The Role of Trade Policies in Innovation: The Case of Malawi

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The Role of Trade Policies in Innovation: The Case of Malawi

By

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Abstract

Trade openness is a key factor in making an economy more receptive to technology spillovers from the global market. This paper assesses how trade liberalization and processes of importing affect innovation in Malawi. Two measures of innovation are used at the macro-level: technological processes and products (TPP) and the technological intensity of imports. At the firm-level, four measures are used: new products, new methods, new logistics, and new ideas. At the macro-level, the results suggest that trade liberalization leads to increased imports of technological products, more than other products, and the benefits are relatively larger for imports from outside COMESA. Therefore, there is a limited role for further COMESA trade integration in regard to innovation enhancement from trade. However, when the technological intensity of imports is assessed, high-technology imports would benefit less than primary and resource-based imports regardless of origin, suggesting low absorption of foreign technologies. At the firm level, firms that reported facing obstacles from customs and trade regulations and those that face higher delays in clearing customs are less likely to innovate using all four measures. On the other hand, firms that use foreign-owned technology are more likely to innovate, confirming the channel through which trade impacts innovation.

JEL Classification: F14, F68, O30

Keywords: Import duty, Imported Inputs, foreign technology, transaction data, firm data

1 Introduction

Innovation can involve developing new goods, services, and processes, which potentially play a key role in economic development (Ma´rquez-Ramos & Mart´ınez-Zarzoso, 2010). At the micro level, firms that show more evidence of innovation perform better, with firm size, research and development, market structure, and trade shares, being key to innovative activity (Bhattacharya & Bloch, 2004). At the macro level, countries that innovate more, are richer and grow faster, with determinants of innovation including institutional quality, human capital, and trade openness (Qureshi et al., 2021). In many cases, these micro and macro determinants are interlinked.

An innovation-based mode of competition becomes diffused around the world through the liberalization of both trade and domestic markets (Mytelka, 2007). International trade in technology improves the quality of innovation, the efficiency of invention, and product variety (Spulber, 2008). By enhancing the productivity of labour, or equivalently the supply of human capital technology trade increases each country's national income, and thus augments the gains from trade. The degree of openness of a country is among the key factors that make an economy more receptive to technology spillovers from the global market (Burunskiene, 2013). Trade policy changes can lead to the trade of new products and varieties and allow new technologies to move more freely globally, with smaller businesses in particular benefiting from technology spillovers (The Organisation for Economic Co-operation and Development (OECD), 2018).

This paper assesses the role of import tariffs at the macro level and trade facilitation measures at the firm level, on innovation in Malawi. For the trade policy, we capture the effect of quantitative changes in import duties for the macro analysis, and the regulatory and bureaucratic processes that firms face when importing for the firm-level analysis. We use two measures of innovation at the macro-level. First, innovation is defined using the more traditional way of technological processes and products (TPP) (Benavente, 2014), and second, using the technological intensity of imports based on the Lall (2000) method. At the firm-level, four measures are used on the basis of the World Bank Enterprise Surveys (WBES) innovation module. These include new products, new methods, new logistics, and new ideas. We compare imports from the Common Market for Eastern and Southern Africa (COMESA), a Regional Economic Community (REC) to which Malawi is a member, and compare with imports from non-COMESA countries for the country-level analysis. We further tease out the import-innovation channels, by assessing if the use of imported inputs and foreign technology affects firms' likelihood to innovate. We use

customs-level data for the country-level analysis and survey data for the firm-level analysis.

Malawi makes for a compelling case on this subject. The country's scores in the global innovation index peaked in 2015 but have been falling gradually in recent years. This notwithstanding, relative to GDP, Malawi's expected innovation performance is above expectations for its level of development. It is therefore important to assess the role of trade in these innovation trends. The comparison between COMESA and non-COMESA countries is based on Malawi's membership to the COMESA Free Trade Area (FTA) and the role of trade integration in innovation (OECD, 2011). Import duty on products from COMESA are much lower than those of other regions, including when compared with import duty on imports from the Southern African Development Community (SADC), of which Malawi is also a member (Chipeta and Montfaucon, 2022). Therefore, the analysis can inform whether existing participation in COMESA and the subsequent low tariffs are contributing to technological trade more than other products and where more innovation gains may be had from further tariff reductions.

We find three main results from the country-level analysis. First, lower tariffs positively affect the value of TPP imports, with a larger impact on extra-COMESA imports. Second, while lower tariffs would also positively affect imports of non-TPP products, the effect is higher for TPP compared to other products, with the difference being larger for imports from outside COMESA. Third, there would also be a positive impact of tariff liberalization on imports of all levels of technological intensity, but the magnitude of the impact is lowest on high-tech imports. Results from the firm-level surveys signal the mechanism through which trade policy and higher imports impact innovation. We find that firms with a higher percentage of material inputs of foreign origin and firms that use foreign-owned technology are more likely to innovate. On the other hand, firms that reported facing obstacles from customs and trade regulations and firms that face higher delays in clearing customs are less likely to innovate products, methods, logistics or come up with new ideas (i.e., all four measures are negatively affected).

These results suggest that tariff liberalizations would benefit imports of TPP much more than other sectors, especially for products originating from outside COMESA. However, the results may signal low absorption of foreign technologies in Malawi, which is critical to ensuring gains of technological spillovers in trade (Cavallaro & Mulino, 2009). Factors such as human resources, infrastructure, and technological ability are key to better absorption (Chen & Wang, 2022). Otherwise, the process of innovation may not persist, and new habits and practices may not remain in use. Mytelka (2007). These findings are

in line with identified challenges for Malawi's innovation in the 2020 Global Innovation Index which comprise weaknesses in the tertiary education system, ICT infrastructure, and patents.

The paper makes several contributions to the trade and innovation literature. First, the measurement of innovation and technological progress has been challenging in the literature (Gault, 2018), especially for developing countries (Kang, 2014). We contribute to this literature and improve on previous studies by making use of several measures that are both direct (firm-level measures) and indirect (TPP, tech intensity of products) indicators of innovation, at both the macro and micro levels to better tease out the channels through which trade policy affects innovation. Using multiple measures further ensures results are robust.

The paper also relates to the literature on the impact of import policy and trade integration on innovation through the lens of imported inputs, such as Feng et al. (2016) and Goldberg et al. (2010). Our analysis expands on these studies by providing evidence from both a macro and a micro-level, showing evidence for a low-income country and extending beyond the focus on tariffs alone in trade policy. We focus on other import regulations including trade facilitation measures and their effect on innovation. On COMESA, trade liberalization is at the heart of the continued efforts of integrating Africa. COMESA is the largest regional economic community on the continent and has made progress in reducing intraregional tariffs. To the best of our knowledge, this is the first empirical analysis that links COMESA integration efforts with innovation in a member state.

Finally, the papers focus on Malawi and the literature for a low-income country, as much of what we know about innovation has been in more developed countries, thus adding to an important knowledge gap on this aspect of development.

The rest of the paper is organized as follows: section 2 briefly reviews the literature on innovation, trade and innovation, and the Malawi context. Section 3 outlines the methodology; section 4 details the data and descriptive analysis of the data; section 5 details the empirical results and section 6 concludes.

2 Determinants of Innovation and the Role of Trade

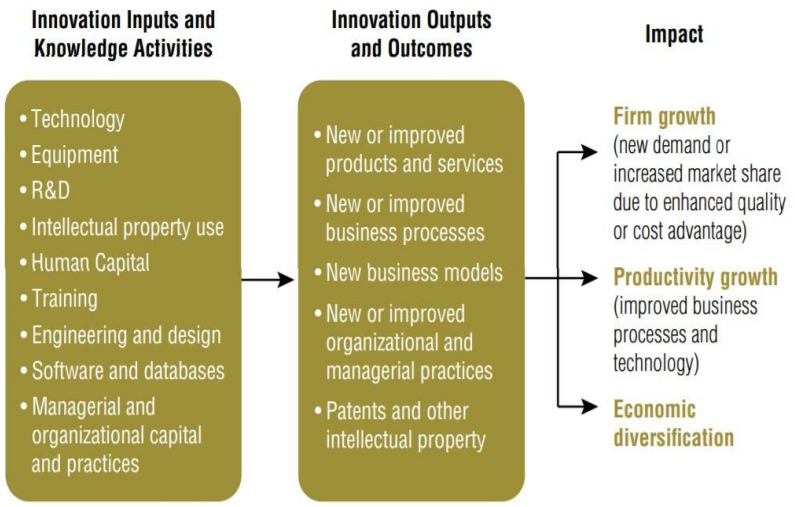
Overview of Determinants of Innovation

Innovation is defined as the “carrying out of new combinations” according to Schumpeter (1934). He resolves innovation into five different types, namely: the introduction of a new good (product), the introduction of a new method of production (process), the opening of a new market, the opening of a new source of supply, and the carrying out of a new organization of any industry, like the creation or breach of a monopoly position.

