Report

Regional trade and infrastructure and firm-level productivity in Sub-Saharan Africa

A background research paper in the project *Regional infrastructure for trade facilitation – impact on growth and poverty reduction*

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Report

Key messages

This paper examines whether regional trade and regional infrastructure have long-lasting effects on firm-level productivity, which is a crucial link in the theory of change from regional infrastructure to sustained poverty reduction.

Firm-level panel data (Malawi, Rwanda, Senegal and South Africa) show regional exporters have a higher level and growth in productivity.

New econometric evidence for sub-Saharan Africa also finds firms in countries with better regional infrastructure have higher productivity.

Policy should focus on improving regional infrastructure. Attention should go not only to reducing clearing costs at different border crossings but also to reducing the large spread in costs among firms using the same gateway.

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The team for the overall study is coordinated by Marie-Agnes Jouanjean and Dirk Willem te Velde and involves a range of ODI researchers (including Judith Tyson, Neil Balchin, Linda Calabrese, Alberto Lemma, Andrew Scott and Catherine Simonet) and international experts (including Olivier Cadot, Douglas Brooks, Ben Shepherd and Marie Gachassin) and others.

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Executive summary

This paper contributes to a larger study on the effects of regional infrastructure on poverty reduction in two ways. It first examines whether regional trade (exports in particular) has a long-lasting effect on productivity, which is a crucial link in the theory of change running from regional infrastructure to sustained poverty reduction. If regional exporters are indeed better performers and this is sustained over time, policy that facilitates regional trade can have long-lasting impacts in addition to the short-run gains from trade. It then examines the impact of regional infrastructure on firm-level productivity directly, encompassing the effects through exporting as well as importing. An important by-product of our analysis is the observation that border crossing costs vary by firms for the same gateway, suggesting there is more to regional infrastructure than hard infrastructure

Regional exporting and productivity
Previous studies have suggested that regional infrastructure stimulates (regional) trade which can improve firm productivity. The evidence from firm-level panel data (in Rwanda, Malawi, Senegal and South Africa) suggests not only that regional exporters have higher productivity than other firms but also that they have greater productivity growth. This works in part through the increased emphasis and impact of technology. This means it is important to facilitate regional trade because of the long-lasting impact on productivity.

Firm-level analysis for regional exporters in **Rwanda** shows regional exporters have a higher level of and faster growth in labour productivity growth over 2006-2011. The average productivity gap is 72%, slightly below the gap for all exporters. The panel data show regional exporters are more likely to innovate and survive (compared with other firms).

In **Malawi**, regional exporters have a higher level of and faster growth in labour productivity growth over 2005-2009. The productivity gap between regional exporters and other firms is 18%. The data on clearing costs at the border suggest these costs vary markedly, at between 1% and 40% of consignment value, depending on the border crossing. More productive firms export through lower-cost border crossings. The least productive firms face the highest costs in crossing borders.

In **Senegal**, regional exporters have a 60% higher level of total factor productivity (TFP) (but this varies by sector and firm size group), with growth over 2003-2007 70% compared with 40% for the control group. Regional exporters have a higher growth in TFP partly because the impact of technology has led to higher productivity and better product quality. The average cost of border crossing is similar across crossings (land, or air and sea), but there is wide variability for each type of crossing, at between 0% and 50% of consignment value. The more productive firms export over land.

In **South Africa**, using World Bank Enterprise Survey panel data for 2003 and 2007, we show growth in productivity has been much greater in regional exporters compared with other firms (non-exporters), leading to a productivity pay-off of some 7% in 2007.

Regional infrastructure and firm-level productivity
Regional infrastructure affects firm-level productivity in different ways, through exporting but also importing through which firms are able to access high quality supplies. We create country- and time-varying measures of the quality of regional infrastructure, and trade- and transport-related infrastructure specifically, and link this to firm-level productivity for sub-Saharan Africa.

We find countries with better regional infrastructure (quality of infrastructure in the neighbours) also have firms with relatively higher productivity. If the regional infrastructure measure increases by one standard deviation, productivity will increase by 7% for changes in the overall infrastructure measure and 19% for changes in the trade-related measure. This effect is robust to including country dummies and other explanatory variables. We also find the impact of regional infrastructure is greater for firms that import some material inputs and supplies.

Policy implications
It is important to invest in regional infrastructure as this supports productivity levels, through facilitating exporting and importing. Such investment should cover more than hard infrastructure alone given that different exporters using the same infrastructure at the same gateway use different clearing costs.

Clearing costs can vary markedly between border crossings (e.g. between 1% and 40% of consignment value in Malawi), but the costs do not only vary across border crossing but also across types of exporters using the same crossing. The difference in average clearing costs between types of gateway (land, airport or sea) reported by South African firms is the same (2.8%) as the difference in clearing costs between regional exporters and global exporters for using these gateways (2.8%). In Senegal, the variation between average clearing costs of border crossings is smaller than the variation among firms using the same gateway. In policy terms, this means it is important to reduce the variation in clearing costs across firms using the same gateway in addition to reducing the average clearing costs of different gateways. Much of this is likely to involve soft regional infrastructure.

1 Introduction

Improved regional infrastructure can lead to increased trade and lower trade costs. More importing and exporting can lead to increased productivity through lower trade costs, more competition (which can stimulate productivity-enhancing investments) and learning. Integration in regional and global value chains can deliver opportunities to improve productivity gains and quality employment. If this is the case, regional infrastructure can have major indirect effects on poverty through the 'firm' channel identified in Jouanjean et al. (2015), see also annex I.

This paper examines the impact of investments in regional infrastructure on trade facilitation in two ways. It first analyses whether regional exports have contributed to increased firm performance. It examines to what extent there is variation in terms of productivity among firms according to whether they export (and import) and export regionally (to other countries in Sub-Saharan Africa) or globally or not at all. It uses World Bank Enterprise Survey (WBES) panel data that can track whether regional exporters have a differential level of and growth in productivity compared with other firms.

