The Main Obstacles to Firms’ Growth in Senegal, Implications for the Long-Run

Mathilde Maurel and Majda Seghir
The Main Obstacles to Firms’ Growth in Senegal, Implications for the Long Run, Working Paper Series N° 208 African Development Bank, Tunis, Tunisia.
The Main Obstacles to Firms’ Growth in Senegal, Implications for the Long-Run¹

Mathilde Maurel² and Majda Seghir³

Working Paper No. 208
August 2014

Office of the Chief Economist

¹ This paper has benefited from a research grant from the African Development Bank. The authors are grateful to Fatou Cisse, who provided us with the data used in this paper. They are also grateful to all participants at the UN-WIDER L2C-Learning to Compete Conference in Helsinki, 24-25th June, 2013, for helpful comments on an earlier version of this paper.

² CES, Université Paris 1 Panthéon-Sorbonne 106-112 Boulevard de l’Hôpital 75647 Paris cedex 13 France, mathilde.maurel@univ-paris1.fr.

³ Erudite Université Paris Est 80 avenue du Général de Gaulle94000 Créteil France, majda.seghir@gmail.com
Abstract

Productivity gains are the prime engine of economic growth. This paper uses firm level accounting information from the Single Information Collecting Centre (CUCI) in Senegal over the period 1998-2011. To investigate the two main obstacles to growth: poor education and poor access to electricity supply, we generate sectoral aggregates using firm level data. The results indicate that a 1% increase in the proportion of skilled technicians increases TFP by 5% (PMG) and by 24% (DOLS). This finding substantiates the conclusion of a recent report (AfDB, 2012) that emphasizes the importance of primary and vocational education to economic growth in Senegal.

The report by the AfBD finds that the main obstacle to industrialization is poor access to electricity and the poor quality of infrastructure. Based on World Bank data on access to electricity and some strong but reasonable assumptions regarding sectoral power demand, we estimate the impact of quality adjusted access to electricity on firm productivity. In the long run, a 1% increase in access to electricity increases total factor productivity by 29% (PMG) and 21% (DOLS) and by 12% (PMG) in the short-run.

Keywords: productivity dynamics, TFP, education, electricity supply
JEL: O11, O44, C33
**Introduction**

Several decades ago, Africa’s economic development was on par to that of South Asia (Collier and Gunning, 1999). However, in the 70s and 80s, economic growth in many African countries lagged and the development paths of the two developing continents diverged (Berthelemy and Söderling, 2001). As a result of the very low rates of growth and deterioration in terms of trade 37 Sub-Saharan African countries adopted stabilization and structural adjustment programs with the financial support of the International Monetary Fund (IMF) and the World Bank. In 1994, Senegal embarked upon Structural Adjustment Programs composed of currency devaluation and a step by step liberalization of the economy in the following two decades. These reforms were able to resuscitate annual growth to rates above 5%. Is this trend sustainable? How can Senegal keep growing? What are the key policies to facilitate this growth trajectory?

This paper aims to shed light on these questions, using firm level data. A country’s growth should ideally be based upon its comparative advantages. Recent theoretical and empirical analysis (Rodrik, 2006), however, emphasises the importance of producing and exporting complex manufacturing products to enable developing countries achieve sustainable growth. This requires substantial investment in education and building human capital. Education plays a critical role in expanding technological frontiers, whether it be for innovation in developed countries (Aghion and Howitt, 2004, Aghion et al., 2006), or for reproduction purposes in less developed countries that are not yet at the frontiers of technological advances. In the context of Senegal, success in the production and export of complex manufacturing products requires, initially, the development of industries that do not depend on a high capital-labour ratio, and the implementation of an effective educational policy. We compute total factor productivity (TFP) across industrial sectors to show the importance of human capital in industrial production. We show that differences in the distribution of educated labour matter for industrial productivity.

