

**The Determinants of Trade Integration:
An Assessment of the East African Community**

by

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*For my parents,
Nancy and Alexander Kaminchia,
for reaching me this far*

ABSTRACT

The East African Community (EAC) aims to integrate member countries through enhanced regional trade, economic policy harmonisation and coordinated investment in infrastructure. This thesis assesses the effectiveness of EAC trade policies in integrating member countries by way of lowering total bilateral trade costs. The thesis estimates and analyses total bilateral trade costs for 16 manufacturing industries over the period 1990-2012. The estimates are derived from data on production and bilateral trade flows for a sample comprising 5 EAC countries and 87 of their trade partners. The thesis then analyses the effect of two key EAC policies aimed at lowering international trade costs - the removal of intra-EAC import tariffs and the upgrading of transit roads. Chapter 2 presents the estimated total bilateral trade costs and shows the importance of natural and policy-related factors in determining the total bilateral trade costs. Chapter 3 shows that total bilateral trade costs for intra-EAC trade declined by 30 per cent after the EAC customs union protocol was implemented, and that associated non-tariff policy measures explain more of the decline in the trade costs than does the removal of import tariffs. Chapter 4 shows that the upgrading of the transit roads in the region over the period 2004-2010 lowered total bilateral trade costs by 21 per cent. This negative association is found to be stronger for industries for which trade barriers other than import tariffs are particularly important. The findings imply that upgrading the remaining Corridor roads may lower total bilateral trade costs by a further 24 per cent. This confirms that poor roads are an exigent obstacle to trade in the EAC. Overall, the thesis concludes that the observed decline in total bilateral trade costs for the EAC manufacturing sector over the study period is mainly reflective of policy actions to remove non-tariff barriers to trade and upgrade transit roads.

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1. Introduction

There is little information in the empirical literature on trade in Africa about the size and distribution of external trade costs among manufacturing industries. Yet this information is essential for the analysis of trade policy effects at the micro-level. The present thesis fills this information gap in the empirical literature with focus on East African countries. The thesis concentrates on the manufacturing sector, which contributes only 10 per cent to the GDP of the countries of the East African Community (EAC). Analysis of the trade costs facing this sector is relevant because the EAC aims to expand trade in industrial goods with a view to “achieve the structural transformation of the economy” and “foster the overall socio-economic development” of the Community ([East African Community, 2002](#), p. 55).

This thesis comprises three empirical studies, which present estimates of total bilateral trade costs facing 16 manufacturing industries and analyses of the efficacy of two key policies of the EAC aimed at integrating member states. These are the elimination of import tariffs and the upgrading of transit roads. The policies are evaluated against the estimates of total bilateral trade costs, which is a measure of trade integration between two countries. The studies are restricted to the period 1990-2012 owing to data availability.

1.1 Relevance of the thesis

The East African Community (EAC) was revived in 1999, 22 years after collapsing over perceived inequitable distribution of benefits from co-operation among member countries. There is little evidence in the literature on the extent to which EAC trade policy measures have integrated member countries. Among these policy measures are the removal of import tariffs, improvement in customs procedures and the upgrading of transportation and communication networks. The policy to remove intra-EAC import tariffs is embodied in the EAC customs union, which is the first integration pillar of the Community that was implemented beginning 2005. The upgrading of transportation and communication networks is identified as an important operational principle in the EAC Treaty. Here, strategic priority is given to the

upgrading of transit roads - the Northern and Central Corridors - which enable trade within the region. For these reasons, this thesis focuses on the elimination of intra-EAC import tariffs and the upgrading of transit roads.

A measure that summarises integration between a pair of countries is used to evaluate the effectiveness of these two policy measures in lowering the cost of engaging in cross-border trade. The measure, called total bilateral trade costs, captures all the costs of trading goods across national borders relative to the cost of trading the goods within the borders. This thesis estimates total bilateral trade costs for 16 industries in the manufacturing sector of the EAC over the period 1990-2012. The results presented demonstrate the relative importance among the two policy initiatives of interest in integrating the EAC within itself and with the rest of the world. In doing so, the thesis makes an empirical contribution to the literature that studies the determinants of bilateral trade flows.

1.2 About the East African Community

By the early years of the 20th century, much of the eastern part of Africa had fallen under British rule following an invasion by European countries. Britain adopted a common approach when it came to the administration of its territories in East Africa. Kenya, Uganda and Tanganyika had been organised into a common market that shared a tax system (featuring a common customs tariff), a currency, and a number of services including air and rail transport, post and telecommunication, statistical, meteorological, education and research (Hazlewood, 1979; Gladden, 1963). The objective behind this set up was to lower the cost of and improve the efficiency of providing these services (Gladden, 1963).

The East African Common Services Authority took over administration of the services from the East African High Commission in 1961 around the time the three colonies attained independence. Tanganyika attained independence in 1961, Uganda in 1962, Kenya in 1963 and Zanzibar in 1963. Tanganyika and Zanzibar joined to become the United Republic of Tanzania in 1964. The three countries signed the Treaty for East African Co-operation in 1967 which established the East African Community (EAC), a regional intergovernmental organization whose institutions took over the administration of the common market. The common services were assigned to regional corporations and the same decentralised. The provisions of the 1967 Treaty, as far as the common market was concerned, were aimed at promoting industrial expansion and intra-regional trade while ensuring equal investment opportunities and distribution of realised gains from co-operation (Green, 1967; Eken, 1979). Notwithstanding its provisions, the 1967 Treaty was dissolved in 1977.

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Many reasons are given in the literature for the disintegration of the Community but the root of the problem may have been that the newly independent states inherited a colonial structure that favoured Kenya economically (Nye Jr., 1963). The colonial power had concentrated much of the administration of joint services in Kenya and most industries were located in Nairobi. This gave Kenya an overbearing advantage over the other two partners. Eken (1979) points out that the relatively stronger industrial base in Kenya yielded benefits to the country in terms of higher domestic and foreign investment, larger exports to the region, higher fiscal revenues accruing from higher incomes, and a more stable external position.

Tanzania and Uganda found it hard to compete with Kenya for industries and were in deficit most of the time, which contributed to the financial strains of the regional corporations under their control (Eken, 1979; Hazlewood, 1979; Mugomba, 1978). The three EAC countries were not growing uniformly, and the institutions established under the 1967 Treaty did not satisfactorily redistribute shared resources among members. This produced a resource inequality in the region. Nye Jr. (1963) also points out that uncoordinated foreign policies undermined the common external tariff in as far as access to the common market could be gotten through bilateral agreement with one of the partners.

Kenya, Tanzania and Uganda came together again in 1999 to revive the EAC. The Treaty for the Establishment of the East African Community was signed in November 1999 and became effective in July 2000. This time, the desires include the achievement of “balanced and harmonious” economic growth and development (East African Community, 2002, p. 13). Unity and co-operation among members are expected to enhance regional economic performance primarily through increased cross-border trade and investment, increased industrial value addition and improved competitiveness.

More significantly though, greater progress with regional integration has been made. The EAC customs union was established in 2005, which provides for the removal of internal import tariffs and non-tariff equivalents (mainly charges, levies and permits), establishment of centralised clearing of traded goods at any EAC border regardless of which partner the goods are destined, lower administration fees, and reduced and simplified trade documentation requirements (East African Community, 2004, 2013). After adoption of a common external tariff, import tariffs with respect to non-EAC trade partners remained unchanged for Burundi, declined by an average of 3 percentage points for Kenya, Rwanda and Tanzania, and rose on average by 6 percentage points for Uganda. The Common Market became operational in 2010, enabling the free movement of goods, persons, labour, services and capital (East African Community, 2009). An additional measure aimed at lowering intra-regional trade costs is the upgrading of the region’s transportation and communication networks. This includes the construction of roads, bridges and railways to link the EAC countries, and installation of regional broadband

infrastructure. Negotiations for a Monetary Union began in 2011. The Community has also expanded after Rwanda and Burundi joined in 2007 and South Sudan in 2016.

1.3 Contribution to the literature on trade integration

Regional trade agreements (RTAs) are expected to promote trade and economic growth among members. The theoretical literature on trade posits that gains from trade integration arise in a number of ways. First, the trade agreements remove national trade policy barriers such as import tariffs which impose negative terms-of-trade effects (lower volume of trade) on trade partners. The policy-induced trade barriers also reduce economic welfare in the importing country through reduced domestic production efficiencies and restricted consumer choice ([Grossman, 1991](#); [Bagwell and Staiger, 1999](#)). RTAs also permit trade-creation wherein domestic producers source supplies from more efficient foreign producers ([Freund and Ornelas, 2009](#); [Panagariya, 2000](#)). This allows for resources to be allocated more productively resulting in positive welfare effects through lower prices for domestic consumers.

For the case of Africa, RTAs are viewed to be useful in mitigating the adverse effects of fragmentation by creating larger regional markets that have stronger bargaining power in international markets ([Brenton and Isik, 2012](#); [Greenaway and Milner, 1990](#)). RTAs also inspire national government commitment to domestic institutional reforms aimed at delivering better governance and resource management, and also motivate the upgrading of national energy, water, transportation and communication infrastructure ([African Development Bank, 2018](#); [United Nations Economic Commission for Africa, African Union and African Development Bank, 2017](#)). Improved physical infrastructure is widely expected to substantially lower the cost of regional and international trade, and to induce inflows of foreign investment capital. Through political co-operation, RTAs would also promote peace, security and regional stability ([United Nations Economic Commission for Africa, African Union and African Development Bank, 2017](#); [Mayer and Thoenig, 2016](#)).

There is little “robust” empirical evidence on the effects of RTAs on economic growth and income equality ([Goldberg and Pavcnik, 2016](#), p. 193). Trade agreements may promote income equality by encouraging faster growth in lower income members, but this outcome has been found to be less likely in Africa where customs unions are formed among countries characterised by stark differences in skilled labour endowments, which lead to trade-diversion in the less endowed union member ([Venables, 2003](#)). Another potential source of growth from RTAs is technological spillovers but there is little evidence of this for trade among developing countries ([Vamvakidis, 1998](#)).

The empirical literature is also not conclusive about whether or not trade agreements actually promote trade. There is some evidence that trade agreements do increase trade among members (Baier and Bergstrand, 2007, 2009), and particularly among members of the East African Community (EAC) (Mayer and Thoenig, 2016; Buigut, 2012). The literature also presents evidence that attributes the growth in world trade to removal of cross-border trade barriers (Baier and Bergstrand, 2001; Gaurav and Mathur, 2016; Jacks et al., 2010, 2011; Pomfret and Sourdin, 2009; Buono and Lalanne, 2012; Debaere and Mostashari, 2010) as well as efficiency gains through improved terms of trade (Anderson and Yotov, 2011). For the case of developing countries, the success of RTAs in promoting trade among members is shown to have been limited by the prevalence of restrictive regulations at customs borders and selective removal of import tariffs (Brenton and Isik, 2012; Greenaway and Milner, 1990).

This thesis contributes to the literature on trade integration empirical evidence on the effect of the EAC trade agreement on regional trade in manufactured goods at the intensive margin. The thesis shows that the trade agreement significantly lowered cross-border trade costs facing the manufacturing sector. This evidence supports the findings in the literature that EAC membership did promote regional trade. The thesis further shows the relative importance of the various trade barriers inhibiting trade in manufactured goods. Overall, the thesis shows that poor roads and non-tariff trade barriers contribute significantly to cross-border trade costs facing the manufacturing sector.

1.4 Organisation of the thesis

Chapter 2 of this thesis presents estimates of total bilateral trade costs for EAC countries with respect to each other and 87 of their trade partners in 16 manufacturing industries over the period 1990-2012. Chapter 3 estimates the extent to which the EAC customs union lowered intra-EAC total bilateral trade costs of manufacturing industries and the contribution of the removal of import tariffs. Chapter 4 analyses the effect of the upgrading of transit roads on the total bilateral trade costs. Focus is on road works done on the two main transit routes over the period 2004-2010. The routes are the Northern Corridor and the Central Corridor, which link the capital cities of Burundi, Kenya, Rwanda, Tanzania and Uganda to the seaports of Mombasa in Kenya and Dar es Salaam in Tanzania. In chapter 5, the findings from chapters 2, 3 and 4 are reviewed and their implications for economic policy are discussed.

2. Estimating Total Bilateral Trade Costs

2.1 Introduction

Trade policies have been implemented by the governments of the East African Community (EAC) to lower the cost of cross-border trade among member countries. Among these policy measures is elimination of import tariffs, reforms to customs procedures and infrastructure upgrading. The extent to which these policies have lowered the total cost of engaging in cross-border trade for manufacturing industries in the region remains to be determined. To make this determination, industry-level total bilateral trade costs estimates for the EAC are required but these are lacking in the empirical literature.

The purpose of this paper is to estimate the size of total bilateral trade costs of EAC countries for 16 industries in the manufacturing sector. The paper focuses on the industry-level because working with disaggregated data paints a more accurate picture of trade costs. The paper answers the question: How large are the total bilateral trade costs facing manufacturing industries in the EAC? Credible estimates of total bilateral trade costs would have the expected relationship with known proxies of trade costs as established in the gravity literature.

Practical methods to derive comprehensive measures of cross-border trade costs have been developed based on the gravity equation (Jacks et al., 2010, 2011; Chen and Novy, 2011; Novy, 2013). Practical in the sense that not all trade costs can be observed so as to be captured in data, and not all trade costs are the same for every cross-border transaction so that collating and aggregating data on individual transactions would be required (Jacks et al., 2011). One such method is the inverse-gravity framework presented in Chen and Novy (2011). The framework adopts a broad definition of trade costs, which is, all the “costs incurred in getting a good to a final user other than the marginal cost of producing the good itself” (Anderson and van Wincoop, 2004, p. 691). This definition permits a wide range of determining factors of trade frictions including costs relating to marketing and sales, taxes, transportation, customs procedures, payments, financing and insurance, language differences, exchange rate arrangements and trade agreements (Jacks et al., 2011; Anderson and van Wincoop, 2004).

Chapter 2: Estimating Total Bilateral Trade Costs

The framework of [Chen and Novy \(2011\)](#) infers from observed production and trade flow data, a single measure of all these trade costs. This is done by combining four unidirectional, industry-level gravity equations to obtain an expression that defines the ratio of bilateral to domestic trade costs in terms of the ratio of domestic to bilateral trade flows, which is scaled by an industry-specific elasticity of substitution parameter. The single measure is specific to a country-pair and industry, and gives the size of all the costs of trading a good between two countries relative to the cost of trading the good domestically in each of the two countries. Studies that have applied this method to data for advanced economies find the total bilateral trade costs estimates have the expected relationship with known proxies for trade frictions among those countries ([Jacks et al., 2010, 2011](#); [Novy, 2013](#)).

The method is particularly useful to the present study because it permits the total bilateral trade costs to be calculated from disaggregated data on production and bilateral trade flows. The estimates derived from EAC data will therefore vary each year by country-pair at the industry level. The estimates can then be used to analyse trade policy effects overtime across industries and by trade partner. One issue with the inverse-gravity method of [Chen and Novy \(2011\)](#) however is that the total bilateral trade costs estimates depend on assumptions made about the elasticity of substitution parameter.

This paper exploits the availability of data on production and export values for manufactured goods classified at the ISIC revision 3 2-digit level for 5 EAC countries (Burundi, Kenya, Rwanda, Tanzania, Uganda). Estimates of total bilateral trade costs are calculated for 16 industries and for trade between the 5 EAC countries and 87 of their trade partners in each year of period 1990-2012. Elasticity of substitution estimates are first calculated following the method in [Feenstra \(1994\)](#), which are then used to calculate total bilateral trade costs following the method of [Chen and Novy \(2011\)](#). The resulting elasticity of substitution estimates for the 16 industries range from 3 to 14 and average to 7. The estimates vary across industries and are assumed to be the same for the entire EAC market. The total bilateral trade costs estimates average to 8 (excluding outliers for 2 industries, the ones manufacturing non-metallic mineral products and coke, refined petroleum products). This means that it costs an EAC country on average 8 times more to trade manufactured goods with another country than to trade the goods domestically within itself.

In terms of the distribution of total bilateral trade costs across country-pairs, the trade costs estimates are larger with respect to trade partners that are located farther away from the EAC, and are smaller with respect to coastal partners as well as partners with whom EAC countries share a trade agreement and colonial history. Regression results show that for EAC countries, trade agreements are an important determinant of total bilateral trade costs even after controlling for geographical distance. Also, larger responses of total bilateral trade costs to

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the determinants are obtained from industry-level total bilateral trade costs as compared with responses estimated from country-level total bilateral trade costs (that is, total manufacturing).

In terms of trends overtime, the total bilateral trade costs estimates for intra-EAC trade turn downwards after 2000 from an average of 3 to 2, which coincides with the coming into effect of the EAC Treaty. Total bilateral trade costs for extra-EAC trade however trend upwards from an average of 7 to 10. Subsequent OLS regressions show the EAC trade agreement to be an important determinant of the total bilateral trade costs.

In terms of the distribution of total bilateral trade costs estimates across industries, industries producing goods characterised by higher weight-to-value ratios and higher import tariff rates have higher total bilateral trade costs. Regression results also show heterogeneous influences of the determinants on total bilateral trade costs across industries. The EAC trade agreement is found to have a weaker influence on the total bilateral trade costs of industries that predominantly trade outside the region.

Robustness checks are conducted to assess how the total bilateral trade costs estimates change with the choice of elasticity of substitution parameter. The checks reveal that total bilateral trade costs calculated using an industry-specific elasticity of substitution parameter are larger in size and variance as compared to estimates derived using an elasticity of substitution parameter that is common across industries. [Chen and Novy \(2011\)](#) consider it appropriate to estimate total bilateral trade costs using an elasticity of substitution parameter that is measured at the same level of disaggregation so as to adequately capture industry-specific effects.

This paper is related to the literature that estimates and analyses total bilateral trade costs ([Jacks et al., 2010, 2011](#); [Chen and Novy, 2011](#); [Novy, 2013](#)). This literature has identified geographical distance, transportation costs, technical barriers to trade and public bureaucracy as important contributors to total bilateral trade costs. The estimated total bilateral trade costs are found to be lower in the presence of a common border, common language, common colonial ties, common religion, membership in a regional trade agreement, higher level of industrialisation, and a fixed exchange rate regime. The studies also find a negative relationship between cross-border trade costs and cross-border trade flows, with the strength of the relationship depending on whether disaggregated production data is used, and also on the import content of traded goods ([Milner and McGowan, 2013](#)).

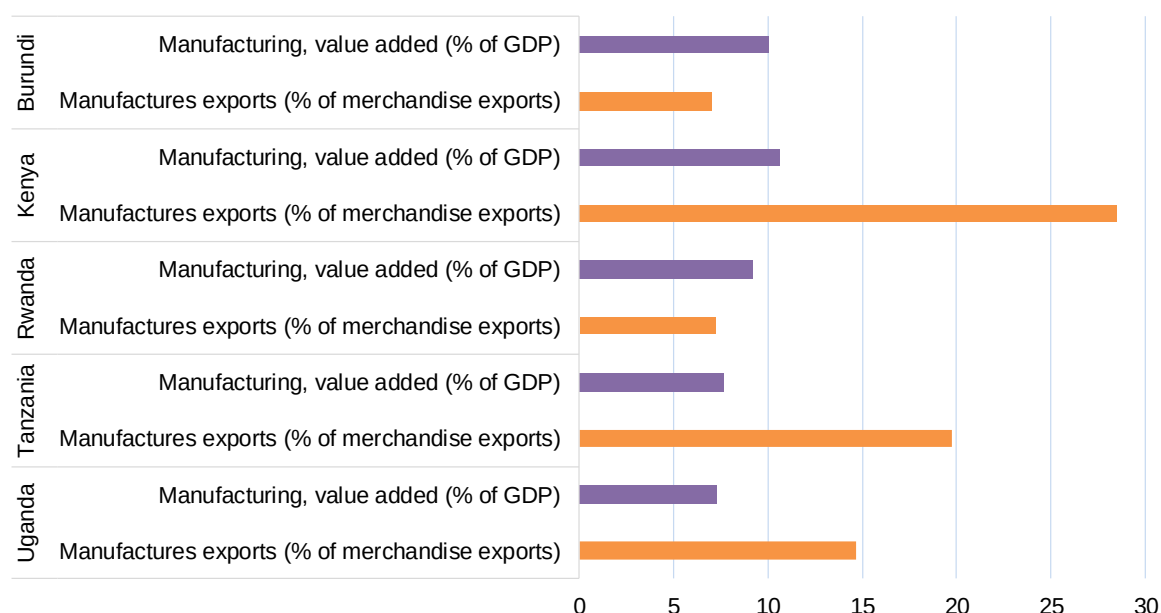
Specific to EAC countries, there are total bilateral trade costs estimates derived using the [Chen and Novy \(2011\)](#) method at an aggregated level of production published in the ESCAP-World Bank trade costs database. These estimates for the period 1996-2010 are analysed in [Arvis et al. \(2016\)](#). The present study contributes to this literature total bilateral trade costs estimates at the 2-digit level of production for EAC countries and evidence on the determinants thereof.

The rest of this paper is organised as follows: an overview of the pattern of production and trade in manufactured goods in the EAC is provided in section 2.2. Section 2.3 provides a description of the data. Section 2.4 outlines the methods used to estimate the elasticity of substitution parameter and total bilateral trade costs for the EAC. The total bilateral trade costs estimates are presented in section 2.5 and an evaluation of the same in relation to known proxies of trade costs is provided in section 2.6. The sensitivity of the total bilateral trade costs estimates to underlying assumptions is assessed in section 2.7 and section 2.8 concludes.

2.2 Background: Production and trade of manufactured output

The manufacturing sector in the EAC is modest, on average contributing less than 10 per cent to EAC countries' gross domestic product (Figure 2.1). In terms of exports, manufactured goods constitute about 30 per cent and 20 per cent of Kenya's and Tanzania's merchandise exports, respectively, and even less for the smaller member countries. Still, the Community's hopes for industrial growth and job creation remain in this sector. Partner states have jointly committed to raise the share of manufacturing in total output to 25 per cent by the year 2032.

Figure 2.1: Size of EAC's manufacturing sector (1990-2012)

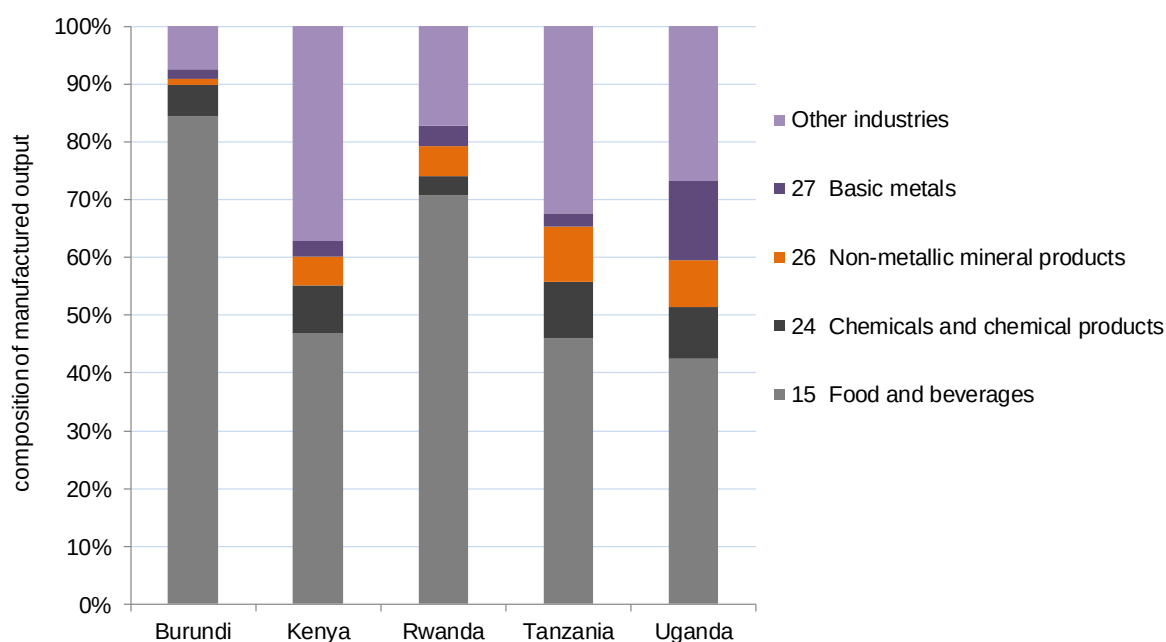


Source: World Bank's World Development Indicators online database.

Chapter 2: Estimating Total Bilateral Trade Costs

During the period 1990-2012, manufactured output of EAC countries was largely of food and beverages (see [Figure 2.2](#) and Panel A of [Table A.1](#) in Appendix A). Other notable industries were those producing chemicals and chemical products, non-metallic mineral products, basic metals, and rubber and plastics products. Over time, the composition of EAC manufactured output did not change significantly.

Figure 2.2: Composition of manufactured output of EAC countries (1990-2012)



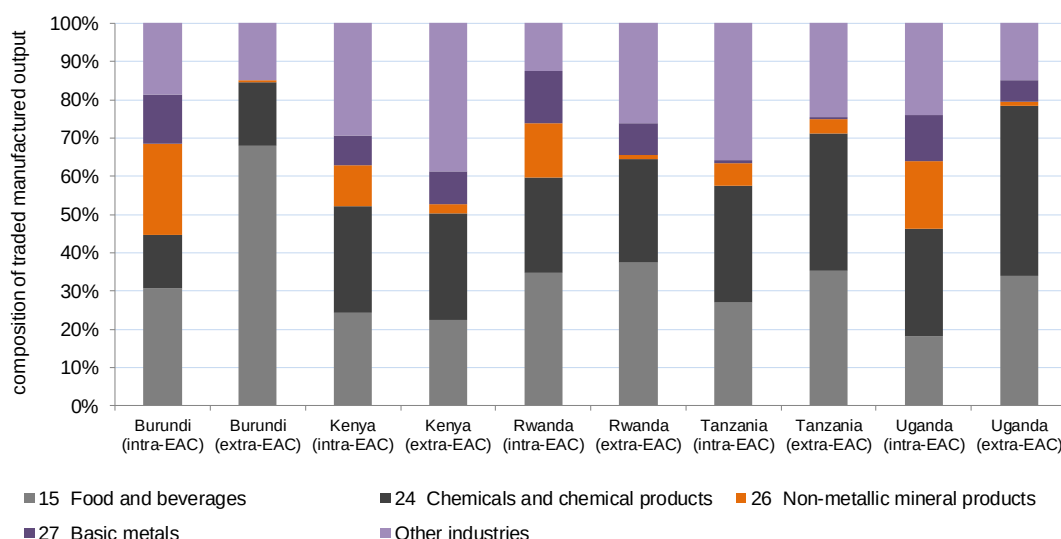
Source: Author's calculations based on data from INDSTAT2 online database.

Little of this output was traded within the EAC and in general. About 8 per cent of Kenya's manufactured food and beverages was exported to the rest of the world, out of which 15 per cent was exported to the EAC (see Panels B and C of [Table A.1](#) in Appendix A¹). Likewise, Tanzania exported 9 per cent of manufactured food and beverages to the rest of the world, out of which 17 per cent was exported to the EAC. Kenya however exported a larger share of its output of chemicals and chemical products, basic metals, and rubber and plastics products to the EAC. Tanzania exported a larger share of its output of refined petroleum products to the EAC while Uganda exported a comparably larger share of basic metals, chemicals and chemical products and non-metallic mineral products to the EAC. In general, more of tobacco, fuel, chemical, rubber, plastic and non-metallic mineral products were traded within the EAC as compared with food and beverages, wearing apparel, leather and wood products, which were predominantly traded with non-EAC partners.

¹Concordance table HS Combined to ISIC revision 3 available from the World Bank's World Integrated Trade Solution (WITS) website was used to map goods traded under the Harmonized System (HS) of classification into ISIC product categories.

Figure 2.3 shows the composition of the total value of manufactured goods that was traded among EAC countries and with 87 non-EAC partners in the period 1990-2012.² Food and beverages, and chemicals and chemical products have the largest share in EAC trade, followed by non-metallic mineral products, basic metals and textiles. The composition of trade in manufactured goods (exports plus imports) is different between intra-EAC and extra-EAC trade, with the difference being more pronounced for Burundi and Uganda.

Figure 2.3: Composition of trade in manufactured goods by EAC countries (1990-2012)



Source: Author's calculations based on data from COMTRADE online database.

2.3 Data description

Sample: The sample for this study comprises annual data for the period 1990-2012 for 5 EAC countries, namely Burundi, Kenya, Rwanda, Tanzania and Uganda, and 87 non-EAC countries. In total, the sample has 260 country-pairs; 10 comprising an EAC exporter and an EAC importer (representing intra-EAC trade) and 250 comprising an EAC exporter and a non-EAC importer (representing extra-EAC trade). See Appendix A, Table A.2 for the list of countries and territories included in the sample. 16 International Standard Industrial Classification (ISIC) revision 3 categories at the 2-digit level are sampled, a list of which is provided in Appendix A, Table A.3. The panel is not balanced and reflects the availability of data on domestic production and two-way export flow values in manufactured goods for a country-pair.

Domestic production: Data on domestic production is output values for the 16 manufactured product groups measured in current US dollars. The data is sourced from the United Nations

²The list of trade partners sampled in this study is provided in Appendix A, Table A.2.

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Industrial Development Organization's Industrial Statistics (INDSTAT2) 2015 online database. Data is available for all countries in the sample until 2012 but with gaps. Data gaps for Egypt, Kenya, South Africa, Tunisia, Uganda and Zambia are filled by extrapolating using indices of industrial production from INDSTAT2 and inflating the indices using the GDP deflator for each country. Data on the GDP deflator is sourced from the World Bank's World Development Indicators (WDI).

Data for Tanzania for the period 2008-2012 is the gross output of industrial establishments with 10 or more workers measured in millions of Tanzania shillings. The data is published by the Tanzania National Bureau of Statistics in the Statistical Abstract. The data captures about 99 per cent of total output from the manufacturing sector in Tanzania. The data is converted to current US dollars using the annual average exchange rate between the Tanzania shilling and the US dollar, which is obtained from WDI. The output data is then extrapolated backwards to 2000 using indices of industrial production (obtained from INDSTAT2) and then inflated using the GDP deflator for Tanzania. From 1994 to 1999, the data is output values reported in INDSTAT2.

Domestic production data for Rwanda in the period 1999-2012 is gross domestic product measured at current prices in billion Rwandan francs, converted to US dollars using the annual average exchange rate between the Rwandan franc and the US dollar. Production data is sourced from the GDP - National Accounts, 2015 Statistical Report of the National Institute of Statistics of Rwanda (NISR). This data is grouped into 8 broad product categories, which I split into 16 ISIC groups using the product line weights used to construct Rwanda's producer price index that are published in the Statistical Yearbook 2015 of the NISR. The exchange rate data for Rwanda is from WDI.

Trade flows: Trade flow data is bilateral export and import volume (measured in kilograms) and export and import values (measured in US dollars) sourced from the United Nations Commodity Trade Statistics (COMTRADE) online database. For each country-pair in the sample and for each ISIC category and in each year from 1990 to 2012, I collect data on the F.O.B³ value and volume of exports from the exporter country to the importer country and data on the F.O.B value and volume of exports from the importer country to the exporter country. The cost of insurance and freight services is excluded from these trade flow values. I do not consider zero trade flows as it is difficult to identify true zeros from missing trade values. This study is therefore limited to the analysis of trade costs at the intensive margin of trade.

For purposes of estimating the elasticity of substitution among traded goods, I also collect data on the C.I.F⁴ value of imports of goods (for each ISIC category) into each exporter country

³Free on board valuation.

⁴Cost, insurance and freight valuation.

from each importer country. Trade flow data classified under the Harmonized System (HS) are grouped into ISIC categories using the ‘HS Combined to ISIC revision 3’ concordance table available from the World Bank’s World Integrated Trade Solution (WITS) website. Data for 196 countries and territories that traded with EAC countries over the period 1990-2012 is used to estimate the elasticity of substitution parameter. Only 87 of these countries and territories have ISIC 2-digit level production data needed to calculate total bilateral trade costs. Data on export values and export volumes reported by Kenya has gaps for periods 1993-1996 and 2011-2012, so data on imports from Kenya as reported by Kenya’s trade partners is used instead for the entire sample period.

Gravity variables: Data on the simple (great-circle) distance between two countries, World Trade Organisation (WTO) membership start dates, and binary variables for common language, common border, common colonial ties and being landlocked are from Centre d’Études Prospectives et d’Informations Internationales (CEPII) files sourced from the UNCTAD Virtual Institute on Trade and Development. EAC and COMESA membership start dates are obtained from the websites of the EAC and Common Market for Eastern and Southern Africa (COMESA) Secretariats, respectively.

Import tariff rates: Data on the Effectively Applied (AHS) tariff rates at the ISIC revision 3 2-digit level for each country in the sample are obtained from the UNCTAD’s Trade Analysis Information System (TRAINS) accessed through the World Bank’s WITS website.

2.4 Theoretical background to the estimation of total bilateral trade costs

2.4.1 The gravity equation

Estimates of total bilateral trade costs are derived from data on production and exports of manufactured goods on the basis of the theoretical framework developed in [Anderson and van Wincoop \(2003\)](#). In this framework, trade in goods between two countries is assumed to be driven by consumer demand for the goods. The utility that consumers derive from consumption is defined in terms of a constant elasticity of substitution (CES) function that sums over expenditure on consumed goods weighted by the degree of substitutability among goods that are available for consumption. Demand in country j for goods produced in country

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i is expressed in the form of a gravity equation defined as follows:

$$x_{ij} = \frac{y_i y_j}{y^W} \left(\frac{t_{ij}}{P_i P_j} \right)^{1-\sigma}, \quad \sigma > 1 \quad (2.1)$$

where x_{ij} denotes exports from country i to country j , y_i denotes gross domestic product (GDP) of country i , y_j denotes GDP of country j , y^W is world GDP, t_{ij} denotes the trade cost factor between countries i and j , P_i and P_j are the consumer price indices of country i and j , respectively, and σ denotes the elasticity of substitution between goods. The trade cost factor t_{ij} captures all the costs of exporting goods from country i to country j such as transportation and information costs. The consumer price indices P_i and P_j are defined in terms of t_{ij} as follows:

$$P_j = \left[\sum_i (\beta_i p_i t_{ij})^{(1-\sigma)} \right]^{\frac{1}{1-\sigma}} \quad (2.1a)$$

$$P_i = \left[\sum_j \left(\frac{t_{ij}}{P_j} \right)^{(1-\sigma)} \theta_j \right]^{\frac{1}{1-\sigma}} \quad (2.1b)$$

where β_i is a positive distribution parameter, p_i is country i 's export price net of cross-border trade costs, and θ_j is country j 's share in world GDP, that is $\theta_j \equiv \frac{y_j}{y^W}$. Lower price indices imply lower trade costs with all countries. P_i and P_j therefore measure multilateral resistance as they capture how easily country i and country j trade with all countries. The price indices introduce substitutability in bilateral trade as they capture developments in the world market that affect bilateral trade between country i and country j . Not accounting for third party trade developments would lead to erroneous attribution of all the effect of a trade barrier on bilateral trade, to developments between countries i and j .