The paper subsequently analyses the impact of regional infrastructure on firm level productivity in sub-Saharan Africa. Whilst this provides a more direct test between regional infrastructure and firm productivity (compared to the regional exporting route), which encompasses the various routes through which regional infrastructure affects productivity, it can use only indirect and aggregated measures of regional infrastructure. Nonetheless we argue that the two types of analyses together provide a persuasive picture of the impact of regional infrastructure.

The structure of this paper is as follows. Section 2 reviews the relevant literature, arguing relatively little is known about the links between firm productivity and *regional* infrastructure or *regional* trade. Section 3 introduces the methodology for the two complementary analyses. Section 4 presents the empirical results on the productivity effects of regional exporting. Section 5 puts this in the broader context of regional infrastructure and firm-level productivity. Section 6 concludes and presents the policy implications.

2 Regional trade, infrastructure and productivity: a brief review

This section provides the context of the paper by recalling the evidence on trade, infrastructure and macroeconomic performance (2.1) and on exporting, infrastructure and firm-level productivity (2.2) before examining these issues at the regional level (2.3).

2.1 Trade, infrastructure and macroeconomic performance

There is a large body of evidence to suggest greater 'openness to trade' – measured as the volume of trade (imports and exports) as a share of gross domestic product (GDP) – is associated with greater economic incomes (Sachs and Warner, 1995). Deepening the analysis, Wacziarg and Welch (2008) examine 141 liberalisation episodes, comparing growth before and after liberalisation, and find that the impact of trade liberalisation on growth is substantial, even after controlling for several other determinants of growth. Per capita growth of liberalising countries was around 1.5 percentage points higher than before liberalisation. Focusing on Sub-Saharan Africa, Brückner and Lederman (2012) suggest trade openness causes economic growth: a 1 percentage point increase in the ratio of trade to GDP is associated with an annual increase of 0.5% in growth year in the short run and an annual 0.8% in the long run.

Trade does not always lead to structural change and productivity change in the right direction. Grossman and Helpman (1991) allow for the possibility of uneven development where countries specialising in products with the greater learning-by-doing potential gain most. McMillan and Rodrik (2011) argue access to global markets and increased competition are expected to drive an economy's resources towards more productive uses and enhance allocative efficiency. As trade barriers have come down, industries have rationalised, upgraded and become more efficient. But an economy's overall productivity depends not only on what is happening within industries but also on the reallocation of resources across sectors.

The literature on the economic impact of infrastructure is large and is surveyed by Jouanjean et al. (2015). For example, Estache (2006) suggests economic returns on investment projects average 30-40% for telecommunications, more than 40% for electricity generation and more than 200% for roads, but when the outliers are excluded the average is about 80%

for roads. Returns tend to be higher in low-income than in middle-income countries (see Briceño et al., 2004, and Canning and Bennathan, 2000).

2.2 Exporting, infrastructure and firm-level productivity

An equivalent literature at firm level can be used to gain more granular insights into the relationships. Exporting and foreign ownership lead firms to be exposed to greater competition, and this involves higher aggregate productivity (Syverson, 2011). Increased competition can change the incentives for innovation through (i) easing market entry conditions; (ii) increased threat or incidence of foreign competition; and (iii) improved regulatory changes. For example, trade liberalisation is found to induce the smallest or least productive firms to exit, as market shares are further allocated towards larger more productive exporters (Melitz, 2003). Only a few large firms are really productive within a given industry; these are also the firms that export and that have a higher probability of being foreign-owned.

The empirical literature includes a reasonable consensus suggesting exporting and foreign-owned firms pay higher wages, are more productive and employ more skills (e.g. te Velde and Morrissey, 2003). In a recent example, Dutz et al. (2011) use a sample of more than 26,000 manufacturing establishments across 71 countries (both developed and developing) and find that (i) bigger enterprises are more likely to invest in research and development (R&D), innovate and have higher total factor productivity (TFP); (ii) enterprises that are incorporated are significantly more likely to do R&D, and incorporation is a plus factor for process innovation by old and large firms and for TFP of micro and mature firms; (iii) foreign borrowing is a strong and statistically significant correlate of R&D activity and TFP for small and young establishments; and (iv) firms that export are significantly more likely to engage in R&D and innovation and to have higher TFP.

There is less consensus on the pathways, reasons and direction of these correlations. The recent debate on trade and growth at the level of the firm suggests not only that the most productive firms within an industry export, but also that such firms are likely to have been the most productive firms within an industry *before* exporting – that is, exporters self-select into markets. This owes in part to the high sunk costs for firms to enter markets. Bernard and Jensen (1995; 2004) find exporters are more productive than exporters. This result supports the hypothesis that firms that engage in trade benefit from learning-by-doing. However, at the same time, firm-level studies suggest productivity typically increases to a greater extent before firms export rather than after they enter export markets (Bernard and Jensen, 2004; Clerides et al., 1998; Greenaway and Kneller, 2007).

Firm-level studies continue to explore the existence or not of learning-by-doing effects for countries that have recently liberalised their trade regimes. For example, Fernandes and Isgut (2008) reinvestigate Colombian manufacturing firms (updating Clerides et al., 1998) and find that, even when controlling for the bias caused by self-selection of the most productive plants, results suggests firms do learn by exporting. The effects are related to export to output ratios, suggesting the existence of spillovers of efficiency gains from export-related tasks to domestic market production, but the effects are smaller for established exporters.

Graner and Isaksson (2007) control for the destination of Kenyan manufacturing exports in order to test for learning-by-exporting effects. After controlling for lagged technical efficiency, Ordinary Least Squares (OLS) estimation provides evidence in favour of the self-selection hypothesis, but no support is found for the existence of learning-by-exporting. The authors find exporters are more efficient than non-exporters and relatively efficient firms self-select into exporting. However, learning effects are found only in South–South trade, not in North–South trade, which suggests destination market is an important determinant.

Van Biesebroeck (2005) finds for a panel of manufacturing firms in nine African countries (data from the World Bank Regional Programme on Enterprise Development collected in the early 1990s) that exporters in these countries are on average more productive and that exporters raise their productivity advantage after entry into the export market. The effects occur through scale effects and are robust to including self-selection and other unobserved differences in productivity.

