36	3.70	1.06
2013	0.58	-0.32	0.54	0.35	3.70	1.06
2014	0.59	-0.31	0.55	0.36	3.71	1.06
2015	0.61	-0.29	0.57	0.36	3.72	1.07
2016	0.59	-0.32	0.55	0.35	3.71	1.06
2017	0.58	-0.33	0.54	0.34	3.70	1.04
2018	0.58	-0.33	0.54	0.34	3.71	1.04

Table 4: Correlation between TFP measures

	Construction			Trade services		
	OP	LP	ACF	OP	LP	ACF
OP	1			1		
LP	0.9159	1		0.3112	1	
ACF	0.9975	0.9218	1	0.6811	0.7171	1

5 Determinants of firm performances

Building on the previous section, we now turn into a more structural model investigating how fiscal pressure, legal form, and local environment affect firm TFP. As LP produces the best alternative within the methods considered, the derived TFP is used in this section.

Let us assume that the firm performance is a function of individual characteristics and local environment

$$y_{it} = \alpha \mathrm{TaxPress}_{it} + \delta \mathrm{LF}_{it} + \gamma \mathrm{Loc}_{it} + \lambda RegFirms_{it} + \beta X_{it} + \varepsilon_{it} \qquad (9)$$

where y_{it} is the log of the firm TFP; $\mathrm{TaxPress}_{it}$ is the log of tax pressure of the firm i at the year t. We define the tax pressure as corporate taxation to sales income. Parameter α informs how productivity responds to tax pressure. The variable LF_{it} is a categorical variable indicating the firm legal form— Sole proprietorship, Public Limited Company, Limited Liability Company, Sole Limited Liability Company, or other—each firm has.

The variable Loc_{it} is a categorical variable informing region of location of the firm — Dakar, Thies, or Saint Louis, Other. The vector of parameters δ shows the effect of the local economic environment on firm performance.

The variable $RegFirms$ indicates the number of firms in a region-sector and captures the extent of competition as in Glaeser et al. (1992). Parameter λ indicates the effect of local competition on the firm performance.

The vector X_{it} includes additional control variables such as firm's age and size.

Table 5 shows estimation results of Equation (9). The results indicate that the effect of tax pressure is negative signifying the existence of penalizing effect of tax on firm productivity. Indeed, a 1% increase in the tax pressure reduce firm productivity by 5% in Construction industry. A similar increase of 1% in the tax pressure reduce firm productivity by 29% in trade services industry.

We observe that the estimated coefficients of the legal form variables in the firm productivity are all positive and statistically significant at least at 10% significance level for the trade services industry. This indicates that the legal form matters for firms in the trade services industry and firms with legal structure being a Sole proprietorship, Public Limited Company, partnership, Limited Liability Company, and Sole Limited Liability Company possess a comparative advantage over Economic Interest Grouping firms. More precisely, their comparative advantage ranges from 1% to 12%. These results are in line with Ahmad and Fakih (2021)'s findings.

Unlike Construction sector, the results also suggest that the local economic environment plays a role on firm performance in the trade industry. Firms in bigger cities and highly congested regions such as Dakar, Thies, and Saint Louis have a lower productivity than firms in smaller cities. Indeed, businesses generally in these highly congested regions face high wage and rental costs, which increase production costs and in turn negatively affects the firm performance.

The extent of local competition affects the firm performances for both industries. An increase of 1000 firms in a region decreases a firm productivity by 1%. The paper also explores the effect of industry frontier's TFP on firm performance. Unlike the construction sector, the results indicate evidence of the existence of positive spillovers initiated from more productive firms in the Trade industry. This result is similar to Bournakis and Mallick (2018).

The firm's size and age play a role on performances for both construction and trade services industries. The results indicate that medium-sized and large-sized firms also demonstrate an advantage over smaller ones. This advantage ranges between 35% and 40% for construction, and between 43% and 118%. Regarding the age, the effect of age of firm is positive but diminishes as firms become older.