Equation (2.1) states that exports from country i to country j increase with an increase in total production of country i (proxied by y_i) and with an increase in the total expenditure of country j (proxied by y_j). The flow of goods from country i to country j is however moderated by a higher value of world output (proxied by y^W). On the other hand, the bilateral trade flow declines with an increase in bilateral trade costs t_{ij} , a reduction in the multilateral resistance of the two countries (proxied by $P_i P_j$), and with an increase in the sensitivity of consumers to the relative price of goods (captured by σ).

A merit of this framework is that it accounts for pure trade costs separately from production and consumption patterns of goods. But there are practical challenges with implementing equation (2.1) empirically. First, the bilateral trade costs term (t_{ij}) is not readily measurable since not all trade costs can be observed and those that are observable have data limitations. The multilateral

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resistance terms are also difficult to measure as price indices only reflect costs that are paid for using money (Anderson and van Wincoop, 2003). Third, estimates of elasticity of substitution (σ) are sensitive to the level of aggregation of trade flows. The practice in the literature is to use time-varying, country-specific fixed effects to proxy the multilateral resistance terms (see for instance Feenstra, 2004) or to reorganise the gravity equation and replace the terms with controls that are more readily measurable. The latter approach is the one adopted in Chen and Novy (2011).

Chen and Novy (2011) explore the size and sources of bilateral trade costs across country-pairs and industries of the European Union (EU) using a single measure of trade costs. The single measure of trade costs captures external trade costs relative to domestic trade costs. This measure is derived from the gravity model of Anderson and van Wincoop (2004), which is the industry-level version of the gravity model (equation (2.1)) presented in Anderson and van Wincoop (2003). The move from the aggregate to the disaggregated gravity equation is permitted by “trade separability”, meaning that the production of and expenditure on a good of a particular industry can be determined independent of the prices of goods from other industries (Anderson and van Wincoop, 2004). The method used to calculate the industry-specific elasticity of substitution parameter that is required in the gravity equation follows Imbs and Mejean (2009), Feenstra (1994) and Broda and Weinstein (2006).

To obtain the formula for calculating the single trade costs measure, Chen and Novy (2011) multiply an industry-level version of equation (2.1) with a corresponding equation for the exports of industry k goods from country j to country i to get the following equation:

$$x_{ij}^k x_{ji}^k = \frac{y_i^k y_j^k y_i^k y_j^k}{y^k y^k} \left(\frac{t_{ij}^k t_{ji}^k}{P_i^k P_j^k P_i^k P_j^k} \right)^{1-\sigma_k} \quad (2.2)$$

where x_{ij}^k denotes nominal exports from country i to country j in industry k goods, x_{ji}^k denotes nominal exports from country j to country i in industry k goods, y_i^k , y_j^k and y^k respectively denote output of industry k goods from country i , country j and the world, t_{ij}^k and t_{ji}^k are bilateral trade cost factors specific to industry k goods, and σ_k denotes the elasticity of substitution for industry k .

The gravity equation for domestic trade in country i in industry k goods is defined as follows:

$$x_{ii}^k = \frac{y_i^k y_i^k}{y^k} \left(\frac{t_{ii}^k}{P_i^k P_i^k} \right)^{1-\sigma_k} \quad (2.2a)$$

where t_{ii}^k denotes the cost of trading in industry k goods within country i . Equation (2.2a) is

rearranged to obtain the following expression:

$$P_i^k P_j^k = \left(\frac{y_i^k y_j^k}{x_{ii}^k x_{jj}^k} \right)^{\frac{1}{1-\sigma_k}} t_{ij}^k. \quad (2.2b)$$

In equation (2.2b), the difficult to measure multilateral resistance terms P_i^k and P_j^k , are expressed as a function of expenditure shares and trade costs. Reason being that domestic trade increases with multilateral resistance. Equation (2.2b) and the analogous one for country j are substituted into equation (2.2) to obtain the following expression:

$$\frac{x_{ij}^k x_{ji}^k}{x_{ii}^k x_{jj}^k} = \left(\frac{t_{ij}^k t_{ji}^k}{t_{ii}^k t_{jj}^k} \right)^{1-\sigma_k}. \quad (2.2c)$$

To avoid making assumptions about whether or not trade costs factors t_{ij}^k and t_{ji}^k are asymmetric (Chen and Novy, 2011, p. 208), the square root of equation (2.2c) is taken to obtain a measure of average bilateral relative trade barrier (or the inverse of bilateral trade integration) between country i and country j for industry k , denoted by θ_{ij}^k , as follows:

$$\theta_{ij}^k = \left(\frac{t_{ij}^k t_{ji}^k}{t_{ii}^k t_{jj}^k} \right)^{\frac{1}{2}} = \left(\frac{x_{ii}^k x_{jj}^k}{x_{ij}^k x_{ji}^k} \right)^{\frac{1}{2(\sigma_k-1)}}. \quad (2.3)$$

The total bilateral trade costs measure θ_{ij}^k is higher if the value of domestic trade in industry k goods in either country i or j is larger than the value of trade in the goods between the two countries, which implies that cross-border trade costs are higher than domestic trade costs. Also, the less sensitive consumers are to the relative prices of industry k goods (σ_k is low), the higher cross-border trade costs are likely to be. Equation (2.3) is used in this paper to estimate total bilateral trade costs between EAC countries and their trade partners for 16 manufacturing industries over the period 1990-2012. The method is appealing because it permits the use of disaggregated data on production and exports and is easy to implement.

2.4.2 Estimating the elasticity of substitution parameter

In this paper, the elasticity of substitution parameter σ_k in equation (2.3) is estimated from data on imports of manufactured goods into EAC countries using the method developed in Feenstra (1994). The method takes into consideration that a change in the availability of varieties of goods may upwardly bias price elasticities estimated from supply-demand equations by

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overstating the share of expenditure on any variety. The price of a variety of a good is expected to be lower in a market that has a wider range of similar varieties. The method accounts for the disappearing of old and the supply of new varieties that are imported into a market by incorporating their appearance and disappearance directly into the import price index.

The formula for estimating the elasticity of substitution parameter from data on imports in [Feenstra \(1994\)](#) is derived as follows: the minimum cost of acquiring one unit of services from a set of varieties i , denoted by c is defined as follows:

$$c(\mathbf{p}_t, \mathbf{I}_t, \mathbf{b}_t) = \left(\sum_{i \in \mathbf{I}_t} b_{i,t} p_{i,t}^{1-\sigma} \right)^{\frac{1}{1-\sigma}}, \quad \sigma > 1 \quad (2.4)$$

where $p_{i,t}$ is the price of variety i that is available in period t , $\mathbf{I}_t$ is the set of varieties that is available in period t , $b_{i,t}$ is a positive taste parameter for variety i , σ is the elasticity of substitution, $\mathbf{p}_t$ is the vector of prices in period t , and $\mathbf{b}_t$ is the vector of taste parameters in period t . Assuming that the set of available varieties $\mathbf{I}_t$ is the same in periods $t-1$ and t and the taste parameters $b_{i,t}$ are constant for $i \in \mathbf{I}$, the exact price index may be defined as follows:

$$P(\mathbf{p}_{t-1}, \mathbf{p}_t, \mathbf{x}_{t-1}, \mathbf{x}_t, \mathbf{I}) = \frac{c(\mathbf{p}_t, \mathbf{I}, \mathbf{b})}{c(\mathbf{p}_{t-1}, \mathbf{I}, \mathbf{b})} \quad (2.5)$$

where $\mathbf{x}_{t-1}$ and $\mathbf{x}_t$ are cost-minimizing quantity vectors given prices $\mathbf{p}_{t-1}$ and $\mathbf{p}_t$.

In the case of a change in the set of available varieties $\mathbf{I}_t$ and a change in the taste parameters $\mathbf{b}_{i,t}$ between periods $t-1$ and t , the conventional price index $P(\cdot)$, which is measured on observed prices and quantities, may be adjusted to obtain the exact price index which is now denoted by $\pi(\cdot)$ as follows:

$$\frac{c(\mathbf{p}_t, \mathbf{I}_t, \mathbf{b}_t)}{c(\mathbf{p}_{t-1}, \mathbf{I}_{t-1}, \mathbf{b}_{t-1})} = \pi(\mathbf{p}_{t-1}, \mathbf{p}_t, \mathbf{x}_{t-1}, \mathbf{x}_t, \mathbf{I}) \equiv P(\mathbf{p}_{t-1}, \mathbf{p}_t, \mathbf{x}_{t-1}, \mathbf{x}_t, \mathbf{I}) \left(\frac{\lambda_t}{\lambda_{t-1}} \right)^{\frac{1}{\sigma-1}} \quad (2.6)$$

where

$$\lambda_r \equiv \frac{\sum_{i \in I} p_{i,r} x_{i,r}}{\sum_{i \in I_r} p_{i,r} x_{i,r}}, \quad \text{for } r = t-1, t \quad (2.6a)$$

and I denotes the set of varieties that is available in periods $t-1$ and t .

From equation (2.6), an increase in the share of expenditure on newly available varieties will lower λ_t and lower the exact price index $\pi(\cdot)$ relative to the conventional price index $P(\cdot)$. However, an increase in σ will lower $\frac{1}{\sigma-1}$ and bring $\pi(\cdot)$ closer to $P(\cdot)$ indicating a smaller impact of new varieties on unit costs.

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For the case of imports from a country i in which a number of varieties are produced, the cost of obtaining a unit of import services is defined as follows:

$$c(\boldsymbol{\pi}_t, \mathbf{I}_t, \mathbf{b}_t) = \left(\sum_{i \in I_t} b_{i,t} \pi_{i,t}^{1-\sigma} \right)^{\frac{1}{1-\sigma}} = \left(\sum_{i \in I_t} b_{i,t} \frac{\lambda_{i,t}}{\lambda_{i,t-1}} P_{i,t}^{1-\sigma} \right)^{\frac{1}{1-\sigma}} \quad (2.7)$$

where $\pi_{i,t}$ is the exact price index of varieties imported from country i defined as $\pi_{i,t} = P_{i,t} (\lambda_{i,t} / \lambda_{i,t-1})^{1/(\sigma-1)}$ according to equation (2.6), and $b_{i,t}$ is the taste parameter for the imports from country i . The share of expenditure on imports from country i , denoted by $s_{i,t}$, (or the demand curve for the variety) is then defined as follows:

$$s_{i,t} = c(\boldsymbol{\pi}_t, \mathbf{I}_t, \mathbf{b}_t)^{\sigma-1} \times P_{i,t}^{-(\sigma-1)} \left(b_{i,t} \frac{\lambda_{i,t-1}}{\lambda_{i,t}} \right) \quad (2.8)$$

where $s_{i,t}$ increases with the number of varieties available from country i , which in turn would be reflected in a lower value of $\lambda_{i,t}$. Equation (2.8) may be written in first-differenced log form as

$$\Delta \ln s_{i,t} = \phi_t - (\sigma - 1) \Delta \ln P_{i,t} + \epsilon_{i,t} \quad (2.9)$$

where

$$\phi_t \equiv (\sigma - 1) \ln [c(\boldsymbol{\pi}_t, \mathbf{I}_t, \mathbf{b}_t) / c(\boldsymbol{\pi}_{t-1}, \mathbf{I}_{t-1}, \mathbf{b}_{t-1})] \quad (2.9a)$$

The supply curve for the imports from country i is given as

$$\Delta \ln P_{i,t} = \omega \Delta \ln x_{i,t} + \xi_{i,t} \quad (2.10)$$

where the quantity of imports from country i (in terms of expenditure share) $x_{i,t} \equiv s_{i,t} E_t / P_{i,t}$, E_t is expenditure on an imported product, $\omega \geq 0$ is the inverse supply elasticity (assumed to be the same for all supplying countries), and $\xi_{i,t}$ does not depend on $\epsilon_{i,t}$.

The equilibrium price, derived by combining the supply and demand curves of the imports from country i , is

$$\Delta \ln P_{i,t} = \psi_t + \rho \frac{\epsilon_{i,t}}{\sigma - 1} + \delta_{i,t} \quad (2.11)$$

where $0 \leq \rho < 1$.

Equations (2.9) and (2.11) are differenced relative to a reference supplier country k to eliminate ϕ_t and ψ_t and obtain equations

$$\tilde{\epsilon}_{i,t} = \epsilon_{i,t} - \epsilon_{k,t} = (\Delta \ln s_{i,t} - \Delta \ln s_{k,t}) + (\sigma - 1) (\Delta \ln P_{i,t} - \Delta \ln P_{k,t}) \quad (2.12)$$

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and

$$\tilde{\delta}_{i,t} = \delta_{i,t} - \delta_{k,t} = (1 - \rho) (\Delta \ln P_{i,t} - \Delta \ln P_{k,t}) - \frac{\rho}{\sigma - 1} (\Delta \ln s_{i,t} - \Delta \ln s_{k,t}) \quad (2.13)$$

which are then multiplied together and divided by $(1 - \rho)(\sigma - 1) > 0$ to get

$$Y_{i,t} = \theta_1 X_{1i,t} + \theta_2 X_{2i,t} + u_{i,t} \quad (2.14)$$

where

$$Y_{i,t} = (\Delta \ln P_{i,t} - \Delta \ln P_{k,t})^2 \quad (2.14a)$$

$$X_{1i,t} = (\Delta \ln s_{i,t} - \Delta \ln s_{k,t})^2 \quad (2.14b)$$

$$X_{2i,t} = (\Delta \ln s_{i,t} - \Delta \ln s_{k,t}) (\Delta \ln P_{i,t} - \Delta \ln P_{k,t}) \quad (2.14c)$$

$$\theta_1 = \frac{\rho}{(\sigma - 1)^2 (1 - \rho)} \quad (2.14d)$$

$$\theta_2 = \frac{(2\rho - 1)}{(\sigma - 1)(1 - \rho)} \quad (2.14e)$$

$$u_{i,t} = \frac{\tilde{\epsilon}_{i,t} \tilde{\delta}_{i,t}}{(1 - \rho)(\sigma - 1)} \quad (2.14f)$$

Variables $X_{1i,t}$ and $X_{2i,t}$ are endogenous in equation (2.14). This problem is addressed by averaging $Y_{i,t}$, $X_{1i,t}$ and $X_{2i,t}$ over the sample period so that the equation estimated for each imported variety i is

$$\bar{Y}_i = \theta_0 + \theta_1 \bar{X}_{1i} + \theta_2 \bar{X}_{2i} + \bar{u}_i \quad (2.15)$$

The constant term θ_0 is included in equation (2.15) to capture the variance of the measurement error, which arises from the use of unit values instead of actual import prices. The estimated coefficients $\hat{\theta}_1$ and $\hat{\theta}_2$ are used to calculate the elasticity of substitution σ using the following formula (derived from equations (2.14d) and (2.14e)):

$$\hat{\sigma} = 1 + \left(\frac{2\hat{\rho} - 1}{1 - \hat{\rho}} \right) \frac{1}{\hat{\theta}_2} > 1 \quad (2.16)$$

where

$$\hat{\rho} = \frac{1}{2} + \left(\frac{1}{4} - \frac{1}{4 + \frac{\hat{\theta}_2^2}{\hat{\theta}_1}} \right)^{\frac{1}{2}} \quad \text{if } \hat{\theta}_2 > 0 \quad (2.16a)$$

or

$$\hat{\rho} = \frac{1}{2} - \left(\frac{1}{4} - \frac{1}{4 + \frac{\hat{\theta}_2^2}{\hat{\theta}_1}} \right)^{\frac{1}{2}} \quad \text{if } \hat{\theta}_2 < 0 \quad (2.16b)$$

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If $\hat{\theta}_1 < 0$, estimates will fall out of the ranges $\hat{\sigma} > 1$ and $0 \leq \hat{\rho} < 1$.

Equation (2.15) is implemented in this paper using import data for each of the 16 industries separately. I use data on the value of imports into 5 EAC countries (Burundi, Kenya, Rwanda, Tanzania and Uganda) from 196 countries and territories (also including EAC countries to capture intra-EAC trade) for the period 1990-2012. The 196 countries and territories exported manufactured goods to at least one of the EAC countries and have the same reported in COMTRADE. Weighted least squares is applied with $1/T$ as weights. T is the total number of years trade in a good occurred between two countries over the sample period. Price and expenditure shares that are averaged over a longer period of time are assigned larger weights (Feenstra, 1991).

Unit values of imported goods are used to calculate price differentials according to equation (2.14a). The US dollar C.I.F values of imported goods are used to calculate expenditure share differentials according to equation (2.14b). For each EAC country, the dominant (or reference) supplier per ISIC category is identified as the country that exported the most to the EAC country in US dollar value terms in all years of the study period. For instance, Kenya and Tanzania imported food and beverages predominantly from Indonesia, while China was the dominant supplier of textiles and furniture to Burundi, Rwanda, Tanzania and Uganda. India was the dominant supplier of chemicals and chemical products to all EAC countries while motor vehicles and trailers were mostly supplied to the region by Japan. The full list of dominant suppliers by EAC country and ISIC category is provided in Appendix A, Table A.4.

The price and expenditure share differentials for each of the EAC countries in each industry are pooled when estimating equation (2.15) so as to obtain average elasticity of substitution estimates for each of the 16 industries for the entire EAC market. The estimated coefficients $\hat{\theta}_1$ and $\hat{\theta}_2$ are then used to calculate the elasticities of substitution for each industry using equation (2.16). I do not calculate the elasticity of substitution when $\hat{\theta}_1 < 0$ since $\hat{\rho}$ would fall out of the range $[0,1]$ and $\hat{\sigma} < 1$. The elasticity of substitution for each industry (ISIC category) are reported in Table 2.1. The estimates range from 3 to 14 with a mean of 7 and a standard deviation of 3. The estimates in Chen and Novy (2011) for the EU also average to 7. Anderson and van Wincoop (2004, p. 716) suggest, based on evidence in the literature, that the elasticity of substitution parameter would be between 5 and 10, implying an average of 7.5.

Non-metallic mineral products (ISIC 26) and fuel products (ISIC 23) have the lowest elasticity of substitution of 3 implying that they are the least price-sensitive of the manufactured products traded by the EAC (Table 2.1). Paper and wood products have an elasticity of substitution of 4 while furniture, leather products and motor vehicles and trailers have an elasticity of substitution of 5. Goods classified as food and beverages, chemicals, rubber, plastics, textiles and basic metals have relatively higher elasticities ranging from 6 to 9. Goods categorised

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under printing and publishing, tobacco products, and machinery and equipment are the most substitutable of the imported goods with elasticity of substitution estimates that are higher than 10.

Table 2.1: Elasticity of substitution estimates by ISIC category, averaged across EAC countries (standard errors are in parentheses)

ISIC code and description	$\hat{\theta}_0$	$\hat{\theta}_1$	$\hat{\theta}_2$	$\hat{\rho}$	$\hat{\sigma}$	$\hat{\sigma}$ for the EU from Chen and Novy (2011)
15 Food and beverages	0.99 (0.14)	0.11 (0.03)	0.30 (0.13)	0.7	6	7
16 Tobacco products	1.75 (0.51)	0.06 (0.06)	0.56 (0.21)	0.9	13	8
17 Textiles	1.50 (0.19)	0.11 (0.05)	0.63 (0.21)	0.9	8	6
18 Wearing apparel, fur	1.58 (0.19)	0.12 (0.05)	0.60 (0.17)	0.8	7	8
19 Leather, leather products and footwear	1.55 (0.50)	0.26 (0.13)	0.85 (0.23)	0.8	5	9
20 Wood products (excl. furniture)	1.69 (0.31)	0.18 (0.07)	0.33 (0.15)	0.7	4	5
21 Paper and paper products	0.93 (0.14)	0.18 (0.03)	0.18 (0.11)	0.6	4	6
22 Printing and publishing	1.48 (0.16)	0.09 (0.04)	0.78 (0.08)	0.9	11	5
23 Coke, refined petroleum products, nuclear fuel	1.35 (0.21)	0.01 (0.02)	-0.41 (0.16)	0.1	3	...
24 Chemicals and chemical products	2.33 (0.28)	0.15 (0.06)	0.54 (0.24)	0.8	6	8
25 Rubber and plastics products	1.45 (0.20)	0.10 (0.04)	0.56 (0.13)	0.8	8	6
26 Non-metallic mineral products	1.58 (0.20)	0.13 (0.06)	-0.32 (0.16)	0.3	3	4
27 Basic metals	1.43 (0.27)	0.11 (0.05)	0.66 (0.28)	0.9	9	4
29 Machinery and equipment n.e.c.	1.36 (0.21)	0.09 (0.04)	1.02 (0.22)	0.9	14	12
34 Motor vehicles, trailers, semi-trailers	1.62 (0.16)	0.15 (0.03)	0.42 (0.21)	0.7	5	10
36 Furniture; manufacturing n.e.c.	1.21 (0.16)	0.20 (0.06)	0.47 (0.17)	0.7	5	6
Spearman's rank correlation coefficient between EAC and EU estimates					0.20	

Note: I report the Spearman's rank correlation coefficient because it is not sensitive to outliers.

Source: Author's calculations based on data from COMTRADE online database.

The estimates of $\hat{\theta}_1$ and $\hat{\theta}_2$ in Table 2.1 imply that price differentials respond negatively to an increase in expenditure share differentials for non-metallic mineral products and fuel products meaning that a supplier increasing their import share relative to the dominant supplier has slower price adjustment relative to the dominant supplier. The relationship between price and expenditure share differentials is positive for the other industries, and strongest for machinery and equipment, leather products, printing and publishing. Measurement errors are important for all ISIC categories as the constant term is statistically significant.

The last column of [Table 2.1](#) shows simple averages of elasticity of substitution estimates for 11 countries of the European Union (EU), which are reported in [Chen and Novy \(2011\)](#). The EAC and EU estimates are in the range of 3 to 14 but are poorly correlated (the Spearman's rank correlation coefficient is 0.20). Consumers in the EAC market are comparably more sensitive to the relative prices of tobacco products, printing and publishing and basic metals, and comparably less sensitive to the relative prices of motor vehicles and leather products. The low correlation between the EU and EAC estimates is not unexpected considering the disparity in income levels across the two country groups. The elasticity of substitution estimates points to a difference in consumer expenditure patterns in the two markets, and indicates the appropriateness of estimating, for the purposes of this study, the elasticity of substitution parameter for the EAC.

2.5 Estimates of total bilateral trade costs

In the remainder of this paper and for ease of exposition, I refer to an EAC country as 'exporter' and their trade partner as 'importer', where the importer can either be an EAC country or a non-EAC country. Note however that the total bilateral trade costs are estimated from two-way trade flow data.

For each year in the period 1990-2012, total bilateral trade costs with respect to each exporter-importer-industry triple are calculated using equation (2.3), where x_{ij}^k is the US dollar F.O.B value of exports of industry k goods from exporter i to importer j , x_{ji}^k is the US dollar F.O.B value of exports of industry k goods from importer j to exporter i , x_{ii}^k and x_{jj}^k are the US dollar values of domestic trade in industry k goods in exporter i and importer j , respectively. Domestic trade is calculated as domestic production minus exports to the rest of the world by the producing country. The elasticity of substitution parameter for each industry, σ_k , is as reported in [Table 2.1](#). 11,095 total bilateral trade costs estimates are generated from the data. The estimates range from 1.03 to 14,825.91 with a mean of 55.81 and a standard deviation of 383.24. The estimates of total bilateral trade costs for each exporter, averaged over the sample period 1990-2012 and across the importers are presented in [Table 2.2](#). A more detailed summary of the estimates is provided in Appendix A, [Table A.5](#). Since the EAC countries do not all trade with the same non-EAC partner in the sample, the estimates in [Table 2.2](#) may reflect trade partner heterogeneity.

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Table 2.2: Summary of total bilateral trade costs estimates
(averaged across importers and period 1990-2012)

ISIC code and description	Burundi	Kenya	Rwanda	Tanzania	Uganda	EAC average	EU estimates from Chen and Novy (2011)
15 Food and beverages	11	7	9	8	6	7	10
16 Tobacco products		2	3	2	2	2	2
17 Textiles	3	3	3	3	3	3	3
18 Wearing apparel, fur		6		5		6	3
19 Leather, leather products and footwear	15	10	9	9	6	9	2
20 Wood products (excl. furniture)	20	17	19	18		18	5
21 Paper and paper products	33	29	15	21	33	28	5
22 Printing and publishing	3	3	3	3	3	3	77
23 Coke, refined petroleum products, nuclear fuel		103		57		93	
24 Chemicals and chemical products	5	5	5	6	7	6	2
25 Rubber and plastics products		4	3	4	4	4	3
26 Non-metallic mineral products	785	500	438	670	461	542	1662
27 Basic metals	2	3	3	3	3	3	42
29 Machinery and equipment n.e.c.		2		2		2	2
34 Motor vehicles, trailers, semi-trailers		11		7		11	1
36 Furniture; manufacturing n.e.c.		15	16	16	18	16	32
Spearman's rank correlation coef. w.r.t EU estimates	n/a	0.25	-0.15	0.31	-0.53	0.25	1.00

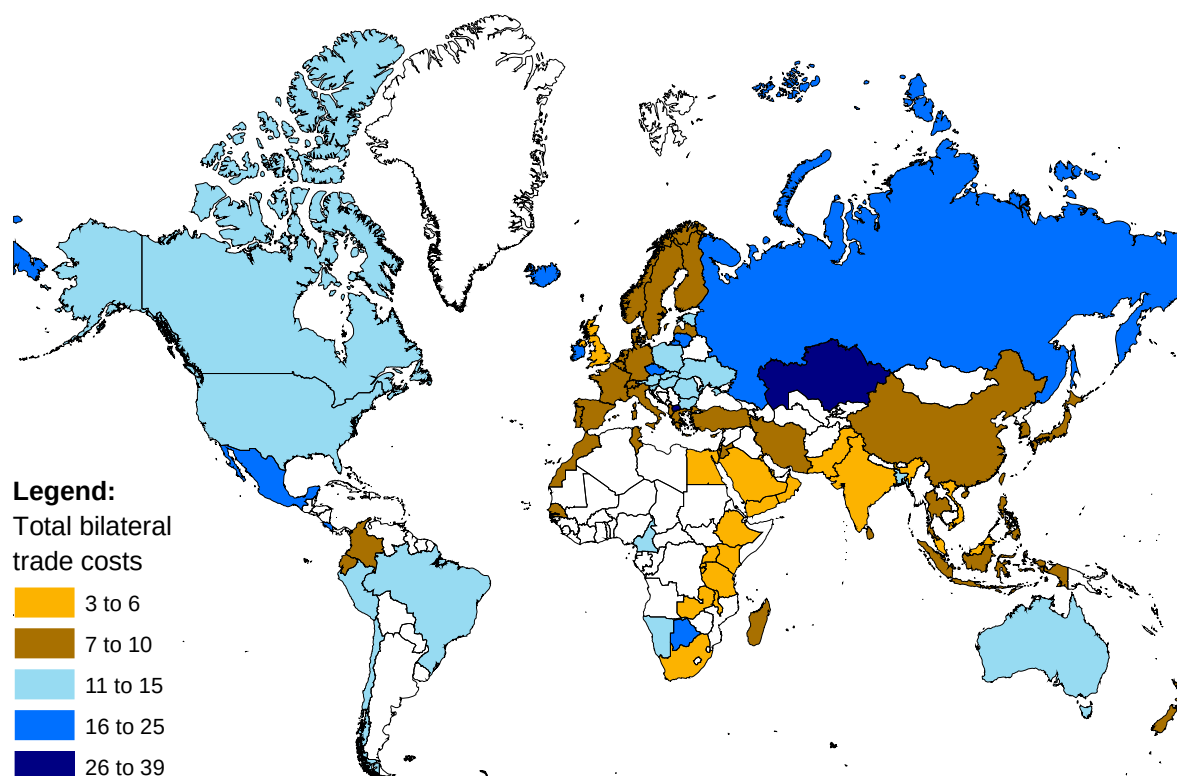
Notes: Total bilateral trade costs indicate the total cost of trading a good between two countries relative to the cost of trading the good domestically in each of the two countries. For example, it costs 11 times more for Burundi to trade food and beverages products across its borders than to trade the products locally in Burundi. It however costs Burundi 3 times more to trade textile products across its borders than to trade the products locally in Burundi. The Spearman's rank correlation coefficient is calculated with respect to the EU estimates. I report the Spearman's rank correlation coefficient because it is not sensitive to outliers. Due to small sample size, the coefficient for Burundi cannot be calculated. **Source:** Author's calculations based on data from INDSTAT2 and COMTRADE online databases.

To see the distribution of total bilateral trade costs across country-pairs, I average the estimates across industries and across the exporters for each importer, and map the same in [Figure 2.4](#). The map shows that total bilateral trade costs are lowest with respect to importers that are located closer to the EAC and those along the rim of the Indian Ocean. These geographical characteristics are potential determinants of EAC total bilateral trade costs. It is noteworthy that the map may reflect product heterogeneity since not all EAC countries traded in the same products with any given trade partner.

Total bilateral trade costs are also lower with respect to the former EAC coloniser, the United Kingdom (UK). This reflects the bilateral trade volumes, which are strong for all the 16 industries and indicates that EAC countries are still generally inclined to trading with the UK as compared with other European countries. This is most likely due to greater familiarity and strong industrial ties with the UK.⁵

⁵The UK is also a key source of foreign direct investment for the Community.

Figure 2.4: Map of total bilateral trade costs, averaged across EAC countries and industries (excluding 2 outlier industries)

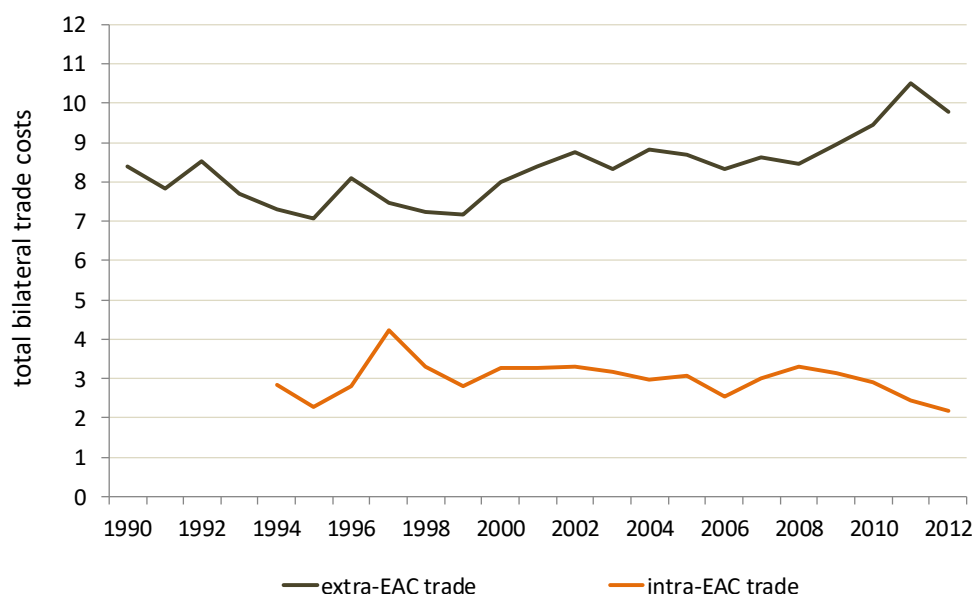


Notes: The map reads as follows, for example: EAC countries find it 3 to 6 times more expensive to trade goods with the countries coloured in orange than to trade the goods domestically within each EAC country. Data is not available for countries marked in white. Industries manufacturing fuel products (ISIC 23) and non-metallic mineral products (ISIC 26) have very high trade costs and are excluded from the map. **Source:** Author's calculations based on data from INDSTAT2 and COMTRADE online databases.

Comparing trends across importers, it costs on average about 3 times more to trade manufactured goods between EAC and non-EAC countries than to trade manufactured goods within the EAC (shown in Figure 2.5). Overtime, intra-EAC total bilateral trade costs show a downward trend while extra-EAC total bilateral trade costs show an upward trend. The divergence in the trends starts after 2000, which is the year the EAC Treaty took effect.⁶ Trade policy measures implemented under the EAC Treaty are therefore potential determinants of the total bilateral trade costs. Aside from changes in international trade costs, it is possible that the time trend in the total bilateral trade costs estimates reflects changes in domestic trade costs both within and outside the EAC.

⁶The difference between intra-EAC and extra-EAC trade costs increased from 4.2 in period 1994-2000 to 5.9 in period 2001-2012. The increase in the difference between intra-EAC and extra-EAC trade costs in period 2001-2012 by 1.8 is statistically significant at the 95 per cent level with a standard error of 0.37.