The availability or non-availability of the determinants can either constrain or spur innovation. We are going to make much reference to Michael Porters Theory of Competitive advantage, which states that some of the determinants of innovation are expenditures on research and development (R&D), market structures (legal and institutional frameworks governing a particular sector), access to technologies which grants competitive advantage, technical skills to carry out the overall task and firm size in both human resource and finances (Porter, 1985). More recently, Cirera and Maloney (2017) extended the concept of innovation as captured in Figure 1, showing that all these aspects need to be combined to yield innovation outcomes. These can lead to impact on firms and the economy at large.

The first determinant of innovation is research and development (RD) expenditure. (Nieminen & Lehtoranta, 2015) argue that a favourable environment for innovation is created by a large and diversified entrepreneurial spirit in both the business and academic worlds. How much businesses and governments invests in education and learning affects the size and, scope, quality, and quantity of the innovation.

Figure 1: The Innovation Function



Source: Cirera and Maloney (2017)

The other determinant of innovation is market structures. Markets have minimum standards that certain innovations must meet to be accepted. There are also legal and institutional frameworks governing sectors that demand compliance from innovators. Certain innovations fail to be actualized because they fall behind set standards to be certified and accepted (Clausen, 2008). For example, in Malawi, a young innovator by the name of Gabriel Kondesi, in 2009 was able to operate a radio station and was able to broadcast some programs within his community but ended up being arrested because he was broadcasting without a license as required by law.[1]

Access to technology is another determinant of innovation. Emerging technologies such as artificial intelligence and robotics have made significant contributions towards innovation by enhancing human capabilities and being a vehicle for innovation. Innovators can use emerging digital technologies such as social media to reach a wider cross-section of potential customers. According to Spulber (2008), technology trade stimulates the entry of inventors leading to more total inventors than there were in either country without technology trade. Technology trade also lowers the total cost of the invention while raising the quality of the expected outcome of the invention. Further, the

[1] https://www.kulinji.com/index.php/article/news/technology/2021/cold-warm-heart-africa-innovator-gabriel-kondesi
In April 2021, Gabriel became a beneficiary of the Malawi University of Science and Technology (MUST) Community Innovator Program aimed at sharpening their skills and innovative ideas

quality of innovation is also increased by technological trade which increases human capital relative to R&D without technology trade.

Technical skills also determine innovation. According to the OECD (2011), for there to be innovation, there need to be people who have the skills to generate and apply knowledge and ideas in the organization or country. Different types of technical skills are needed for an innovation to take place. There is no single mix of skills needed as this is determined by the type of innovation required (Tether et al., 2005). For instance, technological innovations demand more science and engineering-related skills for their functionality. It is therefore important that people have at the least the basic skills that can allow them to be more adaptable to the ever-changing environment of innovation and should also be open-minded to acquire further skills. However, there are no clear-cut links between specific skills and innovation as it is difficult to measure human capital and innovation outputs and outcomes. There are relatively low innovation-specific studies, and this acts as a limitation to the exactness of policy recommendations.

Empirical studies are in line with these observations. Restrepo-Morales et al. (2019) analysed on the determinants of innovation in Colombian micro, small and medium-sized enterprises using the 403 MSME surveys. The study found that Colombian SMEs did not significantly benefit from participation in R&D alliances. Instead, their performance appeared to be dependent upon their internal innovation efforts directed at product development. The results suggested that imitators get a performance almost as high as innovators. Regarding technology, results suggest that almost half of SMEs are classified as followers, namely, they use the same technology as competitors. Bhattacharya and Bloch (2004) observed how firm size, market structure, profitability, and growth influence innovative activity in small to medium-sized Australian manufacturing businesses using survey data. R & D intensity, market structure, and trade shares were found to be conducive to further innovative activity for the full sample and for the high-tech firms.

Chipunza (2019) sought to establish if there is a relationship between firm size and different dimensions of innovation (Product/service, process, marketing, and organizational (PPMO) in Zimbabwe and South Africa where owners/managers of small accommodation businesses (SABs). The results showed that regardless of nationality, there is strong evidence of no association between firm size and innovation. Specifically, SMMEs have no influence on the different dimensions (PPMO) of innovation.

Dotun (2015) examined the key determinants of innovation in small and medium-scale enterprises (SMEs) in southwestern Nigeria using questionnaires and face-to-face interviews with SME Owners/Managers. The

study revealed that eight factors accounted for the technological and organizational innovation performance of SMEs in the study area: accessibility to foreign inputs, government support, relevant academic educational background of owner/managers, comparing the company's products regularly with those of its competitors, extent of investment in R & D, extent of foreign collaboration/number of external partners, prior experience of owner-manager, and availability of patent and copyrights. The study concluded that access to external inputs and the extent of investment in the R & D are the most important factors that influence innovation in SMEs in southwestern Nigeria.

These theoretical and empirical underpinnings already point to the role of trade in innovation.

Trade and Innovation

Kiriyama (2012) identifies three key channels through which trade can lead to diffusion of innovation: through imports, foreign direct investment (FDI), and trade in technology. Trade policies such as liberalization of both tariff and non-tariff barriers contribute to ensuring the link between trade and innovation. Policy changes could lead to importing of products not previously imported or imports from a new country, which would be a new variety of imports (Goldberg & Pavcnik, 2016). Importing intermediate inputs is also linked to acquiring new technology (Almeida & Fernandes, 2008), and two-way traders are more innovative (Seker, 2009). By liberalizing imports of inputs, a country can allow firms to expand their sources of inputs, and their roles in the value chain. The benefits of technology diffusion depend on the channels of diffusion and the absorptive capacity.[2]

Imports allow domestic firms access to foreign technology, including new insights from foreign products and intangible knowledge flows. These may work as a basis for product innovation and process innovation with technology embodied in capital and intermediate goods. Thus, the direct import of these goods is one channel of transmission. It is for this reason that lowering tariffs as a signal for that market access can be useful to predict innovation (Benavente, 2014), as importers see how new technology can make local products more attractive to consumers. We, therefore, expect that a higher degree of openness to import in a country, with firms facing fewer barriers to trade and lower trade costs, would lead to higher levels of innovation. A movement from autarky to free trade has been found to promote innovation

[2] Absorptive capacity in developing countries for instance, needs to be built in order to benefit from technological innovation improvements (M´arquez-Ramos & Mart´ınez-Zarzoso, 2010).

and productivity growth, especially in sectors that are initially less competitive (Navas, 2015). On the other hand, increased protectionist policies, especially in technology-intensive sectors, can limit regions such as Africa to progress as much as China has, on the innovation front (Cornell University and INSEAD and World Intellectual Property Organization, 2018).

There are several theoretical and empirical studies on innovation and trade. The notion in itself is consistent with several existing trade theories dating as far back as David Ricardo. From the view that production technology differences across sectors and countries lead to differences in comparative labour productivity (ECA, AU, AfDB, 2016), to the new technology theory of trade. The new technology theory hypothesizes that the primary cause of international trade is the continuous process of technological innovation and its diffusion (Borkakoti, 1998). Endogenous growth models have also demonstrated this link and the empirical evidence has been strengthened by the availability of disaggregated data in recent years. Still, only a few quantify the benefits of foreign innovations in imported varieties. Another theoretical work by Batabyal and Nijkamp (2014) analyses positive and negative externalities in innovation and trade for economic growth and they show that opening a region to trade leads to more innovation but does not lead to changes in its long-run growth rate.