There is also an emerging literature on the effects of infrastructure at the firm level. Provision of reliable infrastructure services at low costs is essential to improve firm competitiveness and increase firm production. For example, Limi et al. (2015) argue that good-quality transport infrastructure is essential in improving firm productivity as quality roads reduce trade and transport costs of firms so they can minimise inventory costs. The paper focuses on varied infrastructure performance in the manufacturing sectors of Burundi, Kenya, Rwanda, Tanzania and Uganda. Using data from the 2005 Business Environment and Enterprise Performance Survey (BEEPS), the authors find significant results in the electricity, transport and water sectors. The output elasticity with respect to electric infrastructure quality is shown to be the highest, followed closely by that in transport infrastructure. Several other papers (see Jouanjean et al., 2015) also focus on the local or national level, but usually not the regional level.

2.3 Exporting, infrastructure and productivity: the regional dimension

There are far fewer studies examining the link between firm-level productivity and exporting at the *regional* level. Using firm-level data, te Velde (2011) undertakes a number of regressions on World Bank enterprise data for Benin, Malawi and South Africa. The study indicates that exporting firms have higher productivity. Unfortunately, these regressions cannot be used to argue whether good firms export or firms learn through exporting because there was no access to panel data. The study also distinguishes between whether the main exports of the firm go to the region (the West African Economic and Monetary Union (WAEMU) for Benin and Eastern and/or Southern Africa for Malawi and South Africa) or elsewhere. The regression results show exporters to the region and exporters to outside are statistically associated with the same productivity levels – but they might be slightly lower for regional exporters in Benin and higher for regional exporters in Malawi. In the case of South Africa, regional exporters are statistically more productive than worldwide exporters.

Mengistae and Pattillo (2002) use data on manufacturing establishments (from the World Bank Regional Programme on Enterprise Development) to examine the productivity premium for exporters, split by exporters to Africa

and exporters outside Africa. They find that, for Kenya, the productivity premium is 58% (and significant) for exporters outside Africa and 26% (and not significant) for exporters inside Africa. In Ghana, the exporting premia are similar but not significant. Taking three countries together (Ethiopia, Ghana and Kenya) in a combined panel, the exporting premium is 35% (and significant at 1%) for exporters outside Africa but 20% (and significant at 5%) for exporters to Africa. Unfortunately, this study too was not able to test directly for dynamic effects over time such as on learning-by-exporting.

The productivity effects through regional integration do not need to come only from the exporting side. De Hoyos and Iacovone (2013) analyse the impact of the North American Free Trade Agreement (NAFTA) on the productivity of Mexican plants, allowing for heterogeneous productivity effects between firms with varying levels of integration – that is, firms that are integrated through exports or imports or through both exports of final products and imports of raw materials (fully integrated firms). The results show NAFTA stimulates an increase in productivity through import competition and access to imported intermediate goods, but show a weaker relationship between exports and productivity growth. A possible explanation for the lack of evident improvements in the productivity growth of exporters, as opposed to importers, could be that the extra market access for Mexican exporters after NAFTA has been modest given that US tariffs were already low.

Several papers examine the impact of regional infrastructure at the macro level. For example, Richaud et al. (1999) use data over 1960-1997 for African economies to argue that improved, quality infrastructure raises the profitability of domestic and foreign investment and that expansion in one country raises the profitability of investment in nearby countries. They therefore argue for regional approaches to supporting infrastructure. Also, Buys et al. (2010) quantify the effects of upgrading a primary road network that connects major urban areas in the Africa region using spatial network analysis techniques and gravity trade model estimations. The simulations suggest overland trade among Sub-Saharan African countries might expand by about $250 billion over 15 years, with major direct and indirect benefits for the rural poor if regional infrastructure improves at a cost of $20 billion for initial upgrading and $1 billion annually for maintenance.

However, far fewer papers focus on the effects of regional infrastructure at the firm level. In part, this is because of a lack of appropriate measures of regional integration. Nonetheless, economic integration across borders can also be related to firm-level productivity through enhanced competition, improved access to intermediate inputs, learning-by-exporting and foreign direct investment (FDI). Very few papers examine the role of regional infrastructure in firm-level productivity.

In conclusion, there is a rapidly emerging literature on the positive links between trade, infrastructure and economic performance in terms of both macro and micro evidence. However, much less has been written on the regional dimension of these links, especially at the micro level in Africa. There remain crucial questions on whether and how regional infrastructure affects firm-level productivity and whether such links work through exporting, importing or some other way – and, if there are effects through regional exporting, whether this is through self-selection or learning-by-exporting. We turn to these questions now.

3 Methodology

We examine the impact of investment in regional infrastructure for trade facilitation in two steps. The first looks at a key link in this relationship, which is to assess the impact of regional trade on firm-level productivity. The theory of change in Jouanjean et al. (2015) suggests regional infrastructure affects firms through the effect on trade flows and trade prices. For example, if the presence of good regional infrastructure allows firms to export regionally rather than remain domestically oriented, this could have positive effects depending on how this regional engagement affects firm performance. We can use data on regional exporting in a panel context for a handful for African countries to analyse this.

In the second step, we recognise that the impact of good quality regional infrastructure can also work though other channels, for example through importing high quality products or simply through an increase in the contestability of markets through exposure to competitors. Given the lack of data on the regional aspects of these channels, we use a reduced form linking regional infrastructure to productivity directly. We can use cross-section data for a large number of Africa countries measured at different points in time.

With respect to the first step, we use panel data on firm performance for a sample of African countries from the WBES data available online. We cannot use the consolidated database that is available for a large range of developing countries as the data do not cover the regional destination of exports; instead, we use the individual country files, some of which have a panel dimension and include information on the regional destination of exports.