Figure 2.5: Trends in total bilateral trade costs over the period 1990-2012
(excludes ISIC 23 and ISIC 26)

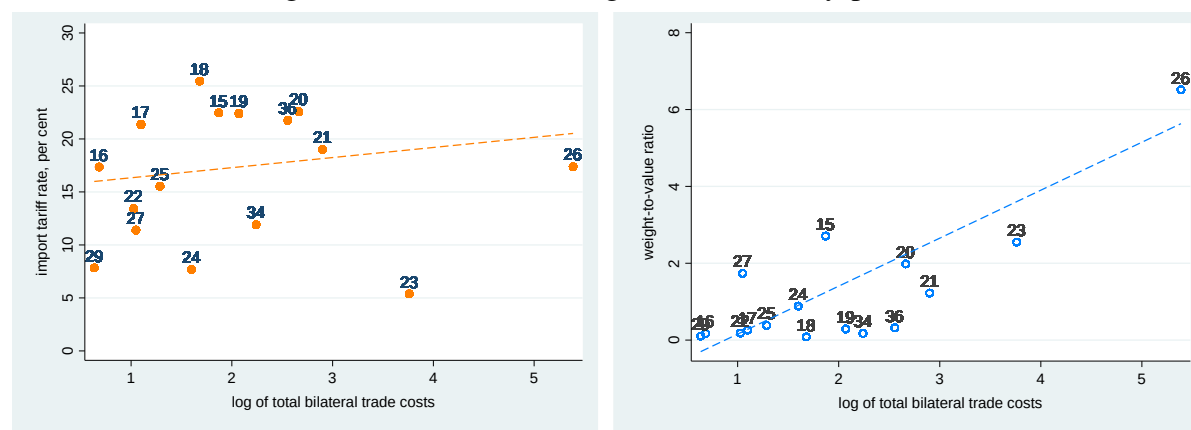


Notes: Total bilateral trade costs indicate the total cost of trading a good between two countries relative to the cost of trading the good domestically in each of the two countries. Extra-EAC trade refers to trade between an EAC country and a non-EAC country. Intra-EAC trade refers to trade between two EAC countries. Industries manufacturing fuel products (ISIC 23) and non-metallic mineral products (ISIC 26) have very high trade costs and are excluded from the figure. **Source:** Author's calculations based on data from INDSTAT2 and COMTRADE online databases.

In terms of the distribution of the estimates across industries, the total bilateral trade costs are on average lower for machinery and equipment, tobacco products, printing and publishing, basic metals, textiles, and rubber and plastics products. It costs between 2 to 4 times more to trade these products across EAC country borders than to trade the products within each EAC country (see [Table 2.2](#)). External bilateral trade costs are on average 20 times more than domestic trade costs for paper products, wood products and furniture. More restrictive external bilateral trade costs are implied for non-metallic mineral products and fuel products. By definition, these estimates correlate negatively with the corresponding elasticity of substitution estimates.

A difference across the industries, which matters for trade costs and for which data is available, is import tariff rates. The import tariff rates for the exporters are averaged across country-pairs and years and then related to the similarly averaged logarithm of total bilateral trade costs in a scatter plot shown in orange in [Figure 2.6](#). The median import tariff rate is 18.6. [Figure 2.6](#) shows that industries facing tariff rates above 18.6 also tend to have comparably higher total bilateral trade costs. This indicates that the import tariff rate is one of the determinants of the distribution of total bilateral trade costs across industries.

Figure 2.6: Scatter plot of total bilateral trade costs versus import tariff rates and weight-to-value ratios (averages across country-pairs and time)



Notes: The numbers in the scatter plots indicate the ISIC codes of each industry. Total bilateral trade costs indicate the total cost of trading a good between two countries relative to the cost of trading the good domestically in each of the two countries. For each industry, import tariff rate is the simple average of the effectively applied tariff rates at the product level. For each industry, weight-to-value ratio is import volume divided by import value. **Source:** Author's calculations based on data from INDSTAT2, COMTRADE and WITS/TRAINS online databases.

Another distinguishing characteristic of industries, which is observable and easily measurable is the weight-to-value ratio of goods. The weight of goods matters for the cost of transporting them over distance (Chen, 2004; Head and Mayer, 2002). For each industry, weight-to-value ratios are calculated from imports data that has been averaged across country-pairs and years in the sample. The ratios are then related to the logarithm of total bilateral trade costs, which is also averaged across country-pairs and time, in a scatter diagram shown in blue in Figure 2.6. The scatter plot shows that non-metallic mineral products (ISIC code 26) have the highest weight-to-value ratio at 6.5 compared with the median of 0.5 for all industries. This industry also has the highest total bilateral trade costs. Generally, there is a positive correlation between the weight-to-value ratios of industries and their total bilateral trade costs. Given this positive correlation, a potential determining factor of EAC total bilateral trade costs would be the quality of transportation infrastructure, which would determine the cost of transporting goods over distance. That the positive correlation between total bilateral trade costs and weight-to-value ratios appears to be stronger than the correlation between the trade costs and import tariff rates indicates a larger role for transportation infrastructure in determining the distribution of trade costs across industries.

The last column of Table 2.2 shows the simple averages of total bilateral trade costs for 11 countries of the EU, which are reported in Chen and Novy (2011). The EAC estimates are within range of the EU estimates but are weakly correlated as indicated by the Spearman's rank correlation coefficient. In comparison, both sets of estimates indicate costly external trade for non-metallic mineral products. However, it is comparably more expensive to trade

paper products, wood products and motor vehicles across EAC country borders than across EU country borders, and less expensive to trade furniture, basic metals and print products across EAC country borders than across EU country borders. The differences between the EAC and EU estimates of total bilateral trade costs reflect the different elasticity of substitution parameters and may also reflect the comparably wider geographical distribution of non-EAC trade partners. The differences in the two sets of estimates could also reflect differences in trade policies pursued by the two trade blocs. The total bilateral trade costs estimates comprise both external and internal trade costs; it is not immediately known which one of the two components drive the differences between the EAC and EU estimates.

In summary, this section presents estimates of total bilateral trade costs for the 5 EAC countries of interest in 16 industries and with respect to themselves and other 87 trade partners over the period 1990-2012. In terms of size, the estimates indicate that cross-border trade costs are on average 56 times larger than domestic trade costs (8 excluding two outlier industries), and that external trade costs increase with geographical distance from the EAC and landlocked-ness. The analysis in this section also suggests that trade policy may be a determinant of the trade costs. This is indicated by the coincidental decline in intra-EAC trade costs after 2000 when the EAC Treaty came into force, as well as the positive correlation between the trade costs estimates and import tariff rates and product weight-to-value ratios. The latter points to transportation costs and implies a role for the quality of transportation infrastructure in determining the distribution of total bilateral trade costs across industries.

2.6 Determinants of total bilateral trade costs

In this section, the estimates of total bilateral trade costs presented in section 2.5 are analysed in relation to a set of proxy variables for trade costs that is standard in the literature that uses the gravity equation.⁷ These proxy variables contain information about the potential determinants of total bilateral trade costs for the EAC, which are highlighted in the previous section (that is, geographical location, colonial history, and tariff and non-tariff policy measures). The model used in the analysis is of the following form:

$$\ln(\text{total bilateral trade costs}_{ijk,t}) = \alpha + \beta X_{ij,t} + \delta_{i,t} + \delta_{j,t} + \delta_{k,t} + \epsilon_{ijk,t} \quad (2.17)$$

where the natural logarithm of total bilateral trade costs between exporter i and importer j for industry k at time t is regressed on a constant, α , a set of trade cost proxy variables, $X_{ij,t}$,

⁷For example, French (2016); Bergstrand et al. (2015); Egger and Sergey (2015); Chen and Novy (2011); Jacks et al. (2011); Vicard (2011); Baier and Bergstrand (2009); Helpman et al. (2008); Silva and Tenreyro (2006); Rose (2004).

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exporter-year fixed effects, $\delta_{i,t}$, importer-year fixed effects, $\delta_{j,t}$ and industry-year fixed effects, $\delta_{k,t}$. $\epsilon_{ijk,t}$ is the error term. To account for correlation of errors within country groups, I cluster and report standard errors at the country-pair level.

The trade cost proxy variables are the natural logarithm of the geographical distance between country-pair ij , and indicator variables for a common border, same official language, common coloniser, landlocked countries and existence of a trade agreement between the countries in the pair. These variables give indication of how close the trading pair is in geographical, cultural and political terms. Total bilateral trade costs are expected to be lower for a country-pair that is geographically closer and are more familiar with each other. The trade cost proxy variables included in equation (2.17) are as described in Table 2.3.

Table 2.3: Description of trade cost proxy variables

Variable	Description
bilateral distance	great-circle distance (in kilometres) between the most populated cities in the respective trading countries
common border	indicator variable equal to 1 if the trading pair share a common border and 0 otherwise
common language (official)	indicator variable equal to 1 if the trading pair have the same official language and 0 otherwise
common colonizer	indicator variable equal to 1 if the trading pair were the colonies of the same third country after 1945 and 0 otherwise
landlocked	indicator variable equal to 1 if both countries in the trading pair are landlocked and 1 otherwise
EAC membership	indicator variable equal to 1 if both countries in the trading pair are members of the EAC and 0 otherwise
COMESA membership	indicator variable equal to 1 if both countries in the trading pair are members of COMESA and 0 otherwise
WTO membership	indicator variable equal to 1 if both countries in the trading pair are members of WTO and 0 otherwise

The variables indicating the existence of a trade agreement between a country-pair capture tariff and non-tariff policy measures aimed at lowering bilateral trade costs. The trade agreements considered in the analysis are membership in the East African Community (EAC), the Common Market for Eastern and Southern Africa (COMESA) and the World Trade Organisation (WTO). The sample of countries for this study consists of 260 unique country-pairs. The membership of these pairs in the three trade blocs is as follows: Burundi, Kenya, Tanzania and Uganda joined the WTO in 1995 and Rwanda in 1996. Burundi, Kenya, Rwanda and Uganda joined COMESA in 1981⁸ while Tanzania was a member from 1981 to 2000. Kenya, Tanzania and Uganda revived the EAC in 2000, Burundi and Rwanda joined in 2007. Among the non-EAC trade partners included in the sample, 67 out of 87 joined the WTO in 1995 while 18 joined

⁸The Treaty establishing COMESA was signed in 1993, replacing the Treaty for the Establishment of the Preferential Trade Area for Eastern and Southern African States, which had been signed in 1981.

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between 1996 and 2012. 5 trade partners (Ethiopia, Madagascar, Malawi, Mauritius, Zambia) joined COMESA in 1981 and one (Egypt) in 1999.

The set of fixed effects included in equation (2.17) control for omitted variables that determine total bilateral trade costs, and which may also be correlated with the explanatory variables included in the equation. These omitted variables would therefore bias the estimated coefficients on the trade cost proxy variables of interest. The exporter-year and importer-year fixed effects control for time-varying country-specific economic characteristics and policy changes that affect domestic trade costs over time. Most notable among these is the quality of regulatory institutions which determine the ease of doing business domestically. The quality of regulatory institutions would also determine the effectiveness of trade policy measures in enhancing cross-border trade flows (Francois and Manchin, 2013; Iwanow and Kirkpatrick, 2009; Esfahania and Ramírez, 2003). The exporter-year and importer-year fixed effects also control for exchange rate movements, which applies because the trade and production data used to estimate the total bilateral trade costs are measured in US dollars. The fixed effects further control for changes in multilateral resistance (Mayer and Thoenig, 2016), but controlling for multilateral resistance is not necessary since these have been netted out of the total bilateral trade costs estimates (Novy, 2013). The industry-year fixed effects control for time-varying differences in production and transportation technologies across industries. These affect the cost of producing goods depending on reliance on imported intermediates and the cost thereof (Milner and McGowan, 2013), and also the cost of transporting goods depending on their weight and/or perishability (Chen and Novy, 2011).

The analysis in this section also considers total bilateral trade costs at a more aggregated level of production (that is, total manufacturing). For each country-pair and year in the sample, I derive total bilateral trade costs from production and export data that has been summed up across the 16 industries and use 8 as the elasticity of substitution.⁹ In doing so, I try to show the benefit of disaggregating the data.

Equation (2.17) is estimated using Ordinary Least Squares (OLS) regression and the results are reported in Table 2.4. Columns (1) and (2) show results relating to total bilateral trade costs derived from data that is aggregated across the 16 industries, for each country-pair and year in the sample. The number of observations subsequently falls to 2,480. The average of the total bilateral trade costs estimates inferred from the aggregated data is 4.9 compared with 8.0 when disaggregated data is used (see the second to last row of Table 2.4). The trade costs estimates from the disaggregated data are larger reflecting the distribution of the elasticity of substitution parameters across industries; about half of the industry parameters are below the average of 7 as

⁹8 is the mid-point of elasticity of substitution estimates reported in the empirical literature (Milner and McGowan, 2013, see footnote on p. 1891).

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shown in Table 2.1. By the definition of equation (2.3), the lower the elasticity of substitution parameter, the higher will be the total bilateral trade costs estimate.

Table 2.4: Determinants of total bilateral trade costs

dependent variable:	ln(total bilateral trade costs)				
	based on country-level data		based on industry-level data		
	(1)	(2)	(3)	(4)	(5)
ln(bilateral distance)	0.103** (0.042)	0.462*** (0.126)	0.229*** (0.058)	0.300*** (0.050)	0.356*** (0.090)
common border	-0.163 (0.099)	-0.100 (0.115)	-0.033 (0.114)	-0.155 (0.103)	-0.302*** (0.071)
common language (off.)	-0.068* (0.041)	-0.088 (0.085)	-0.124* (0.072)	-0.137** (0.065)	-0.200** (0.085)
common colonizer	-0.089* (0.049)	0.121 (0.098)	-0.196** (0.084)	-0.052 (0.062)	0.092 (0.120)
landlocked	0.230* (0.130)	0.105 (0.120)	-0.099 (0.138)	0.227** (0.096)	-0.053 (0.095)
EAC membership	-0.120* (0.065)	0.116 (0.128)	-0.235*** (0.064)	-0.205*** (0.072)	-0.291** (0.136)
COMESA membership	-0.078** (0.039)	-0.002 (0.087)	-0.105* (0.057)	-0.018 (0.050)	-0.061 (0.050)
WTO membership	-0.013 (0.037)		-0.025 (0.068)	-0.392*** (0.104)	
Exporter-year fixed effects	-	Yes	-	-	Yes
Importer-year fixed effects	-	Yes	-	-	Yes
Industry-year fixed effects	-	-	-	Yes	Yes
Observations	2,480	2,480	11,095	11,095	11,095
Adjusted R-squared	0.21	0.62	0.05	0.87	0.89
total bil. trade costs, mean	4.9	4.9	8.0	8.0	8.0
bilateral distance, mean	5,377	5,377	5,470	5,470	5,470

Notes: Table 2.4 shows OLS estimates of equation (2.17). The dependent variable for columns (1) and (2) is the natural logarithm of total bilateral trade costs derived from production and trade data that is aggregated across industries. The dependent variable for columns (3) to (5) is the natural logarithm of total bilateral trade costs derived from industry-level production and trade data. Bilateral distance is measured in kilometres. The constant term is not shown in all cases. The standard errors in parentheses are clustered at the country-pair level. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The results in the first column of Table 2.4 exclude the set of fixed effects. These results indicate that the total bilateral trade costs estimates have the expected relationship with the standard proxies for trade costs. Total bilateral trade costs are higher for country-pairs that are geographically farther apart and for country-pairs that are landlocked, but are lower for country-pairs that share a common official language, were colonised by the same third country, and are parties to a trade agreement. For the case of aggregated data, I am not able to control for industry-specific effects. The results in column (2) include only exporter-year and importer-year fixed effects, which control for changes in domestic trade costs in the

exporter and importer. These fixed effects sweep away the explanatory power of the EAC and COMESA membership variables. The coefficient on EAC membership variable also takes on an unexpected sign. The results in column (2) suggest that EAC total bilateral trade costs are determined by domestic trade costs and the geographical location of trade partners, with no role for the regional trade agreements.

Columns (3) to (5) of [Table 2.4](#) show results relating to total bilateral trade costs that are derived from industry-level data. Without adding any fixed effects (column 3) and comparing with the results in column (1), the disaggregated data yields larger coefficients (when significant). This means that aggregation bias would be in the downward direction, and this is due to the smaller variance in the aggregated data. I am now also able to control for industry-specific effects. Most of the variation in the total bilateral trade costs estimates occurs at the industry level as indicated by the increase in the R^2 upon including industry fixed effects (column 4). After averaging out industry-specific characteristics also, membership in the WTO becomes a significant determinant of EAC total bilateral trade costs.

Unlike in the case of the sector-level data, the EAC membership variable retains its explanatory power after inclusion of exporter-year and importer-year fixed effects (column 5), as does the presence of a common border and language between a trading pair. The results in column (5) of [Table 2.4](#) indicate that the average bilateral distance adds 38 per cent¹⁰ to total bilateral trade costs. The coefficient on the EAC membership variable indicates that intra-EAC total bilateral trade costs are lower than extra-EAC total bilateral trade costs by about 25 per cent $((e^{-0.291} - 1) \times 100)$. This means that the EAC trade agreement almost has the equivalent effect as the average bilateral distance on total bilateral trade costs, but in the opposite direction.

The coefficient on bilateral distance reported in column (5) of [Table 2.4](#) is in the range of estimates reported in literature. The estimated coefficient on bilateral distance is 0.471 in [Chen and Novy \(2011\)](#) based on industry-level data, and 0.313 in [Novy \(2013\)](#) and 0.355 in [Arvis et al. \(2016\)](#) both based on sector-level data for advanced and developing countries, respectively. The estimated coefficients on the other indicator variables are however comparably lower in the literature; the estimated coefficient on the common border variable is -0.077 in [Chen and Novy \(2011\)](#), -0.154 in [Novy \(2013\)](#) and -0.214 in [Arvis et al. \(2016\)](#). The estimated coefficient on the common language variable is -0.149 in [Chen and Novy \(2011\)](#), -0.027 in [Novy \(2013\)](#) and -0.108 in [Arvis et al. \(2016\)](#). The estimated coefficient on the indicator variable for the presence of a trade agreement is -0.068 in [Novy \(2013\)](#) and -0.171 in [Arvis et al. \(2016\)](#). The estimates from the present study thus give a larger role to trade policy measures in determining total bilateral trade costs.

¹⁰This is calculated as $\ln(5,470) \times 0.356/8.0$, where 5,470 is the average bilateral distance (in kilometres) between two countries in the sample, and 8.0 is the average total bilateral trade costs between two countries in the sample (see [Engel and Rogers, 1996](#)).

I now turn to the heterogeneity of effects across industries. The analysis in section 2.5 showed that total bilateral trade costs correlate positively with the weight-to-value ratio of traded goods and import tariff rates faced by industries. I do not in this paper estimate the impact of these factors on total bilateral trade costs. Instead, I group industries by type, according to the amount of technology (measured by R&D expenditure) used in the production of goods. I then estimate equation (2.17) for each industry group. The estimated coefficients will indicate how different types of industries respond to the trade cost proxy variables.

The 16 industries are categorised into two groups as follows:¹¹ products that are low in technology (food and beverages; tobacco products; textiles; wearing apparel, fur; leather, leather products and footwear; wood products (excl. furniture); paper and paper products; basic metals) and products that are medium to high in technology (printing and publishing; coke, refined petroleum products, nuclear fuel; chemicals and chemical products; rubber and plastics products; non-metallic mineral products; machinery and equipment; motor vehicles, trailers, semi-trailers; furniture; manufacturing n.e.c.). Industries with medium- to high-technology products have a median weight-to-value ratio of 0.4, and industries with low-technology products have a median weight-to-value ratio of 1.2. Medium- to high-technology products face a median import tariff rate of 14.4 while low-technology products face a median tariff rate of 23.4.

Equation (2.17) is estimated using OLS regression separately for the two industry groups and the results are reported in Table 2.5. Columns (1) and (2) show results for industries classified as being medium to high, and low in technology, respectively. In terms of cultural and political ties, the coefficients indicate that a country-pair that shares a common official language has lower trade costs by 20 per cent ($((e^{-0.222} - 1) \times 100)$) for low-technology industries as compared with country-pairs that do not share a common official language. The coefficient on the common colonizer variable is not statistically significant for low-technology industries and is wrongly signed for medium- to high-technology industries indicating that a common colonial history does not mitigate EAC trade costs, all other factors considered. Whether country-pairs are landlocked also does not seem to add to EAC trade costs. This result obtains only after inclusion of exporter-year and importer-year fixed effects.

Total bilateral trade costs are lower by 54 per cent ($((e^{-0.787} - 1) \times 100)$) for medium- to high-technology industries when the pair of countries are members of the EAC, whereas total bilateral trade costs among members of COMESA are lower by 19 per cent for low-technology industries. These effects compare with the effect of distance on total bilateral trade costs of 23 per cent ($(\ln(5,454) \times 0.257/9.6)$) for medium- to high-technology industries and 42

¹¹This grouping follows the classification of products used by the Organisation for Economic Co-operation and Development (OECD). The classification is explained in Hatzichronoglou (1997).

Table 2.5: Determinants of total bilateral trade costs, by industry group

dependent variable:	ln(total bilateral trade costs)	
	medium- to high-tech industries	low-tech industries
	(1)	(2)
ln(bilateral distance)	0.257** (0.124)	0.314*** (0.099)
common border	-0.490*** (0.094)	-0.216** (0.108)
common language (official)	-0.121 (0.128)	-0.222*** (0.083)
common colonizer	0.274* (0.143)	-0.025 (0.139)
landlocked	-0.014 (0.100)	-0.198* (0.104)
EAC membership	-0.787*** (0.162)	-0.001 (0.157)
COMESA membership	0.040 (0.057)	-0.209*** (0.074)
Exporter-year fixed effects	Yes	Yes
Importer-year fixed effects	Yes	Yes
Industry-year fixed effects	Yes	Yes
Observations	5,922	5,173
Adjusted R-squared	0.91	0.80
total bilateral trade costs, mean	9.6	6.5
bilateral distance, mean	5,454	5,488
weight-to-value ratio, median	0.4	1.2
import tariff rate, median	14.4	23.4

Notes: Table 2.5 shows OLS estimates of equation (2.17). The dependent variable is the natural logarithm of total bilateral trade costs derived from industry-level data. The medium- to high-technology industries of column (1) are printing and publishing; coke, refined petroleum products, nuclear fuel; chemicals and chemical products; rubber and plastics products; non-metallic mineral products; machinery and equipment; motor vehicles, trailers, semi-trailers; furniture; manufacturing n.e.c. The low-technology industries of column (2) are food and beverages; tobacco products; textiles; wearing apparel, fur; leather, leather products and footwear; wood products (excl. furniture); paper and paper products; basic metals. Weight-to-value ratio is calculated from import data averaged across country-pairs. The import tariff rate is the effectively applied rate of the exporter. The constant term is not shown in all cases. The standard errors in parentheses are clustered at the country-pair level. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

per cent ($\ln(5,488) \times 0.314/6.5$) for low-technology industries. The presence of a common border between a country-pair has a comparable smaller negative impact on the trade costs of low-technology industries. It is noteworthy that low-technology manufactured goods are more predominantly traded with non-EAC partners. For these industries therefore, transport-related trade costs and a trade agreement with wider membership are more important in determining

trade costs.

The results reported in this section show that the total bilateral trade costs estimates are reasonably related to known proxies of trade costs. The results also show the EAC trade agreement to be an important determinant of the trade costs. The closing analysis suggests that the EAC trade agreement is more relevant in influencing the total bilateral trade costs of some industries more than others. This motivates further inquiry into the effect of EAC trade policies on total bilateral trade costs and the distribution thereof across the various industries in the manufacturing sector.

2.7 Robustness checks

In this section, the baseline results reported in [Table 2.4](#), column (5), are assessed for endogeneity biases coming from mismeasurement of the total bilateral trade costs. These include estimating a common elasticity of substitution parameter for the EAC market as opposed to each EAC country, and the use of industry-specific parameters instead of one that is common across industries. I also consider the effect of using mirror trade data for Kenya instead of data reported by Kenya, which has gaps. This section ends with a comparison of the total bilateral trade costs estimates and the residuals from a general gravity model as a way of gauging the validity of the estimates.

A. Assumptions about the elasticity of substitution parameter

To determine the effect of the choice of elasticity of substitution parameter on the total bilateral trade costs estimates, two other sets of total bilateral trade costs estimates are calculated; one where the elasticity of substitution parameter varies by EAC country and by industry, and another where the elasticity of substitution parameter is set at 8 for all EAC countries and all industries. [Figure 2.7](#) plots the baseline and the other 2 sets of total bilateral trade costs estimates for each industry, averaged across country-pairs and time.

In [Figure 2.7](#), the orange dots represent the average total bilateral trade costs for each industry, which are derived assuming an elasticity of substitution parameter of 8 for all industries and countries. These estimates average to 3.8 and do not exceed 5. The black dots represent the average of the baseline total bilateral trade costs for each industry, which are derived assuming that the elasticity of substitution parameter varies across industries but not across EAC countries. The highest of these estimates is 93 for ISIC code 23 (fuel products) and 542 for ISIC code 26 (non-metallic mineral products). The blue dots represent trade costs estimates calculated using an elasticity of substitution parameter that varies by industry and

EAC country. The average of these estimates is well over 1000 (most observations are off the chart). Therefore, the more the elasticity of substitution parameter varies by industry and country, the more likely larger total bilateral trade costs estimates are obtained. Restricting the variability of the elasticity of substitution parameter therefore puts an upper limit on the total bilateral trade costs estimates.

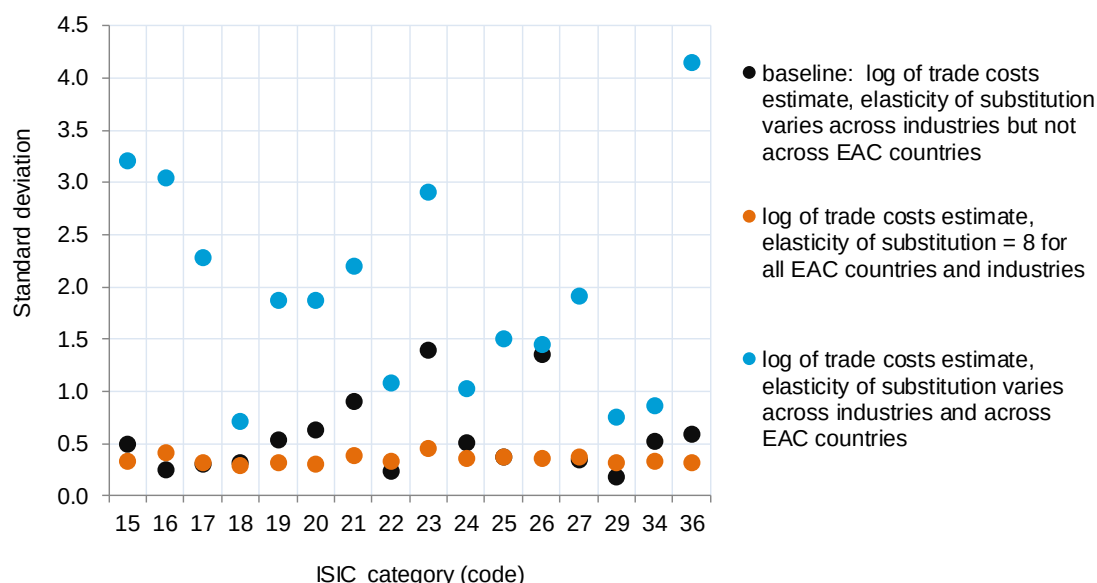
Figure 2.7: Size of total bilateral trade costs estimates given different elasticity of substitution parameters



Further, the variance in the trade costs estimates also depends on the variability of elasticity of substitution parameter as shown in Figure 2.8. The more variable is the elasticity of substitution parameter across industries and EAC countries, the higher is the variance in the trade costs estimates.

The implication is that the size of OLS estimates from regressions of total bilateral trade costs will increase with variability of the elasticity of substitution parameter. Or, the more the data is disaggregated, the larger will be the estimated coefficients. Since the level and variance in trade costs estimates are sensitive to the elasticity of substitution estimate, I think it better to derive the elasticities from the same data (and disaggregation level) from which the total bilateral trade costs are derived.

Figure 2.8: Variance in total bilateral trade costs estimates given different elasticity of substitution parameters



B. Effect of using mirror trade data for Kenya

Due to large gaps in the trade data reported by Kenya in COMTRADE, mirror data (or data reported by Kenya's trade partners) was used to estimate total bilateral trade costs between Kenya and her trade partners. A concern with using mirror data is that the missing export values that would have been reported by Kenya would be valued on free on board (F.O.B) basis (that is, not including freight and insurance charges) whereas data on values imported from Kenya as reported by partners are reported on cost, insurance and freight (C.I.F) basis. The implication is that total bilateral trade costs estimates derived using data with C.I.F valuation would be lower since the calculated value for domestic trade (the x_{ii}^k term in equation (2.3)) would be lower.¹² To see whether total bilateral trade costs estimates based on mirror trade data are significantly lower than estimates based on data as reported by Kenya, the two sets of estimates are subjected to the t-test. The test results are reported in Table 2.6.

The results show that for EAC trade partners, the means of the two sets of trade costs estimates are not significantly different from each other. However, for non-EAC partners, there is a statistically significant difference in the means of the two sets of estimates for 5 industries. The use of mirror trade data is therefore a potential source of bias and it would be appropriate to conduct robustness checks on analyses using these estimates.

¹²Domestic trade is calculated as domestic production minus total exports to the rest of the world.

Table 2.6: Difference in means of total bilateral trade costs estimated from own and mirror trade data for Kenya

ISIC code and description	Kenya's trade with EAC partners				Kenya's trade with non-EAC partners			
	trade costs calculated from mirror trade data	trade costs calculated from trade data reported by Kenya	t stat.	p-value	trade costs calculated from mirror trade data	trade costs calculated from trade data reported by Kenya	t stat.	p-value
15 Food and beverages	3.4	3.6	-1.03	0.31	7.3	7.5	-1.53	0.13
16 Tobacco products	1.7	2.0	-1.24	0.25	2.5	2.5	-0.38	0.71
17 Textiles	1.9	1.9	-0.81	0.42	3.2	3.3	-2.18	0.03
18 Wearing apparel, fur	-	-	-	-	5.3	6.2	-2.96	0.00
19 Leather, leather products and footwear	4.9	4.2	0.91	0.37	8.7	9.7	-2.03	0.04
20 Wood products (excl. furniture)	4.5	5.3	-0.57	0.57	17.4	17.5	-0.16	0.88
21 Paper and paper products	5.4	5.9	-0.57	0.57	26.7	28.6	-1.02	0.31
22 Printing and publishing	2.0	2.0	0.47	0.64	2.9	2.9	-0.44	0.66
23 Coke, refined petroleum products, etc	-	-	-	-	58.9	80.0	-0.78	0.44
24 Chemicals and chemical products	2.3	2.3	0.10	0.92	5.9	5.8	0.43	0.67
25 Rubber and plastics products	1.9	1.9	-0.17	0.87	3.9	3.9	-0.43	0.67
26 Non-metallic mineral products	24.9	23.6	0.28	0.78	502.5	524.0	-0.43	0.67
27 Basic metals	1.6	1.6	-0.01	0.99	3.1	3.0	1.23	0.22
29 Machinery and equipment n.e.c.	1.4	1.4	-0.99	0.34	1.8	1.9	-3.27	0.00
34 Motor vehicles, trailers, semi-trailers	3.3	3.4	-0.16	0.88	8.3	9.7	-2.80	0.01
36 Furniture; manufacturing n.e.c.	5.1	5.2	-0.21	0.84	16.2	17.4	-1.97	0.05

Notes: The null hypothesis under the t test is that the difference between the means of the two data sets is zero.

Table 2.7 shows the baseline estimates of equation (2.17), which are based on total bilateral trade costs estimates that incorporate mirror trade data for Kenya (column 1). The results reported in column (2) are obtained after restricting the sample for the baseline estimates to the years when Kenya reported data. Column (3) shows results based on total bilateral trade costs estimates that incorporate trade data reported by Kenya. The data that is reported by Kenya has gaps in years 1993-1996 and 2011-2012. I restrict the sample to the years when data reported by Kenya is available and remain with 7,388 observations. The baseline estimates (columns 1 and 2) are marginally larger than the estimates reported in column (3) but the difference is not significant. The baseline results are therefore not significantly biased by using mirror trade data for Kenya.

C. Correlation with residuals from a general gravity model

Finally, following Jacks et al. (2011), the total bilateral trade costs estimates are evaluated against the residuals from a general gravity model. According to the gravity equation, any changes in bilateral trade are due to changes in the gross domestic products (GDPs) of the trading countries and the world and/or changes in the bilateral trade costs between the two countries and multilateral resistance (MLR). Once changes to the GDPs and MLR are controlled for, the residuals from a general gravity equation should give an indication of the bilateral trade costs of the country-pair. The residuals arising from a change in bilateral trade flows should correlate negatively with total bilateral trade costs since higher trade values (holding GDP and MLR constant) imply lower bilateral trade costs. The estimated general

Table 2.7: Determinants of total bilateral trade costs, effect of using mirror trade data for Kenya

dependent variable:	ln(total bilateral trade costs)		
	mirror trade data (baseline)		trade data reported by Kenya
	(1)	(2)	(3)
ln(bilateral distance)	0.356*** (0.090)	0.350*** (0.108)	0.347*** (0.104)
common border	-0.302*** (0.071)	-0.288*** (0.091)	-0.286*** (0.090)
common language (official)	-0.200** (0.085)	-0.187** (0.086)	-0.194** (0.087)
common colonizer	0.092 (0.120)	0.061 (0.119)	0.054 (0.117)
landlocked	-0.053 (0.095)	-0.081 (0.105)	-0.032 (0.097)
EAC membership	-0.291** (0.136)	-0.265** (0.134)	-0.260* (0.135)
COMESA membership	-0.061 (0.050)	-0.034 (0.057)	-0.079 (0.069)
Exporter-year fixed effects	Yes	Yes	Yes
Importer-year fixed effects	Yes	Yes	Yes
Industry-year fixed effects	Yes	Yes	Yes
Observations	11,095	7,388	7,388
Adjusted R-squared	0.89	0.89	0.89
total bilateral trade costs, mean	8.0	7.8	8.0

Notes: Table 2.7 shows OLS estimates of equation (2.17). Results in columns (1) and (2) are estimated using mirror trade data for Kenya. Results in column (3) are estimated using trade data reported by Kenya, which has gaps in 1993-1996 and 2011-2012. In all cases, the data for all other countries is unchanged. The constant term is not shown in all cases. The standard errors in parentheses are clustered at the country-pair level. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

gravity equation is of the following form:

$$\ln(x_{ijk,t}x_{jik,t}) = \delta_t + \delta_{i,t} + \delta_{j,t} + \varepsilon_{ijk,t} \quad (2.18)$$

where the logarithm of the product of the value of industry k exports from exporter i to importer j at time t and the value of industry k exports from importer j to exporter i at time t , denoted by $\ln(x_{ijk,t}x_{jik,t})$, is regressed on year fixed effects, δ_t , exporter-year fixed effects, $\delta_{i,t}$, and importer-year fixed effects $\delta_{j,t}$. The year fixed effects control for macroeconomic shocks that affect all countries. The exporter-year and importer-year fixed effects control for MLR as

well as time-varying differences in the supply of and demand for goods across countries that influence their external trade. The error term $\varepsilon_{ijk,t}$ captures residual determinants of bilateral trade including bilateral trade costs.

