Firm Innovation in Africa and Latin America: Heterogeneity and Country Context

Eva Paus, Michael Robinson, Fiona Tregenna

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Abstract

In this paper, we analyse the drivers of firm innovation in 35 African and Latin American countries. We investigate how firm-level capabilities and national country characteristics affect firm innovation activities and innovation outputs. Using data from the World Bank Enterprise Surveys, we analyse the factors driving firm-level innovation by distinguishing two stages in the innovation process: firm engagement with innovation inputs and the translation of innovation inputs into innovation outputs.

The paper provides empirical support for the importance of country level macro and institutional characteristics, in addition to firm level capabilities, across a large number of countries in determining firm level innovation. We demonstrate that capital investment and training are just as important innovation activities as R&D spending in developing economies. We highlight the heterogeneity in firm innovation across firm size, country and firm-level characteristics, and economic sectors.

Keywords: innovation activities, firm capabilities, macro context, institutions, Africa, Latin America

JEL codes: O14, O30, O31, O33, O54, O55

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1. Introduction

In this paper, we analyse the drivers of firm innovation in 35 African and Latin American countries. We investigate how firm capabilities and national framework characteristics affect firm innovation activities and innovation outputs. We focus on Africa and Latin America because both regions have experienced poor economic outcomes in recent decades, exceptions at the country level notwithstanding. Economic growth and productivity growth have generally been low, and the creation of decent employment opportunities has been limited. Relative to developing Asia, both regions have also performed poorly in terms of innovation, technological upgrading and product complexity.

In the current globalisation context, firms' ability to innovate has become considerably more important for the economic advancement of and catching up by middle-income countries, and increasingly for low-income countries as well. Middle-income countries have to move from factor-driven to productivity-driven growth, as wage levels have become relatively too high to compete in the production of standardised labour-intensive commodities (Gill and Kharas 2008; Kharas and Kholi 2011; Paus 2020). Innovation and technological upgrading are crucial for avoiding a 'middle-income technology trap' (Andreoni and Tregenna 2020). Low-income countries also face the challenge of the implications of the fourth industrial revolution and increasing international competition, driven to a considerable extent by China's competitiveness in products across the technology spectrum. Thus, if producers in low-income countries want to increase their competitiveness in home and third markets, they will have to engage in innovation activities significantly earlier than developing economies in the past. When firm innovation in a country is sufficiently widespread, it fosters economic and productivity growth.

Broad-based innovation is a complex, multifaceted and challenging undertaking, at the heart of which are the innovation capabilities of domestic firms (Nelson and Winter 1982; Fagerberg 1988; Lundvall 1992; Cimoli et al. 2009). However, firms do not operate in a vacuum. The characteristics of countries' institutional and economic contexts shape the development of firms' capabilities, their engagement with innovation activities, and the success of such activities.

These insights are at the core of our empirical investigation. From a premise that macro- and institutional factors matter for firm activities and performance, we investigate the interplay of firm-level (micro) and country-level (macro) characteristics for firm-level outcomes. This is especially important in light of the heterogeneity in the relevant country characteristics within and between the two regions.

We analyse the factors driving firm-level innovation distinguishing two stages in the innovation process: firm engagement with innovation inputs and the translation of innovation inputs into innovation outputs. The two stages are conceptually similar to the first two stages in the Crepon, Duguet and Mairesse (CDM) model (Crepon et al. 1998). However, we differ in

the consideration of innovation inputs, as we go beyond expenditures on R&D and also analyse capital investment and the training of employees, in line with the latest Oslo Manual (OECD/Eurostat 2018).

Our empirical analysis uses data from the World Bank Enterprise Surveys (WBES), which allow us to estimate the two-stage process of firm innovation for a large number of economies. Utilising only the latest surveys for all countries in the two regions with compatible innovation-related questions, our sample includes 35 countries – 23 in Africa and 12 in Latin America.

The nature of the data is such that we do not investigate the effect of innovation outputs on firm productivity.[1] Even though not all empirical studies find a positive link between innovation outputs and productivity growth, a lot of empirical evidence shows that product innovation has a positive and significant effect on productivity. The evidence for the effects of process innovation is more varied (Hall 2011; Aboal and Garda 2012; Morris 2018).

Our focus is on the role of country-level macro- and institutional characteristics, as well as firm-level characteristics, in determining firm innovation in a large set of countries. We use maximum likelihood estimation to estimate a two-stage probit model of innovation for all sectors and countries. In addition to the pooled model, we also examine differences and similarities between and within the two regions, as well as between manufacturing and services.

The article makes several contributions to the literature. First, it provides empirical support for the importance of country-level macro- and institutional characteristics in determining firm-level innovation in a large number of countries. Empirical studies of firm-level innovation always include factors that capture firm capabilities and resources, with some variation in the choice of variables. We do so as well. However, where most studies use a dummy variable to control for country effects, we are interested in analysing the effect of specific national context variables on both firms' likelihood of engaging in innovation activities as well as on innovation outcomes. The Latin American firms in our sample are considerably more innovation-intensive than the African firms. Our empirical analysis shows that country context variables account for around half of the differences in innovation activities and outcomes between the two regions.

Second, we demonstrate the importance of non-R&D innovation activities for innovation outcomes in developing economies. While many innovation studies focus on R&D spending

[1] Cross-sectional data do not lend themselves to an analysis of the effect of innovation on productivity, since one would expect innovation to have an impact primarily on productivity growth over time and not on contemporaneous levels. Furthermore, the WBES only provides data on sales, but not on value added; we consider sales per worker a poor proxy for labour productivity. Finally, the WBES surveys for the countries in our sample were undertaken in different years over the period 2014 to 2020, making a productivity comparison difficult, even if measurement was not an issue.

as the main, if not only, channel for innovation engagement, we analyse the determinants of three sets of innovation activities: investment in machinery, training of employees, and R&D expenditure. We find that each of the three activities increases the likelihood of a firm introducing a new product or process.

Third, while firms in the service sector are often assumed to be less innovative than firms in the manufacturing sector, we find that, overall, the same set of firm and country-level variables determine innovation engagement and outcomes in both sectors.

Fourth, in addition to demonstrating the importance of firm and country-level determinants of firm innovation for regional and sectoral aggregates, our analysis also highlights the large heterogeneity in firm innovation behaviour within regions as well as sectors. One of the most relevant findings is that the most innovation-intensive subsectors in manufacturing and services constitute only a small share of the firms in the sample.

Finally, our findings add to the literature that highlights access to funding as a key factor supporting firm innovation (Schumpeter 1983; Mazzucato 2013; AU-NEPAD 2014; Rubalcaba et al. 2016). Both, the relevant firm-level and country-level variables are consistently positive and significant determinants of firm innovation activities and outcomes.

1.1 Analytical Considerations

Economists from different schools of thought, from Solow (1957) and Schumpeter (1983) to Romer (1990), identify innovation as critical for growth and competitiveness. It is evolutionary and structuralist theories that focus explicitly on firm capabilities, learning, path dependency, institutional context, and the structure of the economy in shaping firm-level innovation (Ocampo et al. 2009; Cimoli et al. 2009; Ros 2014; Cimoli et al. 2020). Since they inform the analysis in this paper, we discuss some relevant theoretical considerations and empirical evidence in this section, especially regarding developing economies. We focus on the three aspects most important for our empirical analysis: the meaning of innovation in a developing economy, heterogeneity in firm innovation, and characteristics of the country context shaping firm innovation.

1.2 Meaning of Innovation in Developing Economies

The OECD *Oslo Manual* (2018:18) defines a business innovation as "a new or improved product or business process (or combination thereof) that differs significantly from the firm's previous products or business processes and that has been introduced on the market or brought into use by the firm".[2] In developing economies, business innovation most commonly means the adaptation of innovations developed in the Global North. They are frequently new

[2] "The definition does not require an innovation to be a commercial, financial or strategic success at the time of measurement. A product innovation can fail commercially or a business process innovation may require more time to meet its objectives" (OECD 2018:69)

to the firm, but not to the market. And they are more likely to include incremental advances for a firm, rather than dramatic changes.

