UNITED NATIONS UNIVERSITY

UNU-WIDER

World Institute for Development Economics Research

UNU-WIDER Conference on L2C
Learning to Compete: Industrial Development and Policy in Africa

The impact of education and electricity access on TFP: implications for Senegal

Mathilde Maurel (CES and Paris 1 Panthéon-Sorbonne, Consultant for the ADB)
and Majda Seghir (Erudite and UPEC)

Aim of the paper

- **Estimating the contribution to total productivity factor (TFP) of (i) education and (ii) electricity access in Senegal**

- **Over the period 1998-2011**

- **Using industrial firms micro-data *i.e.* the balance sheets of all registered Senegalese firms**

- **Performing powerful estimators to test for long-run relationships *:***
(i) Pool mean group (PMG) and
(ii) Dynamic ordinary least squares (DOLS)

Intervention plan

1/ Industrialization and economic policies in Senegal

Based upon Choi J.E., Cissé Fatou and M. Maurel (2013), *Scoping paper on Senegal*

2/ The obstacles to industrialization in Senegal

3/ Theoretical background and stylized facts

4/ Empirical approach

4.1 Data

4.2 TFP estimation

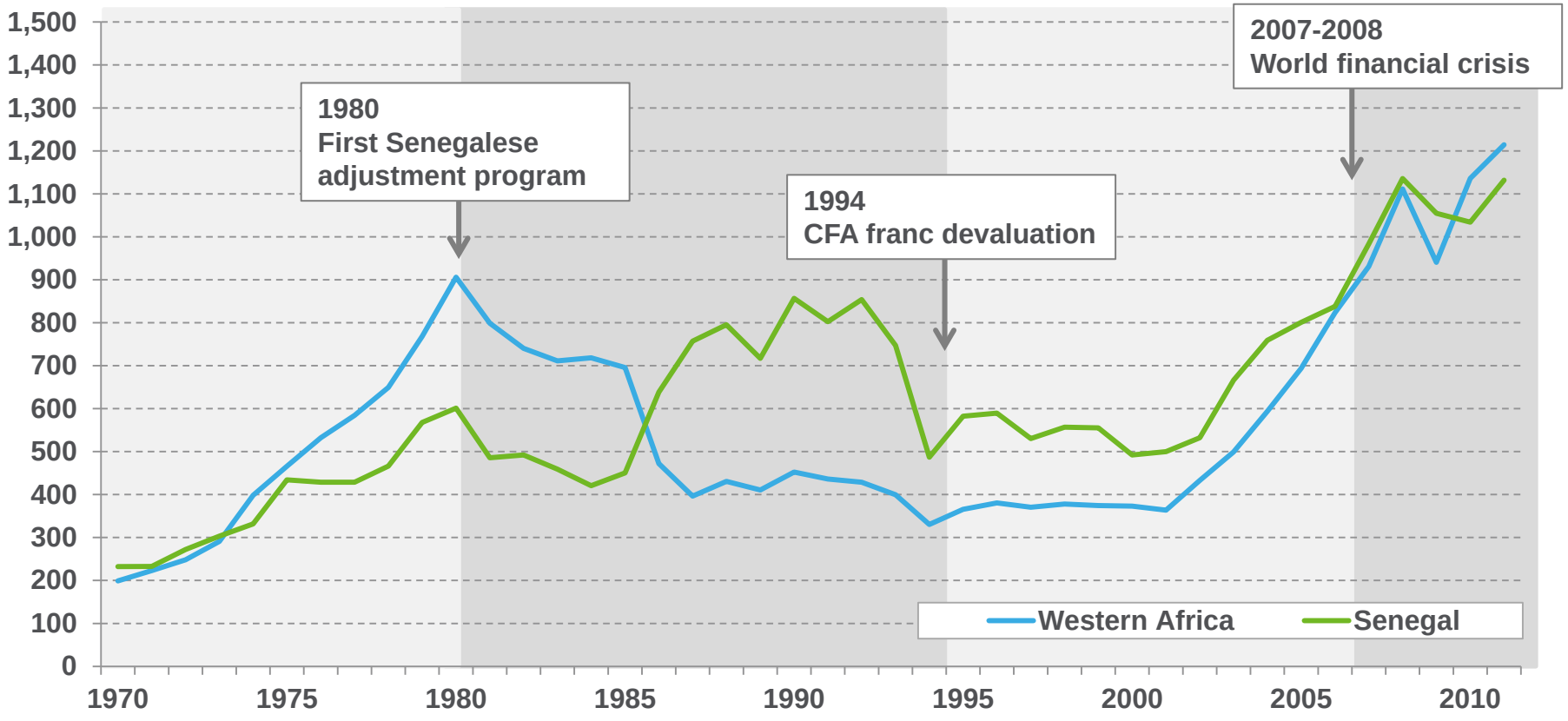
4.3 Unit root and cointegration test

4.4 Long-run parameters estimation

5/ Conclusion

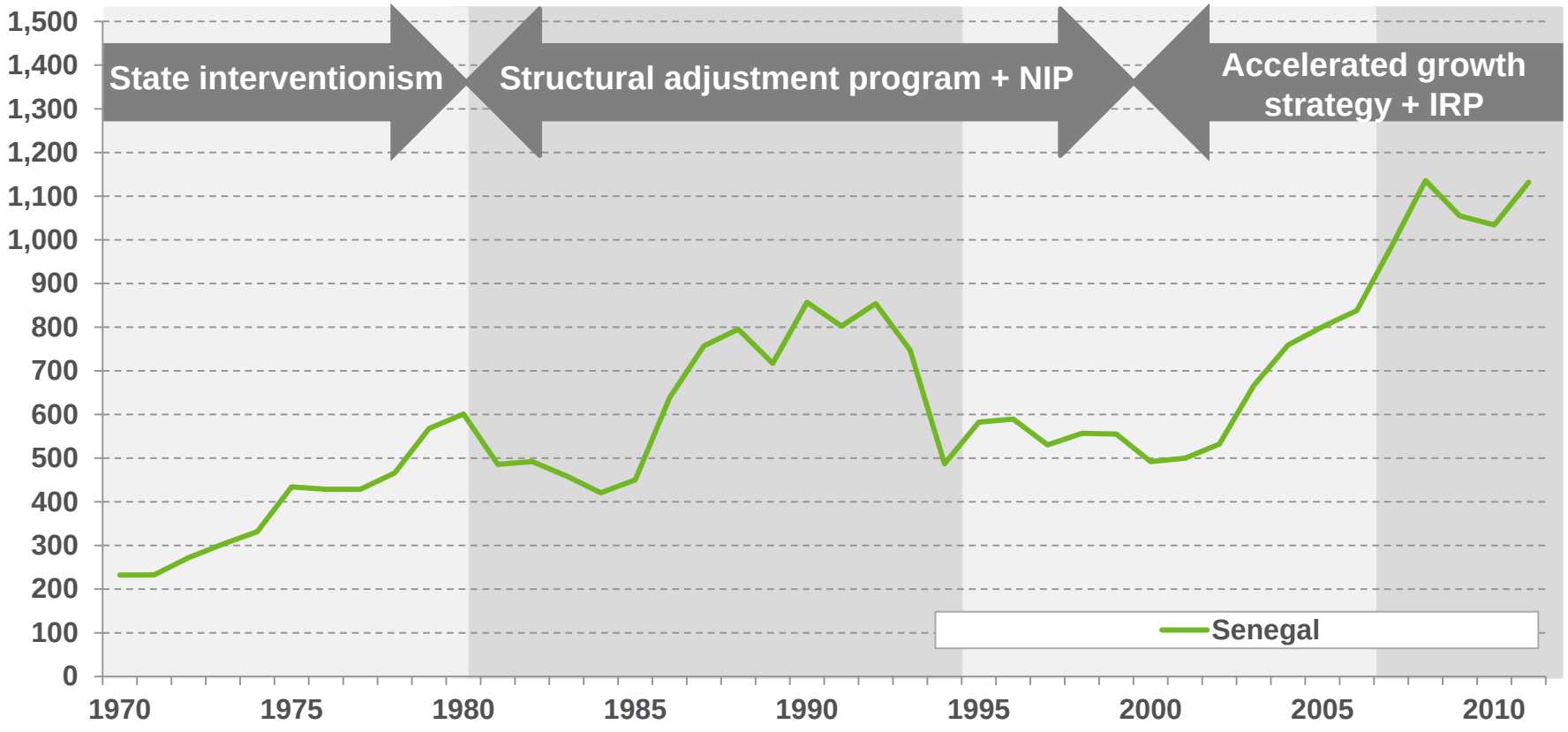
1/ Industrialization and economic policies in Senegal (1)

Per Capita GDP at current prices : Senegal and Western Africa (US dollars)



1/ Industrialization and economic policies in Senegal (2)