Equation (2.18) is estimated using OLS and data for each industry separately and using data that is pooled across the industries (that is, I estimate the equation using all the industries' data at once). The residuals obtained from the regressions are then correlated with the natural logarithm of total bilateral trade costs estimates and the results presented in Table 2.8. The correlation coefficients between the model residuals and the total bilateral trade costs estimates are negative indicating that the total bilateral trade costs estimates are reliable.

Table 2.8: Correlation coefficients between $\ln(\text{total bilateral trade costs})$ and residuals from a general gravity equation

ISIC code and description		based on OLS estimates, by industry	based on pooled OLS estimates
		(1)	(2)
15	Food and beverages	-0.44	-0.70
16	Tobacco products	-0.16	-0.73
17	Textiles	-0.47	-0.70
18	Wearing apparel, fur	-0.02	-0.76
19	Leather, leather products and footwear	-0.35	-0.68
20	Wood products (excl. furniture)	-0.45	-0.55
21	Paper and paper products	-0.35	-0.64
22	Printing and publishing	-0.38	-0.62
23	Coke, refined petroleum products, nuclear fuel	-0.35	-0.69
24	Chemicals and chemical products	-0.46	-0.68
25	Rubber and plastics products	-0.43	-0.68
26	Non-metallic mineral products	-0.43	-0.71
27	Basic metals	-0.30	-0.73
29	Machinery and equipment n.e.c.	-0.23	-0.56
34	Motor vehicles, trailers, semi-trailers	-0.23	-0.42
36	Furniture; manufacturing n.e.c.	-0.45	-0.51

Notes: Column (1) shows correlation coefficients between the natural logarithm of total bilateral trade costs and the residuals from estimation of equation (2.18) using data of each ISIC group separately. Column (2) shows correlation coefficients between the natural logarithm of total bilateral trade costs and the residuals from estimation of equation (2.18) using data that is pooled across ISIC groups.

Although this method of inferring trade costs from the residuals of a general gravity model is simpler, I prefer the inverse-gravity method because it uses observed production and trade data and takes into account the substitutability of goods. Besides, the baseline total bilateral trade costs estimates are less strongly correlated with the residuals from industry-specific regressions of equation (2.18) (see column (1), Table 2.8), perhaps indicating missing industry-specific information from the latter estimates.

2.8 Conclusions

The objective of this study is to estimate total bilateral trade costs for manufacturing industries of the East African Community (EAC). Total bilateral trade costs is a single measure that captures all the costs of engaging in cross-border trade relative to the cost of engaging in domestic trade. The measure is estimated from production and bilateral trade data using the inverse-gravity method of [Chen and Novy \(2011\)](#). The total bilateral trade costs estimates are to serve as the basis for evaluating trade policy measures associated with EAC membership. The estimates are useful for the evaluation exercise because they capture a wide range of trade-related costs and thus allow for comprehensive analysis of various trade policy measures. Note, however, that this study does not consider zero trade flows and is therefore limited to the analysis of trade costs at the intensive margin of trade.

This study uses data on production and exports of manufactured goods in 16 industries for 5 members of the EAC and 87 trade partners over the period 1990-2012. The largest among the industries in terms of the value of output and cross-border trade are those manufacturing food and beverages, chemicals and chemical products, and non-metallic mineral products. A wider range of goods is produced and traded by Kenya and Tanzania as compared with the other EAC countries. The elasticities of substitution among the goods, which are needed to calculate the total bilateral trade costs, are estimated using the method in [Feenstra \(1994\)](#). The elasticity of substitution parameters for the dominant industries average to 7 compared with the range of elasticity of substitution parameters for all industries of 3 to 14. The total bilateral trade costs estimates generated using these parameters average to 8 (excluding outliers) and range from 1 to 14,826. This means that for EAC countries, cross-border trade costs are on average 8 times higher than domestic trade costs. Robustness checks confirm the total bilateral trade costs estimates to be reliable albeit sensitive to the elasticity of substitution parameter. It is therefore appropriate that both the total bilateral trade costs and elasticity of substitution parameters are estimated at the same level of disaggregation.

Simple comparative analysis shows that EAC total bilateral trade costs are lower with respect to coastal trade partners who are located closer to the region. The analysis also shows that intra-EAC total bilateral trade costs trended downwards after 2000, coinciding with the coming into effect of the EAC Treaty. In terms of the distribution of estimates across industries, the comparative analysis shows that industries with higher total bilateral trade costs also tend to have higher product weight-to-value ratios and face higher import tariff rates. These findings indicate geographical location and trade policy measures to be determinants of the total bilateral trade costs.

Chapter 2: Estimating Total Bilateral Trade Costs

More formally, results from OLS regressions indicate that total bilateral trade costs of EAC countries increase with geographical distance and decrease with trade agreements. The EAC trade agreement is found to be particularly important in determining the total bilateral trade costs suggesting that the costs are amenable to policy intervention. Further regression results show that the influence of the EAC trade agreement on trade costs varies across industries.

The findings of this chapter motivate further study of the relationship between the total bilateral trade costs estimates and policy measures implemented under the EAC Treaty. Of interest is the effect on total bilateral trade costs of the removal of import tariffs and the upgrading of transportation infrastructure. This is because the removal of import tariffs is the longest standing, having been completed in 2009, while the ongoing upgrading of transportation infrastructure is the most expensive venture yet. The study of these two policies is undertaken in the next two chapters of this thesis.

3. Elimination of Import Tariffs

3.1 Introduction

The rest of this thesis evaluates the usefulness of two key policies of the East African Community (EAC) in lowering the external trade costs faced by manufacturing industries. The policies are the elimination of import tariffs and the upgrading of transit roads. This chapter analyses the effect of the elimination of import tariffs.

The estimates from chapter 2 of this thesis indicate that total bilateral trade costs for intra-EAC trade declined after 2000, which is also when the EAC Treaty took effect (see [Figure 2.5](#) in chapter 2 of this thesis). Subsequent regression results show that membership in the EAC lowered total bilateral trade costs facing manufacturing industries. The rest of this thesis explains how EAC membership affected external trade costs. The channels are the various integration initiatives that were implemented under the EAC Treaty beginning 2000. These include the harmonisation of macroeconomic policies, the upgrading of transportation and communication networks, and the establishment of the customs union. The EAC customs union protocol, which took effect in 2005, provides for the removal of import tariffs charged on goods originating from within the Community. The protocol also provides for the removal of non-tariff barriers particularly lengthy administrative procedures at customs borders. Reforms to customs procedures are reported to have reduced by about a third the number of documents and days needed to clear goods at the borders over the period 2006-2011 ([World Bank, 2012](#), p. 61).

This paper progresses the findings from the second chapter of this thesis and estimates the contribution of import tariff elimination in lowering intra-EAC total bilateral trade costs. Focus is on import tariffs because of the availability of industry-level data on import tariffs. The chapter does two things. First, it formally estimates the effect of EAC membership on total bilateral trade costs before and after the customs union took effect in 2005. Second, it estimates the role of import tariff elimination in explaining the impact of the customs union. The present study answers the question: to what extent did import tariff elimination under the EAC customs

Chapter 3: Elimination of Import Tariffs

union protocol lower total bilateral trade costs among EAC countries?

The results from this study will explain the impact of EAC membership on external trade costs facing manufacturing industries in terms of the effectiveness of the customs union and, more specifically, the removal of intra-EAC import tariffs. The results will be useful in evaluating the significance of import tariffs as a trade cost. This is relevant because although advanced economies have lowered their import tariff rates considerably overtime, import tariffs remain an important trade policy tool in Africa.

In this paper, the total bilateral trade costs used are derived from production and trade data following the inverse-gravity method of [Chen and Novy \(2011\)](#). The measure is country-pair specific and captures all the costs of engaging in cross-border trade relative to the cost of trading domestically in each of the trade partners. The tariff rate used in this study is the effectively applied nominal import tariff rate for the exporter as this is the rate that is actually charged on imports and thus captures the elimination of tariffs. The total bilateral trade costs and import tariff rates are measured at the ISIC 2-digit level of production for period 2000-2012. Both variables vary annually at the exporter-importer-industry level. I use an EAC binary variable to capture all EAC trade policy initiatives aimed at lowering bilateral trade costs including those associated with the customs union. The indicator variable takes the value one if both countries in a pair are members of the EAC and zero otherwise.

The total bilateral trade costs, import tariff rate and EAC binary variables are analysed within a difference-in-differences (D-i-D) framework, in which the control group comprises country-pairs with EAC exporters and non-EAC importers. These country-pairs are not subject to the EAC customs union protocol. I exploit the panel structure of the data and use country-pair fixed effects to account for characteristic differences across country-pairs and thus address selection bias into the EAC trade agreement.

Within the D-i-D framework, total bilateral trade costs is regressed on the EAC binary variable, an interaction between the EAC binary variable and a time binary variable, and the time binary variable, which equals to one for years in the period that the customs union was effective (2005-2012) and zero otherwise. The estimated coefficient on the EAC binary variable would measure the response of intra-EAC total bilateral trade costs to trade policies implemented beginning 2000 when the EAC Treaty took effect. The coefficient on the interaction term would measure the response of intra-EAC total bilateral trade costs to the trade policies implemented beginning 2005 when the customs union took effect. These policies include the removal of intra-EAC import tariffs and non-tariff barriers. Differences between intra-EAC and extra-EAC total bilateral trade costs that existed before 2005 are accounted for by the control group. The import tariff rate charged by the EAC exporters is then included as an additional regressor in the equation. The coefficient on the import tariff rate captures the response of total

bilateral trade costs to the change in import tariffs net of all other EAC trade policy effects. Potential biases arising from the endogeneity of the EAC binary variable in the equation are addressed using country-pair and industry fixed effects. Robustness checks are undertaken to gauge potential biases arising from mismeasurement of total bilateral trade costs as well as assumptions underlying the choice of the control group.

The estimated coefficient on the interaction of the EAC and time binary variables indicates that over the period 2005-2012, intra-EAC total bilateral trade costs were lower than extra-EAC total bilateral trade costs by 29 per cent due to the EAC customs union non-tariff trade reducing policies while elimination of import tariffs is found to be insignificant in explaining the decline in intra-EAC total bilateral trade costs. However, excluding two industries with very high trade costs, the removal of import tariffs is found to explain 9 per cent of the decline in total bilateral trade costs over the period 2005-2012, while the non-tariff reducing measures explain 20 per cent of the decline. The calculated tariff equivalent effect of the non-tariff reducing measures on total bilateral trade costs is -17 per cent.¹ These results indicate that trade policy initiatives targeting trade barriers other than import tariffs were more effective in lowering the total bilateral trade costs. This conclusion prevails when regressions are run on the data of each industry separately.

The present study contributes to the existing literature on regional trade within the EAC, which offers little, if any, evidence on the effect that import tariff liberalisation had on the total bilateral trade costs among EAC countries. The literature however provides evidence that the elimination of import tariffs under the EAC customs union resulted in a substantial increase in intra-EAC trade flows (Mayer and Thoenig, 2016; Buigut, 2012; Khorana et al., 2009; McIntyre, 2005). Buigut (2012) finds that the customs union increased the value of intra-EAC trade flows by between 85 and 185 per cent (the effect varies by country and by direction of trade) while Mayer and Thoenig (2016) find that the customs union increased the value of intra-EAC trade flows by 42 per cent. This evidence points to a lowering of intra-EAC bilateral trade costs.² Elsewhere, Eberhard-Ruiz and Moradi (2018) find that the establishment of the EAC lowered the cost of crossing intra-EAC borders for local small-scale traders, resulting in a temporary increase in economic activity within border cities.

The present study is close to the set of papers that analyse the determinants of total bilateral trade costs (Jacks et al., 2010; Chen and Novy, 2011; Jacks et al., 2011; Novy, 2013; Arvis et al., 2016). Total bilateral trade costs is a comprehensive measure of the cost of engaging

¹This compares with the average fall in intra-EAC import tariff rates of 12.7 percentage points following liberalisation.

²From the standard gravity model, changes in trade flows between two countries may arise from changes in output of the two countries and/or changes in the cost of trading goods between the two countries and/or changes in each of the two countries' trade costs with all countries.

in external trade, which is derived from observed production and trade data using the method presented in [Chen and Novy \(2011\)](#). The present paper contributes to this literature evidence of the relative importance of tariff versus non-tariff measures in explaining total bilateral trade costs from the perspective of developing economies in East Africa.

The present paper is also related to the literature that studies the effect of regional trade agreements (RTAs) and import tariffs on bilateral trade flows. The literature reports some evidence of a positive relationship between RTAs and bilateral trade flows, conditional on country-pair characteristics. Bilateral and multilateral geographical distance, similarity in economic size, endowment (relative use of labour and capital in production), and language are found to be important determinants of the formation of RTAs among countries. These same factors determine the responsiveness of bilateral trade flows among members to the RTA and associated tariff reduction ([Baier and Bergstrand, 2004](#); [Vicard, 2011](#)). Whether membership in an RTA improves a country's welfare (as opposed to simply increasing the country's trade flows) is addressed in the literature that studies the trade creation and trade diversion effects³ of an RTA ([Panagariya, 2000](#)). This literature finds more evidence in favour of trade creation, which in turn reflects the endogenous nature of RTA formation ([Freund and Ornelas, 2009](#)).

Also within the literature on the effect of RTAs on bilateral trade flows, is a set of studies that attributes about a third of the growth in bilateral trade flows to lower trade-related costs ([Baier and Bergstrand, 2001](#); [Jacks et al., 2010, 2011](#); [Pomfret and Sourdin, 2009](#); [Gaurav and Mathur, 2016](#)), and specifically between 3 and 13 per cent to reductions in import tariffs ([Buono and Lalanne, 2012](#); [Debaere and Mostashari, 2010](#)). In terms of the magnitude of the effect of RTAs on trade flows among members, [Baier and Bergstrand \(2007, 2009\)](#) estimate a doubling of trade flows over 10 years after the formation of the RTA. The estimated responsiveness of trade volumes to import tariffs is however small; [Sequeira \(2016\)](#), [Hoekman and Nicita \(2011\)](#) and [Iwanow and Kirkpatrick \(2009\)](#) report elasticities in the range of 0.02 and 0.2. Collectively, the evidence from this literature is indication of the significance of non-tariff related trade barriers in inhibiting cross-border trade. In contrast, the dependent variable in the present study is trade costs as opposed to trade flows, therefore larger coefficients on the import tariff variable are reported. [Milner and McGowan \(2013\)](#) show that the responsiveness of trade flows to changes in trade costs depends on the trade cost intensities of industries. The present study contributes to this literature evidence from East Africa on the relative importance of tariff and non-tariff measures within an RTA in determining the total bilateral trade costs facing manufacturing industries.

³Trade creation refers to the “shift of production from inefficient domestic providers to efficient RTA members” and trade diversion refers to the “shift of production from efficient external suppliers to inefficient members” ([Freund and Ornelas, 2009](#), p. 1).

The rest of this paper is structured as follows: section 3.2 provides an overview of changes in import tariff rates due to the EAC customs union protocol. The data used in the analysis is described in section 3.3. Section 3.4 describes the empirical strategy, which is implemented, and the results presented in section 3.5. Robustness checks are conducted in section 3.6 and section 3.7 concludes.

3.2 Trade agreements and import tariff rates

The GATT/WTO rules on trade allow for membership in the World Trade Organisation (WTO) and membership in regional trade agreements to overlap provided that the common regional import tariff rates do not exceed the most favoured nation (MFN) import tariff rates⁴ that prevailed prior to formation of the regional trade area, and provided that intra-regional import tariffs are eliminated. Two types of tariffs could be charged alternatively on imports by importing countries. The MFN rate, which is the maximum tariff that is chargeable on imports originating from members of the WTO, and the AHS rate, which is a lower tariff that is chargeable on imports originating from fellow members of a preferential trade agreement. If no preferential trade agreement exists between the trading countries, the AHS rate is equal to the MFN rate. For example, EAC countries charge the MFN rate on imports from trade partners who are WTO members unless the partners are also members of the EAC, in which case imports from EAC partners are levied the lower AHS rate. However, to qualify for the lower AHS rate, goods traded within the EAC must meet rules of origin criteria⁵, which qualifies them as having originated from within the EAC. Otherwise, the higher MFN rate would apply.

This study includes 78 countries who are not members of the EAC but who traded in manufactured goods with EAC countries in the sample period (1990-2012). [Figure 3.1](#) plots the import tariff rates that were charged on imports from these 78 countries into the EAC and the tariff rates that were charged on the exports from EAC countries into these 78 countries. The tariff rates are averaged across countries belonging to the same geographical region.

[Figure 3.1](#) shows that for the sample of countries in the study and for manufactured goods in the 16 ISIC categories of interest, the highest MFN rates were the ones charged by EAC countries on imports from Russia, East Asia, the Pacific, Europe and North America. The lowest MFN rates were the ones charged by North America and Europe on imports from the EAC. Europe and North America (essentially, the United States of America, USA) also charged the lowest

⁴The Most Favoured Nation (MFN) duty is the highest nominal tariff that is chargeable on imports of goods originating from any WTO member country.

⁵The criteria considers the share of imported content in the total value of the final product ([East African Community, 2006](#)).

Chapter 3: Elimination of Import Tariffs

preferential tariff rates (AHS) on manufactured goods imported from the EAC. Generally, more restrictive import tariff barriers for manufactured goods is attributable to Sub-Saharan African countries while less restrictive import tariff barriers for the goods is attributable to Europe and North America.

Figure 3.1: Most Favoured Nation (MFN) and Effectively Applied (AHS) import tariff rates on manufactured goods by geographical region for period 1994, 1997-2012



Notes: The Most Favoured Nation (MFN) tariff is the highest nominal tariff that is chargeable on imports of goods originating from any WTO member country. The Effectively Applied (AHS) tariff is the nominal tariff that is actually charged on imports of goods. The AHS tariff could be the MFN rate or a preferential rate. The figure shows the simple average of tariff rates charged by countries belonging to the geographical locations identified in the figure. **Source:** World Bank's World Integrated Trade Solution (WITS) online database.

In Figure 3.1, the gap between the MFN and AHS import tariff rates charged by the importing country indicates the presence of a preferential trade agreement between the importer country and the trade partner. For instance, EAC countries charged an average MFN tariff rate of 18 per cent on goods imported from Sub-Saharan Africa and an average AHS tariff rate of 10 per cent on goods that qualified for preferential access. EAC countries were also faced with an average MFN tariff rate of 17 per cent charged on their exports to other Sub-Saharan African countries but benefitted from lower AHS tariff rates of 9 per cent on average. The lower AHS tariff rates on both the import and export side of trade between EAC and Sub-Saharan African countries are obtained because EAC countries were parties to preferential trade agreements with some Sub-Saharan African countries during the study period. Burundi, Kenya, Rwanda and Uganda were partners in the Common Market for Eastern and Southern Africa (COMESA) customs union effective 1994 with Egypt, Ethiopia, Madagascar, Malawi, Mauritius and Zambia. Tanzania was a partner in the Southern African Development Community (SADC)

free trade agreement effective 2000 with Botswana, Malawi, Mauritius, Namibia, South Africa and Zambia.

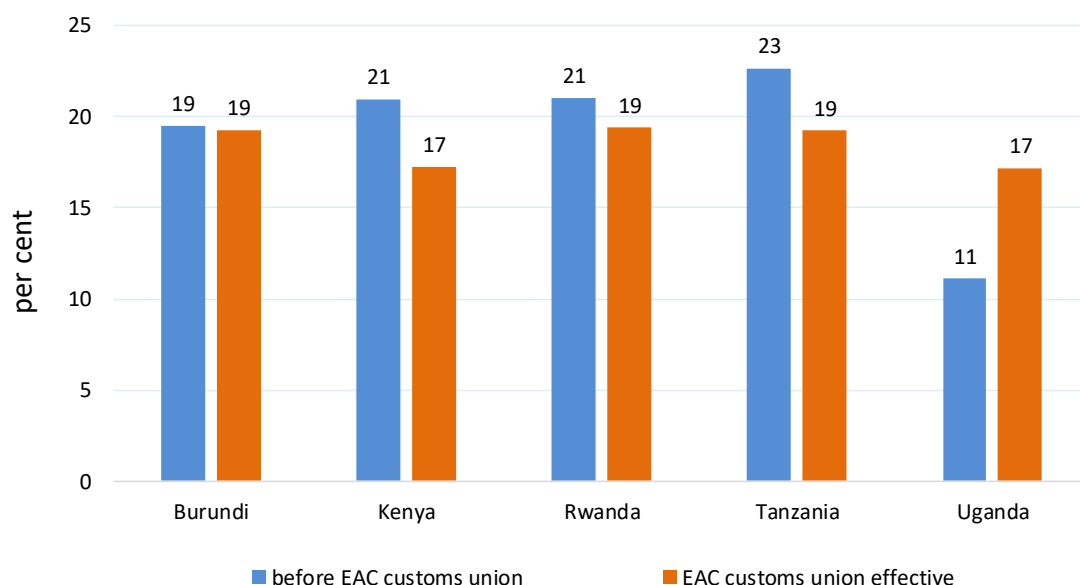
While preferential market access was reciprocated among EAC and Sub-Saharan African countries as well as countries in the Middle East and North Africa, countries in Asia, Europe and North America gave preferential market access to EAC manufactured goods but did not receive preferential access for their manufactured goods to the EAC market. In [Figure 3.1](#), there is no difference between MFN and AHS tariff rates charged by EAC countries on imports from Asia, Latin America and the Caribbean, the Pacific, Europe, the Russian Federation and North America indicating that manufactured goods from these regions were not granted any preferential access to EAC markets. On the other hand, EAC manufactured goods were granted preferential access to some markets in these regions (particularly Europe and North America) hence the lower average AHS tariff rates charged on goods from EAC as compared with the MFN rate. From the 1970s, Burundi, Kenya, Rwanda, Tanzania and Uganda enjoyed duty free access to Australia, Canada, the European Union, Japan, New Zealand, Switzerland, USA, as well as Turkey from 2002 and the Russian Federation from 2010 under the Generalized System of Preferences. Except for Kenya, the other four EAC members also had access under Duty-Free Treatment for Least Developed Countries to Korea from 2000, Morocco from 2001, Iceland from 2002, India from 2008 and China from 2010. Beginning 2000, Kenya, Rwanda, Tanzania and Uganda additionally benefitted from preferential access to the USA under the African Growth and Opportunity Act.

The EAC customs union protocol and import tariff rates

The customs union protocol of the EAC was signed by Kenya, Tanzania and Uganda in 2004 (and became effective in 2005) and by Burundi and Rwanda in 2009. The protocol provides for common import tariff rates to be applied by EAC countries on goods imported from non-EAC countries, and for the removal of tariffs on imports originating from EAC countries. The protocol defines the common external tariff in 3 bands; a minimum rate of 0 per cent (for raw materials, plant and machinery), a middle rate of 10 per cent (for intermediate goods) and a maximum rate of 25 per cent (for finished goods)⁶ ([East African Community, 2004](#)). After adoption of the common external tariff, the average MFN tariff rate levied by Kenya, Rwanda and Tanzania on imports of the manufactured goods sampled in this study declined while the average MFN tariff rate charged by Uganda increased, and all converged around 18 per cent (see [Figure 3.2](#)).

⁶Goods categorised as sensitive have tariff rates higher than 25. Sensitive goods include agriculture and textile products.

Figure 3.2: Most Favoured Nation (MFN) tariff rates by country, averaged across manufacturing industries for period 1994, 1997-2012

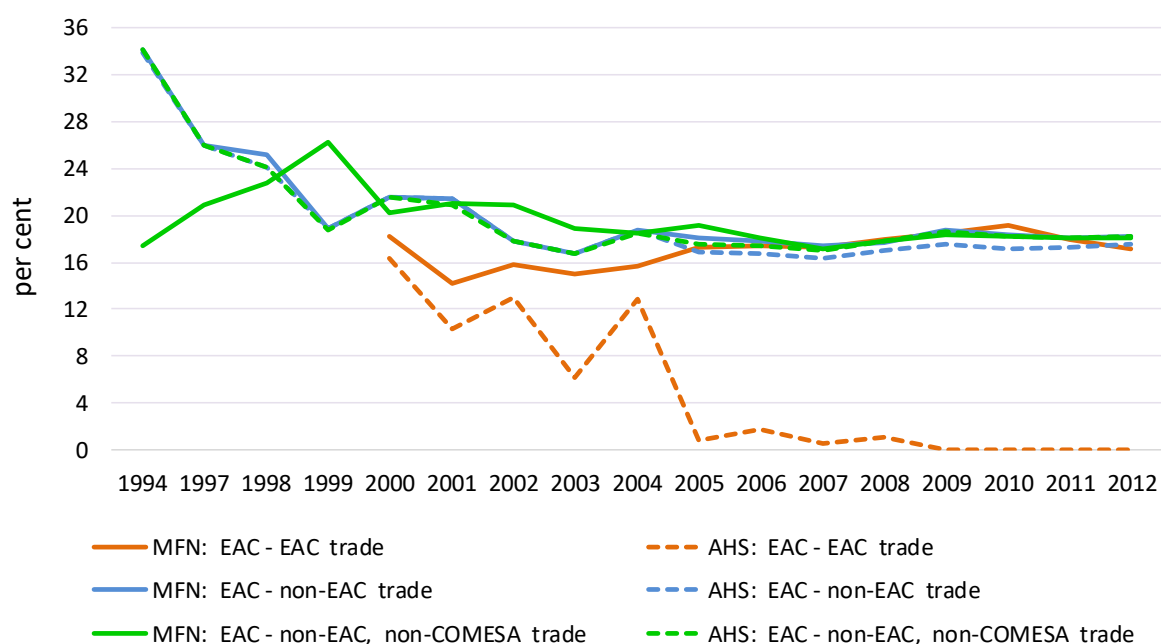


Notes: The figure shows the simple average of Most Favoured Nation (MFN) tariff rates applicable to each traded product falling under the 16 ISIC 2-digit categories considered in this study. The MFN tariff is the highest nominal tariff that is chargeable on imports of goods originating from any WTO member country. The EAC customs union became effective in 2005 for Kenya, Tanzania and Uganda and in 2009 for Burundi and Rwanda. **Source:** World Bank's World Integrated Trade Solution (WITS) online database.

Concerning the elimination of intra-EAC import tariffs, the customs union protocol states that tariffs on goods flowing from Tanzania and Uganda into Kenya, and goods flowing between Tanzania and Uganda are to be eliminated in 2005. Tariffs on some goods originating from Kenya and imported by Tanzania and Uganda were scheduled to be eliminated over a 5-year period beginning 2005. For instance, for goods flowing from Kenya into Uganda and listed as “Category B goods” (mostly manufactured goods), tariff rates were scheduled to decline to 10 per cent in 2005, to 8 per cent in 2006, to 6 per cent in 2007, to 4 per cent in 2008, to 2 per cent in 2009, and 0 per cent thereafter ([East African Community, 2004](#)). The customs union became effective in Burundi and Rwanda in 2009. Both countries removed import tariffs for goods imported from other EAC members in 2009.

Following implementation of the protocol, the AHS tariff rates charged by EAC countries on imports of manufactured goods originating from within the EAC declined from an average of about 16 per cent in 2000 to 0 per cent in 2009 (see [Figure 3.3](#)). The MFN tariff rates applicable to intra-EAC trade on average rose in 2005 reflecting the adoption of higher common external tariff rates by Uganda, which initially had lower rates than the other EAC countries (the MFN rate still applied to goods traded within the EAC in cases where the rules of origin conditions were not met).

Figure 3.3: Nominal import tariff rates charged by EAC countries, averaged across countries and manufacturing industries

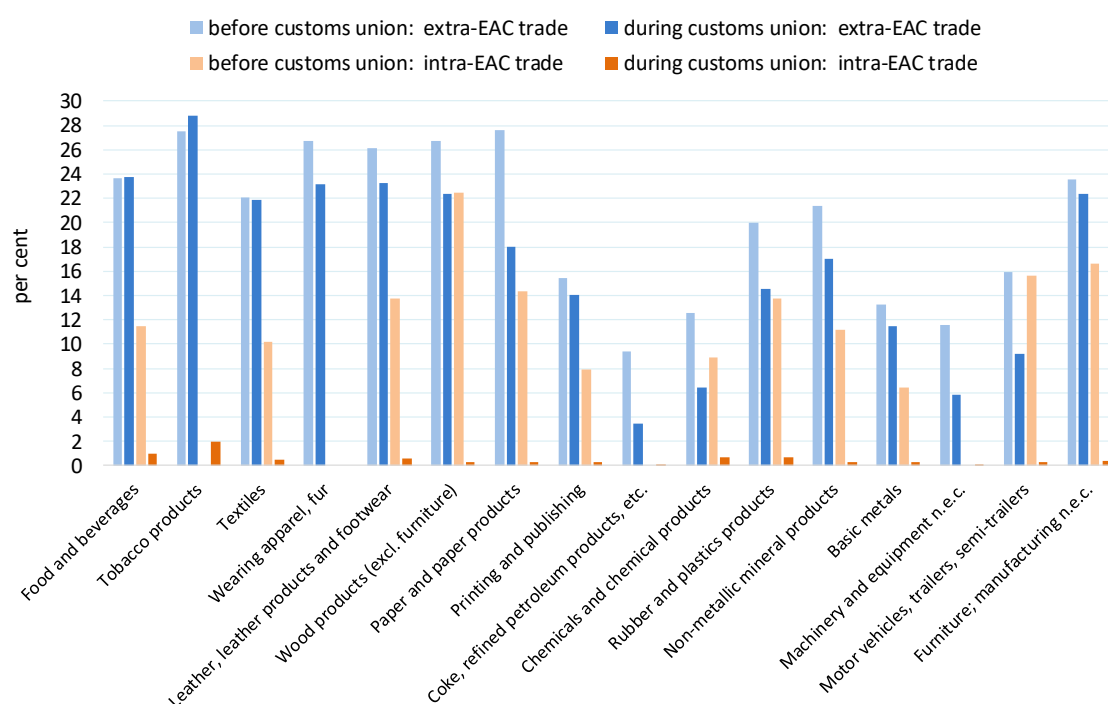


Notes: The Most Favoured Nation (MFN) tariff is the highest nominal tariff that is chargeable on imports of goods originating from any WTO member country. The MFN rate applied to goods traded within the EAC in cases where the rules of origin conditions were not met. The Effectively Applied (AHS) tariff is the nominal tariff that is actually charged on imports of goods. The AHS tariff could be the MFN rate or a preferential rate. Both duty types are averaged simply across product lines within each industry category to arrive at the industry-level average duty rate. **Source:** World Bank's World Integrated Trade Solution (WITS) online database.

Figure 3.3 also shows that on average, the AHS tariff rates effectively charged on manufactured goods imported into the EAC from non-EAC countries declined from around 34 per cent in 1994 to 18 per cent in 2012. For goods imported from non-EAC countries, there is only a small gap between the MFN and the AHS tariff rates indicating that EAC countries did not give much preferential market access to non-EAC countries. Prior to the enforcement of the EAC customs union protocol in 2005, there was some concession on import tariff rates among EAC countries arising from their existing partnership in the COMESA trade agreement. This is reflected in the gap between the MFN and AHS tariff rates charged on manufactured goods traded among EAC countries over the period 2000-2004.

Figure 3.4 shows the AHS import tariff rates by manufacturing industry, averaged across the 5 EAC countries. During the period that the EAC customs union was not in effect (1994-2004), the import tariff rates charged on manufactured goods imported from within the EAC were comparably higher for wood products, furniture and miscellaneous manufactures, motor vehicles and trailers, paper, rubber and plastics products, and lowest for basic metals. After the customs union protocol took effect in 2005, this tariff barrier was removed.

Figure 3.4: Nominal effective (AHS) import tariff rates, averaged across EAC countries



Notes: Figure 3.4 shows the Effectively Applied (AHS) tariff rate, which is the nominal tariff rate that is actually charged on imports of goods. The industry-level average tariff rates are the simple average of tariff rates applied at the product level within each industry category. The EAC customs union took effect in 2005. Extra-EAC trade refers to trade between an EAC country and a non-EAC country. Intra-EAC trade refers to trade between two EAC countries. **Source:** World Bank's World Integrated Trade Solution (WITS) online database.

In Figure 3.4, the bars corresponding to the period 2005-2012 for intra-EAC trade are not at zero reflecting the phasing out of tariffs imposed on EAC products after members assented to the customs union protocol, as well as the later entry by Burundi and Rwanda. The bars corresponding to the period 2005-2012 for intra-EAC trade imply that the slowest decline in tariff rates was for tobacco products, food and beverages, chemicals and chemical products, and rubber and plastics products. For the remaining industries, most tariffs were eliminated in the first year after the customs union protocol was signed.

For manufactured goods imported from non-EAC countries, import tariff rates charged by EAC countries declined across industries except for tobacco products, and food and beverages. After 2005, the tariff rates averaged 24 per cent for tobacco products, food and beverages, leather products, wearing apparel and wood products, and averaged 5 per cent for coke and fuel products, machinery and equipment, and chemicals and chemical products.

This section has reviewed the time trends in import tariff rates charged on manufactured goods imported by EAC countries over the period 1994-2012. The review shows the preference for high import tariffs by EAC countries to support their manufacturing sectors. The tariff barrier

facing intra-regional trade in manufactured goods is eliminated gradually beginning 2005 while the extra-regional import tariff rates remained, edging slightly downwards (except for Uganda). Overall, the adoption of the common external tariff rates does not, on average, occasion a marked adjustment to pre-existing tariff rates facing imports from outside the Community. There is therefore unlikely to be a substantial effect of the adoption of the common external tariff rates on extra-EAC total bilateral trade costs. A larger, negative impact on intra-regional total bilateral trade costs is expected to accrue from the removal of import tariffs.

For the case of Uganda, which adopted higher common external tariff rates after 2004, a stronger trade diverting effect of EAC membership would be expected. This is because higher extra-EAC import tariff rates would mean higher total bilateral trade costs for Uganda with respect to non-EAC countries. [Buigut \(2012\)](#) however finds no significant effect of the change in external tariffs on Uganda's importing behaviour.