In industrialised economies, spending on research and development (R&D) is considered key to the development of new products and processes; operating on the technological frontier has great potential to advance productivity growth. However, there are other activities besides R&D that firms may pursue with the goal of innovation. The *Oslo Manual* (OECD/Eurostat 2018:35) distinguishes eight such activities, acknowledging that some of them may also be carried out for other purposes. These are: R&D; engineering, design and other creative work activities; marketing and branding activities; intellectual property-related activities; employee training activities; software development and database activities; activities related to the acquisition or lease of tangible assets; and innovation management activities.

Many empirical studies of firm innovation in developing economies focus only on R&D, especially those that use the CDM model (Arza and López 2010; Crespi and Zuniga 2012). However, for firms in developing economies, engagement with innovation activities other than R&D may be as important as spending on R&D, given the technological gap in relation to industrialised economies. Some empirical studies on firm innovation in developing countries reflect this assumption, with data availability often restricting the innovation activities included in the analysis. In a study of firm innovation in Colombia, for example, Gallego et al. (2013) distinguish between spending on R&D, machinery, information and communication technology (ICT), and other activities. Fernandez (2017) focuses on positive R&D expenditures and participation in one of a number of innovation activities in an analysis of firm innovation in Argentina, Colombia, Chile, Mexico and Peru. R&D and training as firm innovation activities are used in an analysis of Ethiopia (Hussen and Çokgezen 2020) and Nigeria (Adeyeye et al. 2018).

1.3 Heterogeneity in Firm Innovation

The nature and extent of firm innovation vary considerably by sector and size. What constitutes a new product or process comprises a wide range of meanings. For one company, it may refer to the introduction of new dresses based on different materials or with a different design; for another, it may be the introduction of a more automated process in the interaction with customers; and for a third, it may be the production of a new precision tool not previously available in the domestic market. In each case, the ultimate impact on productivity, and economic performance more broadly, will differ – for the firm as well as for the economy.

It is widely suggested that there are differences in the drivers of innovation in the manufacturing and service sectors. In the service sector, R&D is typically less important, and interactions with suppliers and customers tend to be a more important source of new ideas (Tacsir et al. 2011; Rubalcaba 2015; Rubalcaba et al. 2016). Even so, manufacturing and services are not homogeneous sectors, but rather diverse with respect to innovation

activities. Within services, knowledge-intensive business services (KIBS) are considered much more innovation-intensive and potential catalysts of innovation in other sectors (Rubalcaba et al. 2016; Paus 2021). In contrast, more traditional services, like retail and hotels and restaurants, are less innovative and are less likely to have a significant effect on productivity growth. In the manufacturing sector, we expect firms in more technology-intensive sectors to be more engaged in innovation.

Size is another important source of firm heterogeneity. Large firms are more likely to have the wherewithal to engage in innovation activities, ranging from the ability to recruit skilled personnel to securing the necessary funding, with internal funding playing a more important role. Small firms, on the other hand, tend to be much more constrained, especially with respect to finance. Differences in innovation performance by firm size are particularly pertinent for many Latin American and African economies, as they tend to have few large and internationally competitive firms and a large number of micro- and small enterprises with limited capabilities and lower productivity levels. In a recent study of manufacturing firms in Ethiopia and Tanzania, Diao et al. (2021) find that large, internationally-oriented firms often have productivity levels similar to firms in the Czech Republic, while small firms have very low productivity.

Taking account of this heterogeneity in firm innovation along several relevant dimensions, in this paper we take a broad and inclusive approach to the measurement of innovation.

1.4 Country Context and Firm Innovation

Firm innovation is the outcome of advancements at the micro-level shaped by developments at the macro-level. It depends on firm-specific capabilities embedded in specific regional and national contexts (Lundvall 1992). The key elements of firm capabilities, human capital, finance and government support need to co-evolve to enable innovation on a broad basis.

Few econometric studies use actual macro-variables to capture country characteristics (Srholec 2011; De Fuentes et al. 2020; Hervás-Oliver et al. 2021). Most studies capture country characteristics indirectly by focusing on firm perception of country context-related barriers to innovation (Chadee and Roxas 2013; Barasa et al. 2017; Hussen and Çokgezen 2021). Unless properly controlled for, endogeneity can emerge as an issue, as some studies find that more innovation-intensive firms report the highest barriers (D'Este et al. 2012; Fernandez 2017; De Fuentes et al. 2020).

A number of empirical studies demonstrate the importance of institutional strength (rule of law, corruption, regulatory quality) at the regional or national level for innovation capabilities at the firm level. Included in these studies are Barasa et al. (2017) for Kenya, Tanzania and Uganda for 2010 to 2012; Hussen and Çokgezen (2021) for 19 SSA countries for 2014 to 2016, and Chadee and Roxas (2013) for Russia in 2009.

Access to finance, and thus the nature of a country's financial system, has also been widely highlighted as critical for firm innovation (Schumpeter 1983; Mazzucato 2013). Lack of funds and the cost of innovation are the most frequently cited barriers to innovation in many African countries (AU-NEPAD 2014). The findings are similar for Latin America. Based on case studies of six Latin American countries, Rubalcaba et al. (2016) argue that a lack of funding was a key obstacle to firm innovation, along with missing skills and risk. Lack of funding may be less of an issue for firms in industrialised economies. In an analysis of obstacles to firm innovation in France, Galia and Legros (2004) find that the financial constraint was much less important.

Our empirical analysis thus recognises and investigates the relevance of country-level (as well as firm-level) factors for firm innovation activities and outcomes.

2. Model, Methodology and Data

2.1 Model

We distinguish two stages in our analysis of the factors driving firm-level innovation. The first stage is the firm decision to engage with innovation inputs; the second stage is the translation of innovation inputs into innovation outputs.

- Equation (1) specifies our hypothesis about stage one: the impact of firm and country characteristics on firm engagement with innovation inputs.

Equation (1):

$$P(II_{ijct}^{k} = 1) = \Phi(\beta_0 + \beta_1 FC_{ijct} + \beta_2 CC_{ijct} + \beta_3 YD_{ct} + \beta_4 ID_j),$$

where:

Φ is the cumulative distribution function of the standard normal distribution;

II_{ijc}^{k} represents engagement with the innovation input 'k' of firm 'i' in economic sector 'j' in country 'c' at time 't';

FC_{ijct} is a vector of firm characteristics;

CC_{ct} is a vector of country characteristics;

YD_{ct} is a set of year dummies; and

ID_j is a set of industry dummies at the four-digit ISIC level.

We focus on three innovation activities: expenditure on R&D; formal training programmes for permanent, full-time employees; and spending on fixed assets. While R&D spending clearly aims at innovation, the other two activities may also be undertaken for other purposes.

For firm characteristics, we chose variables that capture firm capabilities and resources, and others that condition firm behaviour. Many of these are used in other studies of firm-level

innovation (Aboal & Garda 2012; Crespi et al. 2014; Barasa et al. 2017; Adeyeye et al. 2018; Ayalew et al. 2020; Avenyo et al. 2021a; Hussen and Çogezen 2021; Naidoo et al. 2021; Paus and Robinson forthcoming). Among firm capabilities and resources, we include the skill level of employees, digital presence, access to funding, foreign market participation, manager experience, and age of the firm (see Table 1 for details). The variables conditioning firm behaviour are the size of the firm, the potential for reaping agglomeration benefits, and foreign ownership.

