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## Policy Brief: Accounting for Productivity Growth: Schumpeterian versus Semi-Endogenous Explanations

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In this paper we analyze whether empirical evidence across a range of countries and manufacturing sectors favours semi-endogenous or Schumpeterian accounts of efficiency gains. Which theoretical framework finds support carries profound implications for policy. Under Schumpeterian productivity growth there exists the prospect sustainable unbounded growth. Under semi-endogenous growth productivity is constrained.

For South Africa our finding is that its manufacturing sectors are heterogeneous. We do find evidence supporting Schumpeterian productivity growth in the chemicals and related sectors, machinery and transport equipment, and basic iron and steel sectors. All other sectors are either semi-endogenous, or unclassifiable in terms of strict theoretical requirements.

The implication is that there does exist the prospect of unbounded productivity growth in South African manufacturing. However, it is relatively narrowly focused in terms of its sectoral distribution.

### Background Theory

In terms of neoclassical growth theory, the existence of steady state constrains long-run output growth to the natural rate of growth, such that per capita income would be constant over time.

The only source of sustained growth in growth in per capita income will be located in technology in the form of growth in total factor productivity (TFP). Empirically, in developed countries approximately 75% of long growth is attributable to growth in TFP, substantially overshadowing the contribution of factor accumulation. The South African evidence mirrors the international evidence, in the sense that growth has come to be increasingly reliant on TFP, rather than factor accumulation.

This places an onus on explaining the source of TFP growth. Schumpeterian growth theory attributes such productivity growth to a knowledge-producing sector. In its original formulations, the knowledge production function was specified to be linear in both R&D input and the level of knowledge. This had the radical implication that there is no diminishing marginal return to either the R&D input or the accumulated level of technology. From which followed the prospect of unbounded growth through continued technological innovation.

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This prediction is consistent with the experience of accelerating output and technological growth over the course of the industrial revolution,. But it also faces more immediate empirical challenges. For instance, while the number of R&D scientists and engineers in the USA increased by 500% over the 1950-88 period, the growth rate of both Y/L and TFP has remained unchanged - directly contradicting the predictions of the Schumpeterian theory.

In this paper we consider the implications of two responses to this empirical contradiction. Semi-endogenous productivity growth suggests that the marginal rate of return to the level of knowledge is now diminishing. This implies that sustained growth in R&D inputs is required to maintain a constant rate of TFP growth. The prediction is that long-run TFP growth, hence per capita GDP growth, is again bounded by the population growth rate.

An alternative response retains the Schumpeterian framework of constant returns to knowledge creation, but requires the R&D input to be distributed across a proliferating set of intermediate (capital) inputs. Proliferation of product variety has the effect of diluting the impact of R&D over an ever-increasing array of projects/innovation streams, potentially neutralizing the growth in R&D input.

This paper presents and implements an empirical specification that nests both theoretical propositions, and tests which finds support.

### Estimation Results


The paper employs three data sets. The first is a country-level panel data set for 13 countries over the 1996 to 2010 period. The second dataset consists of the data of 25 South African manufacturing sectors from 1973 to 19993. Third, we employ data from 10 manufacturing sectors of six OECD countries from 1979 to 2001.

The results based from the panel data estimations are not consistent across the data sets. The results of the country level and South African manufacturing sector panel datasets favour the Schumpeterian productivity growth model. The OECD panel favours the semi-endogenous growth model.

However, from the use of pooled mean group estimators, we do find evidence of sectoral heterogeneity in the panel data.

For this reason we also employed time series estimators at the sectoral level for the South African and OECD data sets.

Time series estimation confirms the existence of heterogeneity in the two datasets. According to the estimation results, 12 out of the 25 South African manufacturing sectors report constant or increasing returns of the level of TFP, consistent with Schumpeterian theory., and implying the possibility of unbounded, sustainable growth in the long run. Furthermore, 6 of the 12 sectors have a positive R&D elasticity towards productivity growth; that is, productivity growth rate would react positively to the changes in the growth rate of R&D input, which creates prospects for successful policy intervention to raise R&D inputs in these sectors. Sectors with Schumpeterian characteristics are found in chemicals and related sectors, machinery and transport equipment, and basic iron and steel sectors.



Results for the OECD sectors indicates that the two North American economies (Canada and USA) have more sectors identified as Schumpeterian than the European economies included in the study (Finland, France, Italy and Spain). Meanwhile, Finland has the most sectors identified with a positive R&D elasticity towards productivity growth, whereas Canada and USA falls below the average level of the four European economies. Again, the OECD manufacturing sectors are heterogeneous not only across sectors but also across countries in terms of their structure of productivity growth, with a preponderance of sectors classified as semi-endogenous rather than Schumpeterian.