The impact of imported technology on South African manufacturing firms

An econometric analysis using the SARS-NT firm-level panel set of administered tax data

Making sure it's possible.





Department: Science and Innovation REPUBLIC OF SOUTH AFRICA



2030

Presentation roadmap





9. Questions and Answers

1. Context, motivation, research question and method

Context: South Africa's economic growth crisis

"For the past decade, the South African economy has experienced stagnation which has put a strain in the effort to tackle the historical structural inequalities, unemployment and poverty." (Economic Reconstruction and Recovery Plan)

South Africa lags its emerging market peers in terms of growth in technology and is failing to harness untapped potential for innovation that could create jobs and reduce poverty (World Bank 2017 Economic Update of South Africa)

Central research question of this research

What are the impacts of accessing foreign technologies on manufacturing <u>firm</u> outcomes, including employment, output, exports, tax revenue and productivity?

Data and method

South African Revenue	Corporate income tax data;
Service and National Treasury Firm-Level Panel (SARS-NT panel)	Employment data from employee income tax certificates
	Product-level customs transaction data on firm exports and imports
	40 000+ manufacturing firms per year from 2010 to 2017
Defining of imported technology	<u>Embodied</u> in imports of high-technology products. Based on Lall (2000) technology classification
	<u>Disembodied</u> form – Royalty payments, Licence fees and Foreign ownership
Empirical method	Descriptive analysis
	Econometric estimation
Caveats	Only capture impact of direct importers
	Spillover effects ignored
	Incomplete matching across databases

Boosts growth and diversification of SA manufacturing exports

SA lags other emerging economies in economic growth and imports of technology

Imported technology Raises manufacturing firm employment, but is associated with a skills bias.

Hi-tech importers make up bulk of corporate tax payable in manufacturing Strong positive impact on South African manufacturing firm productivity.

2. Country-level overview

Thirty-thousand-foot view



Faster economic growth is accompanied by faster growth in imports of high-technology products

SA lags other emerging economies in economic growth and imports of hi-tech goods

Causality cannot be inferred, but association is evident.

Warrants further investigation, especially if this association can be investigated at firm-level.

Historical trend: Imported technology and Gross Domestic Product

Over the last decade, South Africa has seen a decline in the imported technology content of its GDP relative to other upper middle-income countries

45% 50% Percentage change 2008-2019 40% 30% 20% 10% 0% 0% -2% -10% -8% -20% -16% -20% -30% -29% -40% -34% Payments for IP/GDP Fixed capital formation/ High-tech imports/ GDP High-tech imports/ Total GDP imports South Africa Upper middle income (median)

South Africa compared to upper middle income counties, Percentage change, 2008-2019

Source: World Development Indicator and UNComtrade data. Sample of upper middle income countries covers 36 to 44 countries

Signals a hollowing out of productive capacity

Historical trend: Changing geographical composition of imports

Rank	1994 share	
1	Germany	18
2	United States	17
3	United Kingdom	14
4	Japan	8
5	France	6
6	Netherlands	4
7	Canada	4
8	Switzerland	4
9	Hong Kong, China	3
10	Italy	3

2019 share		
China	38,8	
United States	10,4	
Germany	6,2	
India	5,9	
Vietnam	4,0	
France	3,8	
United Kingdom	2,5	
Japan	2,3	
Italy	2,1	
Ireland	2,0	

Emerging economies have become important source of technology embodied in imports.

Reflects trade through Global Value Chains and telecommunication equipment (mobile phones)

3. Firm-level descriptive statistics

Summary statistics on sample of firms

	2010	2017
Total number firms	236,804	281,736
Number manufacturing firms	44,715	52,674
Share manufacturing firms in total firms	19%	19%
High-technology importers as share manufacturing firms	9%	10%
Share manufacturing firms with TFP and employment data in	36%	41%
total manufacturing		

Note: Based on cleaned merged panel data excluding dormant firms, firms without capital and firms with negative value added

Stylized facts, average 2010-2017



The importation of high-technology products by firms occurs in all major sectors, but manufacturing most important in terms of firm numbers

Within manufacturing, highest intensity of high-technology imports in high-technology industries such as the Electrical machinery and Radio, TV & communication industries.

Note: Based on cleaned merged panel data. All firms.

4. Detailed firm-level results

- 1. Imported technology & Productivity
 - a) Embodied in imports
 - b) Disembodied
- 2. Imported technology & Exports
- 3. Imported technology & Employment
- 4. Imported technology & Corporate tax

Importation of technology and manufacturing firm productivity

Complementary inputs

• Learning spillovers arise from the introduction of new varieties that complement existing inputs.

Embodied imported technology:

 Imported HT products are of a higher quality, and/or embody new technology.

Disembodied imported technology:

 Knowledge transfer occurs through foreign direct investment and royalty/licensing agreements.