Table 1: Firm- and Country-level Characteristics and Measurements

Firm-level characteristics	*Measurement*
1. Capabilities and resources	
Skill level of employees	share of permanent workers with completed secondary education
Digital outreach	existence of a firm website
Access to funding	firm has an established credit line
Foreign market participation	
a) exports	exports account for more than 10% of sales
b) adherence to international standards	firm has an internationally recognised quality certificate
Experience	
a) firm age	firm is < 10 years old
	firm is 11-20 years old
	firm is more than 20 years old (omitted category)
b) manager experience	years of manager's experience
2. Conditioning variables	
Firm size	
micro	< 5 employees
small	5-19 employees
medium	20-99 employees
Large	100 + employees (omitted category)
Potential agglomeration benefits	firm is located in a city with a population > 1 million
	firm has multiple locations
Foreign ownership	foreign ownership > 10%
Country-level characteristics	
Broad economic context	
a) income level	GDP p.c. (2010 constant US $)
b) investment ratio	gross fixed capital formation as a share of GDP
c) economic growth	average annual growth of GDP over previous seven years
Education	literacy rate
Financial access*	bank branches per 100 000 adults

* Full sample mean used for countries with missing data (Ethiopia and Sierra Leone).

All variables enter the model as dummies, save employees' skill level and the manager's years of experience. We hypothesise that each of the firm characteristics has a positive and significant effect on firm engagement with innovation.

Regarding country characteristics, we incorporate five variables. Three of the variables capture the broader economic context. The first one is GDP per capita, a proxy for a country's overall development level. The second and third variables reflect the economic dynamism of the country at the time of the survey: the investment ratio and economic growth rate. The

other two variables add two important national dimensions shaping firm innovation: the overall education level in the country, and access to funding. We chose the literacy rate for the former and bank branches per 100 000 adults for the latter.[3] We expect the coefficients on the country-level variables to be positive and significant.

In a second step, we analyse the likelihood that firms that engage in one of the three innovation activities introduce a new product or new process.

Equation (2):

$$P(IO^{n}_{ijct} = 1) = \Phi\,(\beta_0 + II^{k}_{ijct} + \beta_1 FC_{ijct} + \beta_2 CC_{ijct} + \beta_3 YD_{ct} + \beta_4 ID_j),$$

where IO^n is the introduction of a new product or process.

In addition to the three innovation activities, we include all the firm- and country-level characteristics from the innovation input model (step 1) to analyse whether these variables have an effect on introducing a new product or process over and above their impact on R&D, training and capital investment.

2.2 Estimation, Data, and Descriptive Statistics

We use maximum likelihood estimation to estimate the probit models in equations (1) and (2). All estimations include year fixed effects and industry fixed effects at the four-digit ISIC level.

The data for the firm-level variables are from the World Bank Enterprise Surveys. We used the most recent surveys for countries in Latin America and Africa, and included all the countries for which the surveys have compatible innovation-related questions. This resulted in a sample of 35 countries, 12 in Latin America and 23 in Africa (see Appendix 1). The average income level for countries in the two regions is rather different. The majority of Latin American countries in our sample are upper middle-income (6) and high-income (1) countries, with the rest are lower middle-income (5) countries. In Africa, in contrast, the majority are lower middle-income (12) countries, only one is an upper middle-income country (South Africa), and ten are low-income countries.

The WBES cover the period from 2014 to 2020, with most of the surveys conducted in 2016 and 2017. To ensure consistency, we only included the firms that had values for all firm characteristics. The WBES cover firms in manufacturing (ISIC 15-37) and services (ISIC 45-64, 72). Of the 11 984 firms in our sample, 45% were in manufacturing and 55% in services.

A great advantage of the WBES is that they provide information on the same variables for a large number of countries. This allows for considerable breadth in cross-country analyses. At

[3] Data availability for the countries included in the study determined the choice of variables here.

the same time, it is important to note that our analysis covers only firms in the formal sector, since the WBES do not include firms in the informal sector.

The data for the country-level variables come from the World Bank's World Development Indicators. The value for each country characteristic is a three-year average: the average of the year in which the survey was undertaken and the two prior years. Economic growth is the exception, as it averages growth over a seven-year period.

Table 2 shows the mean and standard deviation for all the variables in the model for the pooled model, as well as separately for Africa, Latin America, manufacturing and services. For the pooled data, the share of firms pursuing capital investment and training is more than twice as large as the spending on R&D. A higher percentage of firms introduced a new product (39%) than a new process (25%), and the overwhelming majority of firms are small or medium-sized.

Table 2: Model Variables: Means and Standard Deviations

Variable	Pooled		Africa		Latin America		Services		Manufacturing	
	mean	st. dev.	mean	st. dev.	mean	st. dev.	mean	st. dev.	mean	st. dev.
New product	0.39	0.49	0.24	0.43	0.60	0.49	0.38	0.49	0.41	0.49
New process	0.25	0.43	0.13	0.34	0.43	0.49	0.22	0.42	0.29	0.45
R&D	0.18	0.38	0.13	0.34	0.24	0.43	0.16	0.37	0.20	0.40
Capital investment	0.38	0.49	0.29	0.45	0.52	0.50	0.36	0.48	0.41	0.49
Training	0.40	0.49	0.26	0.44	0.59	0.49	0.39	0.49	0.40	0.49
Skilled labour	68.87	35.32	62.05	36.92	78.48	30.46	71.01	35.66	66.21	34.78
Website	0.61	0.49	0.55	0.50	0.69	0.46	0.60	0.49	0.61	0.49
Line of credit	0.37	0.48	0.19	0.39	0.62	0.49	0.35	0.48	0.39	0.49
Exporter	0.13	0.33	0.13	0.34	0.12	0.32	0.07	0.25	0.20	0.40
Quality certificate	0.16	0.37	0.16	0.36	0.18	0.38	0.10	0.30	0.24	0.43
Firm < 10 years old	0.20	0.40	0.23	0.42	0.16	0.36	0.23	0.42	0.17	0.37
Firm 11-20 years old	0.32	0.47	0.33	0.47	0.31	0.46	0.34	0.47	0.30	0.46
Firm > 20 years old	0.48	0.50	0.44	0.50	0.53	0.50	0.43	0.50	0.53	0.50
Manager experience	20.68	11.96	18.31	11.09	24.01	12.35	19.60	11.66	21.94	12.19
micro	0.02	0.12	0.02	0.13	0.01	0.11	0.02	0.13	0.01	0.11
small	0.46	0.50	0.48	0.50	0.43	0.49	0.53	0.50	0.38	0.48
medium	0.33	0.47	0.32	0.47	0.34	0.47	0.32	0.47	0.34	0.47
large	0.20	0.40	0.19	0.39	0.22	0.41	0.14	0.35	0.27	0.44
City > 1 million	0.50	0.50	0.42	0.49	0.61	0.49	0.48	0.50	0.51	0.50
Multiple locations	0.23	0.42	0.23	0.42	0.22	0.41	0.25	0.43	0.20	0.40
Foreign	0.12	0.32	0.13	0.33	0.10	0.30	0.11	0.32	0.12	0.32
GDP p.c.	4,092	3,154	2,427	1,912	6,440	3,064	3,939	3,121	4,276	3,179
GDP growth (7-yr average)	3.98	1.87	3.94	2.24	4.04	1.14	4.01	1.96	3.95	1.75
GFCF/GDP	19.63	5.70	19.24	6.70	20.18	3.82	20.36	5.81	18.70	5.41
Literacy rate	79.59	17.85	69.94	17.44	93.20	4.75	78.89	18.44	80.41	17.05
Bank branches	9.68	7.60	6.05	4.13	14.78	8.39	9.89	8.04	9.39	7.00

The survey data indicates that Latin American firms are substantially more innovative than African firms. A considerably higher share of firms in Latin America engages with each of the three innovation activities (R&D, capital investment, training), and introduces a new product or process. Not surprisingly, the share of firms introducing a new product or new process

increases with the number of innovation activities in which they engage. Among the firms that do not pursue any innovation activities, only 20% introduced a new product, compared to the 80% of firms that engaged in all three innovation inputs that introduce a new product (see Table 3). Here, too, we find that, in each category, the means for Latin America are considerably higher than for Africa.