Spulber (2008) applies the Dixit–Stiglitz–Krugman model of international monopolistic competition and studies the international technology market in differentiated products. They find that international trade in technology improves the quality of innovation, the efficiency of invention, the volume of trade in goods, and product variety. Cavallaro and Mulino (2009) present an endogenous growth model that assumes that the quality content of the goods manufactured in a country reflects the available stock of knowledge capital and the country's efficiency in converting that capital into innovation. They show that the greater the country's ability to absorb foreign knowledge and improve upon foreign technologies, the greater the gains in competitiveness, and the benefits to long-run growth.

Based on this theoretical work, several empirical studies also exist demonstrating that trade allows countries to adopt innovations developed abroad. Due to a lack of direct measures of innovation, trade in intermediate goods is among the used indirect measures of adoption. Coe et al. (1997) using data from 77 developing countries in a log-linear illustrate that research and development (R&D) spillover from the industrial countries to the developing countries is substantial, allowing a developing country to boost its productivity by importing a larger variety of intermediate products, capital equipment, and acquiring useful information that would otherwise be costly to obtain.

Goldberg et al. (2010) use firm-level data from India and find that lower input tariffs account for the declines in trade costs and lead to gains from trade through access to new imported intermediate inputs. This effect is driven to a large extent by increased firm access to varieties that were unavailable before the trade liberalization. Feng et al. (2016) have shown in China that improving access to imported inputs might have a relatively large effect on enhancing firms' productivity and product quality. Based on the theory of technology spillover in international trade and using an annual panel data set of 31 provinces and regions of China between 2007 and 2015, Xie et al. (2017) find that trade specialization improves radical innovation and uses patents as the main variable to measure innovation.

Fernandes (2007), based on a sample of manufacturing plants in Colombia (1977-91), also suggests that the TFP gains under trade liberalization may be linked to increases in intermediate inputs imports, skill intensity, and machinery investment. Bustos (2011) demonstrates that the trade policy encouraged investment in new technology and R&D, which will also lead to productivity improvements. Bustos does so by studying actual trade liberalization episodes.

There are conceptual linkages between regional integration, innovation, and competitiveness (UNECA, 2016). Firms and investors benefit from economies of scale and scope which is a necessary condition for innovators to become commercial. Regional Integration makes it possible for local firms to come to interact with foreign firms. Such interactions, generate and disseminate knowledge and skills which contribute to innovation activities and Capacities. According to UNECA (2016), regional integration contributes to structural transformation which enhances competition and hence generates growth. Regional integration makes technological innovation from external innovators accessible and usable to local

firms.

Liberalization may be achieved by both trade policy and facilitation measures. Trade policies can include any policy that affects the flow of goods and services between countries, including import tariffs, import quotas, voluntary export restraints, export taxes, and export subsidies. Trade facilitation measures that streamline and simplify the technical and legal procedures for products entering or leaving a country are also key in ensuring access. Africa is on track in encouraging free trade movements with the landmark African Continental Free

Trade Area Agreement (AFCFTA). The scope of the AFCFTA exceeds that of traditional free trade as the AFCFTA goes beyond trade on goods to include

trade in services, investment, intellectual property rights, competition policy, and possibly e-commerce.

Innovation and Trade: The Malawi Context

Innovation in Malawi

Gross domestic expenditure on R&D in Africa has been growing, such as Ethiopia from 0.24% (2009) to 0.61% (2013) of GDP, and Uganda to 0.48% (2010), up from 0.33% in 2008. Malawi devotes 1% of its gross domestic product (GDP) to research and development, which is higher than even South Africa.[3] Researchers in R&D increased from 30 per million people to 50 between 2007 and 2010 according to the UNESCO Institute for Statistics. Nevertheless, R&D spending remains low in real terms, and data on this type of innovation measure is not only outdated but hardly available but does signal progress. This data challenge is not unique to Malawi. As noted by UNESCO (2014), there is still a lack of demand for science, technology, and innovation (STI) indicators from policymakers in developing countries. Further, R&D is receiving more funding from new, non-government sources directly to private groups making it harder to account for and track.

A measure that may give a more recent picture is the Global Innovation Index (GII) , which is a comprehensive measure that has five input pillars to capture national economy enablers of innovative activities[4] and two output pillars that capture innovation outputs. [5]Each pillar has sub-pillars, each of which is made up of eight individual indicators, over 20 of which are trade-related (Cornell University and INSEAD and World Intellectual Property Organization, 2018). GII is a number assigned to each country based on the available GII reports (2014 – 2021). Based on this measure, innovation in Malawi fell gradually from a peak of 29.7 indexes in 2015 to 22.9 index in 2021 Figure 2 a. This notwithstanding, Malawi has high scores in five out of the seven GII pillars compared to other low-income countries but only above average in three out of the seven GII pillars when compared with other sub-Saharan African countries (Market sophistication, Business sophistication and Knowledge technology outputs). Malawi's observed innovation performance is above what is expected for its

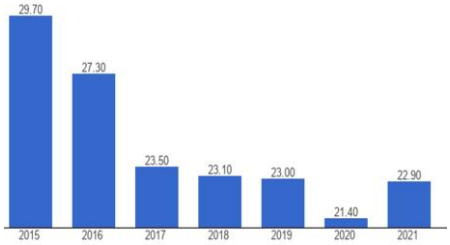
[3] Based on the latest data which is from 2010 as reported in the 2015 UNESCO Science Report: towards 2030.

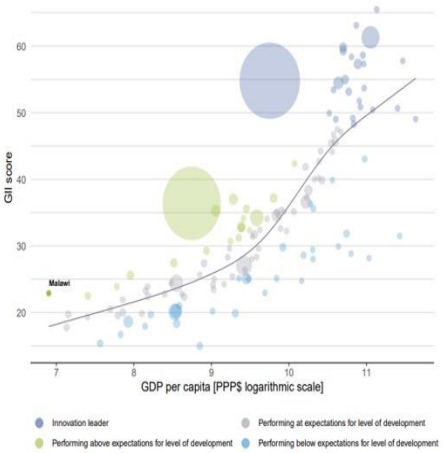
[4] These include (1) Institutions, (2) Human capital and research, (3) Infrastructure, (4) Market sophistication, and (5) Business sophistication.

[5] These are (6) Knowledge and technology outputs and (7) Creative outputs.

income level and Malawi produces more innovation outputs relative to its level of innovation investments Figure 2 b. Notably, the share of high-tech imports in trade is among the strengths in Malawi's innovation assessment, a key variable used in this paper.

Figure 2: Innovation in Malawi





a. GII (0-100)b. Innovation and Development 2021

Author calculations from GII Report.

Trade Policies in Malawi

Malawi has been a member of the COMESA Free Trade Area (FTA) since its inception in October of 2000. As such, tariffs on products from all other 10 member states in the FTA were eliminated (COMESA, 2019). The average tariffs on products from COMESA imported to Malawi are much lower (4.1 percent) than from the rest of the world (13.2 percent) but seem to have increased slightly in recent years (Figure 3, red series). Meanwhile, the share of COMESA products makes up an average of just 8 percent of Malawian import value.[6]

Malawi imports almost all of its ICT products and services. At the firm-level, the World Economic Forum Executive Opinion Survey of 2013 ranked Malawi's firm-level technology absorption at 3.8 out of 7 and company spending on R&D at only 2.3 out of 7.[7] The World Bank Innovation Survey of Malawian firms (2014) shows that only 13 percent of firms received non-financial support from the government for innovation-related activities and only 24 percent purchased

[6] There are, as of writing this article, 10 countries in the COMESA FTA. COMESA mentions 11 countries but lists only 10 by name. These are the ones that joined in 2000, namely Djibouti, Kenya, Madagascar,