3.3 Data description

Sample: The sample for this study consists of 245 country-pairs comprising 20 EAC-exporter and EAC-importer pairs and 225 EAC-exporter and non-EAC-importer pairs, 16 International Standard Industrial Classification (ISIC) revision 3 manufacturing categories at the 2-digit level and 13 years (2000-2012). All exporter countries in the sample are EAC countries, namely Burundi, Kenya, Rwanda, Tanzania and Uganda. The importer countries are the 5 EAC countries and 78 non-EAC countries. The distribution of country-pairs across the industry categories is determined by the availability of data on bilateral trade flow values and import tariff rates, all at the ISIC 2-digit level. The countries used in the study are listed in Appendix B, [Table B.1](#) and the list of industry categories considered is provided in Appendix B, [Table B.2](#).

Total bilateral trade costs: The total bilateral trade costs are estimated at the ISIC revision 3 2-digit level using production and trade data for 16 manufacturing industries and for 5 EAC countries and their trade partners. Production and trade data are obtained from the United Nations' Industrial Development Organization's Industrial Statistics (INDSTAT2) and International Commodity Trade Statistics (COMTRADE) online databases, respectively. The total bilateral trade costs are derived in chapter 2 of this thesis using the inverse-gravity method of [Chen and Novy \(2011\)](#).

The tariff equivalent of the estimated total bilateral trade costs between exporter i and importer j in industry k is defined as follows:

$$\text{tariff equiv. total bilateral trade costs}_{ij}^k = \left(\frac{t_{ij}^k t_{ji}^k}{t_{ii}^k t_{jj}^k} \right)^{\frac{1}{2}} - 1 = \left(\frac{x_{ii}^k x_{jj}^k}{x_{ij}^k x_{ji}^k} \right)^{\frac{1}{2(\sigma_k - 1)}} - 1$$

where t_{ij}^k and t_{ji}^k are the unidirectional cross-border trade cost factors between exporter i and importer j for industry k , and t_{ii}^k and t_{jj}^k are the domestic trade cost factors in countries i and j for industry k , respectively. The ratio of external to domestic trade costs is derived as the geometric mean of the ratio of the product of the value of domestic trade in exporter i and importer j for industry k , denoted by $x_{ii}^k x_{jj}^k$, to the product of the value of unidirectional trade between exporter i and importer j for industry k , denoted by $x_{ij}^k x_{ji}^k$. σ_k is the elasticity of substitution for industry k , which is estimated following the method in [Feenstra \(1994\)](#) and is assumed to be the same across countries. One is subtracted from the ratios to obtain tariff equivalent total bilateral trade costs. This way, external trade costs are expressed as a mark-up on domestic trade costs (or prices⁷).

Import tariff rates: Import tariff rates at the ISIC revision 3 2-digit level for each country in the sample are obtained from the UNCTAD's Trade Analysis Information System (TRAINS) database accessed through the World Bank's World Integrated Trade Solution (WITS) website. The industry-level import tariff rates are calculated as averages of the nominal tariff rates that are levied on individual products. Data is available for the simple and weighted averages of Most Favoured Nation (MFN) and Effectively Applied (AHS) duty types from 1994 to 2012, but with gaps. The study does not consider the bound (BND) duty type, which represents the upper limit beyond which the MFN tariff rate cannot be raised. The study uses the AHS tariff rate (simple average) as this is the one that reflects concessional tariff rates as well as the MFN rate if there is no concession on import tariffs between two countries.

Data on tariff rates applied by EAC countries on imports originating from within the EAC begins in 2000, so the sample period for this paper is 2000-2012. The data on total bilateral trade costs and import tariff rates is summarised in [Table 3.1](#); a more detailed summary is provided in Appendix B, [Table B.3](#). For the period 2000-2012 (Panel A of [Table 3.1](#)), total bilateral trade costs are lower among EAC members and less dispersed across industries as compared with the observations for extra-EAC trade. Consistent with earlier evidence suggesting that the EAC decreased internal trade costs, the data also shows that intra-EAC total bilateral trade costs are on average lower at 4.4 in the period 2005-2012 (Panel C) as compared with the average total bilateral trade costs of 5.1 for the period 2000-2004 (Panel B).

⁷In the gravity model from which total bilateral trade costs are derived, bilateral trade costs are reflected in the difference between the prices of traded goods at origin and the prices at destination.

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The data also reflects the decline in the common external import tariff rates from an average of 19.3 in period 2000-2004 to 17.0 in period 2005-2012. Notwithstanding this decline, extra-EAC total bilateral trade costs increased over the two time periods from 42.0 to 67.6 indicating that non-tariff trade barriers are the more dominant determinants of extra-EAC trade costs. The import tariff rates are also comparably lower for intra-EAC trade due to their elimination beginning 2005 (Panel C) when the EAC customs union took effect.

Table 3.1: Descriptive statistics

	intra-EAC bilateral trade			extra-EAC bilateral trade		
	obs.	mean	std. dev.	obs.	mean	std. dev.
<i>Panel A. Data for period 2000-2012</i>						
total bilateral trade costs	574	4.6	8.0	7,004	61.0	370.2
tariff equivalent total bilateral trade costs	574	3.6	8.0	7,004	60.0	370.2
import tariff rate of EAC country	574	3.9	8.0	7,004	17.6	8.5
<i>Panel B. Data for period 2000-2004</i>						
total bilateral trade costs	149	5.1	7.8	1,818	42.0	160.3
tariff equivalent total bilateral trade costs	149	4.1	7.8	1,818	41.0	160.3
import tariff rate of EAC country	149	13.2	10.7	1,818	19.3	8.9
<i>Panel C. Data for period 2005-2012</i>						
total bilateral trade costs	425	4.4	8.1	5,186	67.6	419.4
tariff equivalent total bilateral trade costs	425	3.4	8.1	5,186	66.6	419.4
import tariff rate of EAC country	425	0.6	2.4	5,186	17.0	8.3

Notes: The data in Table 3.1 is averaged across 16 manufacturing industries. Intra-EAC trade refers to trade between two EAC countries. Extra-EAC trade refers to trade between an EAC country and a non-EAC country. The EAC customs union became effective in 2005. **Source:** Author's calculations based on data from INDSTAT2, COMTRADE and WITS/TRAINS online databases.

3.4 Method

A. Empirical strategy

Several policy actions to reduce the cost of cross-border trade were implemented by EAC governments during the study period (2000-2012). These policy actions are prioritised in the EAC Treaty that established the Community, which came into effect in 2000. The Treaty provides for members to co-operate in trade liberalisation and development, which includes the establishment of the customs union ([East African Community, 2002](#)). Specific initiatives listed in the customs union protocol that became effective in 2005 are the removal of intra-EAC import tariffs and equivalent charges, establishment of a common external tariff, removal of non-tariff barriers to importation with respect to EAC countries, and reduction of administrative requirements at customs borders ([East African Community, 2004](#)). Other areas of co-operation

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provided for in the EAC Treaty include investment and industrial development, infrastructure, and monetary and financial policy. Concerning infrastructure, strategic priority is given to the development of regional transport and communication networks. This includes coordinated construction of regional trunk roads and maintenance of existing road networks.

These policy actions are being implemented concurrently by EAC countries, albeit with different start dates (meaning that there is some time overlap in project implementation). The decline in intra-EAC total bilateral trade costs over the study period therefore reflects the effects of the various policy actions. The purpose of this study is to estimate the contribution of the customs union and particularly the removal of import tariffs in lowering intra-EAC total bilateral trade costs.

The strategy to isolate the effect of the customs union on total bilateral trade costs relies on a difference-in-differences model. The model includes an EAC binary variable that takes the value one for country-pairs that comprise only EAC members and zero otherwise. This variable captures all EAC trade policies that were implemented beginning 2000, when the EAC Treaty came into force. The model also includes a time binary variable that takes the value one for years in the period when the EAC customs union was effective (2005-2012) and zero otherwise. The interaction between the EAC and time binary variables captures all EAC trade policies that were implemented beginning 2005, thus separating policy effects due to the customs union from other EAC trade policy effects. Pre-trends in total bilateral trade costs are controlled for using country-pairs comprising non-EAC trade partners.⁸ This assumes that total bilateral trade costs for intra-EAC trade and extra-EAC trade exhibited similar behaviour before 2005. This assumption is reasonable because trade policies that truly discriminated between intra- and extra-EAC trade were implemented beginning 2005 with the enforcement of the customs union. Country-pair fixed effects are included in the model to control for characteristic differences across country-pairs and associated selection bias into the EAC trade agreement. The model also includes the import tariff rate, which captures the removal of intra-EAC import tariffs due to the customs union.

In the difference-in-differences model, country-pair and industry fixed effects are included to also control for endogeneity of the EAC binary variable arising from omitted variables. Robustness checks are used to assess potential biases arising from the mismeasurement of the total bilateral trade costs variable. Robustness checks are also applied to test the parallel trend assumption underlying the control group.

In the main specification of the model that is outlined in the following subsection, total bilateral trade costs is regressed on an interaction between the EAC and time binary variables, the

⁸The EAC binary variables takes the value zero for country-pairs comprising non-EAC trade partners.

EAC and time binary variables separately, the import tariff rate and a set of country-pair and industry fixed effects. The coefficient on the interaction term captures the differential effect of all EAC trade policies related to the customs union (net of the effect of tariff elimination) on intra-EAC trade costs relative to extra-EAC trade costs. This coefficient thus captures the effect of lowering trade barriers other than import tariffs. The coefficient on the import tariff rate captures the effect of tariff elimination on intra-EAC total bilateral trade costs net of all other EAC policy effects. The coefficient on the import tariff rate also captures the effect of the common external tariffs charged on imports originating from outside the EAC. This effect is expected to be small as there was little adjustment to extra-EAC import tariffs rates as depicted in [Figure 3.3](#). This is with the exception of Uganda that increased its tariffs on extra-EAC imports by an average of 6 percentage points (see [Figure 3.2](#)).

The coefficient on the interaction between the EAC and time binary variables is expected to be negative and the coefficient on the import tariff rate is expected to be positive. The empirical literature suggests that the coefficient capturing the effects of trade barriers not related to tariffs would be larger than the coefficient capturing effects of changing tariffs. To make the two effects comparable, I calculate the tariff equivalent effect of customs union non-tariff reducing policy measures on total bilateral trade costs using the coefficient on the interaction term and the coefficient on the import tariff rate.

B. Model specification

The variables of interest are summarised within a difference-in-differences framework in [Table 3.2](#). Panel A (column 3) shows that import tariff rates for intra-EAC trade declined after 2004 by 11 percentage points compared with a 2-percentage point decline for extra-EAC trade. The average total bilateral trade costs are also lower post-2004 for intra-EAC trade by 26 per cent but are higher post-2004 for extra-EAC trade by 1 per cent (Panel A, column 6). The difference-in-differences estimate indicates that during the period in which the customs union was effective, total bilateral trade costs for intra-EAC trade were lower than the trade costs facing extra-EAC trade by 27 per cent (Panel A, column 6). Panel B of [Table 3.2](#) shows the same analysis but excludes two outlier industries.⁹ Total bilateral trade costs for non-outlier industries are lower but the general trends are unchanged.

[Figure 3.5](#) shows that total bilateral trade costs and import tariff rates are positively correlated. It also shows that elimination of import tariffs over the period 2005-2012 did not remove all the mark-up of external trade costs over domestic trade costs; some observations for intra-EAC trade at zero tariffs are above the horizontal zero line for total bilateral trade costs. This again

⁹The two outlier industries, namely ISIC 23 - coke, refined petroleum products, nuclear fuel, and ISIC 26 - non-metallic mineral products, have very high total bilateral trade costs. See Appendix B, [Table B.3](#).

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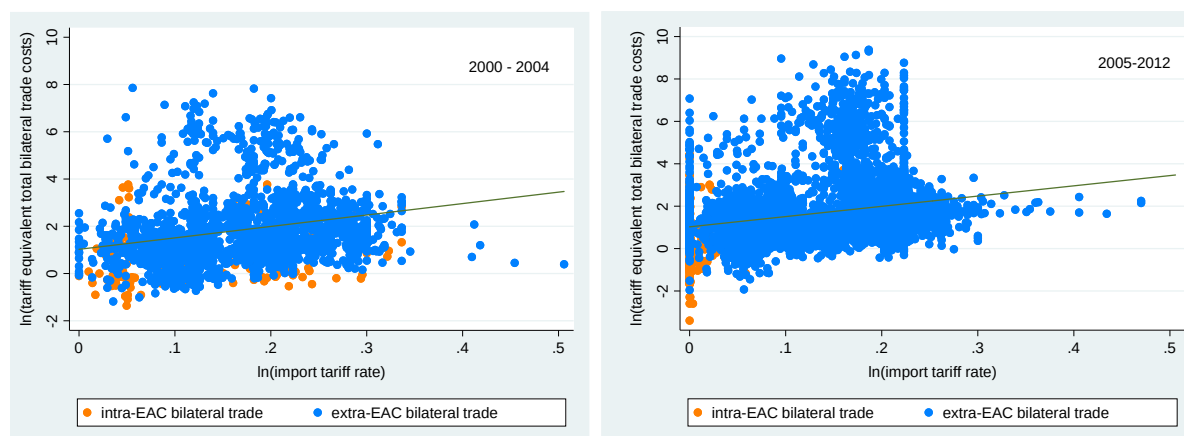
Table 3.2: Comparison of the means of import tariff rates and total bilateral trade costs across country-pairs before and after the EAC customs union (EACU) took effect

	ln(import tariff rate)			ln(tar. equiv. total bilateral trade costs)		
	pre-EACU 2000-2004	post-EACU 2005-2012	diff.	pre-EACU 2000-2004	post-EACU 2005-2012	diff.
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Panel A. Full sample</i>						
intra-EAC bilateral trade	0.12 (0.01)	0.01 (0.00)	-0.11 (0.01)	0.65 (0.09)	0.39 (0.06)	-0.26 (0.10)
extra-EAC bilateral trade	0.17 (0.00)	0.15 (0.00)	-0.02 (0.00)	1.89 (0.04)	1.89 (0.02)	0.01 (0.04)
difference	-0.05 (0.01)	-0.15 (0.00)	-0.09 (0.01)	-1.24 (0.09)	-1.51 (0.06)	-0.27 (0.11)
<i>Panel B. Excluding ISIC codes 23 and 26</i>						
intra-EAC bilateral trade	0.12 (0.01)	0.01 (0.00)	-0.11 (0.01)	0.41 (0.06)	0.16 (0.04)	-0.26 (0.08)
extra-EAC bilateral trade	0.17 (0.00)	0.15 (0.00)	-0.02 (0.00)	1.50 (0.02)	1.52 (0.01)	0.02 (0.03)
difference	-0.05 (0.01)	-0.15 (0.00)	-0.09 (0.01)	-1.09 (0.07)	-1.37 (0.05)	-0.28 (0.08)

Notes: EACU stands for EAC customs union. $\ln(\text{import tariff rate}) = \ln(1 + \text{import tariff rate}/100)$, where import tariff rate is the effectively applied tariff rate of an EAC country. ‘ln’ denotes natural logarithm. In all country-pairs, the exporter is an EAC country. The data is averaged across industries. Data in Panel B excludes observations for coke, refined petroleum products, nuclear fuel (ISIC 23) and non-metallic mineral products (ISIC 26), which have very high total bilateral trade costs. The standard errors in parentheses are calculated from a two-sample t test assuming unequal variances at the 95 per cent confidence level.

indicates an important role for trade barriers other than import tariffs in determining EAC total bilateral trade costs.

Figure 3.5: Import tariff rates and total bilateral trade costs



Source: Author's calculations based on data obtained from INDSTAT2, COMTRADE and WITS online databases.

The differential outcomes in total bilateral trade costs for intra-EAC trade and for extra-EAC trade after 2004 provides opportunity to measure the impact of the customs union using counterfactual analysis. The difference-in-differences model used in this study is derived as follows:

Let EAC_{ij} represent a binary variable that equals to one if both countries in pair ij are members of the EAC, and zero otherwise. Let $E[Trade\ costs_{ij,1}]$ be the expected outcome of total bilateral trade costs for country-pair ij if it is part of the EAC customs union (EACU) and $E[Trade\ costs_{ij,0}]$ be the expected outcome of total bilateral trade costs for country-pair ij if it is not part of the EACU. The difference between the expected total bilateral trade costs for country-pair ij that are EAC members and therefore also part of the EACU (denoted by $E[Trade\ costs_{ij,1}|EAC_{ij}=1]$) and the expected total bilateral trade costs for the same country-pair if it is party to EAC but not to the EACU (denoted by $E[Trade\ costs_{ij,0}|EAC_{ij}=1]$) is the causal effect of EACU trade policies on the total bilateral trade costs of the country-pair (Angrist and Pischke, 2008). This causal effect may be represented by β' and defined as follows:

$$\begin{aligned}\beta' &= E[Trade\ costs_{ij,1}|EAC_{ij}=1] - E[Trade\ costs_{ij,0}|EAC_{ij}=1] \\ &= E[Trade\ costs_{ij,1} - Trade\ costs_{ij,0}|EAC_{ij}=1]\end{aligned}\tag{3.1}$$

Information on how total bilateral trade costs would have turned out for a treated country-pair¹⁰ had the EACU protocol not been effected is therefore required in order to estimate β' . This information is not observable. The observed change in total bilateral trade costs for an untreated country-pair¹¹ over the policy change period may be used to approximate the counterfactual for the treated country-pair. Doing this introduces selection bias into the β' estimate as treated country-pairs are not similar to untreated country-pairs. For instance, most non-EAC countries are located farther away from the EAC so that country-pairs comprising such countries inherently have higher distance-related bilateral trade costs. Selection bias may be addressed by including in a regression of total bilateral trade costs on treatment variable EAC_{ij} and time, fixed effects to control for time-invariant characteristics of country-pairs that influence total bilateral trade costs and correlate with EACU trade policies (Angrist and Pischke, 2008). The effect of EACU trade policies on intra-EAC total bilateral trade costs may

¹⁰A treated country-pair is one that is part of the EACU. This pair comprises only EAC member countries.

¹¹An untreated country-pair is one that is not part of the EACU. This pair comprises non-EAC countries.

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then be defined as follows:

$$\begin{aligned}\beta = & (E[Trade\ costs_{ij,1}|EAC_{ij}=1, Post2004=1] \\ & - E[Trade\ costs_{ij,1}|EAC_{ij}=1, Post2004=0]) \\ & - (E[Trade\ costs_{ij,0}|EAC_{ij}=0, Post2004=1] \\ & - E[Trade\ costs_{ij,0}|EAC_{ij}=0, Post2004=0])\end{aligned}\quad (3.2)$$

where $Post2004=0$ denotes the period before the EACU protocol was effective (2000-2004), $Post2004=1$ denotes the period in which the EACU protocol was in effect (2005-2012), $E[Trade\ costs_{ij,1}|EAC_{ij}=1, Post2004=1] - E[Trade\ costs_{ij,1}|EAC_{ij}=1, Post2004=0]$ represents the change in expected total bilateral trade costs for a treated country-pair over the two time periods, and $E[Trade\ costs_{ij,0}|EAC_{ij}=0, Post2004=1] - E[Trade\ costs_{ij,0}|EAC_{ij}=0, Post2004=0]$ represents the change in expected total bilateral trade costs for an untreated country-pair over the two time periods. β may then be estimated using the following difference-in-differences model:

$$\begin{aligned}\ln(Trade\ costs_{ijk,t}) = & \delta_{ij} + \delta_k + \alpha Post2004_t + \gamma EAC_{ij,t} \\ & + \beta EAC_{ij,t} \times Post2004_t + \epsilon_{ijk,t}\end{aligned}\quad (3.3)$$

where the observed outcome of total bilateral trade costs for country-pair ij in industry k and year t is determined by the time-invariant characteristics of the country-pair such as geographical location, and political and economic history, denoted by δ_{ij} , whether the year falls in the period when the EACU was effective or not, captured by period binary variable $Post2004_t$, whether the country-pair falls in the treatment group or not, captured by treatment binary variable, $EAC_{ij,t}$, and whether the country-pair was treated in the period when the EACU was effective, captured by the interaction of the treatment and period binary variables. Since the total bilateral trade costs are estimated at the industry level, I also include in the specification industry fixed effects, δ_k , to capture economic and institutional differences across industries. $\epsilon_{ijk,t}$ is the error term. The coefficients of equation (3.3) capture the following effects:

$$\begin{aligned}\alpha = & E[Trade\ costs_{ij,0}|EAC_{ij}=0, Post2004=1] \\ & - E[Trade\ costs_{ij,0}|EAC_{ij}=0, Post2004=0]\end{aligned}$$

$$\begin{aligned}\gamma = & E[Trade\ costs_{ij,1}|EAC_{ij}=1, Post2004=0] \\ & - E[Trade\ costs_{ij,0}|EAC_{ij}=0, Post2004=0]\end{aligned}$$

β is as defined in equation (3.2).

Chapter 3: Elimination of Import Tariffs

Later, I include the import tariff rate in equation (3.3) as a covariate to capture the effect of elimination of import tariffs on total bilateral trade costs. The possible endogeneity of the tariff rates in the model then becomes an issue to consider. Of concern is simultaneity bias. The total bilateral trade costs are derived from and therefore reflect bilateral trade flows, and it is plausible that import tariff rates were set in order to encourage or discourage bilateral trade in certain products. For instance, before the EACU took effect, certain domestic industries (for example, textiles) facing growing imports (including from within the region) were categorised as sensitive and high tariff rates were charged on imports of such goods. One would therefore expect a faster decline in the total bilateral trade costs of these protected industries after the removal of intra-EAC tariffs.

However, akin to [Sequeira \(2016\)](#), [Buono and Lalanne \(2012\)](#) and [Topalova and Khandelwal \(2011\)](#), the following is an argument for tariff exogeneity in an equation explaining industry-level total bilateral trade costs: Plans to remove all barriers to intra-EAC trade (tariffs included) are contained in the Treaty for the Establishment of the East African Community, which was signed in 1999 and became effective in 2000. The EACU is therefore part of a scheduled programme to integrate EAC economies at a broader level and not just to enhance trade. Tariff barriers were subsequently removed as per the schedule contained in the EACU protocol that was signed in 2004 and became effective in 2005. The timing of tariff elimination is therefore not linked to the performance of industries in the period 2000-2012. Further, the deadline to remove all intra-EAC tariffs by 2009 precluded delays by individual governments to support any particular industry. Also, tariff elimination was implemented across all industries although initial consideration for certain important industries is reflected in the magnitude of reduction in tariff rates. To address this last point - that higher pre-EACU tariffs were charged on products whose imports were growing faster - the industry fixed effects included in equation (3.3) may remove part of the bias coming from industry-specific policy considerations.

The following section begins with the estimation of the effect of EAC membership on intra-EAC total bilateral trade costs post-2004 using equation (3.3). The contribution of import tariff elimination in lowering intra-EAC total bilateral trade costs is then estimated using an augmented version of equation (3.3). The analysis finishes with the estimation of the effect of EAC membership and tariff elimination on total bilateral trade costs for each manufacturing industry included in the sample.

3.5 Results

3.5.1 Total bilateral trade costs and membership in the EAC

This subsection analyses the impact of EAC membership on total bilateral trade costs using the difference-in-differences model specified in equation (3.3). The model exploits the similarity of trends in total bilateral trade costs for intra- and extra-regional trade before the customs union took effect in 2005 and explains the differential outcome in the trade costs after 2004 net of pre-existing trade policy effects. Figure B.1 and Figure B.2 in Appendix B show that total bilateral trade costs for intra-EAC and extra-EAC trade had similar trends before 2005 but the similarity in the trends weakens thereafter.

In equation (3.3), coefficient γ measures the difference in total bilateral trade costs between intra-EAC trade and extra-EAC trade in the period 2000-2004. This difference is assumed to be due to the trade policies effected under the EAC Treaty beginning 2000. Coefficient β measures the change in intra-EAC total bilateral trade costs relative to the change in extra-EAC total bilateral trade costs in the period 2005-2012. If β is negative and statistically significant, it means that the total bilateral trade costs for intra-EAC trade decreased by a larger magnitude in the period 2005-2012 as compared with the change in total bilateral trade costs for extra-EAC trade. This effect is assumed to be due to all the trade policies of the EAC customs union (EACU) protocol that were implemented beginning 2005. The difference in total bilateral trade costs between intra-EAC trade and extra-EAC trade in the period 2005-2012 would be measured by $\gamma + \beta$.

The country-pair and industry fixed effects included in equation (3.3) control for geographical, economic and institutional differences across country-pairs and industries, which explain the fundamental disparity in the size of total bilateral trade costs across country-pairs and across industries. Equation (3.3) is estimated using Ordinary Least Squares (OLS) and the results are reported in Table 3.3. The reported standard errors are clustered by country-pair to account for correlation of errors within country groups.

In column (1), the equation is estimated without fixed effects and a constant term is included instead. The results indicate that before the EACU took effect, total bilateral trade costs for intra-EAC trade were lower than those for extra-EAC trade by 71 per cent ($e^{-1.238} - 1 \times 100$). The difference-in-differences estimate is -0.270, which is the same as the one obtained in Table 3.2, Panel A (column 6). This estimate implies that after the EACU took effect, total bilateral trade costs for intra-EAC trade declined by 24 per cent ($e^{-0.270} - 1 \times 100$) more than the change in extra-EAC total bilateral trade costs. The difference between intra-EAC and

extra-EAC total bilateral trade costs therefore widened to 78 per cent ($e^{-0.270-1.238} - 1 \times 100$) following implementation of EACU trade policies. This accounts for 82 per cent of the actual difference between intra-EAC and extra-EAC total bilateral trade costs in the policy change period (2005-2012).¹²

Table 3.3: Effect of EAC membership on total bilateral trade costs

dependent variable:	ln(tariff equivalent total bilateral trade costs)			
	(1)	(2)	(3)	(4)
EAC $\times$ Post2004	-0.270** (0.114)	-0.362*** (0.105)	-0.367*** (0.107)	-0.357*** (0.106)
EAC	-1.238*** (0.141)	0.048 (0.221)	0.071 (0.215)	0.079 (0.206)
Post2004	0.005 (0.036)	-0.016 (0.016)		
constant	1.889*** (0.047)			
Country-pair fixed effects	-	Yes	Yes	Yes
Industry fixed effects	-	Yes	Yes	-
Year fixed effects	-	-	Yes	-
Industry-year fixed effects	-	-	-	Yes
Observations	7,578	7,578	7,578	7,578
Adjusted R-squared	0.059	0.956	0.956	0.957

Notes: Table 3.3 shows OLS estimates of equation (3.3) using data for period 2000-2012. The dependent variable is the natural logarithm of tariff equivalent total bilateral trade costs. *EAC* binary variable equals 1 if the two countries in a trading pair are members of the EAC and 0 otherwise. *Post2004* binary variable equals to 1 for years after 2004 and 0 otherwise. The standard errors in parentheses are clustered by country-pair. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

These results suggest that the observed difference between intra-EAC and extra-EAC total bilateral trade costs after 2005 cannot be wholly attributed to EACU trade policies. The unexplained gap may reflect other overlapping behind-the-border measures aimed at lowering intra-EAC trade costs, for example, national trade promotion activities aimed at bridging information gaps. It may also reflect delayed effects of policies implemented before 2005.

The results in column (2) are based on equation (3.3) as specified. The estimate of γ loses its significance upon controlling for characteristic differences across country-pairs and industries. This means that conditional on these characteristics, there was no significant difference between

¹²From Panel C of Table 3.1, the mean tariff equivalent total bilateral trade costs for intra-EAC trade in period 2005-2012 is 3.4, which is 95 per cent lower than the mean tariff equivalent total bilateral trade costs for extra-EAC trade of 66.6. Therefore, $0.82 = -78 \div -95$.

intra-EAC and extra-EAC total bilateral trade costs before 2005. This outcome lends some credibility to the choice of the control group. The estimate of β is now significant at the 1 per cent level and is larger with a smaller standard error. These results indicate that intra-EAC total bilateral trade costs fell faster than the change in extra-EAC total bilateral trade costs in period 2005-2012 by 30 per cent ($e^{-0.362} - 1 \times 100$). The sum of the two coefficients ($\gamma + \beta$) is -0.314 and is not significant; the statistic for the F-test is 2.480 with a probability of 0.116. Therefore, in period 2005-2012 and because of the EAC customs union, intra-EAC trade costs were lower than extra-EAC trade costs by 30 per cent (since there was no differential in the base period 2000-2004). In column (3), year fixed effects are included in place of *Post2004*. The estimate of β is not significantly different from the one reported in the previous column. In column (4), more stringent industry-year fixed effects are included in the model to control for any time-varying determinants of industry-level bilateral trade costs such as changes in production and transportation technologies. In this case, the estimate of β indicates that intra-EAC total bilateral trade costs declined by 30 per cent ($e^{-0.357} - 1 \times 100$) due to the customs union.

It is noteworthy that the estimated effect of EAC membership post-2004 on total bilateral trade costs may not be entirely attributable to the customs union. This effect may also contain delayed influences from policies implemented before 2005. The estimated 30 per cent is therefore an upper bound of the effect of the customs union on intra-EAC total bilateral trade costs facing manufacturing industries.

3.5.2 Non-tariff measures versus removal of import tariffs

The results from subsection 3.5.1 indicate that total bilateral trade costs for intra-EAC trade declined after 2004 when the EAC customs union (EACU) took effect. The analysis of this subsection estimates the relative contributions of EACU non-tariff measures and import tariff elimination in explaining the fall in intra-EAC total bilateral trade costs. The following equation is estimated:

$$\ln(\text{Trade costs}_{ijk,t}) = \delta_{ij} + \delta_k + \alpha \text{Post2004}_t + \gamma \text{EAC}_{ij,t} + \beta \text{EAC}_{ij,t} \times \text{Post2004}_t + \phi \ln(\text{import tariff rate}_{ijk,t}) + \epsilon_{ijk,t} \quad (3.4)$$

which is equation (3.3) but including the natural logarithm of the import tariff rate as a covariate. In equation (3.4), β would capture the effect of all trade policies associated with the EACU, net of the effect of the removal of import tariffs, which would be captured by ϕ . The results from estimating equation (3.4) are reported in column (3) of [Table 3.4](#).

The results in column (1) of [Table 3.4](#) show the responsiveness of total bilateral trade costs to changes in the import tariff rate without including the EAC membership or time period

variables. The results indicate that reducing the import tariff rate by 1 percentage point would lower total bilateral trade costs by 0.53 percent. Since on average, import tariff rates for intra-EAC trade fell by 12.7 percentage points following liberalisation (see Table 3.1), the coefficient in column (1) suggests that total bilateral trade costs for intra-EAC trade declined by 6.7 per cent (0.526×-12.7) due to import tariff elimination. This represents 41 per cent of the total decline in total bilateral trade costs that occurred in the policy change period.¹³

Table 3.4: Effect of non-tariff measures versus import tariff elimination

dependent variable:	ln (tariff equivalent total bilateral trade costs)					
	(1)	(2)	(3)	(4)	(5)	(6)
EAC $\times$ Post2004		-0.362*** (0.105)	-0.342*** (0.106)	-0.343*** (0.110)	-0.219*** (0.076)	-0.214*** (0.079)
EAC		0.048 (0.221)	0.037 (0.221)	0.059 (0.216)	0.083 (0.163)	0.124 (0.151)
Post2004		-0.016 (0.016)	-0.011 (0.016)		-0.008 (0.027)	
ln(import tariff rate)	0.526*** (0.200)		0.229 (0.184)	0.263 (0.185)	0.721* (0.371)	0.702** (0.334)
Industries included	All	All	All	All	No outliers	No outliers
Country-pair fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	-	-	-	Yes	-	-
Industry-year fixed effects	-	-	-	-	-	Yes
Observations	7,578	7,578	7,578	7,578	6,863	6,863
Adjusted R-squared	0.955	0.956	0.956	0.956	0.947	0.949

Notes: Table 3.4 shows OLS estimates of equation (3.4) using data for period 2000-2012. The dependent variable in all specifications is the natural logarithm of tariff equivalent total bilateral trade costs. The import tariff rate is the effectively applied import tariff rate of an EAC country. *EAC* binary variable equals to 1 if both countries of a trading pair are members of the EAC and 0 otherwise. *Post2004* binary variable equals to 1 for years in period 2005-2012 and 0 otherwise. The models in columns (5) and (6) exclude data for coke, refined petroleum products, nuclear fuel, and non-metallic mineral products, which have very high total bilateral trade costs. The standard errors in parentheses are clustered by country-pair. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

For ease of comparison, the results from estimating equation (3.3) as reported in column (2) of Table 3.3 are reproduced in column (2) of Table 3.4. The estimates in column (3) indicate that the advantage of being in the EAC after 2004 in terms of lower total bilateral trade costs (as compared with the outcome for extra-EAC trade costs) is present even after controlling for the removal of import tariffs. The responsiveness of total bilateral trade costs to EACU non-tariff measures is marginally smaller in this specification as compared with the estimate in column (2); the estimate of β indicates that intra-EAC trade costs declined by 29 per cent

¹³From Table 3.1, tariff equivalent total bilateral trade costs for intra-EAC trade declined by 16.4 per cent from 4.1 in 2000-2004 to 3.4 in 2005-2012. Therefore, $0.41 = -6.7 \div -16.4$.

$(e^{-0.342} - 1 \times 100)$ due to EACU non-tariff measures. The coefficient on import tariff rates is also smaller but is not statistically significant. This indicates that EACU trade policies aimed at removing non-tariff barriers were more effective in lowering intra-EAC total bilateral trade costs. Estimating the model with year fixed effects instead of the *Post2004* variable does not significantly affect the results (column 4).

The results in column (5) exclude observations for industries with very high total bilateral trade costs; those manufacturing fuels and non-metallic mineral products. Among the industries sampled, these two industries also have the highest weight-to-value ratios and faced below median pre-EACU import tariff rates. It is therefore plausible that the external trade costs facing these industries are mostly related to non-tariff barriers to trade. After excluding observations for the two outlier industries, the estimate of ϕ in column (5) becomes statistically significant and indicates that for non-outlier industries, the removal of import tariffs lowered intra-EAC total bilateral trade costs by 9 per cent (0.721×-12.6).¹⁴ The estimated coefficient of β indicates that EACU non-tariff policy measures lowered intra-EAC total bilateral trade costs by 20 per cent ($e^{-0.219} - 1 \times 100$), the tariff equivalent of which is -17 per cent ($e^{-0.219 \div 0.721} - 1 \times 100$). This estimate is larger than the 12.6 percentage point average decline in the import tariff rates facing intra-EAC trade in non-outlier industry products following liberalisation. These results do not change significantly when time-varying industry-specific effects are controlled for (column 6).