Table 3: Innovation Activities and Outcomes: Frequencies

	Number of innovation activities			
	0	1	2	3
Percentage of firms introducing new product				
Pooled	19.8	39.4	61.4	79.4
Latin America	39.5	55.3	70.8	84.2
Africa	13.6	26.9	47	37.8
Percentage of firms introducing new process				
Pooled	10.3	22.9	42.6	65.2
Latin America	22.9	36.2	51.6	70.1
Africa	6.4	12.5	28.8	52.1

The averages for firm characteristics are more similar for the two regions. Only with respect to the share of firms with a line of credit do we see a striking difference: 62% in Latin America versus 19% in Africa. Regarding the country characteristics, the average GDP per capita in Latin America is two and a half times larger than that in Africa. Average investment ratios and growth rates are similar in the two regions, but the educational profile and financial access differ, with considerably lower rates in Africa.

When we compare manufacturing and services, it is noticeable how similar the means for the innovation variables are. Contrary to expectations, the share of service firms reporting spending on R&D is nearly the same as in manufacturing.

3. Results

3.1 Pooled Model

Table 4 shows our estimates for the full sample. Columns 1 to 3 present the results for the first-step regressions, with each of our three measures of innovation activities – R&D, capital investment and training – as alternative dependent variables. The second-step results are shown in columns 5 and 6, with innovation outcomes in the form of new products and new processes as the dependent variables respectively.

Table 4: Pooled Data

	(1)	(2)	(3)	(4)	(5)
	First step			Second step	
	R&D	Capital invest.	Training	New product	New process
R&D				0.194***	0.155***
				0.015	0.013
Capital investment				0.167***	0.132***
				0011	0.009
Training				0.119***	0.0828***
				0.011	0.009
Firm characteristics:					
Skilled labour	0.000359***	-0.000481***	0.000578***	0.000	0.000
	0.000	0.000	0.000	0.000	0.000
Website	0.106***	0.0780***	0.136***	0.107***	0.0539***
	0.007	0.011	0.011	0.012	0.009
Line of credit	0.0729***	0.155***	0.131***	0.0757***	0.0498***
	0.008	0.011	0.011	0.011	0.009
Exporter	0.0399***	0.0485***	0.0570***	0.0591***	0,013
	0.011	0.016	0.016	0.017	0.013
Quality certificate	0.0774***	0.0543***	0.117***	-0.013	0.011
	0.011	0.015	0.016	0.015	0.012
Firm < 10 years old	0,005	0.0641***	0.004	-0,008	-0.003
	0.010	0.014	0.014	0.014	0.011
Firm 11 – 20 years	-0.010	0.016	-0.002	0.006	0.004
	0.008	0.011	0.012	0.012	0.009
Manager experience	0,000	0,000	0.00115**	0.001	0.00104***
	0.000	0.000	0,000	0.000	0.000
Micro	-0,041	-0.227***	-0.296***	0.0727*	0.058
	0.027	0.025	0.021	0.044	0.040
Small	-0.0465***	-0.204***	-0.193***	0.0314*	0.0279**
	0.010	0.014	0.015	0.016	0.013
Medium	-0.0370***	-0.0784***	-0.0914***	0.0312**	0.0247**
	0.009	0.014	0.014	0.015	0.012
City > 1 million	0.0326***	0.0374***	0.0759***	0.0889***	0.0514***
	0.008	0.011	0.011	0.011	0.009
Multiple locations	0.0307***	0.0468***	0.0289**	0.0562***	0.0283***
	0.008	0.012	0.012	0.013	0.010
Foreign	-0.002	0.0517***	0.0856***	0.0429***	0.020
	0.010	0.016	0.016	0.016	0.013
Country characteristics:					
GDP p.c.	6.76e-06***	6.78e-06***	0.000	7.82e-06***	1.10e-05***
	0.000	0.000	0.000	0.000	0.000
GDP growth	0.005	0.0158***	0.003	0.0146***	0.0124***
	0.003	0.004	0.004	0.004	0.004
GFCF/GDP	0.00239***	0.0156***	0.0150***	0.0176***	0.00814***
	0.001	0.001	0.001	0.001	0.001
Literacy rate	-0.000759**	0.001	0.00328***	0.00297***	0.00119***
	0.000	0.000	0.000	0.000	0.000
Bank branches	0.00362***	0.00234***	0.00632***	0.00431***	0.00319***
	0.000	0.001	0.001	0.001	0.001
N	11 984	11 984	11 984	11 984	11 984
Log likelihood	-4 780	-6 665	-6 362	-6 028	-5 178
Pseudo R-squared	0.150	0.164	0.211	0.249	0.235
Chi-squared	1 690	2 622	3 401	3 993	3 188

Both firm-level and country-level characteristics are important determinants of firm-level outcomes, both in terms of innovation activities (first step) and innovation outputs (second step). This underscores the value of our approach, which considers not only firm-level determinants (as in most of the extant literature) but also broader macro- and institutional determinants important for understanding firm innovation.

There is a high degree of commonality in the sign and significance of explanatory variables across the first and second steps, with some interesting differences. Most firm-level characteristics are consistently significant determinants of innovation activities (columns 1 to3): having a website (+), having a line of credit (+), engaging in international activities both through exports (+) and through the incorporation of an internationally recognised quality certificate (+), and the benefits of agglomeration through being located in a city with more than a million people (+) and the firm having multiple locations (+).

The skills level of the workforce is significant for all three specifications, but positive for R&D and training while negative for capital investment. Firm size is relevant to explaining innovation activities. With large firms as the omitted category, smaller firm-size categories are associated with fewer innovation activities. This may be understood in terms of smaller firms having fewer resources and capabilities to undertake innovation activities.

Other firm-level variables are significant in some, but not all, of our first-step regressions. Young firms (< 10 years old) are more likely to invest in fixed assets, perhaps as they are still building up their core fixed asset base. Years of manager's experience is only significant and positive for training activities. Foreign ownership increases the likelihood of innovation through capital investment and training activities, but not through R&D. This suggests that there is no extra premium for R&D from foreign firms over and above what is already captured by the other firm characteristics.

Turning to our country-level variables in our first-step regressions, GDP per capita is positively associated with R&D and capital investment, but is not statistically significant for training activities. GDP growth is an important determinant of investment in fixed assets, which is intuitive, as a more dynamic economy is likely to encourage firms to make capital investments. National rates of gross fixed capital formation are positive and significant for each of the three innovation activities, pointing to the importance of aggregate investment for firm-level innovation. Similarly, the results for the number of bank branches show the importance of a country's financial system for firm-level outcomes. It is interesting to note that both this variable (country-level bank branches) and firm-level access to credit are positive and highly significant in all three first-step regressions; even controlling for a firm's own access to credit, broader financial access affects the overall innovation climate and individual firms' innovation activities. Finally, literacy is positive for training outcomes but negative for R&D; the latter result may be understood in terms of literacy being a poor measure of the types of education and skills that are relevant for firms' innovation activities.

Having analysed firm- and country-level determinants of innovation activities, our second-step regressions investigate how each of these three types of innovation activities affects firms' innovation outputs in terms of new products (column 5) and new processes (column 6). Each of the innovation activities – R&D, capital investment and training – is found to positively affect both product and process innovation. In each case, the coefficients are slightly higher for new products than for new processes. This underscores the relevance of analysing determinants of all three of these determinants in the first step, as all are found to matter for innovation outputs.

Considering firm- and country-level variables in the second step, we find that many of the same variables that affected innovation activities also have additional direct effects on innovation outputs. In particular, having a website (+), having access to credit (+), location in a city of at least a million inhabitants (+), and the firm having multiple locations (+) are all important determinants of both new product and new process innovations. Years of manager's experience positively affects only process innovations, perhaps suggesting that this experience enables managers to identify opportunities for improving the ways in which existing goods and services are produced. Foreign ownership and being an exporter matter for new products; these might introduce both the opportunities and competitive pressures for firms to develop new products.