According to Van Biesebroeck (2005), Bigsten et al. (2004), or Mengistae and Patillo (2004), exporting manufacturers have a productivity edge unmatched by non-exporters. Developing exporting capacity is, thus, proposed as a policy tool to facilitate the adoption of new technology, and remove the constraints of small market size and numerous problems surrounding the business environment in developing countries. In this paper we adopt a different but complementary approach to a recent paper by Ann E. Harrison et al. (2011). Harrison et al. (2011) begin by listing all possible explanatory factors influencing labour productivity, sales growth, labour growth, export intensity, and investment rates. They came up with a long list of factors ranging from: geography, political risks, ownership, competition, infrastructure, crime and violence, labour flexibility, and access to more formal and informal finance. Then, given the limited capacity of reformers and policy makers, they focus of identifying the key constraints impeding economic growth.
We rely on an identification method proposed by Hausmann et al (2008) to sort through and rank factors influencing productivity and growth. A recent report by the AfDB (2012), used the same method to identify the main obstacles to growth in Senegal. The report found the dualism of the economy, and the scale of the informal sector is a major obstacle to growth. The supply and quality of electric power constrain both economic growth and industrialization. Finally, the low level of spending on education and infrastructure are major constraints on economic growth. These conclusions which put emphasis on the importance of skilled labor and wider access to electricity constitute the starting point of our analysis of cross sectoral differences in TFP in Senegal.

We take advantage of two unique panel datasets, from the Single Information Collecting Centre (CUCI) (Senegalese National Statistic and Demography Agency (ANSD)). The first dataset contains the balance sheets of all registered Senegalese firms, over the period 1998-2011. The second panel gives the percentage of low, intermediate, and highly skilled labour at the sector level. We construct a proxy for quality of electricity access by multiplying the World Bank Indicator at the country level by an estimate of the sectoral industrial electricity consumption drawn from the dataset. Our analysis focuses on 23 sectors over the period 1998-2011.

In Section 2 we describe the main features of the two main obstacles to productivity and growth: education and electricity supply. In Section 4, we propose a methodology to quantify the impact of education and electricity in both the short and long-run that allows us to take advantage of the panel structure of our datasets. This section is preceded by a description of our data and methodology to proxy the quality of access to electricity. The final section draws the main conclusions.

Education and access to electricity in Senegal

A recent growth diagnostic of Senegal conducted by the AfDB (2012) identified two key obstacles to productivity improvement: the mismatch between labour demand and supply and the insufficient level of education; and the poor development of electricity infrastructure. The former calls for more investment in the primary sector, for higher enrolment in education, especially in rural areas, and for a better fit between market needs and skills. The latter is widely discussed in the literature (Gosh, 2002 for India, Wolde-Rufael, 2005, 2006 and 2009 for Africa, Ferguson et al., 2000 for a more general sample), with a special emphasis on the causality between energy consumption and growth, but with no consensus emerging from the debate.

Inadequate education

According to the Human Development Index (HDI), Senegal is not only one of the poorest countries in terms of GDP per capita, but also in terms of its human development. Cognizant of the role of education as an important pillar of human development, Senegal has devoted over the past 15 years considerable efforts to education.
Between 2000 and 2009, education expenditure rose from 3% to 6% of GDP, i.e. 40% of the total budget (African Economic Outlook: Country Senegal, 2009). In 2009, 47% of total education expenditure was allocated to primary education, 27% to secondary education and 24% to higher education. This breakdown reflects the belief that primary and secondary schooling are more important than tertiary education for poverty reduction, and has been encouraged by international development agencies. From 1985 to 1989, 17 per cent of the World Bank’s worldwide education-sector spending was on higher education. But from 1995 to 1999, the proportion allotted to higher education declined to just 7 per cent. In Senegal, illiteracy is a main concern even by sub-Saharan African standards. In 2009, nearly half of the population of Senegal is illiterate compared to an average of 37.7% in sub-Saharan Africa.

The efficiency of education is assessed based on two criteria: internal and external efficiency. Internal efficiency is jointly measured by the ability of the system to retain the maximum number of pupils in school (average number of years at school and gross enrolment rates), results obtained by pupils (measured by the proportion of repeaters) and available resources (teachers, classes, equipment, etc.). External efficiency corresponds to the match between the provision of education and market needs. More emphasis is given to external efficiency in this paper based on findings in the literature that certain types of education are critical for improving the economic performance of the country.