Per Capita GDP at current prices : Senegal (US dollars)



2/ The obstacles to industrialization in Senegal

- **Factors driving labour productivity are manifold :** geography, political risks, ownerships, competition, infrastructure, crime and violence, labour flexibility, access to more formal and informal finance (Harrison et al. (2011))

- **African Bank of development report (2012) :**
  - (i) Electric power supply and quality appears to be the main obstacle to industrialization
  - (ii) Primary and Technical Education are also key to improve overall economic performance
  - (iii) Spending on education and infrastructure must be improved

3/ Theoretical background and stylized facts (1)

- **Education and skilled labour matter for industrial growth, would it be for innovation or for imitation purposes (Aghion and Meghir; 2006))**

Secondary and Higher Education Enrolment Rates : Senegal and Sub-Saharan Africa (% of population)

2008	Gross Secondary Enrolment Rate			Gross Higher Education Enrolment Rate		
	Total	Male	Women	Total	Male	Female
Senegal	31.4	34.9	27.7	8.3	10 .5	6.0
Sub-Saharan Africa	34.8	39.0	30.5	6.0	7.6	4.8

Source : Unesco

3/ Theoretical background and stylized facts (2)

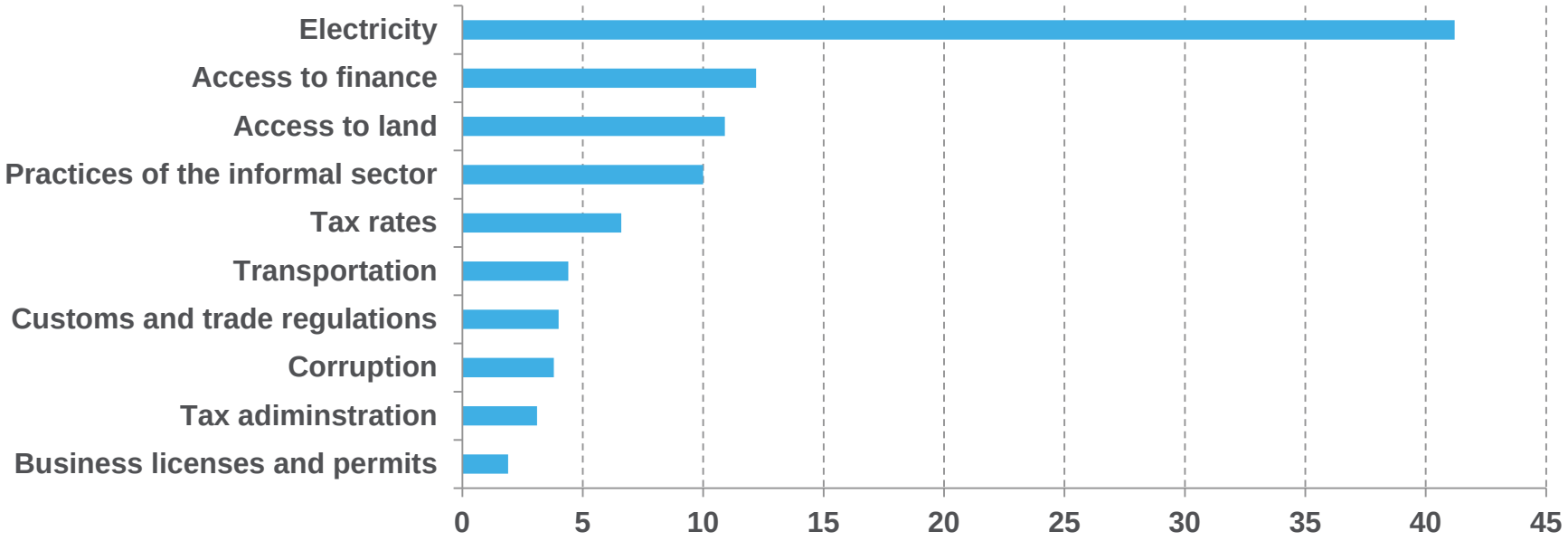
Access to electricity	Senegal		Low-income Countries	Middle income countries
	Late 1990's	Mid 2000's	Mid 2000's	Mid 2000's
National	36.2	47.1	32.8	49.5
Urban	72.8	80.4	72.8	74.4
Rural	7.8	15.8	12.7	26.3
Growth (per year)	-	2.7	4.4	12.1

Source : Eberhard et al. (2008)

3/ Theoretical background and stylized facts (3)