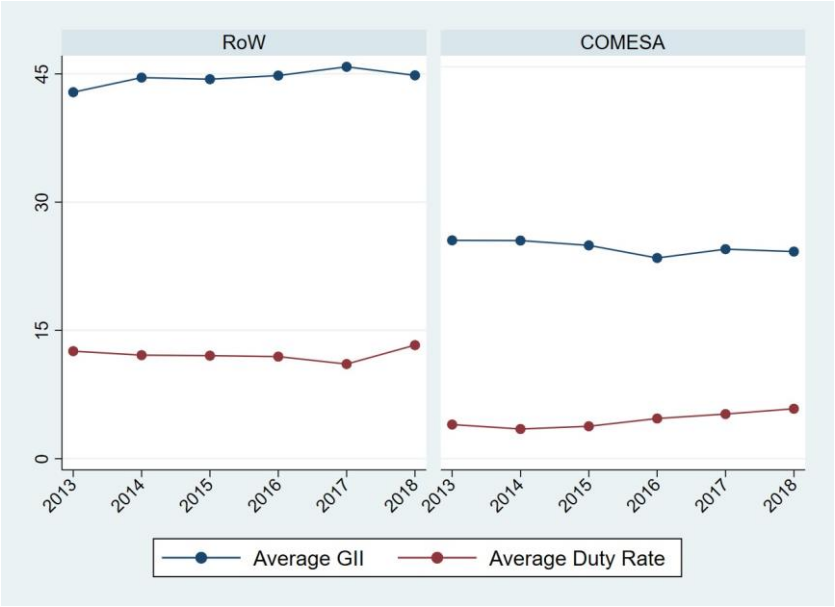
new equipment, machinery, or software for R&D use on innovative products or services and processes. The Malawi Confederation of Chambers of Commerce and Industry (MCCCI) however asserts that the importance of research and its utilization by businesses have been underestimated in Malawi. However, there has not been any patented ICT-based innovation that has been recorded in the country, making the use of patent data as an innovation indicator also challenging.

The Malawi Government put in place several policies that recognize the trade and innovation link, including several tax incentive policies to ease the importation of various capital and intermediate goods. The National Trade Policy recognizes that imported inputs (raw materials and intermediate goods) attract higher tariffs unlike their related finished products (Malawi Government, 2016). Policies to address this include an industrial rebate scheme that exempts companies from paying import duty, value-added tax (VAT), and excise tax on goods used for manufacturing. This was expanded in the 2012/2013 financial year, to include zero import duty, no VAT, and no excise tax on all approved raw materials. These include, among others: car hire and safari companies, hotels, lodges, and inns importing equipment, as long as they are licensed under the Tourism and Hotels Act; waivers to dairy farms on specialized machinery, and equipment; and to the purchase of goods for direct use by the telecommunications' industry, boards responsible for investing in the water supply and electricity generation.[8] More details of Malawi's trade especially with other African countries is further discussed in section 4.

Malawi, Mauritius, Sudan, Zambia, and Zimbabwe; and the two that joined in 2004, namely Burundi and Rwanda.

[7]Source: World Economic Forum (2013) Global Competitiveness Report (2013–2014) [8]This is upon the approval of the Commissioner General of the Malawi Revenue Authority.

Figure 3: GII of Countries Exporting to Malawi and Tariffs on their Products



Source: National Statistical Office of Malawi (NSO) and Cornell University, INSEAD, and WIPO.

Hypotheses and Objectives

The objective of this paper is to assess whether

- Trade liberalization leads to increased imports of technology embodied imports,
- Firms' experiences with the importing process and/or importing regulations affect their level of innovation

Based on the literature and motivation, the hypotheses that we will test therefore are that import liberalization does not (i) lead to increased imports technology embodied imports; (ii) lead firms to innovate.

3 Econometric Methodology

Macro-Level Analysis

The main analysis assesses whether lower import duty increases the imports of technological products in Malawi. The study follows the analytical framework developed by Bøler et al. (2015) and Bas and Berthou (2017) based on the proposition that the intensity of high technology by an importer is a decreasing function of import duty. However, it is important to note that the intensity of technology for the

importer is a function of fixed production costs, fixed costs of high technology and duty on imports among other complementary factors. The general likelihood function of the high technology imports as a function of import duty is expressed as follows:

$$\rho_h = \left(\frac{f_h}{f}\right)^{-\frac{k}{\sigma}-1} \left\{ \left(\frac{c_h}{c_i}\right)^{1-\sigma} - 1 \right\}^{-\frac{k}{1}-\sigma} \quad (1)$$

Where ρ_h represents high technology intensity, f_h represents high technology fixed costs, f is the fixed cost, c_h is the cost of high technology and c_i is the cost of low technology. The relative cost $\frac{c_h}{c_i}$ is an increasing function of import duty, hence $\frac{\partial \frac{c_h}{c_i}}{\partial import\ duty} >$

0 since $0 < \sigma < 1$, and consequently, $\partial \rho_h / \partial import\ duty < 0$.

Assuming that firms are heterogeneous and that the cost of technology adoption is fixed, firms that adopt high technology/increase technology intensity stand to benefit from trade liberalization/input tariff reductions. In this regard, by investing in innovation, the firm can reduce its actual marginal cost (mc) of production below the fixed cost. This is formally defined as follows:

$$mc = \widetilde{mc} - \varepsilon \rho h \quad (2)$$

Where, ρh is the firm's innovation, and $\varepsilon > 0$. We assume that the costs of innovation follow a quadratic function in ρh, such that it equals to $\frac{1}{2} mc \rho h^{\,2}$. The firm with fixed cost $\widetilde{mc}$ maximizes on innovation $\rho h(\widetilde{mc}, \gamma)$ so as to maximize:

$$L\pi(\widetilde{mc} - \varepsilon \rho h, \gamma) - \frac{1}{2} mc \rho h^{\,2} \quad (3)$$

By virtue, $\rho h(\widetilde{mc}, \gamma)$ satisfies the first order condition:

$$\frac{\varepsilon L}{2\beta} = \frac{mc_i \rho h}{\alpha - (\widetilde{mc} - \varepsilon \rho h)\gamma} \quad (4)$$

Equation (4) yields the following equilibrium value for innovation $\rho h^{\,*}$:

$$\rho h^{\,*} = \frac{\alpha - \widetilde{mc}\,\gamma}{\frac{2\beta mc_i}{\varepsilon L} - \varepsilon L} \quad (5)$$

The left and right sides of equation (5) correspond to the equilibrium value of innovation. Empirical evidence suggests that the intensity of innovation is a function of lowering the marginal cost of production, and thus the import tariff. In this regard, the following equation is estimated:

$$Innovation\ Imports_{git} = \beta_0 + \beta_1 Tariff_{git} + \alpha_g + \sigma_i + \gamma_t + \varepsilon_{it}$$

Where, $Innovation\ Imports_{git}$ is the natural log of innovation product value g imports, from country i; $Tariff_{git}$ represents the import duty on product g from country i. α_g, σ_i and γ_t are product, country of origin and time fixed effects respectively and ε_{it} represents the stochastic term. Considering that innovation imports is a function of other factors the market size/GDP of the trading partners and other variables, we are likely to commit omitted variables bias, hence, fixed effects models will remove the bias by measuring changes within groups across time, and including a dummy for the missing or unknown characteristics. The analysis is carried out on two samples based on the origin of the product, that is, COMESA and RoW (non-COMESA) samples.

For our first dependent variable we use the value of the HS-8 product and assess which we define as TPP. these are products within machinery and electrical sector (HS 84-85).[7]. Second, we use the technological intensity of imports based on the Lall (2000) classification, where products are separated into high, medium, and low-tech products as well as others which include primary goods and resource-based goods (more on data in the next section).

Endogeneity and Robustness

There may be concerns about possible endogeneity due to omitted variable bias. It is possible that unobserved characteristics of the firms correlate with the import duty hence affecting TPP or technology-intensity imports. Using product-level and country-level fixed effects eliminates the potential for any time-invariant characteristics of firms to act as confounding factors. It is possible that some omitted time-varying variable biases remain, which time-fixed effects address.

Consequently, another possible source of endogeneity is measurement error. Import duty is measured at the disaggregated product level, as applied tariffs are used per HS-8 product. The dependent variable is measured at the product-origin level. To address this fully, we use the instrumental variable approach. We use the product-country-level instrumental variable following the suggestion by Hummels et al. (2014). We construct an instrument that is correlated with import duty for a product origin but uncorrelated with TPP import value. The instrument variable is calculated through the approach of

[7] These are: HS-84: Nuclear Reactors, Boilers, Machinery and Mechanical Appliances; Parts Thereof. HS85: Electrical Machinery and Equipment and Parts Thereof; Sound Recorders and Reproducers; Television

Image and Sound Recorders and Reproducers, Parts and Accessories of Such Articles

taking the average firm-level import duty. We also include robustness results from various tests. Standard errors are clustered at the product-country level.