Table 5: Determinants of firm performances

	Construction	Trade
Tax Pressure	-0.06***	-0.29***
Firm age (Ref:0-1 years)		
2-4 years	0.07***	0.01***
5-9 years	0.05***	0.02**
10-14 years	0.04	0.01
15 years and +	0.00	0.00
Firm size (Ref: VSEs)		
SMEs	0.30***	0.36***
LEs	0.34***	0.78***
Location		
Dakar	-0.14	-0.04*
Thies	-0.10	-0.05***
Saint Louis	0.05	-0.04*
Legal form (Ref: Other)		
Sole Proprietorship	0.06	0.08**
Public Limited Company	-0.10**	0.11***
Limited Liability Company	0.05	0.12***
Sole Limited Liability Company	0.05	0.11***
Spillover	0.01	0.01*
Competition	-0.00***	-0.00***
Cons	-0.43***	3.42***
-		
N	3962	16446

6 Conclusion

Productivity is one of the key factors of competitiveness and plays a crucial role for economic growth and poverty reduction. Consequently, productivity diagnostic is critical to guide the design and implementation of economic policies. The initial analysis on productivity was conducted at the industry and/or country level and the focus has shifted dramatically towards the firm as the unit of analysis over the past decade. A central issue in exploring firm performances and its determinants is to obtain reliable measures of TFP at the firm level (Bournakis and Mallick 2018).

This study uses administrative census-type data on firms in Senegal over the period 2008-2018 to estimate firm level productivity. We show how different semi-parametric models fare in the estimation of production function for the construction and trade services industries, in particular, to what extent the underlying assumptions of each method are compatible to the data generating process (DGP) and the Senegalese economy. In a second step, the paper explores how corporate taxation, the local environment and competition, and legal form affect firm performances in the two sectors considered in the framework of this study.

The results suggest that the ACF model produces insignificant capital and labor coefficients for both construction and trade services industries, while LP produces the best alternative within semi-parametric models. Corporate taxation adversely affects TFP, and the adverse effect is found to be severe in the group of trades services firms. This suggests that the distortive nature of corporate tax affects disproportionately firms across sectors. Unlike construction sector, the results also suggest that the local economic environment plays a role on firm performance in the trade industry. The extent of local competition negatively affects the firm performances for both industries. The results indicates that medium-sized and large-sized firms also demonstrate an advantage over smaller ones. The effect of age of firm is positive but diminishing over time.

These firm-level productivity diagnostics in Senegal provide valuable insights for evidence-based policymaking. More precisely, understanding how corporate taxation, the local environment, and legal form affect firm performances in the two major sectors in Senegal provides the necessary information for improving the targeting of economic policies and making more accurate predictions of the effects of industry shocks and policy reforms on the economy. It sheds light on the distortive nature of corporate tax and its disproportionate impacts across sectors and industries.

Abdo Ahmad, Issam, and Ali Fakih. 2021. “Does the Legal Form Matter for Firm Performance in the MENA Region?” *Annals of Public and Cooperative Economics*.

Ackerberg, Daniel A., Kevin Caves, and Garth Frazer. 2015. “Identification Properties of Recent Production Function Estimators.” *Econometrica* 83 (6): 2411–51.

Bournakis, Ioannis, and Sushanta Mallick. 2018. “TFP Estimation at Firm Level: The Fiscal Aspect of Productivity Convergence in the UK.” *Economic Modelling* 70: 579–90.

Easterly, William, and Ross Levine. 2001. “What Have We Learned from a Decade of Empirical Research on Growth? It’s Not Factor Accumulation: Stylized Facts and Growth Models.” *The World Bank Economic Review* 15 (2): 177–219. https://doi.org/10.1093/wber/15.2.177.

Gemmell, Norman, Richard Kneller, Danny McGowan, Ismael Sanz, and José F. Sanz-Sanz. 2018. “Corporate Taxation and Productivity Catch-Up: Evidence from European Firms.” *The Scandinavian Journal of Economics* 120 (2): 372–99. https://doi.org/10.1111/sjoe.12212.