Despite recent progress, there is room for improving internal efficiency. In 2009, the average number of years of schooling (+15 years old) was 4.05. Even though close to the sub-Saharan African average, the rate is significantly lower than levels achieved by Latin America and East Asia or even some sub-Saharan African countries (Ghana, Kenya and Zambia). Gross enrolment rates in primary education rose from 68% in 1998 to 86% in 2009. These primary enrolment rates are below the sub-Saharan averages (78% in 1998 and 102% in 2009). The proportion of children completing primary education is rising more slowly than the enrolment rates (58.4% in 2008). The rate attained in 2008 falls far short of the 2015 target rate of 83% set by the World Bank and it is considerably lower than the rates recorded by other West African countries (Ghana 73%, The Gambia 91%, Mali 79% and Cape Verde 85%). The secondary education enrolment rate is much lower - 31.4% in 2008, while enrolment in higher education did not exceed 8.3% in 2008. These rates are considered low even though they are close to the average rates for sub-Saharan Africa (34.8% for secondary education and 6% for higher education).
A 2007 report by the UNESCO Dakar Pole (2007) computed the rates of return on education in Table 2 below. According to this assessment of external efficiency, the most profitable investments are at the primary level (24%), while the return on technical education is found to be higher than the rate for education. Moreover, the efficiency of tertiary level education is marginal. These findings echo a core debate about the social utility of spending in higher education (see Bigsten et al., 2000). Pritchett (2001) argued that educated individuals in developing countries may be attracted by the returns from rent seeking activities, or that the supply of education may be too high compared to a stagnant demand.

As in many places in Africa, the supply of graduates and competition for jobs in Senegal is in excess of opportunities for gainful employment forcing many educated graduates into unemployment, or migration. This signifies the the external inefficiency of the education system or an imbalance between job supply and demand. Unemployment rate is highest among those who left high school without basic knowledge, followed by graduates of higher level of education. Young graduates are hardest hit by unemployment and are forced to emigrate. According to the 2001 Senegalese Household Survey (ESAM II), skilled workers represent 24.1% of the migrant stock. Clemens and Petterson (2007) show that, over the 1995-2005 period, up to 51% of Senegalese doctors and 27% of nurses emigrated, mainly to France.
In one way, the relative weakness of tertiary education enrolment is due to the fact that the job market in Senegal is more open to job seekers with primary, secondary or vocational levels of education. Suboptimal performance of the Senegalese tertiary sector is extensively discussed in the literature. For instance, Berthélémy et al (1996) questions the legitimacy of the tertiary sector by showing the inadequacy of the quality of education in the country.

**Access to electricity**

Despite the immense energy potential Africa possesses, the second main obstacle to firms’ growth is the poor access to electricity and the low level of energy consumption (Karekezi and Kimani, 2002; Economic Commission for Africa, 2004). The average African is still using less energy than the average person used in England more than a century ago (Davidson and Sokona, 2002).

Energy consumption in Senegal is close to the level achieved by African middle-income countries and well above other low-income countries. According to Table 3, about 47% of the population had access to electricity in the 2000s. But this figure hides a wide spatial disparity in access to electricity. Access to electricity in urban areas is close to 80% while close to 85% of rural households do not have access to electricity. These figures mirror the situation in middle-income countries, where rural access are much lower at 15.8% in contrast with 26.3 percent in urban areas. for the former, and 2.7 as compared with 12.1 for the latter. This disparity is also reflected in growth rates in access to electricity indicating diverging rates of electricity access. Growth rates for rural and urban areas averaged at 12.1% and 2.7% respectively.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Unit</th>
<th>Low-Income Countries</th>
<th>Senegal</th>
<th>Middle-Income Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mid-2000s</td>
<td>Late 1990s</td>
<td>Mid-2000s</td>
</tr>
<tr>
<td>National Access to Electricity</td>
<td>% pop</td>
<td>32.8</td>
<td>36.2</td>
<td>47.1</td>
</tr>
<tr>
<td>Urban Access to Electricity</td>
<td>% pop</td>
<td>72.8</td>
<td>72.8</td>
<td>80.4</td>
</tr>
<tr>
<td>Rural Access to Electricity Growth in</td>
<td>% pop</td>
<td>12.7</td>
<td>7.8</td>
<td>15.8</td>
</tr>
<tr>
<td>Access to Electricity</td>
<td>% pop / year</td>
<td>4.4</td>
<td>-</td>
<td>2.7</td>
</tr>
</tbody>
</table>