Interestingly, it is only with firm size that we find divergent results from our first-step regressions. Here, smaller firm size increases the likelihood that firms' innovation activities will translate into innovation outputs. It may be that smaller firms are more 'frugal' in their innovation activities and more dynamic in ensuring that those activities successfully generate positive innovation outcomes. Skilled labour, firm age and possession of an internationally recognised quality certificate do not have an influence on the introduction of a new product or process, beyond their influence on the likelihood of a firm's engagement with innovation activities (step 1).

Our results on the importance of the different firm-level variables generally correspond with the findings in the existing literature, with the exception of the coefficients on the size variable in the second step.

We find country characteristics to be especially important in our second-step regressions, with all five country-level variables being highly significant for both types of innovation outputs. This suggests that macro- and institutional factors make a big difference to whether firms' innovation activities actually yield tangible innovation outputs. It is interesting to note that, even with related firm- and country-level variables included in the same specifications (e.g. firm's investment in fixed assets and national GFCF/GDP; firms' training and skills with national literacy levels; and firms' access to credit alongside national bank branches), the country-level variables still emerge as very important. Again, this shows that what matters for innovation outcomes is not only the characteristics and behaviour of individual firms, but also the broader context within which they operate.

3.2 Africa and Latin America

When estimating the two-step model for Africa and Latin America separately, we find that, overall, the results are not fundamentally different from those in the pooled model. Where there are significant differences in the coefficients, their practical significance is small. The results for the country-level variables are mixed. That is not surprising, given the small number of countries in the separate regressions: only 12 for Latin America and 23 for Africa.[4]

We saw earlier that the share of innovative firms is much larger in Latin America than in Africa. The question then is how much of the differences in innovation can be attributed to differences in firm characteristics between the two regions and how much to differences in the value of country-level variables. Using country means and the coefficients from the pooled regressions, we calculated what percentage of the differences in estimated innovation activities and outcomes between Latin America and Africa can be explained by each independent variable.

The results in Table 5 show that differences in both firm- and country-level characteristics explain the differences in innovation rates between the two regions.[5] For differences in the rates of engagement with R&D, the total contribution of firm-level variables outweighs the importance of the contribution of country-level variables, whereas the reverse is true for differences in the provision of training. For capital investment and innovation outcomes, the contribution of the two sets of factors is roughly the same.

What stands out, again, is the critical role of access to funding. Differences in having a line of credit comprise the most important firm-level characteristic in explaining differences in each of the innovation activities and outcome rates between Latin America and Africa. And differences in access to national credit (proxied by bank branches per 100 000 adults) constitute the most important country-level factor explaining inter-regional differences in R&D and training.

All the African countries in our sample are low-income or lower middle-income economies, with the exception of South Africa, which is an upper middle-income economy. All the Latin American countries are middle-income countries, with about half being lower middle-income and half upper middle-income countries, with Uruguay as the only high-income country. Although this suggests some degree of commonality among countries in each region, there is considerable intra-regional heterogeneity. Appendix 2 shows the aggregate effect of the country-level variables on the Z score for each country, sorted by new product. Their contribution varies widely across countries. Country context always matters, although the extent of this influence varies with the country-specific values for those variables.

[4] These results are available from the authors on request.
[5] We use the marginal effects from the first equations to estimate the contributions, so the total contributions may be larger than 1.

Table 5: Differences in Innovation Activities and Outcomes between Latin America and Africa: Percentage Explained by Variables

	New product	New process	R&D	Capital investment	Training
Innovation activities					
R&D	5.6%	5.7%			
Capital investment	10.5%	11.3%			
Training	10.9%	10.5%			
Firm-level variables					
Skilled labour	-0.3%	-0.9%	6.6%	-3.6%	2.9%
Website	4.3%	3.0%	17.6%	5.0%	5.9%
Line of credit	9.0%	8.2%	33.3%	29.5%	16.9%
Exporter	-0.3%	-0.1%	-0.7%	-0.4%	-0.3%
Quality certificate	-0.1%	0.1%	1.5%	0.4%	0.7%
Firm < 10 years old	0.2%	0.1%	-0.4%	-2.2%	-0.1%
Firm 11-20 years old	0.0%	0.0%	0.2%	-0.1%	0.0%
Manager experience	1.1%	2.3%	1.8%	1.1%	2.0%
Micro	-0.1%	-0.1%	0.3%	0.8%	0.8%
Small	-0.5%	-0.6%	2.8%	5.0%	3.2%
Medium	0.2%	0.2%	-1.1%	-0.9%	-0.7%
City > 1 million	4.6%	3.7%	6.7%	3.1%	4.2%
Multiple locations	-0.2%	-0.2%	-0.5%	-0.3%	-0.1%
Foreign	-0.3%	-0.2%	0.0%	-0.6%	-0.7%
Total firm-level variables	**44.5%**	**43.2%**	**68.0%**	**36.8%**	**34.7%**
Country-level variables					
GDP p.c.	8.8%	17.3%	30.2%	12.2%	-0.5%
GDP growth	0.4%	0.5%	0.5%	0.7%	0.1%
GFCF/GDP	4.6%	3.0%	2.5%	6.5%	4.3%
Literacy rate	19.3%	10.9%	-19.7%	7.7%	23.3%
Bank branches	10.5%	10.9%	35.3%	9.2%	16.8%
Total country-level variables	**43.6%**	**42.6%**	**48.9%**	**36.4%**	**43.9%**

3.3 Manufacturing and Services

Next, we split our sample into manufacturing and service firms. The results are broadly consistent with and confirm the robustness of the results of our pooled model (see Appendix 3). It is worth highlighting a few of the results. First, engagement with any of the three innovation activities (R&D, capital investment, training) increases the likelihood that the firm will introduce a new product or process in both manufacturing and services. Digital presence and line of credit are important determinants of innovation in all first- and second-stage regressions, again for both manufacturing and services. Third, in both sectors, exporting increases firm engagement with each of the three innovation activities and the introduction of a new product, but not the introduction of a new process.

The finding of positive and significant coefficients on exporting differs from the results of some other studies. In Hussen and Çokgezen (2021), the coefficient is not significant; in Gallego et al. (2013), it is negative and significant for manufacturing; in Aboal and Garda

(2012), it is negative and significant for manufacturing, but not for services; and in Crespi et al. (2014), it is negative and significant for both manufacturing and services. Our finding is consistent with other studies, such as Avenyo et al. (2021b), who find a positive effect of exporting on innovation among African firms.