Micro-Level Analysis

For the firm-level data, we will use survey methods. Regular statistical software (that is not designed for survey data) analyses data as if the data were collected using simple random sampling. The WBES uses the stratified random sampling methodology for selecting a representative sample. We use survey data analysis software to take into account the differences between the design that was used to collect the data and simple random sampling. This is because the sampling design affects both the calculation of the point estimates and the standard errors of those estimates. We estimate the following cross-section regression:

$$Innovation_i = \beta_1 Shr_{foreign,i} + \beta_2 \text{Trade obstacles}_i + \beta_3 \text{Foreign Technology}_{i\,(3)} + \beta_4 \text{Days to clear customs}_i + \text{Part of a large firm}_i + \text{Size}_i + \text{industry}_i + \epsilon_i$$

Where $Innovation_i$ is or dependent variable which includes is whether a firm i introduced new (i) products, (ii) methods, (iii) logistics, and if they gave employees time to come up with (iv) new ideas. All these are under the innovation module of the survey and constitute different measures of innovation in our empirical analysis. Our key explanatory variables of interest are $Shr_{foreign,i}$ which is the share of material inputs and supplies of foreign origin, *Trade obstacles* which are whether firms faced trade regulations and customs-related obstacles, *Foreign Technology* which is if the firm used foreign-owned technology and *Days to clear customs*, the number of days to clear customs. We also control for whether the firm is part of a larger firm and control for the firm size and the industry of the firm. The summary statistics and correlation matrix of all macro and micro variables are presented in Table A1 and A2 respectively.

4 Data

Macro-Level Data

We use a monthly series of customs-level transaction data for Malawi's imports between 2007 and 2018. This is a micro dataset confidentially sourced from Malawi's National Statistical Office (NSO). The data contains information on the total import value, reported CIF (cost, insurance, and freight), and the number of units of each import transaction at the 8-digit Harmonized System (HS) product classification, the import taxes paid on it as well as the country of origin. Our data although rich has the limitation that it does not have firm identifiers and thus, we can only speak to product-level effects of the policies,

focusing on machinery and electrical products. We however complement this with firm survey data (more details below).

Several methods and indices have been developed and used to measure innovation, including the number of patents, research and development budget share, and direct measure of innovative output (Ghanbari and Ahmadi, 2017).[8] We use three main measures of innovation in this paper.

First, our main innovation indicator in this paper is defined in the more traditional way of technological processes and products (TPP) (Benavente, 2014). We focus on innovation outputs in the form of exports of machinery and electrical products obtained from trade data sample of goods between the HS-2 categories of 84 and 85. These products made up about 16 percent of all Malawian imports and 5.9 percent of imports from COMESA, between the period of January 2007 and December 2018. Admittedly, these may not be the only sectors with embodied technology. Nevertheless, it allows us to dwell in the products and technology we can measure from the imports data. We also use imports of intermediate products as a dependent variable to supplement this TPP measure.

Second, we use the technology intensity of imports to proxy technological transfer. Foreign technology imports have been found to improve innovation capacity (Dai & Chen, 2016). We assign the technological intensity of imported products using the Lall classification (Lall, 2000) which provides six categories: primary products, resource-based manufactures (agro-based and others), low technology manufactures (textile, garment, and footwear, and others), medium technology manufactures and high technology manufactures. Among the three levels of technology intensity, low-technology products have the least beneficial learning and spillover effects. In this paper, we classify technology intensity as high, medium, low, and others, whereas others refer to primary products resource-based and other unclassified products).

The findings of Spulber (2008) and Cavallaro and Mulino (2009) strengthen our use of

TPP as one of the dependent variables and measures of innovation whilst the models of Navas (2015) and Batabyal and Nijkamp (2014) demonstrate the importance of the trade liberalization variable in assessing innovation. Our analysis further contributes using an empirical case of a small, open developing country such as Malawi and further drawing implications on integration efforts in Africa by looking at COMESA.

[8] Ghanbari and Ahmadi (2017) detail the different measurements in Tables A and Table B of their paper.

Firm-Level Data

We use longitudinal firm-level survey data for firms in Malawi for the years 2009 and 2014 World Bank Enterprise Surveys (WBES), the latest available. The WBES reports on individual firm characteristics, including imported inputs, how long it took to get an import license and if the firm received any waivers from the government in terms of taxes or non-financial support. Other firm characteristics are also reported such as sales and supplies, competition, finance, firm size, location, and performance among other indicators. In total, we have 150 firms in 2009 and 523 firms in 2014 interviewed. However, not all firms answered clearly on whether they imported directly, and we only keep firms who said yes or no to the key questions for the empirical analysis. We keep this procedure of deleting observations where the variable of interest is missing in the survey to get a complete dataset with an accurate and consistent estimation and differences between firms and are left with a total of 166 firms in the sample (48 firms for 2009, and 118 firms for 2014).

We make use of the innovation module of the enterprise survey for Malawi and track the same firms' responses in terms of their importing activities. The module asks firms if they have innovated by having new or significantly improved products or services, logistics, delivery, and distribution, supporting activities, organizational structure, and marketing methods. The module also asks if the firm spent on research and development.

Overview of data trends

Trade by TPP and tech-intensity

A large share of Malawian imports in value consist of mainly chemicals and allied industries (24 percent) and machinery and electrical products (16.3 percent). Over the period of our data, although the former has a larger share, in terms of the number of imported

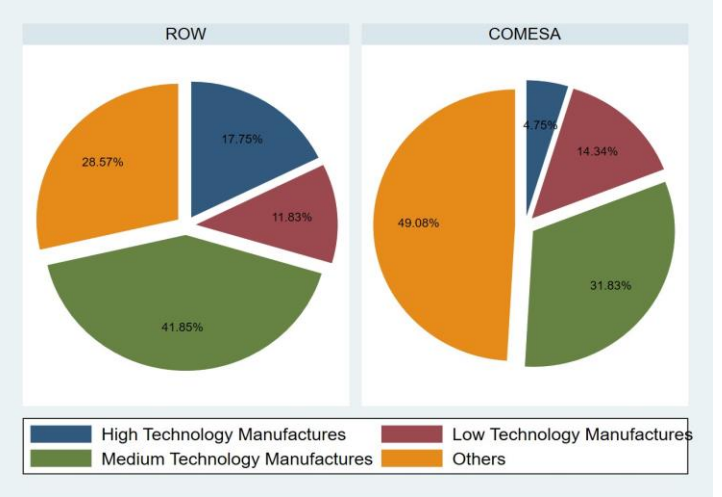
HS-8 products, machinery, and electrical products make up the largest share (27.1 percent). This suggests that some of the electrical and machinery products are lower-value imports.

Machinery and electrical products from COMESA countries in the sample made up a smaller share of these imports. For instance, between 2007 and 2016, about 60 percent of these products were sourced from just three emerging economies: South Africa, China and

India. This may indicate the need for wider liberalization across the products. Mauritius, Zimbabwe, Kenya, and Zambia are the countries from which most of the products were imported within COMESA, but these countries constitute a smaller share of the sources of these products for Malawi.

Nearly half of all imports from COMESA are made up of primary products and resource-based products with less than five percent being high-tech imports in the 2007-2018 period. On the other hand, over 40 percent of imports from ROW are of medium-technology intensity and about 18 percent high-tech (Figure 4).