*Source: Eberhard et al. (2008)*

Even though access to electricity in urban areas is considerably larger, the quality of electricity supply, as proxied by the number of outages per month, is too low and represents a major obstacle to the productivity of
firms. According to the latest World Bank enterprise survey\(^4\), 50% of the firms surveyed consider that electricity is a major or very serious obstacle and 85% of enterprises stated they had experienced at least one power outage in the preceding month (see fig. 1). They also report at least 10 power outages per month. Only 16 of the 835 enterprises surveyed reported they had experienced no power outage in the preceding month. The average duration of power outages reported is 8 hours, which means that every 3 days firms experience a power outage, and that 12.5% of the time allocated to work is lost.

**Figure 1**

*Electricity: A Major and Serious Constraint for Firms by Sector*

![Bar chart showing the percentage of constraints faced by firms in various sectors. The chart shows that electricity is the most significant constraint, followed by access to finance and access to land.](chart)

Notes: Data is collected from Enterprise Surveys, the World Bank.

Figure 2 presents the percentage of annual sales lost as a result of a power outage by sector of activity. The average loss is 4.8% with 4.5% for medium enterprises and 5.4% for large enterprises. The worst affected firms are in the garment and chemical sectors. Successive power outages and cuts lead to the installation of electricity generators, which are much more expensive than grid-supplied electricity. To offset the shortfall in electricity, over 55% of manufacturing enterprises in Senegal (35.3% in Uganda and 38.2% in Zambia) have had to acquire generators.

**Figure 2**

*Loss of Sales As a Result of Power Outages by Sector.*

---

This statistical information provides preliminary evidence of the importance of both low-levels of education and access to electricity in hindering the productivity of firms. In the following sections we provide a description of data and methodology used to identify the exact contribution of these two factors to the missing TFP.

**Data**

The raw data set comes from the Single Information Collecting Centre (CUCI) (Senegalese National Statistic and Demography Agency (ANSD)) which provides accounting information for industrial firms from 1998 to 2011. Some data is available at the sectoral level, but most other variables are available at the firm level. Therefore, the company level observations have been aggregated into 23 sectors within manufacturing. This allows each sector to have different production technologies, which seems reasonable since there are differences in the amount of labour and capital used in different industries as well as the level of technology used.

For the estimation of TFP, time series data on value added, capital stock and labour are required. Some of these variables are directly reported in the datasets were computed. Gross profit is used to measure value added. Gross profit is defined as operating revenue minus costs of goods sold. Tangible fixed asset is used as a measure of capital, and includes assets such as machinery, building and equipment. The number of employees is the measure of labour.

Human capital and physical infrastructure are identified as the determinants of productivity. Human capital is measured by the sectoral employment shares of different degrees of qualification. The CUCI database distinguishes between four categories of employee: i) senior managers, ii) skilled technicians, iii) supervisors and skilled workers, iv) unskilled workers. Qualifications for the first two categories are acquired by investment in education and training, whereas the last two are mainly acquired by learning-by-doing. Therefore, the stock of senior managers and skilled technicians represents the accumulated stock of past investment in education and

---

3 We deflate value added and the capital with the GDP deflator.
training. The indicators are available for the 23 sectors from 1998 to 2011. Figure 4, in the Appendix, gives the average employee qualification across sectors.

Physical infrastructure is approximated by quality adjusted access to electricity. Country level data on access to electricity is provided by the World Bank’s World Development Indicators. Based on WDI’s indicators and the CUCI database, we construct a variable that proxies for access to electricity at the sectoral level. The accounting database provides the tangible fixed assets by sector. We assume a proportional relationship between the size of tangible fixed assets and access to electricity.

**Methodology and results**

The model proposed below aims at explaining the determinants of productivity growth across sectors over the period 1998 to 2011. We focus on the main constraints identified in the Senegalese context, namely education and electricity supply, and we estimate the long run relationship between TFP, human capital and access to electricity.

1. **TFP estimation:**

The first step in our analysis is the estimation of TFP (Total Factor Productivity) at the sector level. We use a cob-Douglas production function to estimate the estimate TFP. We run 23 equations for each of the industry groups. They have the following form:

\[ Y_{it} = A_{it} F(K_{it}, L_{it}) \]  

where \(i\) and \(t\) refer to the industry group and the time dimension respectively. \(Y_{it}\), \(K_{it}\) and \(L_{it}\) are respectively value added, capital and labour and \(A_{it}\) refers to TFP.