- **Electricity access is the major constraint identified by firms in the Senegal enterprise survey conducted by the World Bank**

Senegal : top ten business constraints (% of firms)



Source : Senegal enterprise survey (2007)

4/ The empirical approach

4.1 Empirical approach: data

- About 4000 Firms across 23 manufacturing sectors
- Data span: yearly data from 1998 to 2011
- Estimation of TFP: times series data about value added, capital stock and labour
- Determinants of TFP: human capital measured by the sectoral employment shares of the different qualification degree (senior managers, skilled technicians, supervisors and skilled workers and unskilled workers). Electricity access (proportional relationship between the size of tangible assets and electricity access)
- Accounting Database from the CUCI (Single Information Collecting Centre) and the ANSD (Senegalese National Statistic and Demography Agency)
- All data were converted into logarithms.

4.2 Empirical approach: TFP estimation (1)

- Estimation of TFPs for 23 industry groups : taking the natural logs of a standard Cobb-Douglas function results in a linear production function

$$y_{it} = \beta_{it} + \beta_k k_{it} + \beta_l l_{it} + \omega_{it} \qquad (1)$$

Y : value added *K : stock of capital* *L : labour*

A: level of technology, TFP *i: industry group* *t: year*

- *and*

$$ln(A_{it}) = \beta_0 + \omega_{it} \qquad (2)$$

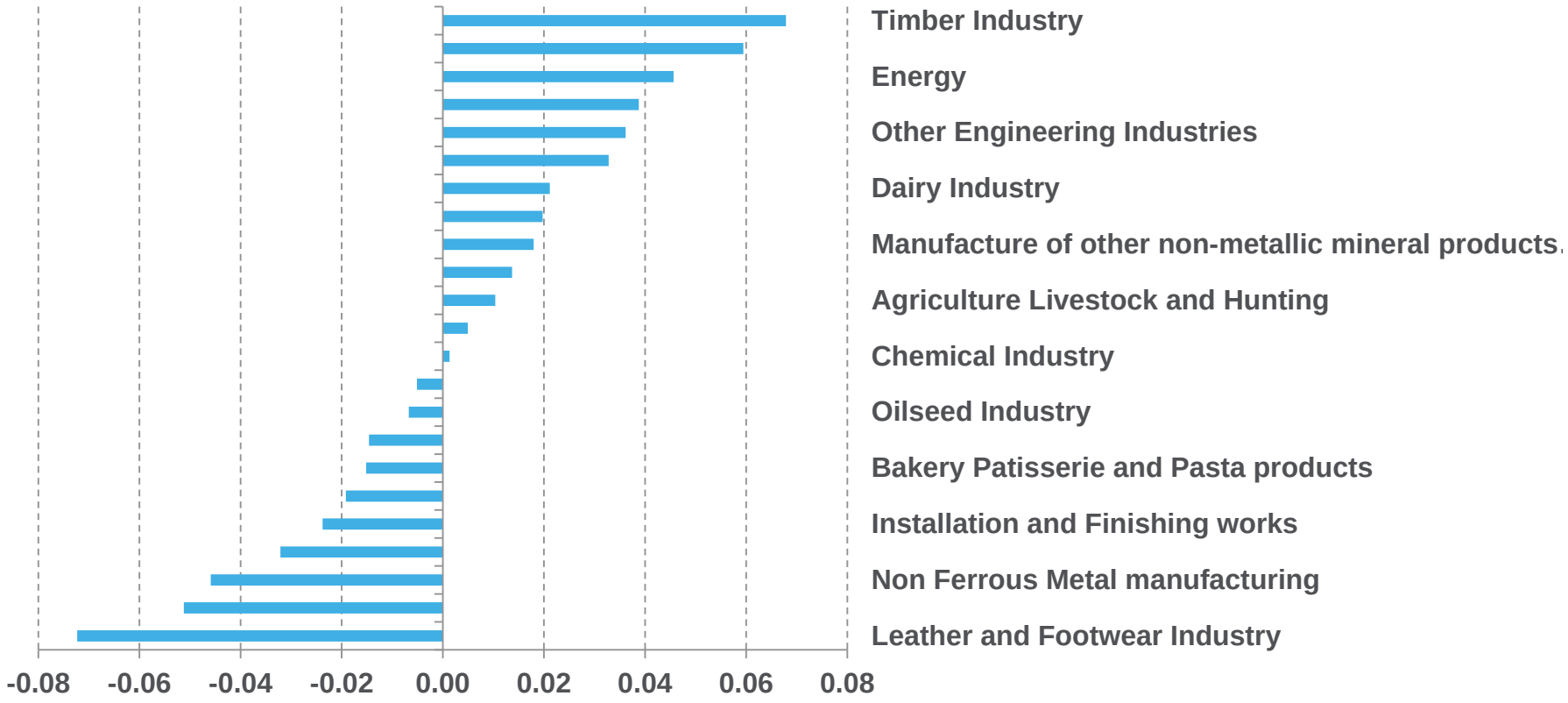
B_0*: mean industries and efficiency level across industries and over time*