Figure 4: Share of Imports by Technology-Intensity



Source: World Bank Enterprise Survey 2014

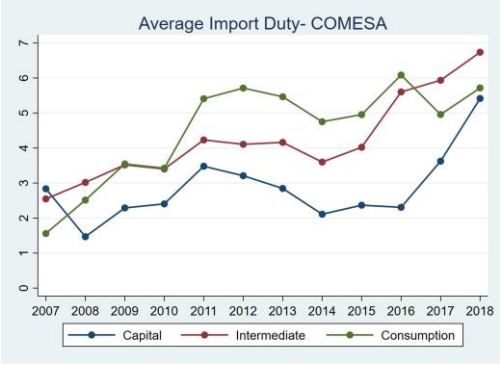
Tariffs

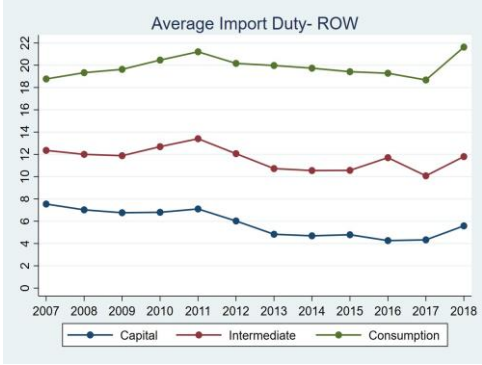
Although import duty rates are lowest for capital goods imports, rates are relatively high for intermediate goods and increasing for all product types in recent years (Figure 5). Duty rates on COMESA imports, based on actual payments at importation at the border, have been increasing, with intermediate products having higher rates than consumption goods from 2016 and rates for capital goods being almost equal to those on consumption goods by 2018 (Figure 5 a). In terms of magnitude, COMESA rates are lower than rates on imports from ROW, except for capital goods. This may be because COMESA member states are more alike in structure to Malawi and may not export capital-heavy products compared to other more developed countries. Nevertheless, even these rates seem to have slightly increased as of the latest year in our data (Figure 5 b).

Among sectors, machinery and electrical products face relatively lower tariffs compared to other products, averaging just 8.3 percent for machinery and electrical products from RoW over the period and just 3.6 percent for COMESA-originating imports. This compares favourably with higher rates for sectors such as food and textiles both an overage above 20 percent for RoW and 4.3 and 6.4 percent respectively for COMESA (Figure A2). For both

COMESA and RoW products into Malawi, import duties are lowest on high-tech goods. For COMESA countries, import duty averaged 2.5 percent, 3.6 percent, and 5.2 percent for high tech, medium tech, and low tech respectively, while for RoW countries, import duty averaged 7.2 percent, 10.1 percent, and 18.1 percent for the high tech, medium tech, and low tech respectively (Figure 6).

Figure 5: Import Duty by Type of Product

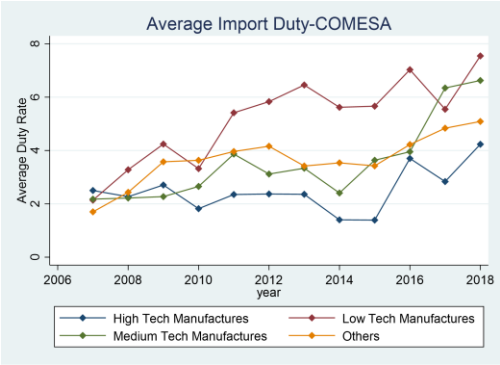


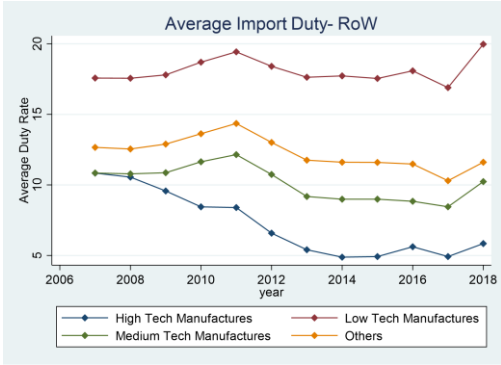


a. COMESA b. ROW

Author calculations from NSO data

Figure 6: Import Duty by Technology Intensity of Product





a. COMESA b. ROW

Author calculations from NSO data

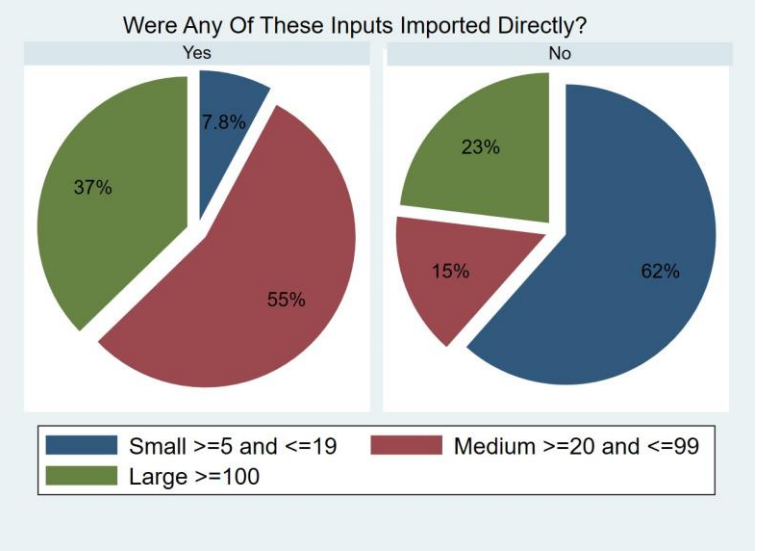
Firm Responses

Only 17 percent of firms were reported to have spent on R&D in the previous three years.

However, among firms that imported inputs directly, nearly 80 percent of them reported having had a new or significant product introduced (Figure 8).

In terms of imports at the firm level, among firms that imported inputs directly, the majority are medium-sized firms (based on the number of employees) followed by large firms (Figure 7). On the other hand, the majority that did not import inputs directly are mainly small firms (62 percent). This demonstrates that smaller firms are thus less likely to innovate, and we control for this in the empirical analysis.

Figure 7: Firms who Imported Foreign Inputs Directly, By Firm Size (2014)



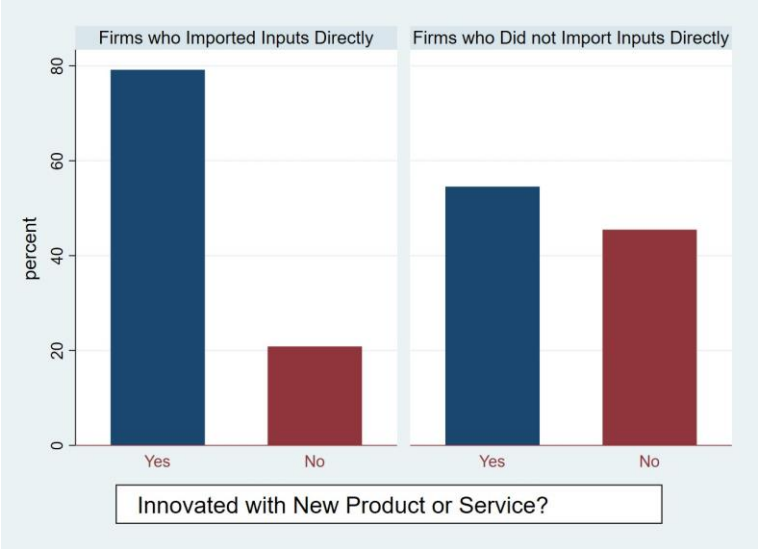
Source: World Bank Enterprise Survey 2014

5 Empirical Results

Macro-level Evidence from Customs Data

TPP Products

Table 1 displays the results from equation 2 with TPP defined as machinery and electrical products. Lower tariffs positively affect the value of TPP imports from both within and outside COMESA, with a larger impact on extra-COMESA imports. A 1 percent decrease in import duty would lead to a 7 percent and 4 percent higher TPP imports of machinery Figure 8: Firms who Introduced a New or Significantly Improved Product (2014)



Source: World Bank Enterprise Survey 2014

and electrical products. This effect is nearly double when the TPP products that are also capital goods, more so than intermediate products.

While lower tariffs would also positively affect imports of non-TPP products, the effect is higher for TPP compared to other products (Table A2), with the difference being larger for imports from outside COMESA and only slightly higher for imports from COMESA. This means that tariff liberalizations would benefit imports of TPP much more than other sectors, especially for products originating from outside COMESA.

Technological Intensity

When assessing the technological intensity of imports from COMESA, we find that there would again be a positive impact of tariff liberalization on imports of all levels of technological intensity (Table 2). The magnitude of the impact is lowest on high-tech imports and highest on medium and low-tech imports. Most notably, imports of primary and resource-based products would increase more than high-tech products following a decrease in tariffs.