3.5.3 Industry effects of elimination of tariff and non-tariff measures

This subsection measures the relative contributions of the removal of tariff and non-tariff trade barriers in lowering the total bilateral trade costs for each manufacturing industry considered in this study. Equation (3.4) is estimated for each industry separately but pooled across country-pairs. Four industries drop out because of insufficient observations. The estimated coefficients are reported in Table 3.5.

The results in column (2) indicate that before the customs union took effect, intra-EAC total bilateral trade costs were higher than extra-EAC trade costs for industries producing textiles, leather products, basic metals, furniture and miscellaneous manufactures. Intra-EAC trade costs then fall relative to extra-EAC trade costs after the customs union takes effect (column 1), and this is not explained by the removal of intra-EAC import tariffs. This suggests a significant impact of non-tariff measures in lowering intra-EAC trade costs facing these industries. In column (4), the negative and statistically significant coefficients on import tariffs for motor

¹⁴For non-outlier industries, intra-EAC import tariff rates declined by an average of 12.6 percentage points after 2004.

Table 3.5: Effect of non-tariff measures versus import tariff elimination, by industry

ISIC code and description	dep. var.: ln(tariff equivalent total bilateral trade costs)			
	EAC × Post2004	EAC	Post2004	ln(import tariff rate)
	(1)	(2)	(3)	(4)
15 Food and beverages	-0.147	0.076	-0.075***	-0.332
17 Textiles	-0.234	1.247***	-0.116***	0.581
19 Leather, leather products and footwear	-0.381*	0.932***	0.030	-0.113
20 Wood products (excl. furniture)	-0.993***		-0.026	-0.007
21 Paper and paper products	-0.210	-0.044	0.015	1.708*
22 Printing and publishing	0.089*	-0.167	-0.082***	0.213
24 Chemicals and chemical products	-0.454***	0.024	-0.052	1.434***
25 Rubber and plastics products	-0.321***	0.007	-0.074	0.461
26 Non-metallic mineral products	-1.100**	-2.057***	0.200**	-1.286
27 Basic metals	-1.141***	0.969***	-0.043	1.245
34 Motor vehicles, trailers, semi-trailers	-0.085		-0.225***	-2.156**
36 Furniture; manufacturing n.e.c.	-0.534***	0.517**	-0.086*	-0.644*

Notes: Table 3.5 shows OLS estimates of equation (3.4) using data for period 2000-2012. The dependent variable in all specifications is the natural logarithm of tariff equivalent total bilateral trade costs. *EAC* binary variable equals to 1 if both countries of a trading pair are members of the EAC and 0 otherwise. *Post2004* binary variable equals to 1 for years in period 2005-2012 and 0 otherwise. The import tariff rate is the effectively applied tariff rate of an EAC country. All specifications include country-pair and industry fixed effects, which are not shown. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, based on standard errors clustered at the country-pair level.

vehicles, trailers, semi-trailers, and furniture and miscellaneous manufactures suggests a larger decline in domestic trade costs (the denominator in the total bilateral trade costs variable). It is plausible that domestic trade in these products increased following the removal of import tariffs on related imported intermediates. For instance, the motor vehicles, trailers, semi-trailers category of traded goods comprises spare parts and accessories. Changes to domestic trade costs would have been controlled for by country-year fixed effects but these would be too stringent for the model.

Overall, the estimates indicate that the effect of EACU non-tariff measures in lowering total bilateral trade costs is more prevalent across the industries as compared with the effect of the removal of import tariffs. These results suggest that non-tariff barriers are especially important in determining the total bilateral trade costs of industries producing wood products, chemical products, rubber and plastics products, non-metallic mineral products, basic metals, and furniture and other miscellaneous manufactures. Non-metallic mineral products, wood products, basic metals, and chemical products have above median weight-to-value ratios, while all but wood products faced below median tariff rates pre-EACU. This suggests that non-tariff measures and transportation costs are important for these industries.

In summary, the results reported in this section indicate that intra-EAC total bilateral trade costs are lower than extra-EAC total bilateral trade costs by 30 per cent in period 2005-2012 due to the implementation of the customs union protocol. Excluding the two industries with very high

trade costs, the regression results indicate that non-tariff reducing policies lowered intra-EAC trade costs by 20 per cent and tariff reducing policies lowered intra-EAC trade costs by 9 per cent. The effectiveness of the EAC customs union in lowering intra-regional trade costs is therefore more attributable to non-tariff reducing policies than to the removal of import tariffs.

3.6 Robustness checks

This section assesses the robustness of the conclusions drawn in section 3.5 to alternative estimates of total bilateral trade costs. The parallel trend assumption underlying the control group and the effect of using an unbalanced panel are also tested.

A. Alternative estimates of total bilateral trade costs

The [Chen and Novy \(2011\)](#) method used to estimate total bilateral trade costs from production and bilateral trade data allows for assumptions to be made about the elasticity of substitution parameter σ . A practice in the literature is to use 8 (which is the average of reported estimates) and assume that this applies to all industries. In chapter 2 of this thesis, I chose to estimate the elasticity of substitution parameter for each industry separately; these range from 3 to 14 and average to 7. Using industry-specific elasticity of substitution estimates yields larger total bilateral trade costs estimates with a larger variance as compared with total bilateral trade costs estimated using an elasticity of substitution of 8 for all industries.

The effect of the choice of elasticity of substitution parameter on the estimates of equation (3.4) can be seen from [Table 3.6](#). For ease of comparison, the results reported in columns (3) and (5) of [Table 3.4](#) in section 3.5 of this chapter are reproduced in columns (1) and (2) of [Table 3.6](#). The results from estimating the equation using total bilateral trade costs derived assuming $\sigma=8$ are reported in columns (3) and (4). Most of the statistically significant coefficients are comparably smaller (albeit marginally) when assuming $\sigma=8$. The models also explain a smaller proportion of the variation in total bilateral trade costs as indicated by the R^2 . In general, the import tariff rate is not statistically significant in explaining total bilateral trade costs for the full sample (column 3). For the subsample excluding outlier industries (column 4), the estimated tariff equivalent effect of EACU non-tariff measures is greater than the 12.7 percentage point decline in intra-EAC import tariff rates (that is, $-12.7\% < -0.47\% = (\exp^{-0.281 \div 0.448} - 1) \times 100$ in absolute terms). The earlier finding that non-tariff reducing policies explain more of the decline in intra-EAC total bilateral trade costs is therefore upheld.

Table 3.6: Results based on alternative estimates of total bilateral trade costs

dependent variable:	ln(tariff equivalent total bilateral trade costs)					
	(industry-specific σ)		$(\sigma = 8 \text{ for all industries})$		(industry-specific σ)	
	mirror data for Kenya		mirror data for Kenya		data reported by Kenya	
	(1)	(2)	(3)	(4)	(5)	(6)
EAC $\times$ Post2004	-0.342*** (0.106)	-0.219*** (0.076)	-0.321*** (0.037)	-0.281*** (0.029)	-0.314*** (0.062)	-0.252*** (0.058)
EAC	0.037 (0.221)	0.083 (0.163)	0.146 (0.134)	0.150 (0.113)	-0.086 (0.200)	0.057 (0.157)
Post2004	-0.011 (0.016)	-0.008 (0.027)	-0.022* (0.011)	-0.019 (0.017)	-0.003 (0.036)	-0.024 (0.033)
ln(import tariff rate)	0.229 (0.184)	0.721* (0.371)	0.204 (0.144)	0.448* (0.233)	0.851 (0.545)	1.037** (0.505)
Industries included	All	no outliers	All	no outliers	All	no outliers
Country-pair fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,578	6,863	7,578	6,863	5,520	4,978
Adjusted R-squared	0.956	0.947	0.905	0.904	0.955	0.946

Notes: Table 3.6 shows OLS estimates of equation (3.4). The dependent variable is the natural logarithm of tariff equivalent total bilateral trade costs. *EAC* binary variable equals 1 if both countries in a trading pair are EAC members and 0 otherwise. *Post2004* binary variable equals to 1 for years after tariff liberalisation (2005-2012) and 0 otherwise. The import tariff rate is the effectively applied import tariff rate of an EAC country. σ is the elasticity of substitution between goods. Models in columns (1), (3) and (5) use data for 16 industries. Models in column (2), (4) and (6) exclude observations for coke, refined petroleum products, nuclear fuel, and non-metallic mineral products, which have high trade costs. The standard errors in parentheses are clustered by country-pair. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The last two columns of Table 3.6 show results from estimating equation (3.4) using total bilateral trade costs derived from trade data that is reported by Kenya. In chapter 2 of this thesis, total bilateral trade costs with respect to Kenya are derived from trade data that is reported by Kenya's trade partners since the data that is reported by Kenya has gaps for periods 1993-1996 and 2011-2012. The concern is the valuation of mirror data on C.I.F instead of F.O.B basis, which lowers the obtained total bilateral trade costs estimates. The estimated coefficients obtained from trade costs estimates that incorporate trade data reported by Kenya imply a larger contribution of the change in import tariffs in explaining the decline in intra-EAC trade costs. The tariff equivalent effect of EACU non-tariff measures is -22 per cent ($e^{-0.252 \div 1.037} - 1 \times 100$, from column 6), which is still larger than the average import tariff decline of 12.7 per cent. The conclusions drawn from the baseline results are therefore robust to the use of mirror trade data for Kenya.

B. The Parallel Trend Assumption

The γ coefficient in the difference-in-differences models (3.3) and (3.4) measures the difference between the trend in intra-EAC total bilateral trade costs and the trend in extra-EAC total

bilateral trade costs due to trade policies implemented over the period 2000-2004. The assumption is that in this period, the trends in intra-EAC and extra-EAC total bilateral trade costs are similar since there was no change in policy then. To test for the similarity in trends before 2005, I estimate an equation in which total bilateral trade costs is regressed on the EAC binary variable interacted with an indicator for each year in the sample period 2000-2012. The estimated coefficients on the interaction terms are reported in Table 3.7. The estimated coefficients become statistically significant and negative after 2004. This suggests that growth in intra-EAC total bilateral trade costs was slower than growth in extra-EAC total bilateral trade costs after 2004.

Table 3.7: Analysis of trends in the trade costs variable

dependent variable:	ln(tariff equivalent total bilateral trade costs)	
	(1)	(2)
EAC $\times$ 2001	0.072	0.029
EAC $\times$ 2002	0.008	0.000
EAC $\times$ 2003	-0.080	-0.131
EAC $\times$ 2004	-0.069	-0.068
EAC $\times$ 2005	-0.272**	-0.137
EAC $\times$ 2006	-0.253	-0.181
EAC $\times$ 2007	-0.290	-0.227*
EAC $\times$ 2008	-0.429**	-0.424***
EAC $\times$ 2009	-0.248**	-0.247***
EAC $\times$ 2010	-0.355**	-0.297***
EAC $\times$ 2011	-0.471***	-0.521***
EAC $\times$ 2012	-1.113***	-0.714***
Industries included	All	No outliers
Country-pair fixed effects	Yes	Yes
Industry-year fixed effects	Yes	Yes
Observations	7,578	6,863
Adjusted R-squared	0.957	0.949

Notes: The dependent variable in all specifications is the natural logarithm of tariff equivalent total bilateral trade costs. *EAC* binary variable equals to 1 if both countries of a trading pair are members of the EAC and 0 otherwise. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, based on standard errors that are clustered by country-pair.

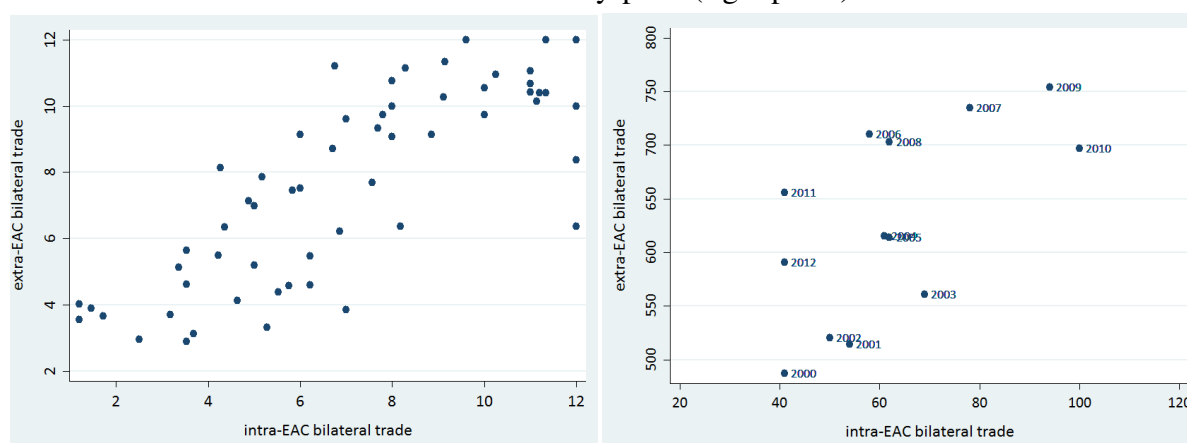
C. Distribution of missing observations in the panel

Lastly, I consider the effect of having an unbalanced panel. The panel is unbalanced mainly due to missing observations on import tariff rates. The estimates reported in section 3.5 of this chapter would reflect selection bias if the occurrence of missing observations is

distributed according to country-pair characteristics. Figure 3.6 shows that the count of missing observations in period 2000-2012 is distributed somewhat evenly across country-pairs representing intra-EAC trade and extra-EAC trade, both across time and across countries.

In the left panel of Figure 3.6, missing observations are counted for each country-pair across the years and the same is averaged over EAC importers and over non-EAC importers. The scatter plot indicates that as the number of missing observations for EAC importers increases, so does the number of missing observations for non-EAC importers. In the right panel of Figure 3.6, missing observations are counted for each year across country-pairs and the count is averaged over EAC importers and over non-EAC importers. The scatter plot indicates that if the number of missing observations for EAC importers was particularly high in one year, the number of missing observations was also high in that year for non-EAC importers. Figure 3.6 suggests that the gaps in the dataset reflect general weakness in data availability across all country-pairs. The baseline results are therefore unlikely to be biased because of the unbalanced panel.

Figure 3.6: Average number of missing observations across time (left panel) and across country-pairs (right panel)



Notes: The sample period is 2000-2012. The left panel shows the average count of missing observations for each country-pair over time. The right panel shows the average count of missing observations for each year across country-pairs. **Source:** Author's calculations based on data obtained from INDSTAT2, COMTRADE and WITS online databases.

3.7 Conclusion

This paper analyses the effect of EAC membership on the total bilateral trade costs of manufacturing industries. Evidence from chapter 2 of this thesis suggests that intra-EAC total bilateral trade costs declined after the EAC Treaty took effect. An important outcome from the Treaty is the establishment of the EAC customs union (EACU), which provides for the removal

Chapter 3: Elimination of Import Tariffs

of tariff and non-tariff barriers to trade. The objective of this chapter is to estimate the effect of the customs union in lowering intra-EAC total bilateral trade costs and the contribution of the removal of intra-EAC import tariffs.

The present study uses data on total bilateral trade costs and effectively applied import tariff rates for 5 EAC countries with respect to 78 of their trade partners and 16 manufacturing industries. The study period is 2000-2012. Following implementation of the EACU protocol beginning 2005, the import tariff rates charged on intra-EAC trade flows declined by an average of 12.7 percentage points compared with a 2.4 percentage point average decline in import tariff rates charged on extra-EAC trade flows ([Table 3.1](#)). The data also shows that intra-EAC total bilateral trade costs reduced after 2005 while extra-EAC total bilateral trade costs rose. These trends in the data make a difference-in-differences model suitable for analysis.

Within the difference-in-differences model, a binary variable that captures membership in the EAC (and all associated trade policies) is interacted with another binary variable that captures the period when the EACU took effect (2005-2012). The interaction term isolates the effect of trade policies associated with the EACU. The control group, which comprises country-pairs with non-EAC trade partners, accounts for the effect of trade policies that were implemented before 2005. The import tariff rate is then included as a regressor to net out the effect of the removal of import tariffs from the coefficient of the interaction term. The tariff equivalent effect of EACU non-tariff measures on total bilateral trade costs is then calculated from the estimated coefficients.

The estimation results for the full sample indicate that the EACU lowered intra-EAC total bilateral trade costs relative to extra-EAC total bilateral trade costs by at most 30 per cent in the period 2005-2012. The results also show that the removal of import tariffs does not significantly explain total bilateral trade costs after controlling for the EACU. For a subsample that excludes industries with very high trade costs, the estimation results indicate that EACU non-tariff measures lowered intra-EAC total bilateral trade costs by 20 per cent and that the removal of intra-EAC import tariffs lowered the trade costs by 9 per cent. The tariff equivalent effect of non-tariff reducing policies on intra-EAC total bilateral trade costs is estimated to be -17 per cent. This is more than the decline in intra-EAC import tariff rates.

These results mean that non-tariff barriers to trade are a significant component of total bilateral trade costs facing manufacturing industries in the region. Non-tariff trade barriers are found to be particularly important for industries producing output with above median weight-to-value ratios, namely wood products, chemical products, rubber and plastics products, non-metallic mineral products, basic metals, and furniture and other miscellaneous manufactures. This indicates a significant role for transportation costs in determining the total bilateral trade costs of these industries.

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The findings from this study are robust to alternative estimates of total bilateral trade costs. The findings are also consistent with those reported in the literature on regional trade agreements and bilateral trade flows, which indicate a larger importance of non-tariff trade barriers in determining bilateral trade flows as compared with import tariffs.

4. Quality of Transit Roads

4.1 Introduction

This thesis evaluates two trade policies aimed at lowering trade costs in the East African Community (EAC), namely the elimination of import tariffs and the upgrading of transit roads. This paper considers the policy to upgrade roads along the Northern and Central Corridors, which are the main transit routes in the EAC. The Northern Corridor connects the landlocked EAC states to the seaport of Mombasa in Kenya, while the Central Corridor connects the landlocked EAC states to the seaport of Dar es Salaam in Tanzania¹. The upgrading of these Corridors is a policy objective that has strategic priority in the EAC Treaty.

Several projects to upgrade roads along the Northern and Central Corridors were undertaken by EAC governments and donor agencies over the period 2004-2010. Information on the resultant change in the condition of roads along these routes is provided in road surveys and project reports published by the agencies. The condition of the roads is indicated by the smoothness of road surface, which is quantified by the International Roughness Index (IRI). The IRI ranges from 0 for a smooth pavement to 20 for a rough pavement. In this study, this information on road conditions is used to create a variable that indicates the quality of transit roads in terms of the share of paved roads in good condition in the total length of road distance along the Corridors between two EAC capital cities and between an EAC capital city and the nearest seaport.² The constructed transit road quality variable indicates that the share of good roads along the Corridors between countries and those leading to the seaports on average increased from 0.40 in 2003 to 0.68 in 2010. The change in transit road quality varies across country-pairs according to the location of an EAC capital city.

This paper provides an empirical estimate of the effect that the improvement in transit road quality had on the total bilateral trade costs of manufacturing industries. The study also estimates the distribution of effects across industries to appraise the outcome for the

¹These are the only two officially identified transit corridors that serve all 5 EAC states considered in this study.

²The capital cities are used as reference points because they are centrally located within EAC countries.

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composition of trade in manufactures. This study answers the question: what is the effect of road upgrading along the Northern and Central Corridors on the total bilateral trade costs of EAC manufacturing industries over the period 2003-2010?

The present study uses estimates of total bilateral trade costs from chapter 2 of this thesis. Total bilateral trade costs measures all the cost of trading a good between two countries relative to the cost of trading the good domestically in each of the countries. This study uses the estimates for 5 EAC countries with respect to 81 trade partners in 16 industries in the manufacturing sector.

The total bilateral trade costs variable is regressed on the transit road quality variable to estimate the effect of changing road conditions on industry-level total bilateral trade costs. The panel structure of the dataset allows for the inclusion of country-pair, exporter-year, importer-year and industry-year fixed effects in the regression. This set of fixed effects controls for country and industry characteristics that affect total bilateral trade costs and correlate with the transit road quality variable. This, to some degree, addresses the endogeneity of transit road quality to trade costs. A placebo test is conducted to assess the estimated coefficients for endogeneity bias coming from simultaneity. To address biases coming from mismeasurement of the transit road quality variable, robustness checks are conducted using alternative estimates of the transit road quality variable.

The present study finds that the increase in transit road quality reduced total bilateral trade costs by 21 per cent, which is equivalent to reducing the effect of bilateral distance on total bilateral trade costs by about a third. The results imply that upgrading the remaining transit roads would lower total bilateral trade costs by a further 24 per cent. The effect of upgrading all the Corridor roads would therefore exceed the 30 per cent downward impact of the EAC customs union on total bilateral trade costs that is estimated in chapter 3 of this thesis.

The estimated negative effect of better transit road quality on total bilateral trade costs probably reflects a larger fall in cross-border trade costs as compared with the fall in domestic trade costs. In order to determine the change in external trade costs and in domestic trade costs due to the improvement in transit road quality, external trade volume and domestic trade are each regressed on transit road quality.³ Following from the standard gravity model, since the regressions include controls for changes in supply and demand, and multilateral resistance (that is, exporter-year, importer-year, industry-year fixed effects), the estimated effect of transit road quality on either of the gross trade flows reflects a change in related trade costs. The study finds a positive and statistically significant effect of increased transit road quality on external trade volume and domestic trade. The resultant increase in external trade volume implies a fall

³External trade volume is measured for each exporter-importer-industry triple as export volume plus import volume. Domestic trade is measured for each exporter-industry pair as total output minus exports to the rest of the world. Both measures vary annually.

in international trade costs and the increase in domestic trade implies a fall in domestic trade costs. The negative effect of increased transit road quality on total bilateral trade costs however suggests that international trade costs fell by a larger margin than did domestic trade costs. The important implication is that the 21 per cent is a lower bound of the absolute effect of the road upgrading on international trade costs.

This paper also considers the effect of better-quality transit roads in the EAC on the composition of cross-border trade in manufactured goods. An expected result would be a larger negative impact on the trade costs of industries with comparably higher transportation cost intensities. The transportation cost intensity of an industry may be proxied by the weight of traded goods because weight matters for the cost of transporting goods over distance ([Chen, 2004](#); [Head and Mayer, 2002](#)). This study thus estimates the effect of the change in transit road quality on total bilateral trade costs for industries according to their weight-to-value ratio. The weight-to-value ratio is used because it is a distinguishing feature of output across industries and is easily measurable from trade data. Existing studies on the impact of roads on trade find that industries producing heavy output increase their trade flows in response to better roads by a larger margin as compared with other industries ([Coşar and Demir, 2016](#); [Duranton et al., 2014](#)). A compositional change in trade flows can therefore be anticipated depending on which group of industries experienced a larger fall in their trade costs due to better transit roads.

The study finds that the negative effect of increased transit road quality on total bilateral trade costs and the positive effect of increased transit road quality on external trade volume is attributable to industries with weight-to-value ratios that are above the 50th percentile. It would therefore be expected that the upgrading of transit roads would have a big compositional effect on trade. However, this group of industries already contribute the most to EAC manufactured output and make up most of EAC's cross-border trade in manufactures. This implies that upgrading the remaining transit roads will increase the volume of trade in manufactured goods but may leave the composition thereof unchanged. For the case of domestic trade, the study does not find a differential effect of the increase in transit road quality across the two industry groups.

Transportation infrastructure has a multifaceted role to play in promoting trade and economic development. Good quality and wider road networks, for instance, directly lower the transactions and operating costs of businesses and also improve communication, connectivity and access to markets. Further, infrastructure services are an input to production and complement private capital by raising the productivity of capital and labour ([African Development Bank, 2018](#); [Mbekeani, 2010](#)). Infrastructure services also complement improvements to the business environment obtained from institutional reforms. This is done by giving opportunity to domestic firms to adopt modern logistics and inventory management

practices, which improve their competitiveness in international markets ([World Bank, 1994](#)). The cost of infrastructure services declines with better quality infrastructure.

The negative effect of geographical location and poor state of infrastructure on the economies of Sub-Saharan Africa is documented in the empirical literature on international trade and growth.⁴ For the case of East Africa, the condition of transit roads, the presence of numerous roadblocks and weighbridges along transit roads, and lengthy administrative procedures at the seaports and customs borders have been cited as important contributors to international transportation costs ([Jedwab et al., 2015](#); [African Development Bank, 2013](#); [Ranganathan and Foster, 2011](#); [Milner et al., 1998](#)). [Milner et al. \(1998\)](#) estimate that transit transportation costs faced by landlocked Uganda are equivalent to a 30 per cent tax on the international trade flows of Uganda.⁵ [Mbuli \(2007, p. 4\)](#) reports that it costs about three times more to transport goods by road between Uganda and the Port of Mombasa in neighbouring Kenya than to transport the goods by sea from the Port of Mombasa to overseas destinations.

These studies convey the importance of the transit corridors in facilitating the region's external trade and the significance of the policy to upgrade the roads. The literature does not (to my knowledge) have an estimate of the impact of the upgrading of these roads on manufacturing industries' total trade costs and the likely effect on the composition of trade flows. This information is important for the assessment of ongoing expenditure on regional transportation infrastructure in the EAC for possible effects on domestic and regional trade. Studies on the effect of roads on trade in more advanced economies show that improving on road quality tends to disproportionately benefit industries with higher transport intensities. The present study fills this gap in the literature on Africa.

Also, by using data on actual road conditions, the present paper differs from existing studies on Africa that quantify the quality of physical infrastructure using an index of infrastructure variables ([Kodongo and Ojah, 2016](#); [Francois and Manchin, 2013](#); [Portugal-Perez and Wilson, 2012](#); [Calderón and Servén, 2010](#); [Iwanow and Kirkpatrick, 2009](#); [Limão and Venables, 2001](#)). Another difference is that the present study considers total bilateral trade costs, which is a broad measure of costs associated with international trade, and not just transportation costs. Roads affect trade through channels (other than transportation costs) such as time and uncertainty ([Hummels and Schaur, 2013](#); [Freund and Rocha, 2011](#)). The focus on total bilateral trade costs is therefore beneficial from a policy perspective since the policy to upgrade transit roads is evaluated against all the trade frictions inhibiting EAC manufacturing industries.

⁴See [Naudé \(2009\)](#) and [Ndulu \(2006\)](#) for a survey of the literature on Sub-Saharan Africa.

⁵[Milner et al. \(1998\)](#) estimate using data for Uganda that overland transit transportation costs are the equivalent of 25.7 per cent tax on importers and 29.4 per cent equivalent tax on exporters. This compares with an average import tariff of 22.3 per cent.

This paper also contributes to the literature on transportation infrastructure and international trade evidence from East Africa on the extent to which an increase in the quality of transit roads will lower the total bilateral trade costs of manufacturing industries and the likely effect on the composition of trade flows. This literature contains evidence from other parts of the world that the quantity and quality of own and transit roads influence the direction, size and composition of international trade flows (Bonfatti and Poelhekke, 2017; Duranton et al., 2014; Duranton, 2015; Coşar and Demir, 2016; Volpe Martincus et al., 2014; Volpe Martincus and Blyde, 2013; Francois and Manchin, 2013; Limão and Venables, 2001). This literature also evaluates the relative importance of different types of infrastructure in influencing bilateral trade flows. Iwanow and Kirkpatrick (2009) argue that transportation infrastructure, communication infrastructure and the quality of regulatory institutions all matter for Africa's manufactured exports. Portugal-Perez and Wilson (2012) and Freund and Rocha (2011) however argue that physical infrastructure has a comparably larger effect on the export volumes of African countries.

Also related to the present study is the economic geography literature that analyses the importance of distance in determining bilateral trade flows, international prices and the distribution of incomes across countries (Versailles, 2012; Redding and Venables, 2004). Berthelon and Freund (2008) and Huang (2007) provide evidence suggesting that information and transportation costs in part explain the effect of distance on bilateral trade volumes. The present study contributes to this literature an estimate of the extent to which better transit roads mitigate the positive impact of bilateral distance on total bilateral trade costs of manufacturing industries for EAC countries.

This paper is related to the literature that studies the effect of transportation, communication and energy infrastructure on sectoral productivity and economic growth. The evidence from this literature is that a higher stock and better quality of these types of infrastructure improves economic performance (Calderón and Servén, 2010; Esfahania and Ramírez, 2003) and increases the attractiveness of a country to Multinational Enterprises (MNEs) as well as the export-orientation of MNE affiliates (Kumar, 2002). Burgess and Donaldson (2012) show that transportation infrastructure lowers the responsiveness of domestic prices and incomes to productivity shocks. Kodongo and Ojah (2016) argue that for the case of Sub-Saharan Africa where the stock of infrastructure is low, it is the spending on infrastructure that matters for economic growth.

Lastly, this paper is closely related to the literature that analyses the determinants of total bilateral trade costs (Jacks et al., 2010, 2011; Chen and Novy, 2011; Novy, 2013; Arvis et al., 2016). This literature provides evidence that distance-related transportation and information costs are important determinants of total bilateral trade costs. The present study contributes to

this literature estimates of the responsiveness of total bilateral trade costs to improvements in transportation infrastructure based on the data of developing East African countries.

The rest of this paper is organised as follows: an overview of transit road projects undertaken in the EAC over the period 2004-2010 is provided in section 4.2. Section 4.2 also describes how the transit road quality variable is calculated. Section 4.3 provides a description of the data, empirical method and equations used in the analysis. The estimation results are reported and discussed in section 4.4. Robustness checks are conducted in section 4.5 and section 4.6 concludes.

4.2 Transit road projects (2004-2010)

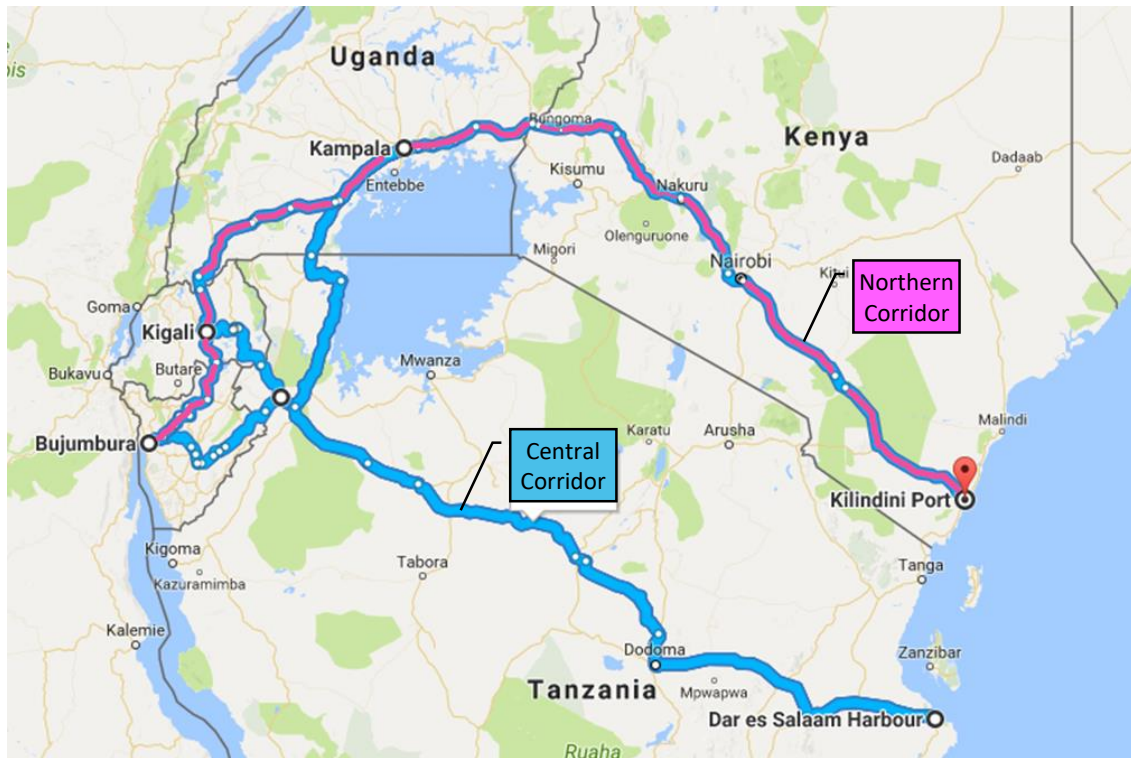
4.2.1 Overview

This study estimates the impact of road improvements along the two main transit routes in the East African Community (EAC) on the total bilateral trade costs of manufacturing industries. One route is the Northern Corridor, which connects landlocked EAC countries (Burundi, Rwanda, Uganda) to the Port of Mombasa in Kenya ([Figure 4.1](#)). The other route is the Central Corridor, which connects landlocked EAC countries to the Port of Dar es Salaam in Tanzania.

[Figure 4.2](#) shows that Uganda predominantly used the Northern Corridor, Rwanda was divided between both corridors and Burundi predominantly used the Central Corridor. The relative use of the Northern and Central Corridors by Burundi, Rwanda and Uganda is associated with geographical proximity to and efficiency of the seaports of Mombasa and Dar es Salaam. In 2009, there was 15 times more transit traffic (in terms of weight of goods transported) along the Northern Corridor than the Central Corridor. [Nathan Associates Inc. \(2011, p. 56\)](#) report that it was comparably cheaper for Uganda to transport a container (light or heavy) along the Northern Corridor and for Rwanda and Burundi to transport a container along the Central Corridor at the time. However, total time spent shipping the container was found to be less along the Northern Corridor for all three landlocked countries owing to “faster service” at the Port of Mombasa.