Table 6: Innovation Activities and Outcomes by Technology Intensity

Pooled	n	New product	New process	R&D	Capital invest.	Training
Manufacturing	5 388	0.409	0.286	0.203	0.415	0.406
Low-tech/medium-low-tech	4 590	0.397	0.277	0.184	0.405	0.385
Medium-high-tech/high-tech	**817**	**0.461**	**0.330**	**0.306**	**0.453**	**0.512**
Services	6 596	0.378	0.225	0.159	0.357	0.394
Construction	704	0.247	0.190	0.172	0.393	0.372
Service of motor vehicles	604	0.344	0.219	0.123	0.358	0.409
Wholesale trade	**1 169**	**0.498**	**0.302**	**0.182**	**0.448**	**0.453**
Retail trade	2 206	0.398	0.204	0.122	0.292	0.342
Hotels & restaurants	876	0.350	0.200	0.187	0.312	0.365
Transportation	357	0.279	0.216	0.155	0.396	0.440
Telecom & IT	**340**	**0.491**	**0.291**	**0.294**	**0.465**	**0.571**
Latin America						
Manufacturing	2 312	0.629	0.475	0.285	0.548	0.603
Low-tech/medium-low-tech	1 948	0.615	0.462	0.263	0.545	0.585
Medium-high-tech/high-tech	**364**	**0.706**	**0.559**	**0.413**	**0.574**	**0.713**
Services	2 660	0.582	0.382	0.203	0.488	0.582
Construction	208	0.452	0.385	0.212	0.615	0.577
Service of motor vehicles	227	0.467	0.366	0.150	0.485	0.586
Wholesale trade	**706**	**0.637**	**0.409**	**0.234**	**0.503**	**0.585**
Retail trade	961	0.592	0.348	0.156	0.402	0.506
Hotels & restaurants	198	0.611	0.359	0.202	0.510	0.727
Transportation	223	0.475	0.381	0.224	0.578	0.704
Telecom & IT	**137**	**0.693**	**0.511**	**0.423**	**0.599**	**0.657**
Africa						
Manufacturing	3 095	0.242	0.144	0.141	0.312	0.256
Low-tech/medium-low-tech	2 642	0.236	0.141	0.126	0.303	0.238
Medium-high-tech/high-tech	**453**	**0.267**	**0.159**	**0.230**	**0.360**	**0.358**
Services	3 896	0.244	0.120	0.130	0.272	0.270
Construction	496	0.161	0.109	0.155	0.300	0.286
Service of motor vehicles	377	0.271	0.130	0.106	0.281	0.302
Wholesale trade	**463**	**0.285**	**0.138**	**0.104**	**0.365**	**0.253**
Retail trade	1 245	0.281	0.101	0.103	0.225	0.237
Hotels & restaurants	678	0.274	0.153	0.183	0.254	0.260
Transportation	434	0.177	0.131	0.120	0.302	0.304
Telecom & IT	**203**	**0.325**	**0.123**	**0.207**	**0.345**	**0.483**

Among the country-level variables, the investment ratio (GFCF/GDP) and the breadth of the financial sector most consistently have a positive and significant effect across innovation activities and outcomes. That is true for both manufacturing and services.

Manufacturing and services comprise a heterogeneous set of subsectors, where firms are likely to differ in innovation activities and outcomes. To explore this heterogeneity, we look at sub-stratifications in each sector. In the manufacturing sector, we distinguish between low-tech/low-medium-tech sectors on the one hand, and medium-high-tech/high-tech sectors on the other, using the OECD classification of sectors by R&D intensity (OECD 2011). In the service sector, we look at innovation behaviour at the two-digit ISIC level.

The results in Table 6 confirm our expectations. In manufacturing, the medium-high-tech/high-tech sectors have significantly higher means in innovation activities and outcomes than the low-tech/medium-low-tech sectors. Among the service sectors, innovation in wholesale trade as well as telecommunications and IT is significantly higher than in the other sectors. That is true for the pooled data as well as for Latin America and Africa separately. Since the WBES aim for a mix of firms representative of a country's economic structure in manufacturing and services, the results suggest that the most innovation-intensive sectors play a relatively limited role in the economies in our sample.

4. Conclusions

This paper has demonstrated the importance of macro- and institutional country characteristics, in addition to firm-level characteristics, in determining firm-level innovation in 35 countries in Latin America and Africa. Innovation intensity is significantly lower in Africa than in Latin America, with country-level variables accounting for around half of the difference in innovation intensity between the two regions.

Our analysis suggests two policy implications for enhancing innovation in countries in both regions. First, the importance of enabling access to funding, especially important in the African countries. Second, the importance of focusing on the development of innovation capabilities in small and medium-sized firms. These firms account for the vast majority of firms, but their innovation intensity is considerably lower than for large firms.

Given the much higher means for the innovation variables in Latin America, one may wonder why this has not translated into higher aggregate productivity growth in the region. While our empirical analysis does not speak to that question and the answer is undoubtedly complex, we offer two observations, both linked to the dominance of the neoliberal model since the 1980s. One concerns the nature of structural change in many of the economies over the past three decades. Labour has moved from agriculture (and in the case of Latin America from manufacturing as well) to sectors with lower productivity, often to the service sector, and frequently to the informal economy (McMillan and Rodrik 2011; McMillan et al. 2014; Tregenna 2016a, 2016b; Paus 2020). The result of this premature de-industrialisation was that

productivity growth no longer came from the movement of labour from low- to high-productivity sectors, but from within-sector productivity growth. As we have seen, the most innovation-intensive sectors in manufacturing and services account for only a relatively small number of firms.

The second observation concerns the lack of concerted government support for innovation. Policies aimed at advancing innovation have lacked coherence, continuity and financial support, both in Latin America (Paus 2020) and in Africa (Iizuka et al. 2015). Innovation has not been a strategic priority.

5. References

Aboal, D. & Garda, P. (2012). Technological and non-technological innovation and productivity in services vis a vis manufacturing in Uruguay. Discussion Paper No. IDB-DP-264. Washington, DC: Inter-American Development Bank.

Adeyeye, D., Egbetokun, A. Opele, J., Oluatope, O. & Sanni, M. (2018). How barriers influence firms' search strategies and innovative performance. *International Journal of Innovation Management*, 22(2): 1850011.

Andreoni, A. & Tregenna, F. (2020). Escaping the middle-income technology trap: A comparative analysis of industrial policies in China, Brazil and South Africa. *Structural Change and Economic Dynamics*, 54: 324-340.

Arza, V. & López, A. (2010). Innovation and productivity in the Argentine productivity sector. Working Paper No. IDB-WP-187. Washington, DC: Inter-American Development Bank.

AU-NEPAD. (2014). *African innovation outlook 2014*. Pretoria: African Union-New Partnership for African Development.

Avenyo, E., Tregenna, F. & Kraemer-Mbula, E. (2021a). Do productive capabilities affect export performance? Evidence from African firms. *European Journal of Development Research*, 33: 304-329.

Avenyo, E., Tregenna, F. & Ngwadleka, K. (2021b). 'Learning to export' and 'learning to innovate': Revisiting the relationship between innovation and exports in African firms. ERSA Working Paper No. 861. Cape Town: Economic Research Southern Africa.

Ayalew, M., Xianzhi, Z., Dinberu, Y. & Hailu, D. (2020). The determinants of firm's innovation in Africa. *Journal of Industry, Competition, and Trade*, 20: 527-567.

Barasa, L., Knoben, J., Vermeulen, P., Kimuyu, P. & Kinyanjui, B. (2017). Institutions, resources, and innovation in East Africa: A firm level approach. *Research Policy*, 46: 280-291.

Chadee, D. & Roxas, B. (2013). Institutional environment, innovation capacity and firm performance in Russia. *Critical Perspectives on International Business*, 9(1/2): 19-39.

Cimoli, M., Dosi, G., Nelson, R. & Stiglitz, J. (2009). Institutions and policies in developing economies. In B. Lundvall, K. J. Joseph, C. Chaminade & J. Vang (eds), *Handbook of innovation systems and developing countries: Building domestic capabilities in a global setting* (pp. 337-359). Cheltenham, UK and Northampton, MA: Edward Elgar.

Cimoli, M., Dosi, G. & Yu, X. (2020). Industrial policies, patterns of learning and development: An evolutionary perspective. In H.-J. Chang, R. Kozul-Wright & A. Oqubay (eds), *The Oxford handbook of industrial policy* (pp. 93-124). Oxford: Oxford University Press.

Crepon, B., Duguet, E. & Mairesse J. (1998). Research, innovation, and productivity: An econometric analysis at the firm level. *Economics of Innovation and New Technology*, 7: 115-158.

Crespi, G. & Zuniga, P. (2012). Innovation and productivity: Evidence from six Latin American countries, *World Development*, 40(2): 273-290.

Crespi, G., Tacsir, E. & Vargas, F. (2014). Productivity and innovation in services. Empirical evidence from Latin America. Technical Note No. IDB-TN-690. Washington, DC: Inter-American Development Bank.

De Fuentes, C., Santiago, F. & Temel, S. (2020). Perception of innovation barriers by successful and unsuccessful innovators in emerging economies. *The Journal of Technology Transfer*, 45: 1283-1307.