We use the estimation results for the production function (see, e.g., Qureshi and te Velde, 2013) and derive measures of TFP, which are then used as the dependent variable. We examine the effects of exporting (and importing) on firm-level productivity and whether the destination of exporting matters (alongside other variables). Extending te Velde (2011), we examine the effect of regional integration on firm performance. We estimate *TFP* and the effect of (regional) exporting (to and from the region and to and from outside the region) and foreign ownership and other characteristics of the firm (*F*) and other characteristics (*X*) and estimate:

$$\log(TFP_{it}) = \beta_0 + \beta_S EXP_{it,region} + \sum_k \beta_{F_k} F_{ik} + \sum_j \beta_{X_j} X_{jk} + \nu_{it} \quad (1)$$

where ν_i is a white noise error term, *F* includes firm characteristics such as age, size and ownership of the firm and *X* comprises a number of other factors. This can be done for panel data for firm *i* at time *t*. A regional exporter is classified as a firm that exports and whose exports are destined for regional neighbours for at least 50% of the value of its exports,

We further exploit the panel dimension to differentiate between those firms that have stayed in the market and those that have not and then compare their performance in relation to regional exporting. We use the available WBES data that include panel data for a range of countries so we can test whether regional exporting precedes or follows productivity. The following panel data surveys have information on destination by exports: Burkina Faso (2006-2009), Cameroon (2006-2009), Malawi (2005-2009), Mali (2003-2007), Rwanda (2006-2011), Senegal (2003-2008), South Africa (2003-2007) and Tanzania (2006-2013); there exist also data on exports by destination for cross-section surveys in Botswana (2010), Burundi (2006), Central African Republic (CAR) (2011), Chad (2009), Democratic Republic of Congo (DRC) (2010), Côte d'Ivoire (2010), Ethiopia (2011), Ghana (2007), Kenya (2007), Uganda (2006) and Zambia (2007). Our analysis focuses on Malawi, Rwanda, Senegal and South Africa as illustrative examples.

We follow Saliola and Seker (2011) in estimating productivity: total factor productivity (TFP is measured as the residual term of estimating a standard production function as follows:

*Ln (value-added) = a*capital + b*labour + residual (2)*

where value-added is measured as firm sales (database code: d2) minus cost of raw materials and intermediate materials (n2e), capital as value of property, machinery and land (n6a + n6b) and labour as total compensation (n2a n4a). Firms in some countries do not report capital stocks in one or more years and in this case we use data on labour productivity.

The second step in the analysis uses a measure of regional infrastructure and links this to firm-level performance (as per equation 1) calculated using the consolidated WBES database. To examine infrastructure for trade facilitation, we use the regional dimension of the Logistics Performance Index (LPI), for both the overall index and the index examining specifically the quality of trade related expenditure. In line with Cadot et al. (2015) and Shepherd (2015), we construct indicators of regional infrastructure by taking the average of the index of all neighbouring countries (excluding island states) in sub-Saharan Africa.

The LPI database contains data for 2007, 2010, 2012 and 2014, and we match these to the nearest year in which the survey was undertaken. For example, we use the 2007 data for the survey in 2006. The LPI 2014 ranks 160 countries on six dimensions of trade logistics:

- Efficiency of customs and border management clearance ('Customs');
- Quality of trade and transport infrastructure ('Infrastructure');
- Ease of arranging competitively priced shipments ('Ease of arranging shipments');
- Competence and quality of logistics services – trucking, forwarding and customs brokerage ('Quality of logistics services');
- Ability to track and trace consignments ('Tracking and tracing');
- Frequency with which shipments reach consignees within scheduled or expected delivery times ('Timeliness').

The data used in the ranking are derived from a survey of logistics professionals who are asked questions about the foreign countries in which they operate. The LPI uses standard statistical techniques to aggregate the

data into a single indicator that can be used for cross-country comparisons.[1] We use the aggregate index as well as the specific index on the quality of trade and transport infrastructure.

The measures vary across countries and over time. We use this variation to examine whether firms in countries that have seen improvements in regional infrastructure have also seen greater productivity. Because the consolidated WBES files report firm performance data expressed in local currency in current prices, we transform the data into real US dollars using deflators and exchange rates from the World Development Indicators (WDI) database.

[1] See http://lpi.worldbank.org/ for further information.

4 Regional exporting and productivity: empirical findings

This section examines the role of regional exporting in productivity through a careful examination in the following countries: Rwanda (4.1), Malawi (4.2), Senegal (4.3) and South Africa (4.4). Data analysis for these countries shows regional exporters tend to have a higher level and faster growth in labour productivity growth. They are also more likely to innovate and survive (compared with other firms). These findings are important as they suggest it is important to facilitate regional exporters: regional infrastructure that facilitates regional trade is likely to have long-lasting impacts on the performance of firms (through productivity effects), which can be helpful in development and poverty reduction more generally. Thus these findings address an important link in the overall theory of change on how regional infrastructure affects growth and poverty reduction.

4.1 Rwanda (2006-2011)

This section presents a number of important findings for Rwanda based on the WBES panel data for 2006 and 2011.

Regional exporters (REXP, those that export at least 50% of their output to regional neighbours) have a greater chance of survival than other firms. Of those firms that were sampled in 2006 and that had a complete effective interview in 2011 (93), eight were regional exporters. Of those firms that were sampled in 2006 and whose business was discontinued by 2011, none was a regional exporter.

Table 1: Numbers of firms, Rwanda

	No REXP	REXP	Total
In both 2006 and 2011	85	8	93
Sampled in 2006 but discontinued by 2011	25	0	25

Regional exporters have a higher level of and more growth in labour productivity than other firms (Rwanda's data for 2011 do not report capital stock data, so we cannot compute TFP).

Table 2: Labour productivity for regional exporters and other firms, Rwanda

	No REXP	REXP	Total
2006	14.95	16.22	115
2011	15.49	15.67	61
Total number	157	19	176

A regression of labour productivity growth on regional exporting status shows that, over 2006 and 2011, regional exporters had on average a 72% higher level of productivity (and the difference is significant with a t-statistic of 2.14). Going beyond the regional level, exporters in general have an 86% higher level of labour productivity (and the difference is significant with a t-statistic of 2.14). The difference between the effects of regional exports and all exporters is insignificant (although we have to bear in mind the low sample exporters that are not regional), suggesting the productivity effect comes from exporting, regardless of where this takes place, at regional or global level.

For those firms included in both 2006 and 2011, the (nominal) growth in value addition per employee is greater over 2006-2011 in regional exporters (Table 3).