Imposing constant returns to scale in private inputs, and dividing both sides in eq. (1) by \(L\) yields the following equation:

\[
\frac{Y}{L} = A \left(\frac{K}{L}\right)^{\alpha} 
\]  

Finally taking the natural logarithm yields the regression equation that is typically employed by empirical studies relying on the production function approach:

\[
(y_{it} - l_{it}) = \beta_0 + \beta_1 t + \alpha(k_{it} - l_{it}) \text{ and } \ln(A_{it}) = \beta_0 + \beta_1 t 
\]  

where \(A_{it}\) represents the level of technology, TFP.
We find an elasticity of output with respect to capital, which is statistically significant and equal to 0.46. Figure 3 gives the corresponding TFP annual average growth rate from 1998 to 2011 for each sector. Over the period considered, about 10 out of 23 sectors recorded an average decline in productivity. By contrast, the other sectors registered an increase in TFP over the period 1998-2011.

Figure 3
TFP annual average growth rate by sector from 1998 to 2011

2. Estimation and testing of the long-run relationship:

In the second stage we empirically assess the links between TFP, human capital and access to electricity. Our focus is on two main determinants:

1. Education: Vandenbussche, Aghion and Meghir (2006) distinguish two sources of increase in TFP, namely imitation and innovation, both driven by education. Their argue that cross-sectoral differences in TFP growth are the consequence of differences in human capital endowment and the ability to both introduce innovations and/or replicate the best practices. We assume a stonger capacity for imitation (reproduction) in Senegal -in contrast to scope for pure innovation.
2. *Access to electricity*: As emphasised in the previous section, electricity shortages have been identified as being the main obstacle to growth in several surveys conducted by the World Bank. By correlating TFP at the sectoral level and the proxy for quality adjusted access to electricity in the different sectors, we test whether any change in the quality of access can produce positive spillover effects and translate into TFP improvement.

A growing number of studies (Funk 2001; Guellec and van Pottelsberghe de la potterie 2004; Lee 2006, Aspargis 2008) have used dynamic panel cointegration to study such links. Following this literature, we conduct our examination of the relationship between TFP, human capital and electricity access in three stages. First, we test for cross section dependence and the order of integration of the variables. Secondly, we employ panel cointegration tests to examine whether a long-run relationship exists among the variables. Thirdly, we estimate long run parameters using Dynamic Ordinary Least Squares (DOLS). Finally, we use the Pooled Mean Group (PMG), developed by Pesaran et al. (1999) to distinguish between the short and the long run effects of human capital and electricity access on TFP.

First, we test for cross sectional dependence in order to avoid spurious results. Cross sectional dependence may arise due to unobserved common factors, externalities, regional links and unaccounted for residual interdependence. We implement two tests: Pesaran (2004) and Friedman (1937). The tests shown in Table 1 (in the Appendix) strongly reject the null hypothesis of no cross-sectional dependence at the 1% level of significance. This indicates that there is cross-sectional correlation in our panel, which can reflect the presence of similar regulations in various fields.

Then, we test the order of integration of the series using three unit root tests, namely: Pesaran (2005), IPS (2003) and the Maddala and Wu (1999) test. Neither of them takes into account the cross sectional dependence between sectors. The third one, the Pesaran (2005) test, allows for cross-sectional dependence and thus controls for the common factor proxied by the cross-section averages of lags and differences on the individual series. The results in Table (4), show that all the variables of interest are integrated to the order of one.

| Table 4 | Panel unit root test: results |
|---|---|---|
| | Statistic | P-values | Statistic | P-values | Statistic | P-values |
| TFP | -1.238 | 0.108 | 54.380 | 0.186 | 2.396 | 0.992 |
| Δ(TFP) | -8.485 | 0.000 | 375.07 | 0.000 | -8.115 | 0.000 |
| Senior managers | 0.467 | 0.680 | 169.051 | 0.000 | 2.853 | 0.998 |
| Δ(Senior managers) | -16.48 | 0.000 | 460.00 | 0.000 | -9.815 | 0.000 |
| Skilled technicians | 2.014 | 0.978 | 55.200 | 0.166 | 0.939 | 0.826 |
Once the order of integration of the series is defined, we test whether there is a long-run relationship among these variables. Since we have cross-sectional dependence in our series, cross-sectional dependence in cointegration vectors is likely. Therefore, we perform the Westerlund (2007) cointegration test with bootstrap under the assumption of cross-sectional dependence. The results in Table 2 (in the Appendix), show that all the statistics reject the hypothesis of no cointegration between productivity, human capital and electricity access.