4a. Imported Technology and Productivity

High-technology imports and firm Total Factor Productivity (TFP)

Descriptive statistics

Trends in average firm Total Factor Productivity (TFP) by importer status (2010-2017)



Mean firm productivity in manufacturing stagnated over the period, with a 11% decline from 2013-2017.

Mean firm TFP by importer status (2017)



There is wide variation in average firm TFP within and across industries, but in all cases importers of HT products are more productive than other firms.

Regression analysis – cursory overview of basic model

Identify relationship between imported technology and firm outcomes in two ways:

- 1. See how firm outcomes change when a manufacturing firm starts to import high-technology products.
- 2. Analyse how outcomes are influenced by changes in the intensity of high-technology usage, measured as value of high-tech imports over costs.

$$TFP_{it} = \alpha + \beta_1 M_{it-1} + \beta_2 MHT_{it-1} + \beta_3 MV_{it-1} + \beta_3 MV_{it-1} + \beta_4 DX_{it-1} + \sum_m \beta_m C_{it}^m + \lambda_i + \lambda_t + \varepsilon_{it}$$

Regression analysis – results

Manufacturing firms experience increases in TFP upon entry into importing of high-technology products (6-7 percent)

Strongest effects experienced in Radio & TV equipment (9 percent) and Transport equipment (12 percent)



Importer, non-HT Importer, HT

Source: SARS-NT data. Manufacturing firms only. Based on estimates over period 2010-2017. All explanatory variables (including export status, employment, capital/labour ratio, wage) are lagged by one period. Estimates include firm and year fixed effects. Firm TFP obtained from Krueser and Brink (2021).

Other results

10% increase in imported varieties



0.35% increase in firm TFP

Inclusion of medium tech in measure of imported tech

Weakens TFP results by a third to half

10-percentage point increase in high-tech imports/costs



No significant impact for low & medium wage firms 2% increase in TFP for high wage firms

4b. Imported Technology and productivity

Disembodied foreign technology and firm Total Factor Productivity (TFP)

Data

Summary statistics on sample of manufacturing firms, 2017

	Number of firms	Share manufacturing firms (%)	Expenditure/sales (%)
Foreign (broad) firms	4 968	23.19	
Foreign (strict) firms	597	2.79	
Royalty/licence paying firms	774	3.60	1.29
R&D firms	322	1.50	0.74

Note: The sample only covers manufacturing firms with employment and TFP data. Strict foreign are firms ultimately foreign controlled. Broad foreign includes branches/permanent establishments of foreign company and firms non-resident for income tax purposes

Few manufacturing firms in the sample declare royalty/licence payments (3.6%) or expenditure on R&D (1.5%)

Average royalty/licence payments as share sales (1.29%) is higher than R&D expenditure as share sales (0.74%), but in both cases the shares are low.

Most expenditure (88 percent) on licences/royalties is made to foreign sources.

Note: Based on cleaned merged panel data

Regression estimates

There is a strong positive association between firm TFP and disembodied knowledge transfer, as measured by payments for royalties/licences (20%) and foreign ownership (15%).

The productivity premium for firms declaring expenditure on R&D (6%) is lower than for firms through licencing and royalty payments.

Percentage increase in firm TFP associated with foreign ownership, payment of royalties/licences and R&D expenditure, 2017



Source: SARS-NT data. Manufacturing firms only. Based on estimates over period 2013-2017. Based on estimate including dummy variables for firms engaging in importing (incl. high-tech) R&D, royalty/licence and foreign ownership. Other explanatory variables (including export status, employment, capital/labour ratio, wage) are for concurrent periods. Estimates include 2-digit industry by province by year fixed effects. Firm TFP obtained from Krueser and Brink (2021).

5. Imported technology and export performance

Imported technology and export performance in manufacturing

- Policy objective
 - Growth in export volumes by 6% per annum (10% non-traditional exports) by 2030 (NDP).



The period from 2013/14 reflects a retreat from exporting by manufacturing firms.

- Constraints
 - Infrastructure bottlenecks, electricity constraints, port & transport costs, non-tariff barriers, high input costs.
 - Role of imported technology?