Table 3: Growth in nominal value addition per employee, 2006-2011, Rwanda

	No REXP	REXP
Firms reporting in both 2006 and 2011	125%	398%

Regional exporters have a higher level of and growth in labour productivity partly because they are more likely to innovate (Tables 4 and 5), 79% (15 out of 19) for REXP and 58% (165 out of 281) for other firms in Table 4 and 83% (10 out of 12) versus 80% in Table 5.

Table 4: Firms having introduced new products in past three years, Rwanda

	No REXP	REXP	Total
Yes	165	15	180
No	116	4	120
Total	281	19	241

Table 5: Firms having introduced new organisational structures and management techniques in past three years, Rwanda

	No REXP	REXP	Total
Yes	184	10	229
No	45	2	12
Total	229	12	241

4.2 Malawi (2005-2009)

This section presents a number of important findings for Malawi based on WBES panel data for 2005 and 2009. Data analysis shows regional exporters have a higher level of and faster growth in labour productivity growth.

Regional exporters have a higher level of and more growth in labour productivity than other firms in 2009.

Table 6: Labour productivity for regional exporters and other firms, Malawi

	No REXP	REXP	Total number
2009	13.62	13.81	13.65
Total number	51	15	66

A regression of labour productivity growth on regional exporting status shows that, in 2009, regional exporters have on average an 18% higher level of productivity (but the difference is not significant at the 5% level). The same applies to exporters in general.

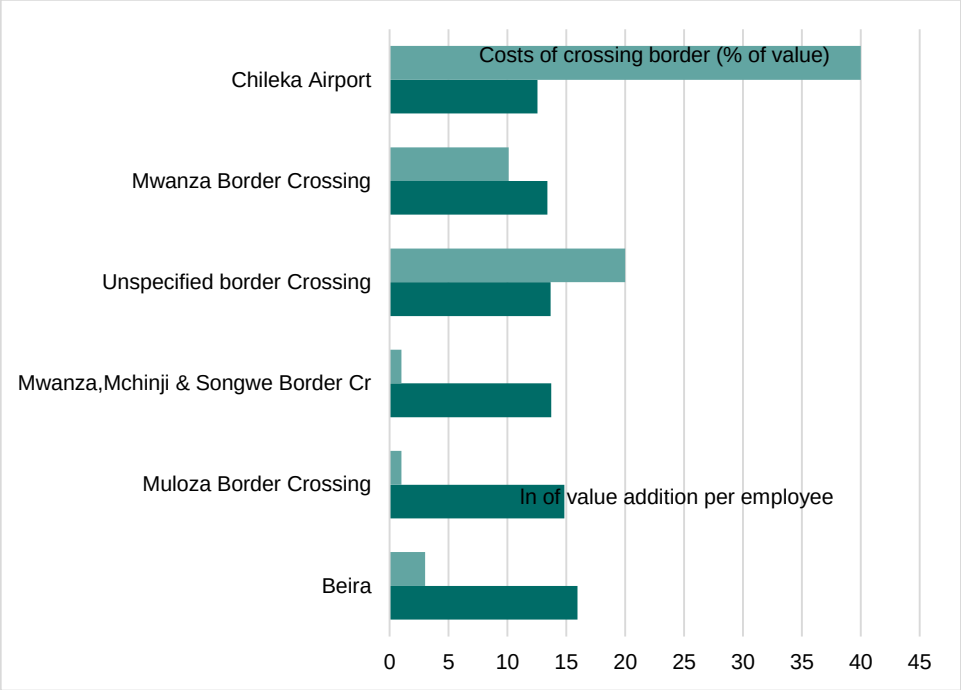
For those firms included in both 2005 and 2009, the (nominal) growth in value addition per employee is greater over 2006-2011 in regional exporters (Table 2).

Table 7: Growth in nominal value addition per employee, 2005-2009, Malawi

	No REXP	REXP
Firms reporting in both 2006 and 2011	83%	123%

There were no data on innovation in the panel dataset for Malawi. However, the panel data do provide information on clearing costs at the border. These vary markedly by border crossing, at between 1% and 40% of consignment value. Figure 1 compares labour productivity levels with cross-border costs. The data suggest more productive firms export through lower-cost border crossing. The least productive firms face the highest costs in crossing borders.

Figure 1: Comparing costs of crossing border to labour productivity



Source: Own calculations based on WBES data for Malawi.

4.3 Senegal (2003-2007)

This section presents a number of important findings for Senegal based on WBES panel data for 2003 and 2007. The panel data show growth in productivity has been much greater in regional exporters compared with other firms, leading to a productivity pay-off of more than 60% in 2007. This is in part because of the positive impact of investment in technology.

Regional exporters had a similar level of TFP to other firms in 2003, but by 2007 TFP was higher in regional exporters. This is reflected in the growth in TFP over 2003-2007 in those firms that were regional exporters in 2007: this was 71%, compared with 41% in other firms.

Table 8: Total factor productivity in regional exporters and other firms, Senegal

	No REXP	REXP
2003	-0.09	-0.13
2007	0.32	0.58
Growth in TFP 2007-2003	0.41	0.71

Note: Included are 137 firms interviewed in both 2003 and 2007. TFP is calculated as the residual of a regression of ln value added on ln capital stock and ln employment.

Table 9: Explaining TFP, Senegal

	2003	2007	2007	2007
REXP	0.02 (0.07)		0.64 (2.84)*	0.56 (2.55)*
Foreign ownership	0.34 (1.58)	0.66 (3.18)*	0.62 (2.72)*	0.66 (3.18)*
Size (ln employment size)	-0.08 (-1.06)	-0.05 (-0.87)	-0.08 (-1.22)*	-0.05 (-0.87)
Global exporter			0.21 (1.05)	
Exporting		0.26 (1.65)*		
No. of observations	113	206	206	206

Note: TFP is calculated as the residual of a regression of ln value added on ln capital stock and ln employment.

A regression of TFP on regional exporting status shows regional exporters had on average a 56% higher level of productivity (and the difference is significant with a t-statistic of 2.55) in 2007. Going beyond the regional level, exporters in general have a 26% higher level of labour productivity. The productivity effect in Senegal comes from exporting, but especially regional exporting.