ω_{it}*: time and sector-specific deviation from the mean*

$B_k; \beta_l$ *: capital and labor shares with* $(B_k + \beta_l) = 1$

4.2 Empirical approach: TFP estimation (2)

Senegalese industries : TFP annual average growth rate 1998-2011 (log)



Source : Maurel and Seghir (2013)

4.3 Unit root and cointegration test

- **The 2-step verification of the integration to the same order variables**

  1/ testing for cross section dependence

  Result : no cross sectionnal dependence

  2/ testing for the integration of the series with 3 unit root tests

Panel unit root tests : results

	Im et al.(2003)		Maddala and Wu (1999)		Pesaran (2005)	
	Statistic	P-values	Statistic	P-values	Statistic	P-values
TFP	-1.238	0.108	54.380	0.186	2.396	0.992
∆(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
∆(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
∆(Skilled technicians)	-16.83	0.000	554.27	0.000	-9.640	0.000
Electricity access	1.776	0.962	36.102	0.852	0.676	0.750
∆(Electricity access)	-11.06	0.000	274.87	0.000	-3.212	0.000

Source : Maurel and Seghir (2013)

4.4 Empirical approach: long-run parameter estimation (1)

- **Testing for a long-run relationship among variables : Westerlund (2007) cointegration test with bootstrap approach computable under the assumption of cross-section dependence**

  Result : all the statistics reject the hypothesis of no cointegration between productivity, human capital and electricity access

Westerlund (2007) panel cointegration test : results

Statistic	Value	Robust P-Value
Gt	-2.614	0.080
Ga	-6.016	0.000
Pt	-10.68	0.055
Pa	-6.176	0.025

Source : Maurel and Seghir (2013)

4.4 Empirical approach: long-run parameter estimation (2)

- Performing DOLS and PMG estimators to estimate the long run vector

- DOLS estimator (Kao and Chiang (2000)) :

$$TFP_{it} = \alpha_i + \beta X'_{it} + \Sigma c_{ij} \Delta X_{i,t+j} + v_{it}$$

c_{ij} : coefficient of lead or lag of first explanatory variables X_{it}

DOLS long-run parameter estimation : results

	Senior managers	Skilled technicians	Electricity access
Coefficients	-0.195(1.506)***	0.242(1.345)***	0.210(1.775)***

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

Source : Maurel and Seghir (2013)

4.4 Empirical approach: long-run parameter estimation (3)

$$\Delta TFP_{it} = \emptyset_i\left(TFP_{i,t-1} - \theta_i X_{it}\right) + \sum_{j=1}^{p-1} \gamma_{ij}\,\Delta TFP_{i,t-1} + \sum_{j=0}^{q-1} \delta_{ij}\,\Delta X_{i,t-j} + \mu_i + \varepsilon_{it}$$

μ_i : the sector-specific effect
δ_{ij} : the coefficient of explanatory variables
θ_i : the vector which contains the long-run relationships between the variables
Φ_i : the error –correcting speed of adjustment term

PMG long-run parameter estimation : results

	Senior managers	Skilled technicians	Electricity access
Short run	0.064(0.023)***	-0.004(0.019)	0.128(0.060)**
ECT		-0.500(0.010)***	
Long run	-0.100(0.024)***	0.053(0.026)**	0.295(0.023)***

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.

Source : Maurel and Seghir (2013)

5/ Results

- **Productivity responds to deviations from long-run equilibrium :**
  - the error correction term is significantly negative
  - the estimated speed of adjustment of TFP is around -0.500

- **Electricity access has a significant positive impact in the long-run**
  - a 1% increase will increase the TFP by 29% (PMG) and by 21% (DOLS)…
  - …and by 12% in the short-run (PMG)

- **Positive effect of skilled technicians whereas the senior managers have a negative impact**
  - a 1% increase of the proportion of skilled technicians increase the TFP by 5% (PMG) and by 24% (DOLS)