The cointegration tests allow us to assess whether there is a long run equilibrium relationship. Nevertheless, they do not provide parameter estimates either for the long run or the short run. To estimate the long-run vector, we consider two estimators with error correction: the Pool Mean Group estimator (PMG) and the Dynamic Ordinary Least Squares estimator (DOLS). The DOLS estimator, proposed by Kao and Chiang (2000), corrects the standard pooled OLS for serial correlation and endogeneity of regressors that are normally present in long-run relationships. Therefore we use this estimator to estimate the long-run relationship between total productivity factors, human capital and electricity access. In order to obtain an unbiased estimator of the long-run parameters, the DOLS estimator uses parametric adjustment to the errors by including lead and lags of the differenced I(1) regressors. The DOLS estimator is obtained from the following equation:

\[
TFP_{it} = \alpha_t + \beta X'_{it} + \sum_{j=-q_t}^{l=q_t} c_{ij} \Delta X_{i,t+j} + \nu_{it} \tag{4}
\]

Where \(c_{ij}\) is the coefficient of lead or lag of explanatory variables \(X_{it}\). Table (5) shows the results of this estimation.

In order to test the robustness of the previous results, we use an alternative methodology, the Pool Mean Group Estimator (PMG) to estimate the cointegration relationship between TFP, human capital and electricity access. The main advantage of the PMG estimator over the DOLS model is that it can allow the short-run dynamic specification to differ from sector to sector while the long-run coefficients are constrained to be the same.

Assuming an autoregressive distributive lag (ARDL)(p,q_1..q_k) dynamic panel specification of the form:

\[
TFP_{it} = \sum_{j=1}^{p} \gamma_{ij} \Delta TFP_{i,t-j} + \sum_{j=0}^{q} \delta_{ij} \Delta X_{i,t-j} + \mu_i + \varepsilon_{it} \tag{5}
\]

Hence, the error-correction reparametrization of Eq. (5) is given by:
\[ \Delta TFP_{it} = \Phi_i(TFP_{it-1} - \theta_iX_{it}) + \sum_{j=1}^{p-1} \gamma_{ij}\Delta TFP_{i,t-1} + \sum_{j=0}^{q-1} \delta_{ij}\Delta X_{it-j} + \mu_i + \varepsilon_{it} \]  

(6)

Where the number of sectors, and time period are designated, respectively, as \( i=1,2,\ldots,N; \) and \( t=1,2,\ldots,T \). \( X_{it} \) are explanatory variables (human capital and electricity access); \( \delta_{ij} \) are the coefficients of explanatory variables; \( \mu_i \) is the sector-specific effect. \( \theta_i \) is the vector which contains the long-run relationships between the variables and finally \( \Phi_i \) is the error-correcting speed of adjustment. If \( \Phi_i < 0 \), there is a long-run relationship between \( TFP_{it} \) and \( X_{it} \) defined by:

\[ TFP_{it} = -\left( \frac{\theta_i}{\Phi_i} \right)X_{it} + \tau_{it} \]  

(7)

for each \( i \), where \( \tau_{it} \) is a stationary process. The parameter \( \Phi_i \) represents the speed of adjustment at which the values of TFP, human capital and electricity access come back to the long-run equilibrium levels, once they deviate from the long-run equilibrium relationship. The negative signs of the estimated speed of adjustment coefficients are in accordance with the convergence towards the long-run equilibrium.

**Table 5**

<table>
<thead>
<tr>
<th></th>
<th>Senior managers</th>
<th>Skilled technicians</th>
<th>Electricity access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coefficients</td>
<td>-0.195(1.506)***</td>
<td>0.242(1.345)***</td>
<td>0.210(1.775)***</td>
</tr>
</tbody>
</table>

Notes: *** significant at the 1% level; ** at the 5% level; * at the 10% level. Standard errors are given in parentheses. The dependent variable is TFP.