The Northern Corridor comprises a road, a railway line and an oil pipeline. About 90 per cent of the transit cargo along the Corridor is transported by road ([Louis Berger, 2011b; Nathan Associates Inc., 2011](#)). The railway is primarily used to transport empty shipping containers back to the Port of Mombasa although it also carries soda ash, food grains and flours ([Louis Berger, 2011a, p. 3-12](#)). Within Kenya, most petroleum products are transported via the pipeline. The Central Corridor also comprises a road and a railway line. About 75 per

Figure 4.1: Map of roads linking landlocked EAC countries and Kilindini Harbour at the Port of Mombasa and the Port of Dar es Salaam

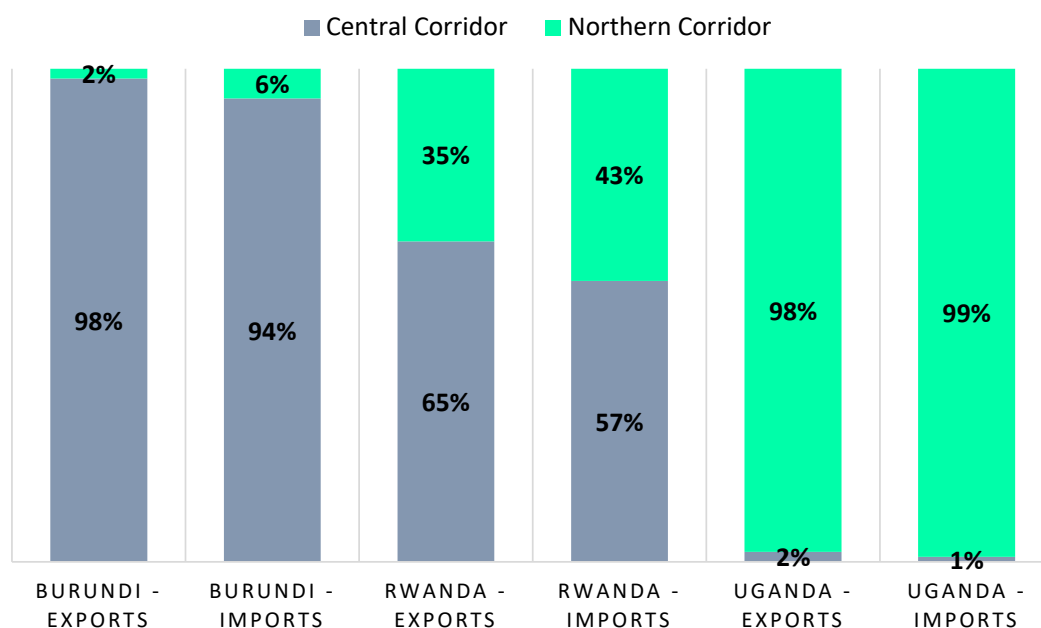


Notes: The map shows the travel routes by road between landlocked EAC countries and the sea Ports of Mombasa and Dar es Salaam. **Source:** Author's estimations using Google Maps.

cent of the cargo traffic in Tanzania is transported by road, while the railway predominantly serves the domestic market carrying mostly petroleum products, cement, food grains, sugar and cotton (United Republic of Tanzania and Japan International Cooperation Agency, 2014, p. 4-3 and 5-2). Incidentally, the transit Corridors also connect major towns within EAC countries, and therefore also link the towns with international airports. International cargo channelled through EAC airports consists mainly of fresh horticultural produce and high-value manufactures (Iches, 2005). The reported airfreight tonnage handled by Kenya, Tanzania and Uganda is however low (about 30 thousand tonnes in 2003, Iches (2005, p. 25-27)), compared with the volumes landed at the port of Mombasa (about 380,353 thousand tonnes in 2003, Nathan Associates Inc. (2011, p. 7)). Roads are therefore the predominant mode of transportation in the EAC.

Several projects to upgrade roads along the Corridors were completed beginning 2004. The projects were a joint effort undertaken by member countries, with support from multilateral donor agencies that was coordinated by the EAC. For example, over the period 2004-2015, the Government of Kenya and the World Bank implemented the Northern Corridor Transport

Figure 4.2: Distribution of transit cargo traffic along the Northern and Central Corridors by landlocked EAC countries in 2009



Source: Adapted from Figure 4-4 in Nathan Associates Inc. (2011, p. 63).

Improvement Project, which included the rehabilitation of roads⁶ in Kenya that lie along the Northern Corridor. The aim was to reduce transit times between Mombasa and Malaba and Busia (towns at the Kenya-Uganda border) and the costs of operating and maintaining road vehicles (World Bank, 2016). Following completion of road works as at 2009, the travel time between Mombasa and Malaba/Busia is reported to have reduced by half a day (from 19 hours in 2004 to 14 hours in 2009) (World Bank, 2016, p. iii). This means that upgrading sections of the road between Kenya and Uganda removed some bottlenecks along the route, and this was enough to generate significant cost reduction benefits to road users.

The Government of Tanzania in collaboration with the African Development Bank and other development partners also implemented a number of projects to upgrade roads along the Central Corridor over the period 2000-2007. These include the paving of the Shelui-Nzega road, which was completed in 2005. The stated objective of this project was to reduce “road maintenance and vehicle operating costs, and to promote regional integration, in particular, between Tanzania, Rwanda and Burundi” (African Development Bank, 2014, p. 4). After the road was paved, the travel time between Shelui and Nzega is reported to have halved (from 5 hours to 2 hours). There is also the Nzega-Tinde-Isaka road upgrading project that was implemented by the Government of Tanzania in 2004-2008, with the support of the European

⁶This included resurfacing and widening of priority road sections. It is not clear from the project report what determined the priority of a road section.

Union ([United Republic of Tanzania, 2010](#)).

Work has also been done in the landlocked countries. For instance, the Kicukiro–Kirundo Road Project was implemented in 2006–2008 by the Governments of Burundi and Rwanda with the support of the African Development Bank and other donors ([African Development Bank, 2006](#)). This project included paving of the Kicukiro–Kirundo road, which connects Rwanda and Burundi. In Uganda, the Strengthening of Northern Corridor Route project included the rehabilitation of the Jinja–Bugiri road and the Kampala–Katuna road ([Government of Uganda and European Commission, 2007, 2003](#)).

A mapping of road projects undertaken on the Corridors over the period 2004–2010 is provided in [Figure 4.3](#). The figure shows a correspondence between the location of road projects and sections of the Corridors that were reported to be in good condition as at 2010.

4.2.2 Estimating transit road quality by country-pair

This subsection explains my approach to attribute a certain improvement in transit road quality to a specific country-pair. My approach relies on road distances along the Northern and Central Corridors. The distances are estimated with reference to EAC capital cities, namely Nairobi (Kenya), Kampala (Uganda), Kigali (Rwanda), Bujumbura (Burundi), and Dodoma (Tanzania). The cities are chosen as reference points because they are centrally located within the countries.

I assume that traders are cost minimisers who choose the shortest travel distance to destination. This assumption recognises time as a trade cost ([Hummels and Schaur, 2013](#)) and is consistent with the information in [Figure 4.2](#). For the case of trade between two EAC countries, I estimate using Google Maps the shortest road distance along the Corridors between their capital cities. For the case of trade between an EAC country and an overseas country, I estimate the shortest road distance along the Corridors between the EAC country's capital city and the nearest EAC seaport. The routes and corresponding road distances by country-pair are presented in [Table 4.1](#). Few points are worth noting about the information provided in [Table 4.1](#). The capital cities of Kenya and Tanzania are not directly connected by either the Northern or the Central Corridor. These are the two largest economies in the EAC and I choose not to ignore the trade between them. I therefore include in the sample, data on the shortest road distance between Nairobi and Dodoma, which is along the Trans-African Highway. There is no reported change in the quality of this road over the study period. So, any response of trade costs to a change in transit road quality would be due to changing road conditions along the Northern or Central Corridors.

Figure 4.3: EAC road projects 2004-2010, and condition of Corridor roads in 2010



Source: United Republic of Tanzania and Japan International Cooperation Agency (2014, p. 4-2)

Key:

Grading of road conditions is according to the International Roughness Index

— Sound = 2 to 6	— Warning = 6 to 10	— Severe > 10
— Gravel	— Under construction	

Country and road project	length, km	cost, US\$ M
Kenya: Project Name: Northern Corridor Transport Improvement Project		
(A) Maji ya Chumvi - Miritini road	35	49
(B) Lanet - Njoro Turnoff - Timboroa road	100	138

Source: Kenya National Highways Authority (2017); World Bank (2016)

Uganda: Project Name: Ten Years Road Sector Development Programme / Strengthening of Northern Corridor Route		
(C) Jinja-Bugiri road	73	not available
(D) Kampala - Katuna road (prog. no. 8 ACP UG 31)	427	

Source: Government of Uganda and European Commission (2003, 2007)

Tanzania: Project Name: United Republic of Tanzania Integrated Road Programme		
(E) Mutukula - Muhutwe - Kagoma road	137	20
(F) Isuna - Singida - Shelui - Nzega road	284	106
(G) Morogoro - Dodoma - Manyoni road	383	139

Source: United Republic of Tanzania and Japan International Cooperation Agency (2014, p. 4-20); United Republic of Tanzania (2010)

Table 4.1: Length and quality of roads along the Northern and Central Corridors between EAC capital cities and seaports

Trade partners		City to city points	Corridor	Road distance	Transit road quality		Δ Transit road quality
				(kilometres)	2003	2010	(Δ = 2010 - 2003)
A. intra - EAC trade							
Kenya	- Uganda	Nairobi - Kampala	Northern	660	0.27	0.44	0.17
Kenya	- Rwanda	Nairobi - Kampala - Kigali	Northern	1,170	0.16	0.68	0.52
Kenya	- Burundi	Nairobi - Kampala - Kigali - Bujumbura	Northern	1,435	0.21	0.74	0.53
Uganda	- Rwanda	Kampala - Kigali	Northern	514	0.00	1.00	1.00
Uganda	- Burundi	Kampala - Kigali - Bujumbura	Northern	777	0.16	1.00	0.84
Rwanda	- Burundi	Kigali - Bujumbura	Northern	282	0.45	1.00	0.55
Tanzania	- Uganda	Dodoma - Kampala	Central	1,292	0.36	0.64	0.28
Tanzania	- Rwanda	Dodoma - Kigali	Central	1,042	0.34	0.61	0.27
Tanzania	- Burundi	Dodoma - Bujumbura	Central	1,114	0.33	0.64	0.31
Kenya	- Tanzania	Nairobi - Dodoma	Trans-African Highway	681	0.00	0.00	0.00
B. overseas trade							
Kenya	- overseas country	Nairobi - Port of Mombasa	Northern	483	0.17	0.58	0.41
Uganda	- overseas country	Kampala - Nairobi - Port of Mombasa	Northern	1,143	0.23	0.50	0.27
Burundi	- overseas country	Bujumbura - Dodoma - Port of Dar es Salaam	Central	1,568	0.52	0.75	0.23
Tanzania	- overseas country	Dodoma - Port of Dar es Salaam	Central	454	1.00	1.00	0.00
Rwanda	- overseas country	average of (Kigali - Kampala - Nairobi - Port of Mombasa) and (Kigali - Dodoma - Port of Dar es Salaam)	Northern + Central	1,576	0.34	0.69	0.35

Notes: *Transit road quality* is as defined in equation (4.1). The capital cities are Nairobi (Kenya), Kampala (Uganda), Kigali (Rwanda), Bujumbura (Burundi), Dodoma (Tanzania). For Rwanda, road distance to the nearest seaport is the average distance between Kigali and Mombasa, and Kigali and Dar es Salaam. **Sources:** Author's calculations based on Google Maps, [United Republic of Tanzania and Japan International Cooperation Agency \(2014\)](#), [African Development Bank and United Nations Economic Commission for Africa \(003b\)](#), [World Bank \(2004\)](#), [African Development Bank \(2001\)](#), [International Conference on the Great Lakes Region \(2006\)](#).

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For the case of Rwanda's trade with overseas countries, I am motivated by the information in [Figure 4.2](#) to take the average of the road distance between Kigali and the Port of Mombasa and the road distance between Kigali and the Port of Dar es Salaam.

The last point to note is that for overseas trade, the road distances are the same for all overseas partners when they trade with one particular EAC country. The use of industry-level trade data compensates for this reduced variation in road distances across country-pairs. In the sample and on average in 2003 and 2010, Kenya traded in 16 industry categories with 58 countries, Rwanda traded in 10 industry categories with 11 countries, Uganda traded in 10 industry categories with 28 countries, and Tanzania traded in 12 industry categories with 43 countries. Therefore, it is possible to estimate responses of total bilateral trade costs to changes in transit road quality across industries at the exporter level.

Data on the quality of roads along the road distances is compiled from various road project and survey reports published by the African Development Bank and the United Nations Economic Commission for Africa, the Japan International Cooperation Agency for the Ministry of Transport in Tanzania, the International Conference on the Great Lakes Region and the World Bank. Maps and tables from which information is extracted are presented in the Appendix C, [Figure C.1](#) to [Figure C.4](#). A breakdown of the condition of roads per route and year based on the maps and reports is summarised in Appendix C, [Table C.3](#).

The data presented in these reports indicate the condition of paved and unpaved roads as either good, fair or poor. Some reports grade road conditions using the International Roughness Index (IRI) while other reports use the structural condition of pavement. I map the IRI rating of 'sound' (top of the scale) to the structural reading of 'good' (top of the scale). Research in the engineering field shows the IRI to be a good predictor of road pavement conditions ([Arhin et al., 2015](#)). I classify roads as being in good condition if the road is paved and the IRI rating is *sound* or the structural condition of pavement rating is *good*. For all other ratings, I categorise the road as not being in good condition.

For each country-pair and years 2003 and 2010, I use the road distances reported in [Table 4.1](#) along with the information on road conditions that is summarised in Appendix C, [Table C.3](#) and calculate transit road quality for country-pair ij at time t as follows:

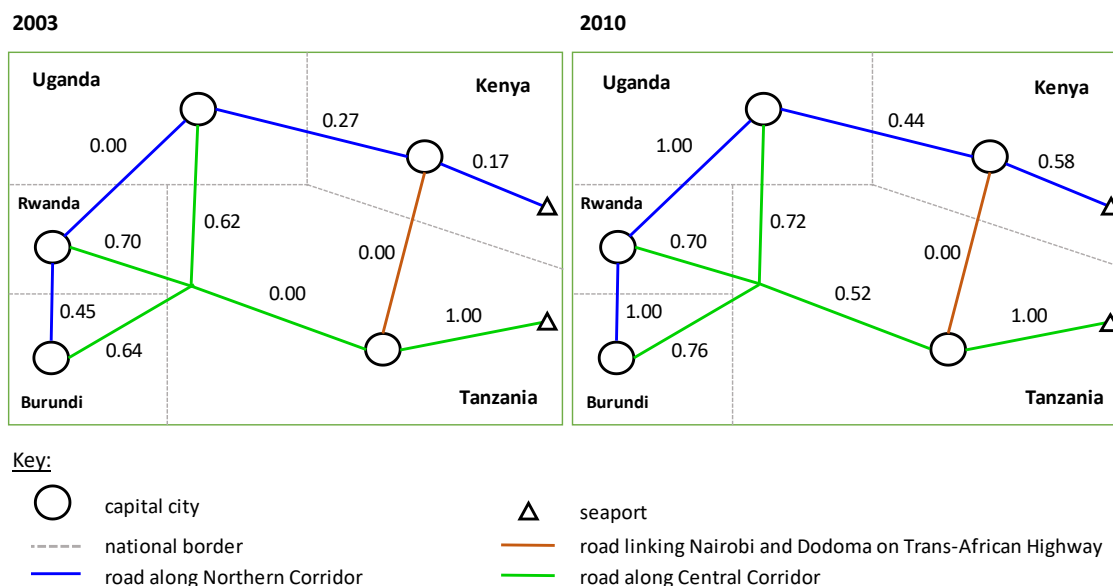
$$\text{transit road quality}_{ij,t} = \frac{\sum_{ij,t} \text{length of paved road in good condition along road distance}_{ij,t}}{\sum_{ij} \text{road distance}_{ij}} \quad (4.1)$$

Estimates of transit road quality between EAC capital cities and seaports in 2003 and 2010 are

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reported in Table 4.1 and the same is illustrated in Figure 4.4.

Figure 4.4: Sketch of road conditions along the Northern and Central Corridors in 2003 and 2010.



Notes: The numbers in the sketch give the share of paved roads in good condition along the road distance between capital cities and the seaports. For purposes of illustration, the point at which the roads along the Central Corridor branch off towards the landlocked countries is Isaka, Tanzania. **Source:** Author's calculations based on Google Maps, [United Republic of Tanzania and Japan International Cooperation Agency \(2014\)](#), [African Development Bank and United Nations Economic Commission for Africa \(2003b\)](#), [World Bank \(2004\)](#), [African Development Bank \(2001\)](#), [International Conference on the Great Lakes Region \(2006\)](#).

In Table 4.1 for example, using the capital cities as reference points, the share of good roads on the Uganda-Rwanda route was 0.00 in 2003 and 1.00 in 2010, while the share of good roads on the Uganda-Burundi route was 0.16 in 2003 and 1.00 in 2010 (Panel A of Table 4.1). The increase in transit road quality between these countries is attributed to the upgrading of the Kampala-Katuna road. For the case of overseas trade (Panel B), the share of good roads between Kampala, Uganda and the Port of Mombasa, Kenya was 0.23 in 2003 and 0.50 in 2010. The upgrading of the Jinja-Bugiri road in Uganda and the Lanet-Timboroa and Maji ya Chumvi-Miritini roads in Kenya contributed to the increase in the quality of roads along this distance. For Uganda, therefore, there was a larger increase in the quality of roads leading to other landlocked EAC countries as compared with the road leading to the seaport, and from there to overseas countries. This is shown in Figure 4.4 as an increase in the numbers on the blue lines linking the node in Burundi to the nodes in Kenya from 2003 to 2010.

For estimation purposes, zero values of the transit road quality variable are replaced by 0.15 (a small positive number). This is for the cases of trade between Kenya and Tanzania in 2003 and

2010, and Uganda and Rwanda in 2003 (see [Table 4.1](#)). Otherwise, the zero observations may unduly influence the estimated coefficients of interest.

4.3 Data and Method

4.3.1 Data description

Sample: The sample for this study comprises 5 EAC countries and 81 non-EAC countries, 16 manufacturing industries and years 2003 and 2010. The exporter countries are EAC countries, namely Burundi, Kenya, Rwanda, Tanzania and Uganda. The importer countries are the 5 EAC countries and 81 non-EAC countries. The distribution of country-pairs across the industry categories is determined by the availability of data on production and bilateral trade needed to estimate total bilateral trade costs at the International Standard Industrial Classification (ISIC) 2-digit level of production. The countries used in the study are listed in Appendix C, [Table C.1](#) and the industry categories considered are listed in Appendix C, [Table C.2](#).

Total bilateral trade costs: The total bilateral trade costs variable used in this study is estimated at the ISIC revision 3 2-digit level of production using output and bilateral trade data for 16 manufacturing industries and for 5 EAC countries and their trade partners. The data is obtained from the United Nations' Industrial Development Organization's Industrial Statistics (INDSTAT2) and International Commodity Trade Statistics (COMTRADE) online databases. The total bilateral trade costs are derived in chapter 2 of this thesis using the inverse-gravity method of [Chen and Novy \(2011\)](#). For each year in the sample, the tariff equivalent of the estimated total bilateral trade costs between exporter i and importer j in industry k is defined as follows:

$$\text{tariff equiv. total bilateral trade costs}_{ij}^k = \left(\frac{t_{ij}^k t_{ji}^k}{t_{ii}^k t_{jj}^k} \right)^{\frac{1}{2}} - 1 = \left(\frac{x_{ii}^k x_{jj}^k}{x_{ij}^k x_{ji}^k} \right)^{\frac{1}{2(\sigma_k - 1)}} - 1 \quad (4.2)$$

where t_{ij}^k and t_{ji}^k are the unidirectional cross-border trade cost factors between countries i and j in industry k , and t_{ii}^k and t_{jj}^k are the domestic trade cost factors for industry k in countries i and j , respectively. The ratio of external to domestic trade costs is derived as the geometric mean of the ratio of the product of the value of domestic trade in exporter i and importer j in industry k , denoted by $x_{ii}^k x_{jj}^k$ to the product of the value of unidirectional trade between exporter i and importer j in industry k , denoted by $x_{ij}^k x_{ji}^k$. σ_k is the elasticity of substitution for industry k , which is estimated from trade flow data following the method in [Feenstra \(1994\)](#) and is assumed to be the same across countries. One is subtracted from the ratios to obtain tariff equivalent total bilateral trade costs.

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Transit road quality: The transit road quality variable is calculated according to equation (4.1), which obtains after following the approach outlined in subsection 4.2.2.

External trade values and volumes: Data on external trade values and volumes for each exporter-importer-industry-year quadruple is obtained from COMTRADE online database. Export and import values are free-on-board (F.O.B) values⁷ measured in current US dollars. Export and import volumes are measured as net weight in kilograms (that is, less packaging). The external trade volume variable used in this study is calculated as export volume plus import volume, from the perspective of the exporter. The export and import data is also used to calculate the weight-to-value ratios used in this study.

Domestic trade: Domestic trade is measured in US dollars as output minus exports to the rest of the world. The variable is calculated at the ISIC revision 3 2-digit level of production using output values obtained from the INDSTAT2 online database and export values obtained from COMTRADE.

Gravity variables: Data on the simple (great-circle) distance between two countries, and binary variables for common border, common colonial ties and common official language are from Centre d'Études Prospectives et d'Informations Internationales (CEPII) files sourced from the UNCTAD Virtual Institute on Trade and Development.

A summary of the data used in this study is reported in Table 4.2. On average, total bilateral trade costs and external trade volume are marginally lower in 2010 as compared with 2003, while domestic trade and the quality of transit roads are higher in 2010.

Table 4.2: Descriptive statistics

	2003				2010			
	obs.	mean	median	std. dev.	obs.	mean	median	std. dev.
log of total bilateral trade costs	578	1.824	1.553	1.47	720	1.816	1.466	1.58
log of trade volume	578	12.169	12.253	3.08	720	12.010	12.315	3.58
log of domestic trade	578	18.380	18.822	1.56	720	18.699	18.874	1.65
transit road quality, unadjusted	578	0.401	0.174	0.37	720	0.675	0.584	0.20
transit road quality	578	0.406	0.174	0.36	720	0.677	0.584	0.20

Notes: *transit road quality, unadjusted* contains zero values for trade between Kenya and Tanzania, and Uganda and Rwanda, as reported in Table 4.1. For *transit road quality*, the zero values are replaced by 0.15.

⁷The value of imports by an EAC country from a partner is the corresponding F.O.B export value reported by the partner.

4.3.2 Method

I estimate in this paper, the effect of the increase in transit road quality on the total bilateral trade costs facing manufacturing industries. For each of years 2003 and 2010, I have data on total bilateral trade costs that is calculated at the exporter-importer-industry level and data on transit road quality that is calculated at the exporter-importer level. The study considers country-pairs comprising only EAC countries and country-pairs comprising an EAC exporter and an overseas importer.

As a way to explain the estimated effect of transit road quality on total bilateral trade costs, the study also estimates the effect of transit road quality on the components of total bilateral trade costs (that is, international trade costs and domestic trade costs). Both components would be impacted by the improvement in the transit roads, which serve both domestic and international trade. If transit road quality is found to have a negative effect on total bilateral trade costs, it would be because international trade costs fell by a larger margin than did domestic trade costs. In the absence of an all-inclusive measure for each of international and domestic trade costs, the impact of transit road quality on these costs is estimated indirectly through the effect on external trade volume (export volume plus import volume from the exporter's perspective) and domestic trade (industrial output minus exports to the rest of the world).

A. Empirical strategy

The upgrading (that is, paving, resurfacing and/or widening) of roads along the transit corridors affected all EAC exporters but to different degrees. The variation in the change in transit road quality among the exporters comes from the section-wise way in which the roads were upgraded. That is, only certain sections within a stretch of road linking two countries were upgraded leading to varied road conditions depending on the country-pair considered. This variation implies different exposure to better-quality transit roads among exporter-importer pairs given the location of the exporter. For instance, in the example of Uganda given on page 91 of this paper, there was a larger increase in the quality of roads leading to other landlocked EAC countries as compared with the road leading to the seaport of Mombasa in Kenya.

There are also likely to be varied influences of the improvement in transit road quality on total bilateral trade costs across industries at the exporter level. For example, Uganda's trade with either Rwanda, Burundi or an overseas importer consisted of several products, which may have different transport intensities, meaning how much weight needs to be transported per kilometre (Uganda traded in an average of 10 ISIC manufactured product groups with 28 importers in 2003 and 2010). After controlling for bilateral distance, economic developments and trade relations among Uganda, Burundi, Rwanda and any of Uganda's overseas trade partners, as

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well as product characteristics, the relative change in trade costs between Uganda and her trade partners, and among product groups traded with the partners, is assumed to be due to the relative change in the quality of transit roads linking Uganda and the trade partners.

The upgrading of transit roads in the EAC was influenced by long transit times and high freight costs. The transit road quality variable is therefore endogenous to total bilateral trade costs. Given that total bilateral trade costs varies at the exporter-importer-industry-year level, I can control for country-pair, exporter-year, importer-year and industry-year fixed effects to address endogeneity arising from omitted variables. This set of fixed effects control for country and industry characteristics that determine total bilateral trade costs, and which also correlate with long transit times and high freight costs. An important characteristic controlled for by exporter-year and importer-year fixed effects is slow economic growth, which limited infrastructure development. The exporter-year and importer-year fixed effects also control for exchange rate movements⁸ and changes to trade policies that induced changes to non-tariff trade barriers. Policy changes that are industry-specific such as changes in import tariffs are controlled for by industry-year fixed effects. These fixed effects also control for product characteristics such as weight, which may have made the products less likely to be traded over longer distances and given the prevailing condition of the roads.

The set of fixed effects included in the estimating equations (that is, country-pair, exporter-year, importer-year and industry-year fixed effects) do not address endogeneity of the transit road quality variable coming from simultaneity. For example, a larger improvement of roads may have occurred between cities that were growing faster. In this case, total bilateral trade costs and transit road quality would be negatively correlated, since fast growing trade implies falling trade costs. Endogeneity bias may also arise if there was a larger improvement of roads where the roads were in worse condition. In this case, the correlation between total bilateral trade costs and transit road quality would be positive. It is therefore difficult to tell the net effect of potential biases on the estimated coefficient on transit road quality. Statistically, the simple correlation coefficient between total bilateral trade costs and transit road quality is 0.06, indicating that in the trade costs equation, the coefficient on transit road quality would more likely be biased upwards. I conduct a falsification test to assess the estimated coefficients for endogeneity biases.

The set of fixed effects also do not address biases arising from mismeasurement of the transit road quality variable. I address biases arising from measurement errors by performing robustness checks on the assumptions used to calculate the transit road quality variable.

The identification strategy for this study therefore exploits the panel structure of the data and

⁸It is important to control for exchange rate movements since the trade and production data used to estimate the total bilateral trade costs are measured in US dollars.

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relies on country-pair, exporter-year, importer-year and industry-year fixed effects to control for country and industry characteristics, so that the location of the exporter affects total bilateral trade costs only through transit road quality. Any remaining influencing factors would come in at the exporter-importer-year level (the transit road quality variable varies at this level).

B. Estimating equations

The responsiveness of total bilateral trade costs and external trade volume to the change in transit road quality is estimated using the following equation:

$$\ln(y_{ijk,t}) = \beta \text{transit road quality}_{ij,t} + \gamma \mathbf{X}_{ij} + \delta_{i,t} + \delta_{j,t} + \delta_{k,t} + \epsilon_{ijk,t} \quad (4.3)$$

where outcome variable $y_{ijk,t}$ for country-pair ij in industry k at time t , is either tariff equivalent total bilateral trade costs or external trade volume, $\text{transit road quality}_{ij,t}$ is the share of good roads in the total length of transit road distance between country-pair ij at time t , $\mathbf{X}_{ij}$ is a set of time-invariant country-pair variables comprising bilateral distance, and binary variables for common border, common coloniser and common official language, $\delta_{i,t}$ denotes exporter-year fixed effects, $\delta_{j,t}$ denotes importer-year fixed effects, $\delta_{k,t}$ denotes industry-year fixed effects and $\epsilon_{ijk,t}$ is the error term. In an alternative specification, $\mathbf{X}_{ij}$ is replaced by country-pair fixed effects, which control for a wider range of country-pair characteristics.

The coefficient of interest in equation (4.3) is β , which measures the responsiveness of either total bilateral trade costs or external trade volume to a change in transit road quality. A negative value for β is expected when the outcome variable is total bilateral trade costs because costs associated with transportation, time and uncertainty are expected to fall with an increase in the quality of transit roads. This is provided that international trade costs fall by a larger margin than domestic trade costs. It is not clear *a priori* whether this scenario would obtain because the transit corridors link EAC capital cities as well as major towns within the EAC countries. The transit roads therefore serve both domestic trade and international trade.

When the outcome variable is external trade volume, the β coefficient is expected to be positive. Since demand and supply shocks, and multilateral resistance are controlled for by the exporter-year and importer-year fixed effects, a positive β would indicate a fall in international trade costs. To account for correlation of errors within country groups, I cluster and report standard errors at the exporter-importer level.

For the case of domestic trade, the dependent variable is unilateral, therefore, equation (4.3) cannot be used. The relationship between domestic trade and transit road quality is estimated using the following equation, in which the explanatory variables are specific to each EAC

country and do not make reference to any particular trade partner:

$$\ln(\text{domestic trade}_{ik,t}) = \phi \text{transit road quality}_{i,t}^* + \delta_i + \delta_{k,t} + \varepsilon_{ik,t} \cdot \quad (4.4)$$

In equation (4.4), *transit road quality*_{*i,t*}^{*} is calculated with respect to the total length of transit road distance that lies within each exporter *i*. Exporter-specific characteristics are controlled for by exporter fixed effects denoted by δ_i , and time-varying industry characteristics are controlled for by industry-year fixed effects denoted by $\delta_{k,t}$. $\varepsilon_{ik,t}$ is the error term. The ϕ coefficient is expected to be positive and would reflect a fall in domestic trade costs. For the case of domestic trade, I cluster and report standard errors at the exporter level.

The estimate of ϕ could potentially be biased upwards because richer countries would also have higher domestic trade and better infrastructure. This bias would be removed by the inclusion of exporter-year fixed effects in the equation, but these would be collinear with the transit road quality variable. Alternatively, I conduct a placebo test to assess the extent of bias in the estimate of ϕ .

The β coefficient in equation (4.3) with respect to external trade volume and the ϕ coefficient in equation (4.4) are comparable in terms of their sign. If both coefficients are positive, it would mean that associated trade costs have fallen because of higher transit road quality. The size of the two coefficients is less useful because inference cannot be made from gravity equation (4.3) about the absolute size of international trade costs (Anderson and van Wincoop, 2004).

C. Heterogeneous effects of transit road quality at the industry level

This paper also considers the effect of transit road quality on total bilateral trade costs, external trade volume and domestic trade across manufacturing industries depending on the weight of traded goods. The weight of traded goods is a determinant of the effect of distance on transportation costs (Chen, 2004; Head and Mayer, 2002).

For each industry-year pair, and with observations averaged across country-pairs, weight-to-value ratio is calculated as follows:

$$\text{weight-to-value ratio}_{k,t} = \frac{\text{export volume}_{k,t} + \text{import volume}_{k,t}}{\text{export value}_{k,t} + \text{import value}_{k,t}} \quad (4.5)$$

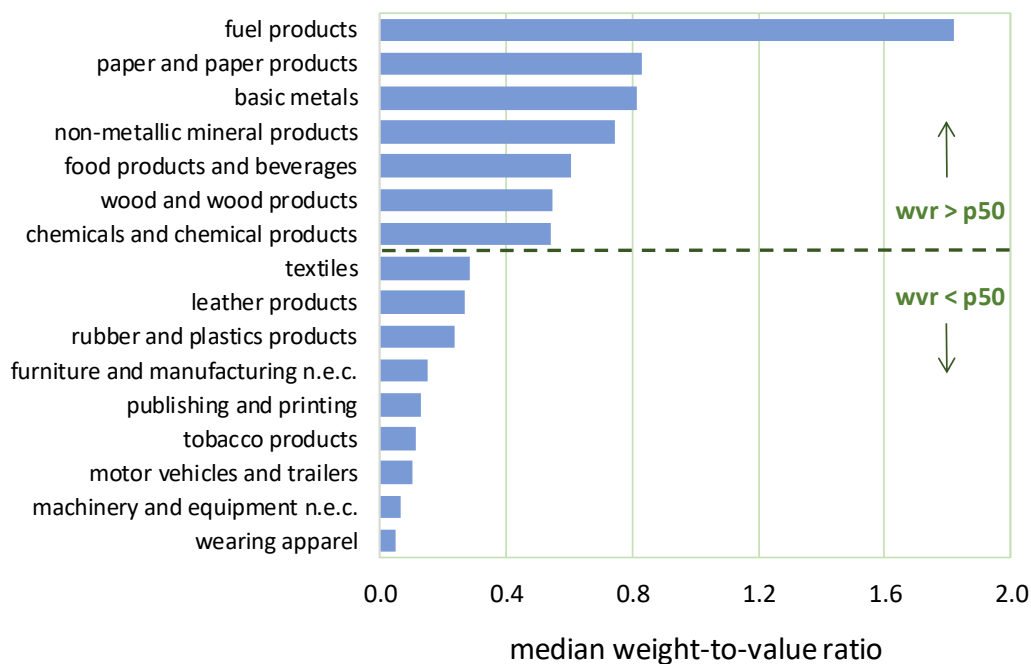
where export and import volumes are measured in kilograms and export and import values are F.O.B values⁹ measured in current US dollars. Weight-to-value ratios are usually calculated

⁹The imports of an EAC country from a partner are the reported F.O.B exports of the partner to the EAC country.

using either export or import data, but in this case, the trade flows are combined because the total bilateral trade costs are calculated based on two-way trade flows. Since the exports and imports in equation (4.5) are averaged across country-pairs, the weight-to-value ratios are unlikely to be endogenous to total bilateral trade costs, external trade volume or domestic trade (Chen and Novy, 2011). Also, the ratios do not change if only data on imports is used.¹⁰

An indicator variable denoted by $wvr_{k,t}$ is then constructed to take the value one for weight-to-value ratios that are above the 50th percentile and zero otherwise. The median weight-to-value ratios for the industries are shown in Figure 4.5. The highest weight-to-value ratios are associated with fuel products, paper products, basis metals, non-metallic mineral products, food and beverages, wood products and chemical products. For these industries, $wvr_{k,t}=1$. High value products, namely machinery, equipment, motor vehicles and trailers have comparably low weight-to-value ratios. For these and other industries with below median weight-to-value ratios, $wvr_{k,t}=0$.

Figure 4.5: Median weight-to-value ratio by industry



Notes: $wvr > p50$ indicates weight-to-value ratio above the 50th percentile. $wvr < p50$ indicates weight-to-value ratio below the 50th percentile. **Source:** Author's calculations based on data from COMTRADE online database.