Imported technology and export performance

Access to imported technology can affect exports directly and indirectly:

Imports & imported technology

Export outcomes

Direct cost channel

• Reduces production costs

Indirect productivity channel

- Wider range of complementary inputs
- Quality of input channel
- Technology embodied in imports
- Knowledge transfer (Foreign ownership, licences, GVC-links)

Higher aggregate value of exports, driven by:

- 1. More exporters
- 2. More products to more destinations (varieties)
- 3. Higher export value per variety and firm

Regression results

Entering importing raises probability that the firm commences exporting, with effect working indirectly through TFP



Imported technology and access to access to a wider range of imported inputs leads to higher firm export values and product innovation, as measured by the export of new varieties. Percentage change in export value of two-way traders from 1 percentage point rise in share of high-technology imports in costs and 10% rise in number of imported varieties



Contribution to export value by export value per variety (intensive margin)

Contribution to export value by export variety (extensive margin)

Two of the many additional regressions

Split sample into low and medium wage firms	Estimates at 2-digit industry level	
Exports of low & medium wage firms benefit most (1.1% vs. 0.3% increase following 1 pp increase in HT imports/costs)	Increases in most manufacturing industries, but few observations reduces power of estimates.	

Notes: for detailed regression results, see the full report.

- Exports of low & medium wage firms benefit most, suggesting that foreign technology embodied in imports is an important source of competitiveness for lower wage firms.
- Increases found in most industries

Results highlight critical role imported technologies can play in realising the NDP 2030 goal of increasing export volumes by 6 percent per year and non-traditional exports by 10 percent per year.

6. Foreign technology and employment

Schematic representation of employment effects



Net employment result

Manufacturing firms that import high-technology products employ significantly more workers than other manufacturing firms (and in all firm-wage categories).

Employment impact following firm commencing importing (relative to non-importing)



Source: SARS-NT data for manufacturing firms over period 2010-2017. Values based on coefficients on import status in employment regressions presented. Dependent variable is employment (in logs). Explanatory variables include (lagged) export status, import status, HT import status, TFP, capital/labour ratio and wage. Firm and year fixed effects are included. The coefficients, thus, reveal employment outcomes associated with the transition within a firms across import status categories over time.

Net employment result

High-tech importer-employment relationship holds within all manufacturing industries.

Impact of firm commencing importing (relative to non-importing) by industry



Source: SARS-NT data for manufacturing firms over period 2010-2017. Values based on coefficients on import status in employment regressions presented. Dependent variable is employment (in logs). Explanatory variables include (lagged) export status, import status, HT import status, TFP, capital/labour ratio and wage. Firm and year fixed effects are included. The coefficients, thus, reveal employment outcomes associated with the transition within a firms across import status categories over time.

Productivity channel - Employment intensity

Imported technology has a positive effect on the employment intensity in high-skilled or high-wage firms, but a labour-saving effect in low and medium-wage firms.

Impact of 10 percentage point increase in firm imports as share costs on employment intensity in manufacturing



Foreign technology embodied in imports of HT goods, may lead to a widening of wage differentials between skilled and unskilled workers

The employment effect of increased output for lower skill firms is greater than the labour-saving effect

Source: Based on labour demand regressions estimated using the system generalized method of moments (GMM) of (Arellano & Bover, 1995). Simulated short-run effect based on a 10 percentage point increase in import value to cost of sales. Wages, and value added are treated as endogenous. All estimates include time fixed effects, exporter fixed effects and (in logs) value added, wages (current and lagged one period) and employment (lagged one and two periods). Estimates cover the period 2010-2017 using a balanced sample of firms. Low denotes firms in first wage quartile, Medium denotes firm in 2nd and 3rd quartile, High denotes firms fall in the 75th to 95th percentile of the firm wage distribution, and Ultra-high denotes firms in the top 95th percentile. The letters below the legends signify the following: 'a' denotes significance (10 percent level) of the coefficient on imports/costs, and 'b' signifies that the coefficient on imports of high-technology/costs is significantly different from the coefficient on imports/costs.

7. Imported technology and tax

Corporate income tax

Importers of high-technology products pay 77% of corporate tax payable by manufacturing firms, despite only making up 9% of firms in manufacturing

They are more likely to pay corporate income tax because more profitable, and pay higher levels of corporate income tax because they are larger

Corporate income tax payable by manufacturing firm import status, share total and average value, 2013



Source: SARS-NT. Manufacturing firms only, 2013. HT denotes Lall high-technology.

Personal income tax from salaries and wages also expected to be larger given relative size of HT importers. Import duties also collected, but values low.

8. Summary, caveats & recommendations

Boosts growth and diversification of SA manufacturing exports

SA lags other emerging economies in economic growth and imports of technology

Imported technology Raises manufacturing firm employment, but is associated with a skills bias.

Hi-tech importers make up bulk of corporate tax payable in manufacturing Strong positive impact on South African manufacturing firm productivity.

Caveats and areas for further research

1. Only focuses on manufacturing sector, but, as shown in the paper, firms in other industries also import high-technology goods.

2. Local spill over effects and indirect purchases imported high-technology goods not accounted for.

3. Within firm employment adjustments to imported technology not studied.

4. Possibility of residual endogeneity biases.

8. Questions and answers

Making sure it's possible.



science & innovation

Department: Science and Innovation REPUBLIC OF SOUTH AFRICA