**Table 6**

<table>
<thead>
<tr>
<th></th>
<th>Senior managers</th>
<th>Skilled technicians</th>
<th>Electricity access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short run</td>
<td>0.064(0.023)***</td>
<td>-0.004(0.019)</td>
<td>0.128(0.060)***</td>
</tr>
<tr>
<td>ECT</td>
<td>-0.500(0.010)***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Long Run</td>
<td>-0.100(0.024)***</td>
<td>0.053(0.026)***</td>
<td>0.295(0.023)***</td>
</tr>
</tbody>
</table>

Notes: *** significant at the 1% level; ** at the 5% level; * at the 10% level. Standard errors are given in parentheses. The dependent variable is TFP.

The results in Tables (5) and (6) are consistent with the values and signs suggested in the TFP literature. In regard to the PMG estimates, the error correction term (ECT) is significantly negative, suggesting that productivity responds to deviations from the long-run equilibrium. The estimated speed of adjustment of TFP is around (-0.500) and is statistically significant at the 1% level. Moreover, the results converge to those found by using the DOLS and the PMG procedures.

Electricity expands productive capacity by increasing resources and improving the productivity of private capital. In both the long-run and the short run, access to electricity has a significant positive impact on economic...
performance. In the long-run, a 1% increase in access to electricity increases total productivity by 29% (PMG) and 21% (DOLS) and by 12% (PMG) in the short-run.

These results are in line with Wolde-Rufael (2009), who presented granger causality relationships between energy consumption and growth in a sample of 17 African countries. The study finds a uni-directional causality running from economic growth to energy consumption in Senegal. This implies that energy consumption may be reduced with little or no adverse effect on economic growth. Our results emphasise that improving the quantity and quality of electricity supply could indeed alleviate obstacles to productivity improvement.

Human capital is also a robust determinant of TFP. While low skilled workers do not correlate with productivity (results available upon request), skilled workers play a key role in improving firms’ TFP. Our results allow us to distinguish two categories of skilled workers: senior managers and skilled technicians. Only for the latter does the long-run relationship highlight a positive effect on TFP. A 1% increase in the proportion of skilled technicians increases TFP by 5% (PMG) and by 24% (DOLS). For the senior manager category indeed, the effect is negative. These findings are in line with the diagnosis made by the UNESCO Dakar Pole (2007), which pointed to the low external efficiency of tertiary education enrolment and the higher efficiency of technical education.

Conclusion

The paper analysed the dynamics of TFP growth exploiting sectoral information for a set of Senegalese manufacturing firms over the period 1998-2013. We perform a careful analysis of the time series properties of our dataset, and we compute two sets of estimates, PMG and DOLS.

We found significant differences across sectoral TFP. By taking advantage of a growth diagnostics test recently published by the AfDB (2012), we proposed two factors to explain these differences: education and quality adjusted access to electricity. The two factors explain a sizable proportion of TFP differences across firms. A 1% increase in the proportion of skilled technicians increases TFP by 5% (PMG) and by 24% (DOLS). The effect is negative for the senior manager category. Our proxy for access to electricity is based on country level data from WDI (World Bank Indicator). Based on this data we generate quality adjusted access to electricity at the sector/firm level by assuming demand for electricity is proportional to the size of tangible fixed assets. A 1% increase in electricity access increases the total productivity factor by 29% (PMG) and 21% (DOLS) in the long-run and by 12% (PMG) in the short-run.

Important policy implications can be derived from these results. To improve the ability of the education system to build human capital, Senegal should focus on primary education and technical training tailored to market
needs. As emphasised in Section 2, the job market in Senegal is more open to job seekers with primary, secondary and technical levels of education than to university graduates. This is confirmed by our empirical analysis, showing that, in the long run, the productivity premium to technical education is much higher than for tertiary level education.