Again, we look at some of the reasons behind the success of regional exporters. Regional exporters have a higher growth in TFP partly because of the impact of investment in new technologies. Table 10 suggests the impact of technology in regional exporters has been in higher productivity and better product quality.

Tables 11 and 12 provide further information suggesting the TFP productivity mark-up varies across sectors and firm size group.

Table 10: If you have invested in new technology, what has been the impact? Senegal

	Non-regional exporters (604)	Regional exporters (11)
Not applicable	0.42	0.09
No answer provided	0.02	0
Higher productivity	0.18	0.45
Reduction in labour force	0.06	0
Better product quality	0.18	0.36
Other	0.14	0.09

Table 11: Productivity difference for regional exporters, by sector, 2007, Senegal

	Other manufacturing	Food	Garments	Chemicals
Non regional exporters (604)	1.23 (2.73)*	0.97 (1.11)	0.07 (0.22)	0.42 (0.59)
No of observations	64	71	32	8

Note: Regressors including employment size and foreign ownership.

Table 12: Productivity difference for regional exporters, by size, 2007, Senegal

	Small	Medium	Large
Non regional exporters (604)	0.19 (0.52)	1.58 (3.70)**	0.48 (1.31)
No of observations	166	29	11

Note: Regressors including employment size and foreign ownership.

There are data on clearing costs at the border. There are two main routes: Dakar via airport or sea and Rosso/Casamance via land in the north/south. The clearing costs vary substantially between close to zero and 50% of consignment value for Dakar and between 4% and 30% for the other routes via land. However, the average clearing cost is 14% for regional exporters for both types of crossing and 18% for all exporters via Dakar and 14% via land. Interestingly, exporters have higher productivity going over land compared with sea or air: the gap is 50% for regional exporters and 27% for all exporters.

4.4 South Africa (2003-2007)

This section presents a number of important findings for South Africa based on WBES panel data for 2003 and 2007. The panel data show the growth in productivity has been much greater in regional exporters compared with o other firms, leading to a productivity pay-off of some 7% in 2007.

Regional exporters had a 14% higher level of TFP compared with no-exporters in 2003. Both regional exporters and no-exporters faced a decline in productivity (in local currency), but the decline was faster in no-exporters than in regional exporters (63% vs. 56%).

Table 13: TFP in regional exporters and other firms, South Africa

	No EXP	REXP
2003	0.52	0.66
2007	-0.11	0.10
Growth in TFP 2007-2003	-0.63	-0.56

Note: Included are 73 regional exporter firms and 221 non-exporters interviewed in 2003 and 2007. TFP is calculated as the residual of a regression of ln value added on ln capital stock and ln employment.

Table 14: Explaining TFP in South African firms

	2003	2007	2007
Regional exporting	0.16 (0.96)	0.29 (2.86)**	0.32 (3.04)**
Foreign ownership	0.003 (2.31)**	0.001 (0.65)	0.001 (0.49)
Global exporter			0.18 (1.50)
No of observations	313	651	651

Note: TFP is calculated as the residual of a regression of ln value added on ln capital stock and ln employment.

A regression of TFP on regional exporting status shows regional exporters had on average a 30% higher level of productivity (and the difference is significant) in 2007. There is a productivity effect in South Africa from exporting, especially regional exporting.

Table 15: Productivity difference for regional exporters, by sector, 2007, South Africa

	Other manufacturing	Food	Garments	Chemicals	Plastics	Electronics	Machinery
Regional exporters	0.22 (0.96)	0.70 (2.12)*	1.05 (2.56)*	-0.08 (-0.35)	0.43 (0.90)	0.58 (1.25)	0.38 (1.86)*
No of obs	167	105	95	77	21	21	34

Note: Regressors including foreign ownership.

Table 16: Productivity difference for regional exporters, by firm size, 2007, South Africa

	Small	Medium	Large
Regional exporters	0.03 (0.10)	0.21 (1.49)	0.54 (2.99)***
No of observations	225	259	167

Note: Regressors including foreign ownership.

The reported costs of a border crossing vary markedly across crossings, from 0% for the crossing to Namibia to 25% for Durban port and 30% for the Beit Bridge over the Limpopo River. Importantly, regional exporters from South Africa face higher clearing costs (by around 3 percentage points) at border crossing than global exporters.

Table 17: Clearing costs at border crossings, 2007 (% of consignment values), South Africa

	Global exporters	Regional exporters	All exporters
Land	5.8 (7)	8.5 (51)	8.2
Airport	4.6 (8)	8.7 (9)	6.8
Sea	8.5 (51)	11.3 (32)	9.6
All	7.6	9.4	8.7

5 Regional infrastructure and firm-level productivity in sub-Saharan Africa: empirical findings

The previous section presented a number of findings related to the thinking on the indirect and sustained effects of regional trade through effects on firm-level productivity. However, it focused specifically on regional exporting, whereas the effects from infrastructure may work through both exporting and importing, as already suggested by de Hoyos and Iacovone (2013) in the case of NAFTA.

We now move to a discussion of the impact of regional infrastructure on firm-level productivity. We first construct regional infrastructure measures in sub-Saharan Africa using LPIs and check whether the quality of regional infrastructure is better than a country's own infrastructure (first column) or worse (second column). There are 16 African countries for which the regional infrastructure is better than own infrastructure.