D'Este, P., Iammarino, S., Savona, M. & Von Tunzelman, N. (2012). What hampers innovation? Revealed barriers versus deterring barriers. *Research Policy*, 41: 482-488.

Diao, X., Ellis, M., McMillan, M. & Rodrik, D. (2021). Africa's manufacturing puzzle: Evidence from Tanzanian and Ethiopian firms. NBER Working Paper No. 28344. Cambridge, MA: National Bureau of Economic Research.

Fagerberg, J. (1988). Why growth rates differ. In G. Dosi, C. Freeman, R. Nelson, G. Silverberg & L. Soete (eds), *Technical change and economic theory* (pp. 432-457). New York and London: Pinter Publishers.

Fernandez, V. (2017). The finance of innovation in Latin America. *International Review of Financial Analysis,* 53: 37-47.

Galia, F. & Legros, D. (2004). Complementarities between obstacles to innovation: Evidence from France. *Research Policy*, 33: 1185-1199.

Gallego, J. M., Gutiérrez, H. & Taborda, R. (2013). Innovation and productivity in the Colombian service industry. Discussion Paper No. IDB-DP-287. Washington, DC: Inter-American Development Bank.

Gill, I. & Kharas, H. (2008). *An East Asia renaissance. Ideas for economic growth*. Washington, DC: World Bank.

Hall, B. (2011). Innovation and productivity. NBER Working Paper 17178. Cambridge, MA: National Bureau of Economic Research.

Hervás-Oliver, J., Parilli, M. D., Rodríguez-Pose, A. & Sempere-Ripoll, F. (2021). The drivers of SME innovation in the regions of the EU. *Research Policy*, 50: 1-13.

Hussen, M. S. & Çokgezen, M. (2020). Analysis of factors affecting firm innovation: An empirical investigation for Ethiopian firms. *Journal of African Business*, 21(2): 169-192.

Hussen, M. S. & Çokgezen, M. (2021). The impact of regional institutional quality on firm innovation: Evidence from Africa. *Innovation and Development*, 11(1): 69-90.

Iizuka, M., Mawoko, P. & Gault, F. (2015). Innovation for development in Southern and Eastern Africa: Challenges for promoting ST&I policy. UNU-Merit Policy Brief No. 1/2015. Helsinki: UNU-WIDER

Kharas, H. & Kohli, H. (2011). What is the middle income trap, why do countries fall into it, and how can it be avoided? *Global Journal of Emerging Market Economies*, 3(3): 281-289.

Lundvall, B. A. (1992). *National systems of innovation*. London: Pinter.

Mazzucato, M. (2013). Financing innovation: Creative destruction vs. destructive creation. *Industrial and Corporate Change*, 22(4): 851-867.

McMillan M. & Rodrik, D. (2011). Globalization, structural change and productivity growth. NBER Working Paper No. 17143. Cambridge, MA: National Bureau of Economic Research

McMillan, M., Rodrik, D. &Verduzco-Gallo, I. (2014). Globalization, structural change, and productivity growth, with an update on Africa. *World Development*, 63: 11-32.

Morris, D. M. (2020). Innovation and productivity among heterogeneous firms. *Research Policy*, 47: 1918-1932.

Naidoo, K., Bengoa, M., Kraemer-Mbula, E. & Tregenna, F. (2021). Firm innovation and employment in South Africa: Examining the role of export participation and innovation novelty. SARChI Industrial Development Working Paper Series WP 2021-03. Johannesburg: SARChI Industrial Development, University of Johannesburg.

Nelson, R. & Winter, S. (1982). *An evolutionary theory of economic change*. Cambridge, MA: Harvard University Press.

Ocampo, J. A., Rada, C. & Taylor, L. (2009). *Growth and policy in developing countries. A structuralist approach*. New York: Columbia University Press.

OECD. (2011). *ISIC Rev. 3 Technology intensity definition*. Paris: OECD Economic Analysis and Statistics Division.

OECD/Eurostat. (2018). *Oslo Manual 2018: Guidelines for collecting, reporting, and using data on innovation*. *The measurement of scientific, technological, and innovation activities*. 4th edition. Paris: OECD Publishing.

Paus, E. (2020). Innovation strategies matter. Latin America's middle income trap meets China and globalization. *Journal of Development Studies*, 56(4): 657-679.

Paus, E. (2021). The role of services in the future development of Latin America. Paper presented at the 2021 Congress of the Latin American Studies Association. 25-29 May, Vancouver, Canada.

Paus, E. & Robinson, M. (forthcoming). Firm-level innovation, government policies and the middle income trap: Insights from five Latin American economics. *CEPAL Review*.

Romer, P. (1990). Endogenous technological change. *Journal of Political Economy*, 198: S71-S102.

Ros, J. (2014). Productividad y crecimiento en América Latina: Por qué la productividad crece más en unas economías que en otras? Desarrollo Económico, CEPAL, Mexico.

Rubalcaba, L. (2015). Service innovation in developing economies: Policy rationale and framework. *Emerging Markets, Finance, and Trade*, 51: 540-557.

Rubalcaba, L., Aboal, D. & Garda, P. (2016). Service innovation in developing economies: Evidence from Latin America and the Caribbean. *The Journal of Development Studies,* 52(5): 607-626.

Schumpeter, J. A. (1983). *The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle*. New Brunswick: Transaction Publishers.

Solow. R. (1957). Technical change and the aggregate production function. *Review of Economics and Statistics*, 39: 312-320.

Srholec, M. (2011). A multilevel analysis of innovation in developing countries. *Industrial and Cultural Change*, 20(6): 1539-1569.

Tacsir, E., Guaipatin, C., Cathles, A., Larsson, M., Magri, N. & Virgem, S. (2011). Innovation in services: The hard case of Latin America and the Caribbean. Discussion Paper No. IDB-DP-203. Washington, DC: Inter-American Development Bank

Tregenna, F. (2016a). Deindustrialisation and premature deindustrialisation. In J. Ghosh, R. Kattel & E. Reinert (eds), *Elgar handbook of alternative theories of economic development* (pp. 710-728). Northampton, MA: Edward Elgar Publishing,

Tregenna, F. (2016b). Deindustrialisation: An issue for both developed and developing countries. In J. Weiss and M. Tribe (eds), *The Routledge handbook on industry and development* (pp. 97-115). Oxfordshire: Routledge.

Appendix 1: Sample Countries

	Country	GDP p.c.	Income category	WBES Survey Year
Africa				
	Benin	1 135	LMIC	2016
	Cameroon	1 469	LMIC	2016
	Chad	812	LIC	2018
	Egypt	2 763	LMIC	2016
	Eswatini	4 650	LMIC	2016
	Ethiopia	483	LIC	2015
	Guinea	810	LIC	2016
	Ivory Coast	1 530	LMIC	2016
	Kenya	1 201	LMIC	2018
	Lesotho	1 325	LMIC	2016
	Liberia	548	LIC	2017
	Mali	750	LIC	2016
	Morocco	3 408	LMIC	2019
	Mozambique	593	LIC	2018
	Niger	535	LIC	2017
	Rwanda	901	LIC	2019
	Senegal	1 304	LMIC	2014
	Sierra Leone	467	LIC	2017
	South Africa	6 748	UMIC	2020
	Togo	649	LIC	2016
	Tunisia	3 984	LMIC	2020
	Zambia	1 558	LMIC	2020
	Zimbabwe	1 224	LMIC	2016
Latin America				
	Argentina	10 419	UMIC	2017
	Bolivia	2 491	LMIC	2017
	Colombia	7 621	UMIC	2017
	Dominican Republic	7 026	UMIC	2016
	Ecuador	5 206	UMIC	2017
	El Salvador	3 382	LMIC	2016
	Guatemala	3 290	LMIC	2018
	Honduras	2 176	LMIC	2017
	Nicaragua	1 958	LMIC	2017
	Paraguay	5 270	UMIC	2017
	Peru	6 314	UMIC	2017
	Uruguay	14 302	HIC	2017