A similar result is seen in imports from outside COMESA (Table 3). While a decrease in tariffs by 1 percent would increase imports of the high, medium, and low tech by 6 percent Table 1: Effects of Tariffs on TPP Products (HS84 and HS85) within and Outside COMESA

TPP as defined by Machinery and Electrical Products (HS 84-85)						
	All		Intermediate		Capital	
	RoW	COMESA	RoW	COMESA	RoW	COMESA
Import duty	-0.07***	-0.04***	-0.02***	0.01***	-0.13***	-0.08***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	9.37***	8.89***	1.71***	0.67***	3.89***	1.42***
	(0.05)	(0.22)	(0.03)	(0.12)	(0.04)	(0.15)
Observations	767,468	36,850	767,468	36,850	767,468	36,850
Number of *g*	102,167	9,706	102,167	9,706	102,167	9,706
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	No	No	No	No

Note: Robust standard errors are in parentheses and standard errors are clustered at the product level. Asterisk(s) denote(s) the significance level: *** for 1%, ** for 5%, and * for 10%.

Source: Authors' estimation.

each, imports of primary and resource-based products would increase by slightly more (8

percent).

These results may signal low absorption of foreign technologies in Malawi, which is critical to ensuring competitiveness and economic growth gains (Cavallaro & Mulino,

2009). Factors such as human resources, infrastructure, and technological ability (Chen & Wang, 2022) could enhance this.

Table 2: Effects of Tariffs on Products by tech-intensity within COMESA

	High Tech Imports	Medium Tech Imports	low Tech Imports	Others
Import duty	-0.06***	-0.10***	-0.10***	-0.09***
	(0.01)	(0.01)	(0.01)	(0.01)
Constant	12.54***	12.77***	11.63***	12.14***

	(0.54)	(0.53)	(0.24)	(0.33)
Observations	2,986	8,894	11,743	3,809
Number of *g*	1,013	2,877	3,276	886
Time FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes

Note: Robust standard errors are in parentheses and standard errors are clustered at the product level. Asterisk(s) denote(s) the significance level: *** for 1%, ** for 5%, and * for 10%.

Source: Authors' estimation.

Table 3: Effects of Tariffs on Products by tech-intensity Outside COMESA

	High Tech Imports	Medium Tech Imports	low Tech Imports	Others
Import duty	-0.06***	-0.06***	-0.06***	-0.08***
	(0.00)	(0.00)	(0.00)	(0.00)
Constant	11.94***	12.93***	12.45***	12.32***
	(0.05)	(0.04)	(0.11)	(0.07)
Observations	93,662	229,531	236,242	74,994
Number of *g*	14,493	32,829	30,296	8,663
Time FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes

Note: Robust standard errors are in parentheses and standard errors are clustered at the product level. Asterisk(s) denote(s) the significance level: *** for 1%, ** for 5%, and * for 10%.

Source: Authors' estimation.

Robustness

While multiple fixed effects accounted for other product and country characteristics, we run the main equation including other variables based on the standard gravity model. We this is done the results are consistent and we find that higher GDP in Malawi increases the import of TPP (Table 4) in both COMESA and RoW, the coefficients are slightly higher.

Table 4: Effects of Tariffs on TPP Products and Hight-tech Products

	TPP		High-tech	
	ROW	COMESA	ROW	COMESA
DUTY RATE	-0.10***	-0.05***	-0.07***	-0.11***
	(0.00)	(0.01)	(0.00)	(0.01)
GDP partner	0.01	0.03	0.05	-0.11***
	(0.01)	(0.02)	(0.08)	(0.02)
GDP Malawi	0.29	0.53***	0.87***	0.75***
	(0.21)	(0.09)	(0.10)	(0.13)
Distance	0.01	0.16	-0.06	-0.01
	(0.03)	(0.13)	(0.12)	(0.05)
Observations	264,538	11,647	34,279	1,050
Number of ID N	54,268	4,134	8,292	460
Time FE	Yes	Yes	Yes	Yes
Country FE	Yes	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes

Note: Robust standard errors are in parentheses and standard errors are clustered at the product level. Asterisk(s) denote(s) the significance level: *** for 1%, ** for 5%, and * for 10%.

Source: Authors' estimation.

Micro Evidence from Firm-Level Data

Using the firm surveys, we assess the impact on innovation from various aspects made possible through liberalization. First, firms with a higher percentage of material inputs of foreign origin, tend to be less likely to have method innovations (Table 5, column 3). A ten-percentage point increase in the share of foreign material reduces the likelihood of innovating a product (method) by 1.1%.

We also discovered that obstacles from customs and trade regulations reduced the likelihood of firms innovating products, logistics, new

manufacturing methods, and giving employees time to come up with new ideas by 11%, 16.9%, 8.8%, and 16.3%, respectively.

Using foreign-owned technology, on the other hand, increased the likelihood of firms innovating products, logistics, new manufacturing methods, and giving employees time to come up with new ideas by 10.6%, 14.9%, 15%, and 0.9%, respectively.

The average number of days for imported goods to clear customs reduced the likelihood of all the measures of innovation. The higher the delays in clearing customs the less likely to innovate in products, logistics, new manufacturing methods, and new ideas by 0.3%, 0.1%, 0.3%, and 0.3% respectively.

Finally, firms being part of the large firm increased their likelihood of innovating products and new methods by 2.1% and 6.1% respectively, while reducing the likelihood of the firms to innovate in logistics and new ideas by 12.7% and 4.2% respectively.

Table 5: Effect of imports and trade policy on Innovation

	Marginal Effect Results of Logit Model			
	Product Inn	**Logistic Inn**	**Method Inn**	**New Inn**
Obstacle from Customs and Trade Regulations (1=Yes)	-0.110***	-0.169***	-0.0879***	-0.163***
	(0.000192)	(0.000226)	(0.000174)	(0.000159)
Use Technology Licensed from A Foreign-Owned Company (1=Yes)	0.106***	0.149***	0.150***	0.00931***
	(0.000172)	(0.000236)	(0.000151)	(0.000165)
Avg. num. of Days for Imported Goods to Clear Customs	-0.0026***	-0.00141***	-0.00313***	-0.0027***
	(2.84e-06)	(5.15e-06)	(3.52e-06)	(2.88e-06)
Part of a Large Firm (1=Yes	0.0214***	-0.127***	0.0612***	-0.0423***
	(0.000155)	(0.000197)	(0.000147)	(0.000150)
Observations	67	45	71	66
PseuR2	0.0329	0.0891	0.0997	0.0659

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Note: All dependent variables refer to new or significantly improved product/manufacturing method/logistics including delivery in the last three

years. For column (4), refers to whether employees were given time to develop a new idea. The model controls for the time and industry fixed effects as well as whether the firm is foreign-owned.

Material inputs and foreign technology may be directly linked to imports and by extension, foreign direct investment. On the other hand, trade regulations and border delays are more directly linked to trade policy and trade facilitation. In all cases, these results demonstrate the key role that trade plays in the firm's innovative processes.

6 Conclusion

This paper uses a unique data set of disaggregated Malawian imports and firm-level data to study the role of Malawi's trade policies on innovation from both macro and micro perspectives. At the macro-level, we assess whether tariff liberalization leads to increased imports of technology embodied imports. Innovation is defined using two measures: technological processes and products (TPP) which is proxied by machinery and electrical products and the technological intensity of imports. Trade policies further zero in on COMESA of which Malawi is a member. At the firm level, we assess whether firms that use foreign inputs and import their inputs directly are more likely to innovate and whether those that face obstacles to importing are less likely to innovate. Innovation is defined using four measures: products, methods, logistics, and new ideas.

We find three main results from our analysis. First, lower tariffs positively affect the value of TPP imports, with a larger impact on extra-COMESA imports. Second, while lower tariffs would also positively affect imports of non-TPP products, the effect is higher for TPP compared to other products, with the difference being larger for imports from outside COMESA. Third, there would also be a positive impact of tariff liberalization on imports of all levels of technological intensity, but the magnitude of the impact is lowest on high-tech imports. Finally, using the firm-level surveys, we find the mechanism through which trade policy and higher imports impact innovation at the firm level. Firms with a higher percentage of material inputs of foreign origin and firms that use foreign-owned technology are more likely to innovate. On the other hand, firms that reported facing obstacles from customs and trade regulations and firms that face higher delays in clearing customs are less likely to innovate products.