Table 18: Comparing infrastructure in neighbours with own infrastructure

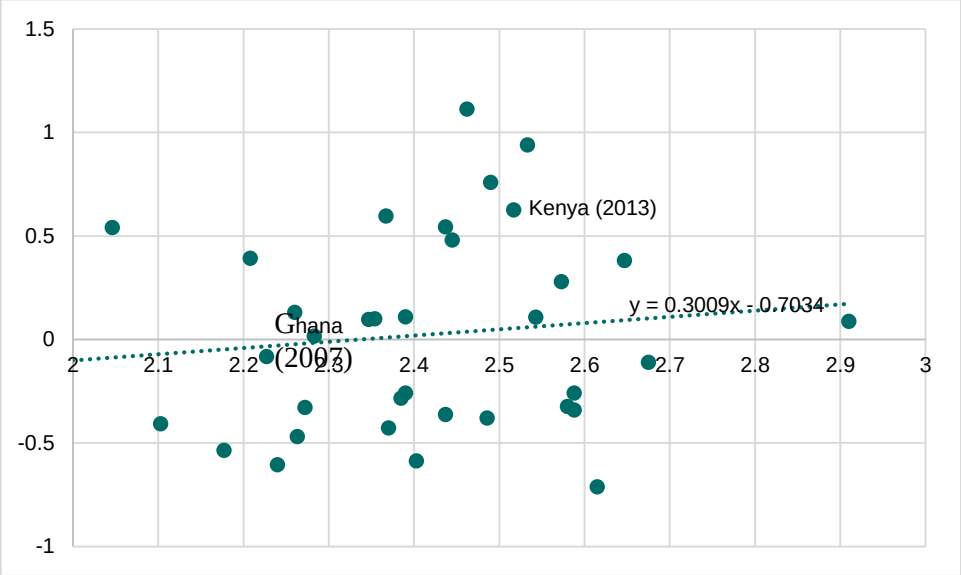
Neighbours' infrastructure better than own	Neighbours' infrastructure worse than own
Angola	Benin
Botswana	Burundi
Burkina Faso	CAR
Cameroon	Côte d'Ivoire
Chad	DRC
Congo	Gabon
Eritrea	Gambia
Ethiopia	Ghana
Guinea Bissau	Guinea
Liberia	Lesotho
Mali	Kenya
Mozambique	Malawi
Namibia	Mauretania
Rwanda	Niger
Senegal	Nigeria
Sierra Leone	South Africa
Tanzania	Uganda
Zambia	
Zimbabwe	

Source: own calculations based on LPIs (from WDI).

Figure 2 compares the average value of the index for countries in specific years with average productivity levels (residuals of production functions). It

suggests a positive relationship, meaning that, when countries have good regional infrastructure, their firms have relatively higher productivity. If the regional infrastructure measure increases by one standard deviation (e.g. from Ghana to Kenya), productivity will increase by 6% (0.19 * 0.30).

Figure 2: Regional infrastructure score (horizontal) is associated with higher average productivity level at country level (vertical level)



Source: Own calculations.

We then estimate a number of regressions explaining TFP and present the results in Table 19. We first provide estimates of a simple regression of regional infrastructure on firm-level TFP (as measured by the residual) (see columns 5 and 6). The results suggest better regional infrastructure does lead to higher productivity, for both logistics measures (total and specific). We need to bear in mind that the effects might pick up the fact that some countries have more exporters, more foreign-owned firms or a larger proportion of larger firms, all of which are associated with higher productivity. Controlling for these firm-specific factors, columns 3 and 4 suggest the effects of the regional infrastructure variables are robust and broadly similar.

It may also be the case that the regional infrastructure measure, which varies across countries but not across firms within a country, picks up some other variation across countries. We control for that possibility using country dummies in columns 1 and 2. Again, the results suggest countries with better regional infrastructure also have firms with relatively higher productivity. If the regional infrastructure measure increases by one standard deviation (e.g. from Ghana to Kenya), productivity will increase by 7% for changes in the overall infrastructure measure and 19% for changes in the trade-related measure.

Table 19: Explaining firm-level TFP in sub-Saharan Africa

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Regional infrastructure (overall)	0.36 (4.35)***		0.12 (7.14)***		0.10 (6.02)***		0.34 (4.16)***	0.37 (4.44)***
Regional infrastructure (trade-related)		1.05 (12.0)***		0.14 (7.79)***		0.14 (7.38)***		
Foreign ownership	0.002 (5.56)***	0.002 (5.56)***	0.002 (5.08)***	0.002 (5.01)***			0.002 (4.88)***	0.001 (4.65)***
Size (ln employment size)	0.10 (12.34)***	0.10 (12.34)***	0.11 (13.01)***	0.11 (12.88)***			0.09 (10.69)***	0.09 (10.47)***
Exporting	0.06 (2.00)**	0.06 (2.00)**	0.07 (2.14)**	0.06 (2.02)**			0.03 (1.10)	0.03 (0.98)
Reg inf * importing inputs							0.05 (4.55)***	-0.02 (-0.75)
Importing inputs								0.18 (2.29)**
Country dummies included	Yes	Yes	No	No	No	No	Yes	Yes
No of observations	6,980	6,980	6,980	6,980	6,991	6,991	6,980	6,980

Note: TFP is calculated as the residual of a regression of ln value added on ln capital stock and ln employment. *** is significant at 1%, ** at 5%

Finally, we include into the regressions the effects of importing. One question in the WBES data asks: were any of the material inputs and supplies imported directly? We would expect firms that are linked in to global networks to be able to source the best quality inputs and hence improve production quality in this way. Such firms would also be able to learn from their suppliers, increasing productivity through importing. These effects will be multiplied with good quality infrastructure: the impact of regional infrastructure on productivity should be higher when firms import inputs and supplies.

Column 7 is an extension of the regression in column 1, by including the role of importing. As expected, it finds the impact of regional infrastructure is greater for firms that import some material inputs and supplies. Column 8 includes importing separately and this provides for a strong effect, which is in fact more robust than the exporting channel. This is another important finding: importing is associated with higher productivity, and (regional) infrastructure can support these links.

6 Conclusions and policy implications

This paper contributes to a study on the effects of regional infrastructure on poverty reduction. It first examined whether regional trade (exports in particular) has a long-lasting effect on productivity, which is a crucial link in the theory of change running from regional infrastructure to sustained poverty reduction. If regional exporters are indeed better performers and this is sustained over time, policy that facilitates regional trade can have long-lasting impacts in addition to the short-run gains from trade. The paper then examined the impact of regional infrastructure on firm-level productivity directly, encompassing the effects through exporting and importing.

6.1 Regional exporting and productivity

New evidence using firm-level panel data (in Rwanda, Malawi, Senegal and South Africa) suggests not only that regional exporters have higher productivity than other firms but also that they have greater productivity growth. This works in part through the increased emphasis on and impact of technology in regional exporters. This means it is important to facilitate regional trade because of the long-lasting impact on productivity.