Senegal spends a non-negligible amount on the infrastructure sector – on average close to 11% of GDP. However, the amount allotted to electrification and improving its quality is very small and has proven to be an impediment to industrial growth. Between 2000 and 2009, power generation capacity grew from 365 MW to 510 MW it was unable to keep pace with demand which grew at a rate of 25-30 MW per year. While the increase in power supply was undoubtedly significant it fell short of demand. In addition to the high demand for electricity, the SENELEC is unable to overhaul power generation and transmission facilities that are obsolete. As a result its ability to satiate demand and improve the quality of its services and limit power disruptions is largely impaired.

A series of enterprise surveys by the World Bank also identify weak supply and frequent outages as the main obstacle to the development of the country’s industrial activities and economic growth. This paper shows that better access to electricity could result in a considerable improvement in TFP.
Appendix

Table 1: Cross-section dependence results.

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Statistic</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pesaran</td>
<td>6.649</td>
<td>0.000</td>
</tr>
<tr>
<td>Friedman</td>
<td>51.01</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Table 2: Westerlund (2007) panel cointegration test results.

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Value</th>
<th>Robust P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gt</td>
<td>-2.614</td>
<td>0.080</td>
</tr>
<tr>
<td>Ga</td>
<td>-6.016</td>
<td>0.000</td>
</tr>
<tr>
<td>Pt</td>
<td>-10.68</td>
<td>0.055</td>
</tr>
<tr>
<td>Pa</td>
<td>-6.176</td>
<td>0.025</td>
</tr>
</tbody>
</table>

Figure 4:
Average distribution of employees across the sectors
References


Michael A Clemens, and Gunilla Pettersson, 2007, New data on African health professionals abroad, Human Resources for Health http://www.human-resources-health.com/content/6/1/1


Docquier and Marfouk (2005), International Migration by Educational Attainment (1990-2000), DRC (Centre for Migration, Globalization and Poverty), University of Sussex.


<table>
<thead>
<tr>
<th>n°</th>
<th>Year</th>
<th>Author(s)</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>207</td>
<td>2014</td>
<td>John C. Anyanwu</td>
<td>Factors Affecting Economic Growth In Africa: Any Lessons From The Soaring Dragon (China)?</td>
</tr>
<tr>
<td>205</td>
<td>2014</td>
<td>Gibert Galibaka and Thierry Kangoye</td>
<td>Améliorer la Compétitivité en Afrique par le Développement des Infrastructures Rapport Pays : Sénégal</td>
</tr>
<tr>
<td>204</td>
<td>2014</td>
<td>Mthuli Ncube, Zuzana Brixiová, and Thierry Kangoye</td>
<td>Skills and Youth Entrepreneurship in Africa :Analysis with Evidence from Swaziland</td>
</tr>
<tr>
<td>203</td>
<td>2014</td>
<td>Ousman Gajigo and Audrey Verdier-Chouchane</td>
<td>Immigrants, Skills and Wages in The Gambian Labor Market</td>
</tr>
<tr>
<td>202</td>
<td>2014</td>
<td>Jacob Oduor, Moses Muse Sichei, Samuel Kiplangat Tiriongo and Chris Shimba</td>
<td>Segmentation and efficiency of the interbank market and their implication for the conduct of monetary policy</td>
</tr>
<tr>
<td>201</td>
<td>2014</td>
<td>John C. Anyanwu</td>
<td>Does Intra-African Trade Reduce Youth Unemployment In Africa?</td>
</tr>
<tr>
<td>200</td>
<td>2014</td>
<td>Nadège Désirée Yaméogo</td>
<td>Analysis of Household Expenditures and the Impact of Remittances and Migration using a latent class model: the Case of Burkina Faso</td>
</tr>
<tr>
<td>199</td>
<td>2014</td>
<td>Emmanuel Mutisya and Masaru Yarime</td>
<td>Microcredit for the Development of the Bottom of the Pyramid Segment: Impact of Access to Financial Services on Microcredit Clients, Institutions and Urban Sustainability</td>
</tr>
<tr>
<td>198</td>
<td>2014</td>
<td>Mthuli Ncube, Zuzana Brixiová, and Quigwei Meng</td>
<td>Can Intra-Regional Trade Act As a Global Shock Absorber in Africa?</td>
</tr>
<tr>
<td>197</td>
<td>2014</td>
<td>Mthuli Ncube, Basil Jones, and Zorobabel Bicaba</td>
<td>Estimating the Economic Cost of Fragility in Africa</td>
</tr>
</tbody>
</table>