GDP p.c.: in constant 2010 US $, 3-year average incl. survey year; income group based on World Bank classification in the year of the WBES

Appendix 2. Contribution of Country-level Variables to the Z Scores for Innovation Activities and Outcomes, by Country (sorted by new product)

	New product	New process	R&D	Capital investment	Training
Zambia	2.66	1.73	0.38	1.86	2.44
Ecuador	2.28	1.59	0.36	1.49	2.06
Nicaragua	2.26	1.50	0.32	1.53	2.06
DR	2.23	1.61	0.39	1.45	1.96
Morocco	2.21	1.51	0.39	1.53	1.99
Colombia	2.20	1.61	0.39	1.42	1.94
Lesotho	2.20	1.45	0.33	1.52	2.02
Peru	2.15	1.54	0.35	1.38	1.91
Uruguay	2.14	1.75	0.53	1.34	1.78
Togo	2.10	1.38	0.35	1.49	1.90
Guinea	2.08	1.39	0.52	1.63	1.83
Honduras	2.05	1.37	0.26	1.32	1.91
Bolivia	2.03	1.36	0.23	1.28	1.88
Paraguay	2.01	1.43	0.29	1.25	1.82
Rwanda	2.01	1.33	0.29	1.37	1.84
Cameroon	1.96	1.30	0.27	1.29	1.81
Mozambique	1.93	1.28	0.33	1.36	1.77
Argentina	1.91	1.49	0.37	1.13	1.68
Niger	1.91	1.28	0.46	1.47	1.70
South Africa	1.76	1.30	0.30	1.05	1.62
Tunisia	1.76	1.23	0.27	1.10	1.65
Kenya	1.76	1.16	0.20	1.10	1.65
El Salvador	1.71	1.18	0.20	1.01	1.61
Ivory Coast	1.67	1.14	0.36	1.20	1.50
Senegal	1.63	1.11	0.37	1.17	1.49
Eswatini	1.60	1.15	0.21	0.92	1.50
Guatemala	1.59	1.11	0.21	0.95	1.49
Liberia	1.58	1.05	0.31	1.11	1.46
Benin	1.56	1.06	0.35	1.12	1.42
Chad	1.53	1.04	0.44	1.19	1.38
Zimbabwe	1.48	0.99	0.10	0.82	1.41
Egypt	1.47	1.03	0.22	0.89	1.39
Mali	1.37	0.93	0.35	1.00	1.25

Appendix 3: Comparison of Manufacturing and Services

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	First step						Second step			
	Manuf.	Services	Manuf.	Services	Manuf.	Services	Manuf.	Services	Manuf.	Services
	R&D	R&D	Capital invest.	Capital invest.	Training	Training	New product	New product	New process	New process
R&D							0.212***	0.174***	0.184***	0.125***
							0.021	0.020	0.019	0.017
Capital investment							0.193***	0.145***	0.159***	0.110***
							0.016	0.015	0.014	0.011
Training							0.122***	0.115***	0.0782***	0.0833***
							0.018	0.015	0.015	0.011
Firm characteristics:										
Skilled labour	0.000329*	0.000366**	0.000	-0.000636***	0.000817***	0.000398*	0,000	0,000	0,000	0,000
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Website	0.107***	0.104***	0.0607***	0.0888***	0.112***	0.148***	0.122***	0.0958***	0.0522***	0.0571***
	0.012	0.009	0.018	0.015	0.018	0.015	0.018	0.015	0.016	0.011
Line of credit	0.0935***	0.0541***	0.190***	0.124***	0.141***	0.122***	0.0855***	0.0646***	0.0792***	0.0256**
	0.013	0.011	0.016	0.015	0.017	0.015	0.018	0.015	0.015	0.011
Exporter	0.0471***	0.0357*	0.0379*	0.0653**	0.0717***	0.0502*	0.0558**	0.0752***	0.016	0.017
	0.015	0.018	0.021	0.027	0.021	0.028	0.022	0.029	0.018	0.021
Quality certificate	0.0831***	0.0785***	0.0569***	0.0599***	0.140***	0.0970***	-0.027	0.012	0.006	0.021
	0.015	0.017	0.020	0.022	0.021	0.024	0.021	0.023	0.017	0.017
Firm < 10 years old	0.015	0.002	0.0810***	0.0562***	0.0417*	-0.018	-0.019	0.003	-0.011	0.005
	0.017	0.012	0.023	0.018	0.023	0.019	0.023	0.019	0.019	0.014
Firm 11 – 20 years	-0.013	-0.008	0.016	0.016	-0.001	-0.002	-0.005	0.016	-0.009	0.013
	0.012	0.010	0.018	0.015	0.018	0.016	0.018	0.016	0.015	0.012
Manager experience	0.00114**	0.000	0.000	0.00101*	0.001	0.00159**	0,000	0.00138**	0.00119**	0.000874*
	0.000	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000
Micro	-0.034	-0.048	-0.251***	-0.211***	-0.291***	-0.297***	0.167**	0.011	0.120*	0.018
	0.047	0.030	0.044	0.030	0.038	0.025	0.071	0.054	0.070	0.045
Small	-0.0463***	-0.0505***	-0.201***	-0.205***	-0.200***	-0.184***	0.0467*	0,018	0.0487**	0.015
	0.015	0.013	0.021	0.020	0.021	0.021	0.025	0.023	0.021	0.016
Medium	-0.0460***	-0.0340***	-0.0839***	-0.0737***	-0.117***	-0.0711***	0.029	0.028	0.026	0.022

	0.013	0.012	0.019	0.019	0.019	0.021	0.022	0.022	0.018	0.016
City > 1 million	0.0520***	0.0165*	0.0589***	0,019	0.0935***	0.0625***	0.117***	0.0657***	0.0821***	0.0294***
	0.013	0.010	0.017	0.014	0.018	0.015	0.018	0.015	0.015	0.011
Multiple locations	0.0356**	0.0244**	0.0818***	0,021	0,002	0.0466***	0.0399**	0.0659***	0,023	0.0304**
	0.014	0.011	0.019	0.015	0.019	0.016	0.020	0.016	0.017	0.012
Foreign	-0.018	0,010	0.0567**	0.0464**	0.0549**	0.109***	0.039	0.0436**	0,032	0.010
	0.015	0.014	0.024	0.020	0.025	0.022	0.025	0.021	0.021	0.015
Country characteristics:										
GDP p.c.	0,000	6.96e-06***	0,000	7.84e-06**	0,000	0,000	9.47e-06**	6.32e-06*	7.77e-06**	1.22e-05***
	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
GDP growth	0.0129***	-0,003	0.0208***	0.00945*	0.006	0.001	0.0187***	0.0112*	0.008	0.0137***
	0.005	0.004	0.006	0.005	0.007	0.006	0.007	0.006	0.006	0.004
GFCF	0.00324***	0.00206**	0.0153***	0.0158***	0.0151***	0.0146***	0.0173***	0.0175***	0.00964***	0.00705***
	0.001	0.001	0.002	0.001	0.002	0.001	0.002	0.001	0.001	0.001
Bank branches	0.00413***	0.00333***	0.00391***	0.001	0.00831***	0.00506***	0.00653***	0.00286***	0.00368***	0.00276***
	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Literacy	-0,001	-0.000881**	0,001	0,001	0.00314***	0.00345***	0.00275***	0.00294***	0.00173**	0.000820*
	0.001	0.000	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.000
N	5 371	6 596	5 388	6 596	5 388	6 596	5 388	6 596	5 388	6 596
Log likelihood	-2 235	-2 521	-3 054	-3 589	-2 781	-3 559	-2 665	-3 346	-2 411	-2 747
Pseudo R-squared	0.177	0.126	0.165	0.165	0.236	0.195	0.269	0.235	0.253	0.219
Chi-Squared	961.9	727.5	1 204	1 422	1 716	1 729	1 958	2 058	1 631	1 537

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