These results suggest that tariff liberalizations would benefit imports of TPP much more than other sectors, especially for products originating from outside COMESA, as import duty on COMESA-originating goods is already low. Thus, limited role for further trade liberalization in the context of the REC, with

regards to innovation gains. However, the results on the technological intensity of imports may signal low absorption of foreign technologies in Malawi, which is critical to ensuring gains of technological spillovers in trade. Factors such as human resources, infrastructure, and technological ability are key to better absorption. Otherwise, the process of innovation may not persist, and new habits and practices may not remain in use. These findings are in line with identified challenges for Malawi's innovation in the 2021 Global Innovation Index which comprise weaknesses in the secondary and tertiary education system (human resource), ICT infrastructure including access, and patents.

The findings of this paper demonstrate that trade liberalization (i) improves trade flows that are innovative and by extension, productivity-enhancing compared to other products from a macro level, and (ii) has the potential to enhance innovation at the firm level. Crucially, regulations on importing beyond tariffs can play a crucial role in firms' innovation. These findings are important in informing trade and industrial policies to be better targeted to productivity-enhancing activities. Specifically, further liberalization of TPP imports, including from non-COMESA countries would most likely benefit higher innovation processes for Malawi. Further, liberalization of intermediate goods could have firms better integrate into GVCs. Finally, other trade measures such as trade facilitation and border procedures create a barrier for firms, which then leads to a negative impact on innovation through trade and trade-related activities.

Further analysis of these and their specifics could further inform policy. A natural extension for further research is the effect of import liberalization on exports. A natural extension for further research is the effect of import liberalization on exports.

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Appendix

Table A1: Summary Statistics for Macro Variables and Firm Level Variables

Summary Statistics for Macro Variables					
Variable	**Obs**	**Mean**	**Std. dev.**	**Min**	**Max**
TPP All	804,814	1815020700	2.60e+09	0	5.57e+09
TPP Intermediate	92,947	4005310700	3.92e+09	6	5.57e+09
TPP Capital	104,450	9611180700	6.04e+09	14	5.54e+09
High Tech Imports	96,648	1.24e+07	2.13e+08	14	2.40e+10
Medium Tech Imports	238,425	1.23e+07	1.22e+08	2	3.41e+10
Low Tech Imports	247,985	3478100700	4.74e+07	1	1.01e+10
Other Tech Imports	78,803	6295160700	5.45e+07	1	7.21e+09
Duty Rate	804,318	12.365	12.110	0	200
COMESA(COMESA=1)	804,318	0.0458	.2090843	0	1
GDP Partner	373,040	17.96	2.277	10.39	23.78
GDP Malawi	424,422	15.56	0.209	15.13	15.85

Summary Statistics for Firm Level Variables					
Variable	**Obs**	**Mean**	**Std. dev.**	**Min**	**Max**
Product Innovation(1=Yes)	117	0.62	0.49	0	1
Method Innovation (1=Yes)	72	0.60	0.49	0	1
Logistics Innovation (1=Yes)	116	0.27	0.44	0	1

New Innovation (1=Yes)	116	0.69	0.46	0	1
Foreign Origin (%)	166	1.75	9.64	0	100
Obstacle from Customs and Trade Regulations (1=Yes)	163	0.76	0.43	0	1
Use Technology Licensed from A Foreign-Owned Company (1=Yes)	166	0.30	0.46	0	1
Avg. num. of Days for Imported Goods to Clear Customs	115	16.83	23.48	0	150
Part of a Large Firm(1=Yes)	166	0.39	0.49	0	1

Source: Author Calculation from NSO and WBES

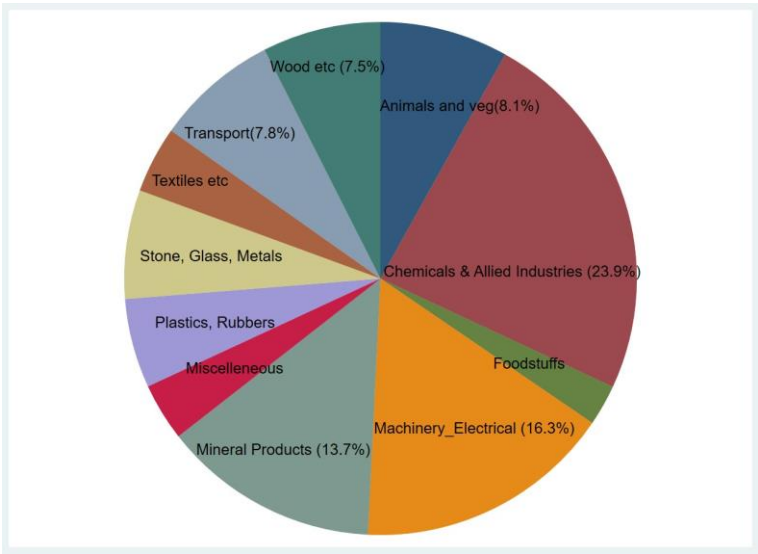
Table A2: Correlation Matrix for Macro Variables and Micro Variables

	Macro Variables							
	TPP All	TPP Inter	TPP Cap	High Tech	Med Tech	Low Tech	Other Tech	Duty Rate
TPP All	1.000							
TPP Inter	0.548	1.000						
TPP Cap	0.636	-0.134	1.000					
High Tech	0.294	0.160	0.210	1.000				
Med Tech	0.348	0.188	0.193	-0.228	1.000			
Low Tech	-0.383	-0.230	-0.246	-0.235	-0.409	1.000		
Other Tech	0.160	0.103	0.157	-0.117	-0.204	-0.210	1.000	
Duty Rate	-0.254	-0.101	-0.263	-0.185	-0.167	0.245	-0.100	1.000

Firm Level Variables									
	Log	Meth	New	FO	OBS	FT	Days	PLF	
Log	1.00								
Meth	-0.22	1.00							
New	-0.17	0.18	1.00						
FO	0.31	-0.08	0.17	1.00					
OBS	-0.27	0.05	-0.01	-0.35	1.00				
FT	0.15	0.20	0.13	0.24	-0.23	1.00			
Days	0.02	-0.21	0.06	0.16	-0.13	-0.17	1.00		
PLF	-0.10	0.13	-0.03	0.13	0.27	0.01	0.13	1.00	

Note: Log=Logistic Innovation, Meth=Method Innovation, New=New Innovation, FO=Foreign Origin, OBS=Obstacle from Customs and regulation, FT=technology license from foreign, Days= days for imported goods to clear customs, and PLF= part of a large firm.

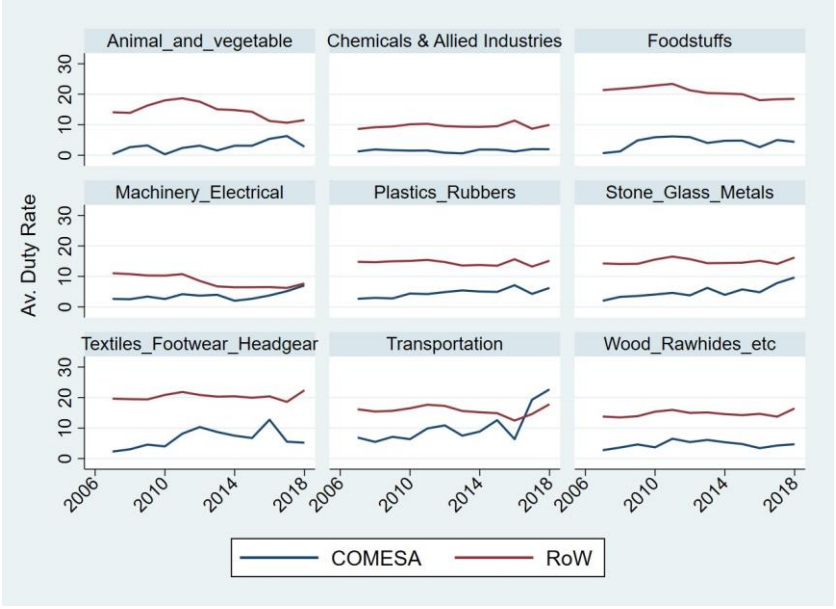
Figure A1: Share of Import Value (in MWK) by Sector (2007-2018)



Source: National Statistical Office of Malawi (NSO).

Source: Author calculations

Figure A2: Average Duty Rate by HS-2 Sector (2007-2018)



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