Glaeser, Edward L., Hedi D. Kallal, Jose A. Scheinkman, and Andrei Shleifer. 1992. “Growth in Cities.” *Journal of Political Economy* 100 (6): 1126–52.

Harhoff, Dietmar, Konrad Stahl, and Michaerl Woywode. 1998. “Legal Form, Growth and Exit of West German Firms—Empirical Results for Manufacturing, Construction, Trade and Service Industries.” *The Journal of Industrial Economics* 46 (4): 453–88.

Levinsohn, James, and Amil Petrin. 2003. “Estimating Production Functions Using Inputs to Control for Unobservables.” *The Review of Economic Studies* 70 (2): 317–41.

Marschak, Jacob, and William H. Andrews. 1944. “Random Simultaneous Equations and the Theory of Production.” *Econometrica, Journal of the Econometric Society*, 143–205.

Olley, G. Steven, and Ariel Pakes. 1996. “The Dynamics of Productivity in the Telecommunications Equipment Industry.” *Econometrica* 64 (6): 1263.

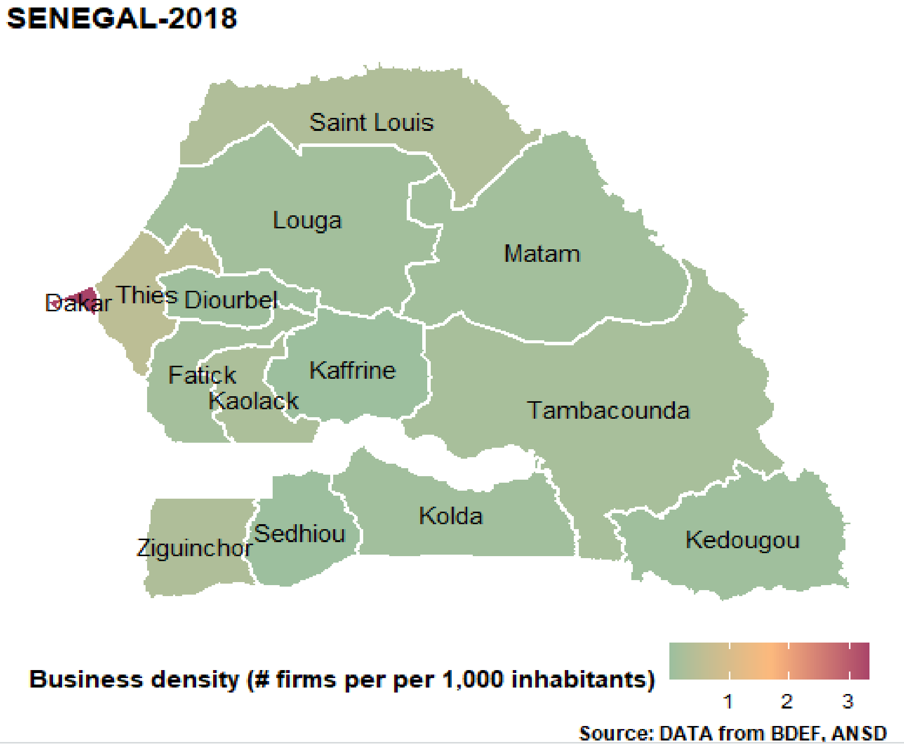
Pagés, Carmen. 2010. “The Age of Productivity.” In *The Age of Productivity*, 1–21. Springer.

Škare, Marinko, and Tea Hasić. 2016. “Corporate Governance, Firm Performance, and Economic Growth–Theoretical Analysis.” *Journal of Business Economics and Management* 17 (1): 35–51.

Syverson, Chad. 2011. “What Determines Productivity?” *Journal of Economic Literature* 49 (2): 326–65.

7 Annexes

Figure 1: Formal business density per 1,000 inhabitants for 2018



Note: This map provides the spatial distribution of the formal business in 2018. The indicator is the business density, which is the number of firms per 1,000 inhabitants. We calculate the business density for each region. More the area is red, the higher the business density.

Figure 2: Dynamics of firm production per sector