6.2 Regional infrastructure and firm-level productivity

Regional infrastructure affects firm-level productivity in different ways, through exporting but also importing. We created country-specific and time-varying measures of the quality of regional infrastructure, and trade- and transport-related regional infrastructure specifically, and link this to firm-level productivity.

We find countries with better regional infrastructure also have firms with relatively higher productivity. If the regional infrastructure measure increases by one standard deviation (e.g. from Ghana to Kenya), productivity will increase by 7% for changes in the overall infrastructure measure and 19% for changes in the trade-related measure. This effect is robust to including country dummies and other explanatory variables. We also find the impact of regional infrastructure is greater for firms that import some material inputs and supplies.

6.3 Policy issues

Clearly, it is important to invest in regional infrastructure as this supports productivity levels, through facilitating exporting and importing. Such investment should cover more than hard infrastructure alone, given that different exporters using the same infrastructure at the same gateway use different clearing costs.

The evidence in this paper shows clearing costs vary markedly between border crossings in Malawi, at between 1% and 40% of consignment value. The more productive the firm the lower the costs it faces. But the costs vary not only across border crossing but also across types of exporters using the same crossing. The reported costs for South Africa firms of a border crossing vary markedly across crossings, from 0% for the crossing to Namibia to 25% for Durban port and 30% for the Beit Bridge over the Limpopo River. At the same time, the difference in average clearing costs between types of gateway (land, airport or sea) is the same (2.8%) as the difference in clearing costs between regional exporters and global exporters for using these gateways (2.8%).

In other cases, the variation between border crossings is smaller than the variation among firms. For example, in Senegal, the gateways are Dakar via airport or sea and Rosso/Casamance via land in the north/south. The average clearing costs are very similar: 14% for regional exporters for both types of crossing and 18% for all exporters via Dakar and 14% via land. However, there is substantial variation across firms using the same gateway: between close to zero and 50% of consignment value for Dakar and between 4% and 30% for the other routes via land. In policy terms, this means it is important to reduce the variation in clearing costs across firms using the same gateway as well as bringing down the average clearing costs across gateways. Much of this will need to focus on soft regional infrastructure.

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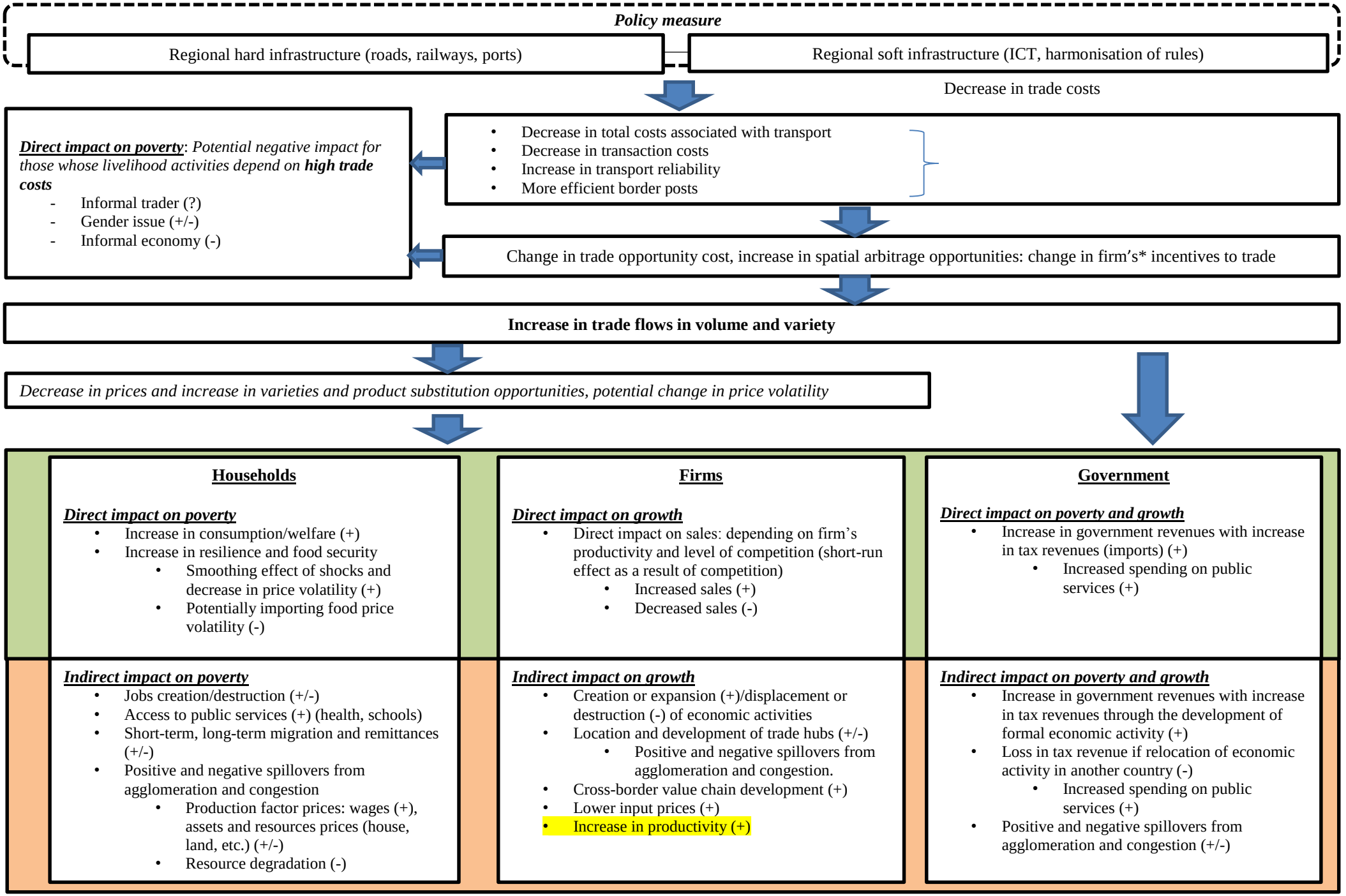
Annex 1: Link to overall theory of change



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