Equation (4.3) is modified to include an interaction between *transit road quality*_{ij,t} and $wvr_{k,t}$, and country-pair fixed effects, δ_{ij} , in place of the time-invariant country-pair variables. The

¹⁰In the sample, import values (and volume) are four times larger than export values (and volume).

industry-year fixed effects, $\delta_{k,t}$, preclude the inclusion of $wvr_{k,t}$ by itself. The following specification is obtained:

$$\ln(y_{ijk,t}) = \phi_1 \text{transit road quality}_{ij,t} \times wvr_{k,t} + \phi_2 \text{transit road quality}_{ij,t} + \delta_{ij} + \delta_{i,t} + \delta_{j,t} + \delta_{k,t} + \nu_{ijk,t} \quad (4.6)$$

In equation (4.6), ϕ_1 captures the differential effect of the increase in transit road quality on the outcome variable for industries with weight-to-value ratios that are above the 50th percentile relative to other industries. The average effect of the increase in transit road quality on the outcome variable for industries with above median weight-to-value ratios will be captured by $\phi_1 + \phi_2$.

Heterogeneous effects of the increase in transit road quality on domestic trade across industries are similarly estimated by including an interaction between the indicator variable for weight-to-value ratio ($wvr_{k,t}$) and the transit road quality variable in equation (4.4).

4.4 Results

4.4.1 Effect of transit road quality on total bilateral trade costs

The Ordinary Least Squares (OLS) estimates of equations (4.3) and (4.4) are reported in Table 4.3. The results in column (1) exclude the fixed effects, and in column (2), industry-year fixed effects are introduced. From the difference in the adjusted R^2 in these two columns, most (about 79 per cent) of the variation in total bilateral trade costs occurs at the industry level. The coefficients on the control variables are signed as would be expected and indicate that total bilateral trade costs are lower for country-pairs that are geographically closer, and share a common colonial history and official language. The coefficient on transit road quality has the unexpected sign and is statistically insignificant. In columns (3) and (4), country-pair, exporter-year and importer-year fixed effects are introduced; these control for omitted variables that correlate with transit road quality and determine total bilateral trade costs. In these results, the coefficient on transit road quality assumes the expected sign and is statistically significant at the 1 per cent level.

The coefficients in column (3) indicates that an increase in transit road quality by 10 percentage points reduces total bilateral trade costs by 7.6 per cent. On average, transit road quality increased by 27 percentage points between 2003 and 2010 (see Table 4.2), implying that, over this period, total bilateral trade costs decreased by 21 per cent ($0.27 \times -0.760 \times 100$) due to the upgrading of transit roads. If the remaining road sections along the Corridors were

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upgraded, transit road quality would increase by a further 0.32 percentage points¹¹ and reduce total bilateral trade costs by 24 per cent ($0.32 \times -0.760 \times 100$). The total effect of upgrading all the Corridor roads would therefore be to reduce total bilateral trade costs by 45 per cent (21 + 24).

Table 4.3: Effect of transit road quality on trade costs and trade flows

dependent variable:	ln(total bilateral trade costs)				ln(external trade volume)		ln(domestic trade)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
transit road quality	0.118 (0.101)	0.101 (0.099)	-0.760*** (0.202)	-0.526** (0.228)	2.752*** (0.932)	2.931*** (0.885)	2.860* (1.259)
ln(bilateral distance)	0.460*** (0.070)	0.439*** (0.057)	0.546*** (0.100)		-1.493** (0.608)		
common border	-0.010 (0.183)	-0.246 (0.156)	-0.291* (0.153)		-0.205 (0.632)		
common coloniser	-0.229** (0.102)	-0.051 (0.085)	0.128 (0.133)		-1.664* (0.924)		
common official language	-0.146* (0.086)	-0.191** (0.077)	-0.496*** (0.144)		2.462*** (0.409)		
Country-pair fixed effects	-	-	-	Yes	-	Yes	-
Exporter-year fixed effects	-	-	Yes	Yes	Yes	Yes	-
Importer-year fixed effects	-	-	Yes	Yes	Yes	Yes	-
Industry-year fixed effects	-	Yes	Yes	Yes	Yes	Yes	Yes
Exporter fixed effects	-	-	-	-	-	-	Yes
Observations	1,298	1,298	1,298	1,298	1,298	1,298	87
Adjusted R-squared	0.075	0.867	0.905	0.906	0.668	0.676	0.717

Notes: Table 4.3 shows OLS estimates of equations (4.3) and (4.4). The time sample in all specifications is 2003 and 2010. Total bilateral trade costs measures all the costs of trading a good between two countries relative to the cost of trading the good in each country of the trading pair. External trade volume is export volume plus import volume, from the perspective of the exporter. For each industry, domestic trade is the exporter's domestic output minus exports to the rest of the world. 'ln' denotes natural logarithm. 'FE' denotes fixed effects. The constant term is not shown in all cases. For columns (1) to (6), the standard errors in parentheses are clustered at the country-pair level. For column (7), the standard errors in parentheses are clustered at the exporter level. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The results in column (3) also indicate that bilateral distance would have to reduce by a about third ($-0.38 \times 0.546 = 0.21$) in order to get the same effect of the increase in transit road quality on total bilateral trade costs. This estimate is comparable to the reported 25 per cent reduction in travel time between Mombasa and the Kenya-Uganda border and the 40 per cent reduction in travel time between Shelui and Nzega in Tanzania.¹²

In order to explain the estimated effect of transit road quality on total bilateral trade costs, external trade volume and domestic trade are regressed on transit road quality. The idea is to infer from the estimated coefficients, the effect of road upgrading on gross international trade

¹¹ $0.323 = 1 - 0.677$, where 0.677 is the average transit road quality for 2010. See Table 4.2.

¹² As stated in section 4.2 of this paper, the travel time between Mombasa and Malaba/Busia is reported to have reduced from 19 hours in 2004 to 14 hours in 2009 following the upgrading of the Northern Corridor roads (World Bank, 2016, p. iii). The travel time between Shelui and Nzega is estimated to have reduced from 5 hours to 2 hours following the paving of the Shelui-Nzega road (African Development Bank, 2014, p. 20).

costs and gross domestic trade costs, which are components of total bilateral trade costs. The results in columns (5) and (6) indicate that the increase in transit road quality had a positive effect on external trade volume (imports plus exports). Since the specifications in the two columns also control for changes in demand and supply conditions in the exporter and importer as well as multilateral resistance using exporter-year and importer-year fixed effects, the results suggest a fall in gross bilateral trade costs.

Quantitatively, the estimate reported in column (6) indicates that an increase in transit road quality by 10 percentage points would increase bilateral trade volumes by 29 per cent. On average, transit road quality increased by 27 percentage points between 2003 and 2010 (see [Table 4.2](#)), implying that bilateral trade volumes increased by 79 per cent ($0.27 \times 2.931 \times 100$) due to the upgrading of transit roads. The estimate in column (6) of [Table 4.3](#) also suggests that upgrading all the roads along the two Corridors could potentially result in a doubling of the volume of cross-border trade in manufactures.¹³

The coefficient on transit road quality in column (6) of [Table 4.3](#) is much larger than comparable ones reported in the literature, perhaps reflecting the differences in measuring the quality of infrastructure. For example, [Limão and Venables \(2001, p. 462\)](#) estimate for a sample of about 100 countries including African States, that an increase in the quality of infrastructure (measured by an index of road, rail and telephone line densities) of 10 percentage points would increase bilateral import values by 13 per cent.¹⁴ For the cases of Colombia and USA, [Duranton \(2015\)](#) and [Duranton et al. \(2014\)](#) estimate that an increase in the length of within city highways by 10 per cent would raise the city's weight and value of exports by about 3 to 5 per cent.

In column (7), domestic trade, which measures the exporter's industrial output that was not exported to the rest of the world, is regressed on transit road quality. Only 87 observations remain because domestic trade varies at the exporter-industry level. In this specification, industry-specific demand and supply shocks that would affect domestic trade in the exporter are controlled for using industry-year fixed effects. The positive response of domestic trade in the exporter to an increase in transit road quality is therefore attributable to a decline in domestic trade costs. It is noteworthy that domestic economic activity within EAC countries is concentrated along the transit roads ([Ranganathan and Foster, 2011](#))¹⁵ so that improvement in the transit roads would directly benefit domestic traders. A case in point is that the prices of

¹³Upgrading the remaining sections of the transit roads would mean adding another 0.32 percentage points ($1 - 0.677 = 0.323$) to the transit road quality variable or 94 per cent ($0.32 \times 2.931 \times 100$) to external trade volume. This means that external trade volume would more than double in response to the upgrading of all Corridor roads ($79 + 94 = 173$ per cent). 0.677 is the average transit road quality for 2010. See [Table 4.2](#).

¹⁴I estimate this from the coefficient on the infrastructure variable of 1.32, which is reported in [Limão and Venables \(2001, Table 3, p. 462\)](#).

¹⁵See [Ranganathan and Foster \(2011, p. 4\)](#) for a map showing the spatial distribution of economic activity in East Africa.

agricultural inputs in Nzega and the cost of transporting cattle from Nzega to Dar es Salaam are reported to have declined following the paving of the Shelui-Nzega road in Tanzania ([African Development Bank, 2014](#), p. 20). The upgrading of this road was a significant improvement to the Central Corridor.

According to the gravity equation, bilateral trade depends on relative trade costs. The equation cannot be used to estimate the absolute size of either domestic or cross-border trade costs ([Anderson and van Wincoop, 2004](#)). I can therefore only state implicitly based on the results reported in [Table 4.3](#) that both cross-border and domestic trade costs were lowered by the upgrading of transit roads. An explicit indication of the relative effect of increased transit road quality on these two costs is given by the total bilateral trade costs variable. This variable is negatively correlated with transit road quality indicating that cross-border trade costs fell by a larger margin than did domestic trade costs.

4.4.2 Heterogeneous effects of transit road quality on trade costs

In this subsection, the effect of improved transit road quality on the composition of trade in manufactured goods is assessed. This is done by estimating the differential impact of the change in transit road quality on the trade costs of two industry groups. Industries are grouped according to the weight of goods traded. For each industry in the sample, weight-to-value ratios are calculated according to equation (4.5) and an indicator variable is constructed to take the value one for weight-to-value ratios that are above the 50th percentile and zero otherwise. The indicator variable is interacted with the transit road quality variable and included as a regressor in equation (4.6). The OLS estimates of equation (4.6) are reported in [Table 4.4](#).

Column (1) of [Table 4.4](#) includes only the transit road quality variable, the coefficient of which is negative and statistically significant. The results in column (2) include the interaction between transit road quality and the indicator variable that takes the value one for industries with above median weight-to-value ratios and zero otherwise. The coefficient on the interaction term is negative and statistically significant indicating that the negative effect of increased transit road quality on total bilateral trade costs is stronger for industries producing output with high weight relative to their value. The overall negative effect of the increased transit road quality on total bilateral trade costs for this group of industries is 15 per cent ($0.27 \times -(0.336 + 0.215)$). This compares with -9 per cent (0.27×-0.336) for the group with below median weight-to-value ratios, although the effect is not statistically significant.

In columns (3) and (4), the dependent variable is external trade volume (exports plus imports). The positive effect of the increase in transit road quality on external trade volume accrues

to industries with above median weight-to-value ratios (column 4). For the case of domestic trade (columns 5 and 6), the results indicate that the effect of improved transit road quality on domestic trade was positive and statistically significant for industries regardless of the weight of traded output.

Table 4.4: Effect of better-quality transit roads by industry group

dependent variable:	ln(total bilateral trade costs)		ln(external trade volume)		ln(domestic trade)	
	(1)	(2)	(3)	(4)	(5)	(6)
transit road quality $\times$ wvr(> p50)		-0.215*** (0.064)		2.527*** (0.337)		-0.287 (0.410)
transit road quality	-0.526** (0.228)	-0.336 (0.208)	2.931*** (0.885)	0.696 (1.100)	2.860* (1.259)	2.842* (1.127)
Country-pair FE	Yes	Yes	Yes	Yes	-	-
Exporter-year FE	Yes	Yes	Yes	Yes	-	-
Importer-year FE	Yes	Yes	Yes	Yes	-	-
Industry-year FE	Yes	Yes	Yes	Yes	Yes	Yes
Exporter FE	-	-	-	-	Yes	Yes
Observations	1,298	1,298	1,298	1,298	87	87
Adjusted R-squared	0.906	0.907	0.676	0.712	0.717	0.712

Notes: Table 4.4 shows OLS estimates of equation (4.6). The time sample in all specifications is 2003 and 2010. Total bilateral trade costs measures all the costs of trading a good between two countries relative to the cost of trading the good in each country of the trading pair. External trade volume is export volume plus import volume, from the perspective of the exporter. Domestic trade is the exporter's domestic output minus exports to the rest of the world. Indicator variable 'wvr(> p50)' takes the value 1 for weight-to-value ratios that are above the 50th percentile and 0 otherwise. 'ln' denotes natural logarithm. 'FE' denotes fixed effects. The constant term is not shown in all cases. For columns (1) to (4), the standard errors in parentheses are clustered at the country-pair level. For columns (5) and (6), the standard errors in parentheses are clustered at the exporter level. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The results in Table 4.4 are in line with the evidence in the literature that regions or cities with better road connectivity tend to trade more in heavy goods (Coşar and Demir, 2016; Duranton et al., 2014). For the EAC, the industries with above median weight-to-value ratios dominate the manufacturing sector in terms of output and trade shares (see Figure 4.5 and Appendix C, Figure C.5 and Figure C.6). This means that the composition of trade in manufactured goods is unlikely to change following the upgrading of transit roads in the region.

4.5 Robustness checks

In this section, a falsification test is conducted to determine whether the results reported in section 4.4 spuriously attribute a decline in trade costs to an increase in transit road quality. The falsification test also assesses the exogeneity of the transit road quality variable to total bilateral trade costs, external trade volume and domestic trade conditional on the inclusion of country-pair, exporter-year, importer-year and industry-year fixed effects in the models.

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The falsification test is set up as follows: there was no significant improvement in transit road quality between 2001 and 2003 since the upgrading of the roads was implemented after 2003. I calculate a placebo transit road quality variable according to equation (4.1) for years 2001 and 2003, in which I use data on road conditions for 2003 in 2001 and data on road conditions for 2010 in 2003. I then estimate equations (4.3) and (4.4) using this placebo transit road quality variable. The placebo transit road quality variable should not have a statistically significant effect on total bilateral trade costs, external trade volume or domestic trade. The placebo test results are reported in Panel B of Table 4.5. The baseline results from Table 4.3 are reproduced in Panel A of Table 4.5.

The results in the first column of Panel B show that the effect of the placebo transit road quality on total bilateral trade costs is not statistically significant. The coefficient is also diminished in size as compared with the baseline estimate in Panel A. When external trade volume is considered (column 2), the placebo test results are statistically significant but counterintuitive. The statistical significance is explained by the inclusion of observations for the industry producing non-metallic mineral products, which has the highest weight-to-value ratio in the sample. This suggests that the upgrading of roads began to benefit external trade in these products only after 2003. The coefficient on the placebo transit road quality variable is also not statistically significant for the case of domestic trade (column 3). Overall, the falsification test results indicate that there are no pre-trends confounding the baseline results. The results also indicate that after including the set of fixed effects in the models, the transit road quality variable is unlikely to be correlated with any remaining omitted factors that may affect total bilateral trade costs, external trade volume or domestic trade.

The set of fixed effects included in the models does not address the endogeneity of the transit road quality variable arising from mismeasurement of the variable. A source of measurement error would be the road distances used to calculate the transit road quality variable. The condition of roads along these distances is given by the source documents and therefore does not change.

I first consider the effect of assuming that Rwanda uses both the Northern and Central Corridors equally as depicted in Figure 4.2, which only relates to year 2009. To test whether the baseline results depend on this assumption, I estimate equation (4.3) using two alternative transit road quality variables for any trade involving Rwanda, but hold the transit road quality variable unchanged for all other EAC countries. In the first case, I calculate the transit road quality variable for Rwanda assuming the distances and changes in road conditions along the Northern Corridor only. For the second case, I calculate another transit road quality variable for Rwanda assuming the distances and changes in road conditions along the Central Corridor only. The results reported in Panels C and D of Table 4.5 respectively assume that Rwanda uses the

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Table 4.5: Robustness checks: effect of using different estimates of transit road quality

dependent variable:	ln(total bilateral trade costs)	ln(external trade volume)	ln(domestic trade)
	(1)	(2)	(3)
<i>Panel A. baseline</i>			
transit road quality	-0.526** (0.228)	2.931*** (0.885)	2.860* (1.259)
obs.	1,298	1,298	87
adj. R2	0.906	0.676	0.717
<i>Panel B. placebo</i>			
transit road quality	-0.142 (0.276)	-2.033** (0.996)	-0.905 (1.022)
obs.	1,099	1,099	78
adj. R2	0.922	0.677	0.721
<i>Panel C. Rwanda uses Northern Corridor</i>			
transit road quality	-0.553** (0.215)	2.639*** (0.776)	-
obs.	1,298	1,298	
adj. R2	0.906	0.676	
<i>Panel D. Rwanda uses Central Corridor</i>			
transit road quality	-0.472*** (0.164)	2.399*** (0.802)	-
obs.	1,298	1,298	
adj. R2	0.906	0.676	
<i>Panel E. Dar es Salaam is the reference point instead of Dodoma</i>			
transit road quality	-0.581*** (0.194)	2.600*** (0.881)	-
obs.	1,298	1,298	
adj. R2	0.906	0.676	
Country-pair fixed effects	Yes	Yes	-
Exporter-year fixed effects	Yes	Yes	-
Importer-year fixed effects	Yes	Yes	-
Industry-year fixed effects	Yes	Yes	Yes
Exporter fixed effects	-	-	Yes

Notes: Table 4.5 shows OLS estimates of equations (4.3) and (4.4). The dependent variable in column (1) is the natural logarithm of tariff equivalent total bilateral trade costs. The dependent variable in column (2) is the natural logarithm of external trade volume measured in kilograms as export volume plus import volume. For column (3), the dependent variable is the natural logarithm of domestic trade measured in US dollars as the exporter's domestic output minus exports to the rest of the world. The time sample is 2003 and 2010 except in Panel B, where the time sample is 2001 and 2003. In Panel B, transit road quality for 2003 is imposed onto 2001 and transit road quality for 2010 is imposed onto 2003. There was no significant improvement in transit road quality between 2001 and 2003. In Panel C, transit road quality is calculated assuming Rwanda uses only the Northern Corridor as opposed to using both Corridors equally. In Panel D, transit road quality is calculated assuming Rwanda uses only the Central Corridor. In Panel E, transit road quality is calculated assuming Dar es Salaam is the reference city instead of Dodoma. The constant term is not shown in all cases. For columns (1) and (2), the standard errors in parentheses are clustered at the country-pair level. For column (3), the standard errors in parentheses are clustered at the exporter level. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Northern Corridor or the Central Corridor exclusively. These are not materially different from the baseline results.¹⁶

¹⁶From column (1) of Panels C and D, the 0.27 percentage point increase in transit road quality reduced total bilateral trade costs by 15 per cent (0.27×-0.553) and 13 per cent (0.27×-0.472), respectively, compared with 14 per cent implied by the baseline estimate in Panel A. From column (2) of Panels C and D, the increase in transit road quality increased bilateral trade volume by 71 per cent (0.27×2.639) and 65 per cent (0.27×2.399), respectively, compared with 79 per cent implied by the baseline estimate in Panel A.

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I also consider the use of Dodoma, the capital city of Tanzania, as the reference point when estimating road distances with respect to Tanzania instead of Dar es Salaam where most of Tanzania's industrial activity is located. I calculate a transit road quality variable that uses road distances with respect to Dar es Salaam for any trade involving Tanzania, holding the estimates for all other countries unchanged. The results from estimating equation (4.3) using this variable are reported in Panel E of Table 4.5. Again, the results are not significantly different from the baseline results.¹⁷ There is therefore unlikely to be a significant bias in the baseline results arising from the estimated road distances.

Finally, the effect of using mirror trade data and using an industry-specific elasticity of substitution parameter to calculate the total bilateral trade costs is considered. The total bilateral trade costs for Kenya were derived from mirror trade data because of gaps in the data reported by Kenya. The total bilateral trade costs estimates are therefore lower than would have been if data reported by Kenya were used. This is because Kenya would have reported exports on F.O.B basis whereas trade partners report the corresponding imports from Kenya on C.I.F. basis. For the years used in this paper, trade data reported by Kenya is not missing. The estimates of equation (4.3) using total bilateral trade costs that incorporate trade data that is reported by Kenya are reported in column (3) of Table 4.6. The estimate is not significantly different from the baseline result (column 1).¹⁸

The total bilateral trade costs estimates used in this thesis are derived assuming an industry-specific elasticity of substitution parameter. There is a practice in the literature of assuming that all industries have an elasticity of substitution parameter of 8.¹⁹ When equation (4.3) is estimated using total bilateral trade costs derived using an elasticity of substitution parameter of 8, the results reported in column (2) of Table 4.6 are obtained. This estimate is also not significantly different from the baseline estimate in column (1). The assumptions used to estimate total bilateral trade costs therefore do not significantly bias the baseline results.

¹⁷From column (1), Panel E, the 0.27 percentage point increase in transit road quality reduced total bilateral trade costs by 16 per cent (0.27×-0.581), compared with 14 per cent implied by the baseline estimate in Panel A. From column (2), Panel E, the increase in transit road quality increased bilateral trade volume by 70 per cent (0.27×2.600) compared with 79 per cent implied by the baseline estimate in Panel A.

¹⁸The results in column (3) indicate that the increase in transit road quality by 0.27 percentage points reduced total bilateral trade costs by 15 per cent (0.27×-0.568), compared with 14 per cent implied by the baseline estimate in column (1).

¹⁹8 is the mid-point of elasticity of substitution estimates reported in the empirical literature (Milner and McGowan, 2013, see footnote on p. 1891).

Table 4.6: Robustness checks: effect on alternative estimates of total bilateral trade costs

dependent variable:	ln(total bilateral trade costs)		
	mirror trade data		own trade data
	industry-specific σ	$\sigma = 8$	industry-specific σ
	(1)	(2)	(3)
transit road quality	-0.526** (0.228)	-0.464** (0.179)	-0.568** (0.259)
Country-pair fixed effects	Yes	Yes	Yes
Exporter-year fixed effects	Yes	Yes	Yes
Importer-year fixed effects	Yes	Yes	Yes
Industry-year fixed effects	Yes	Yes	Yes
Observations	1,298	1,298	1,049
Adjusted R-squared	0.906	0.655	0.906

Notes: Table 4.6 shows OLS estimates of equation (4.3). In all specifications, the time sample is 2003 and 2010 and the dependent variable is tariff equivalent total bilateral trade costs. σ is the elasticity of substitution between goods. The constant term is not shown in all cases. The standard errors in parentheses are clustered at the country-pair level. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

4.6 Conclusions

This paper investigates the effect of improvement in the quality of roads along the Northern Corridor and the Central Corridor in the East African Community (EAC) on the total bilateral trade costs of manufacturing industries. The study uses information on the condition of roads along these two Corridors, which is reported by EAC governments and donor agencies in several road surveys and project reports. The reports pertain to road upgrading projects that were completed in the period 2004-2010. The information on road conditions contained in these reports is used to construct a transit road quality variable, which captures the share of paved roads in good condition in the total length of road distance between two EAC capital cities (for the case of intra-EAC trade) and between an EAC capital city and the nearest seaport (for the case of overseas trade). On average, the share of good roads along the Corridors increased from 0.40 in 2003 to 0.68 in 2010.

The effect of the increase in transit road quality on industry-level total bilateral trade costs is estimated using an equation that includes country-pair, exporter-year, importer-year and industry-year fixed effects. This set of fixed effects aids in identifying the effect of interest and addresses the endogeneity of the transit road quality variable. The results suggest that the increase in transit road quality over the period 2003-2010 reduced total bilateral trade costs of

Chapter 4: Quality of Transit Roads

manufacturing industries by 21 per cent. This is equivalent to reducing the effect of bilateral distance on total bilateral trade costs by about a third. The estimated coefficient on transit road quality further implies that upgrading all the roads along the two Corridors would lower total bilateral trade costs by 45 per cent. This effect is larger than the negative effect of the EAC customs union on total bilateral trade costs of 30 per cent, which is estimated in chapter 3 of this thesis.

As a way to explain this result, the effect of increased transit road quality on external trade volume (exports plus imports) and domestic trade (industrial output minus exports to the rest of the world) is also estimated. The results show a positive effect of transit road quality on the two variables. Since the regressions control for changes in supply and demand conditions, the positive effect of transit road quality on external trade volume and domestic trade indicates a fall in both cross-border and domestic trade costs. The reduction in total bilateral trade costs due to the increase in transit road quality however suggests that the fall in cross-border trade costs was larger than the fall in domestic trade costs.

This study also assesses whether the composition of trade in manufactures would change following the upgrading of transit roads. This is done by estimating the differential effect of increased transit road quality on total bilateral trade costs, external trade volume and domestic trade for industries producing heavy output as compared with other industries. The results show that the negative effect of better-quality transit roads on total bilateral trade costs and the positive effect of better roads on external trade volume accrues to industries producing goods with above median weight-to-value ratios. Industries producing goods with above median weight-to-value ratios include those manufacturing fuel products, paper products, basic metals, non-metallic mineral products, food and beverages, wood products, and chemical products. These industries dominate EAC's manufacturing sector both in terms of output and trade shares. The composition of the Community's cross-border trade in manufactures is therefore unlikely to change following the upgrading of transit roads. For the case of domestic trade, the study finds no differential effect of the increase in transit road quality across the two industry groups.

In the last part of this paper, falsification tests are conducted to vet the baseline results considering that transit road quality is endogenous to trade. The baseline results are found not to be spurious implying that the set of fixed effects included in the models sufficiently account for omitted variables. Further tests show that the baseline results are not sensitive to assumptions made when calculating the transit road quality and total bilateral trade costs variables.

The findings from this study support the evidence in the empirical literature that the quality of roads significantly influences the size of international trade flows, with a bias in favour of industries producing heavy output. Moreover, the findings from this study offer some insight

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into the possible magnitude of impact that the ongoing expenditure on transit infrastructure in the EAC may have on the Community's external trade in manufactures. Overall, the findings suggest that upgrading all corridor roads could potentially double the volume of external trade in manufactured goods. In terms of lowering the total cost of engaging in international trade faced by the manufacturing sector, as more roads are upgraded, the effects are likely to disproportionately impact on the already dominant industries.

5. Conclusion

The East African Community (EAC) aims to integrate member countries through trade, among other channels. A measure of trade integration is total bilateral trade costs, which captures all the costs of engaging in cross-border trade relative to domestic trade costs. The measure ranges from 1 (for a country-pair that is perfectly integrated) and increases in value as trade integration between two countries weakens. This thesis assesses the effectiveness of EAC trade policies in lowering the total bilateral trade costs of the manufacturing sector.

5.1 Summary of the three main chapters

The analysis begins in chapter 2 with the estimation of total bilateral trade costs for 5 EAC countries relative to each other and 87 non-EAC trade partners over the period 1990-2012. The estimates are derived at the International Standard Industrial Classification (ISIC) revision 3, 2-digit level of production for 16 manufacturing industries, thereby extending from existing studies that analyse total bilateral trade costs at the 1-digit level of production. The total bilateral trade costs estimates indicate that it costs on average 3 times more to trade manufactured goods between EAC countries than to trade the goods domestically within each EAC country. The estimates also indicate that it costs on average 8 times more to trade manufactured goods with non-EAC countries than to trade the goods domestically within each EAC country.

The distribution of the total bilateral trade costs estimates across country-pairs is as expected. The estimates are lower with respect to partners that are close to the EAC in geographical, political and cultural terms and with whom EAC countries share a trade agreement. The distribution of the estimates across industries is such that industries with higher total bilateral trade costs also have higher product weight-to-value ratios and face higher import tariff rates. Regression results show the EAC trade agreement to be an important determinant of the total bilateral trade costs. This indicates that the trade costs are amenable to policy intervention and motivates further study into the effect of two key EAC trade policy measures on the trade costs.

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These are the removal of intra-EAC import tariffs and the upgrading of transit roads.

Chapter 3 of this thesis assesses the empirical contribution of the removal of import tariffs to the decline in intra-EAC total bilateral trade costs that occurred after 2004. The trends of total bilateral trade costs for intra-EAC and extra-EAC trade are similar until around 2004 when the intra-EAC trade costs turn downwards. This divergence in trends coincides with the coming into force of the EAC customs union protocol. Intra-EAC import tariffs were eliminated beginning 2005 resulting in a decline in the import tariff rates by 12.7 percentage points to zero on average. Import tariff rates for extra-EAC trade remained positive.

A difference-in-differences model is used to estimate the extent to which the fall in intra-EAC total bilateral trade costs is due to the removal of import tariffs. The results are that, for most industries, the removal of import tariffs does not significantly explain the decline in intra-EAC total bilateral trade costs after 2004. The estimated downward effect of the EAC customs union on trade costs of 30 per cent is attributable to non-tariff policy measures. The estimated tariff equivalent of the effect of non-tariff measures on total bilateral trade costs is -17 per cent, which is more than the average decline in intra-EAC import tariff rates. This finding points to non-tariff barriers being the more dominant determinant of total bilateral trade costs facing manufacturing industries in the EAC as compared with import tariffs. This matches the evidence in the existing literature that non-tariff barriers to trade influence international trade flows more than import tariffs.

Another trade barrier that is highlighted severally in the literature on trade in Africa, and particularly in the EAC, is the poor state of roads. To remove this impediment, EAC governments initiated the upgrading of regional transit roads along the Northern and Central Corridors. The objective of chapter 4 of this thesis is to estimate the extent to which the upgrading of transit roads lowered total bilateral trade costs. To meet this objective, I collect data on road conditions from reports on road projects implemented over the period 2004-2010 and create a variable that measures the quality of transit roads in 2003 and 2010. The transit road quality variable indicates that the share of roads in good condition along the two Corridors doubled between 2003 and 2010.

Results from regressing total bilateral trade costs on transit road quality show a negative and statistically significant relationship between the two variables. This result indicates that external trade costs fell by more than domestic trade cost following the upgrading of the transit roads. The decline in international trade costs is also implied by the positive and statistically significant effect of the increase in transit road quality on external trade volume, after controlling for macroeconomic shocks and multilateral resistance. The decline in domestic trade costs is likewise also implied by the positive and statistically significant effect of the increase in transit road quality on the value of domestic trade, after controlling

Chapter 5: Conclusion

for macroeconomic shocks.

The regression results imply that upgrading all the transit roads would lower total bilateral trade costs by 45 per cent and result in a doubling of the volume of cross-border trade in manufactured goods. The estimated effect however falls on industries that produce output with above median weight-to-value ratios. This group of industries already dominate EAC's manufacturing sector in terms of output and cross-border trade values. The composition of trade flows in manufactured goods is therefore not likely to be altered by the upgrading of roads in the region. This finding agrees with the evidence in the literature that cities and countries that have better road networks tend to trade more in output that is transport intensive. The results presented in chapter 4 also indicate that the better-quality transit roads had an equivalent effect on total bilateral trade costs as reducing the effect of bilateral distance on total bilateral trade costs by a third. This result compares well with the information from road project reports that travel times along the Corridors fell by between 25 and 40 per cent following the upgrading of the roads.

The findings of this thesis may be summarised as follows: The total cost of engaging in cross-border trade for manufacturing industries in the EAC is high owing to distance and policy-related factors. For intra-EAC trade, total bilateral trade costs declined following the implementation of the EAC customs union protocol. Less than half of the decline in total bilateral trade costs is due to the removal of import tariffs. A larger portion of the decline is attributable to the removal of non-tariff trade barriers. Poor roads are another prominent barrier to trade in the EAC. The study finds a significantly larger negative effect of transit road upgrading on external trade costs as compared with the negative effect on domestic trade costs.

In terms of the distribution of the identified policy effects across manufacturing industries, non-tariff barriers are particularly important for industries producing non-metallic mineral products, wood products, basic metals and chemical products. These same industries are also found to be among those whose total bilateral trade costs responded more negatively to the upgrading of transit roads in the region.

It is noteworthy that the findings of this thesis relate only to the manufacturing sector, which constitutes a small part of total production in the EAC countries (see [Figure 2.1](#)). In this regard, the results from this study are limited in scope and may not apply to the other sectors of the economy.

5.2 Policy implications

This thesis suggests that improving the quality of roads in the EAC will do more to lower cross-border trade costs facing manufacturing industries than will other trade policy initiatives singly. The policy implication of this conclusion is that the much-touted infrastructure gap in Africa ([African Development Bank, 2018](#)) is indeed a binding constraint in the EAC. How to finance the closing of this gap then becomes the main question because the venture will be expensive and EAC countries are financially constrained. Naturally, the best answer is to remove inefficiencies in public resource and expenditure management.

This thesis also indicates that upgrading transit roads will support the dominant industries with above median weight-to-value ratios. These comprise extractive industries such as those dealing in fuel, wood and non-metallic minerals. Policy intervention will be required to promote the smaller, non-extractive industries and ensure product diversity in manufacturing.

Economic activity in the EAC is concentrated along the transit routes ([Ranganathan and Foster, 2011](#)). The finding that upgrading transit roads will support already dominant industries also implies that disproportionate spending on transit infrastructure may further agglomerate manufacturing along the transit routes and disadvantage development of the hinterlands.

5.3 Contribution to existing research

To the literature that estimates and analyses total bilateral trade costs, and the literature that studies the determinants of bilateral trade flows, this thesis contributes total bilateral trade costs estimates for manufactured goods at the 2-digit level of production for the EAC. The thesis then contributes evidence of the relative importance of tariff and non-tariff measures within a regional trade agreement in determining total bilateral trade costs. This is done in the context of African economies where tariffs remain an important policy instrument. Overall, this thesis offers some insights into why the EAC customs union was effective in increasing the value of trade among members.

To the literature on the effect of roads on trade, this thesis provides evidence on the impact of better-quality transit roads on trade costs and the composition of trade flows, based on previously unused data on road conditions in East Africa.

To the economic geography literature, this thesis contributes an estimate, based on the data of countries in East Africa, of the extent to which good roads mitigate the effect of distance on

bilateral trade volumes.

5.4 Directions for future research

The analysis in this thesis is limited to positive trade flows and therefore focuses only on the intensive margin of trade. The thesis may be extended to the analysis of trade costs at the extensive margin by also calculating total bilateral trade cost for the case of zero trade flows. These costs may be higher on average as very large trade costs are implied where no trade occurs between countries. Analysis of trade costs at the extensive margin would highlight the impact of EAC trade policies on the range of manufactured goods that is traded by the Community.

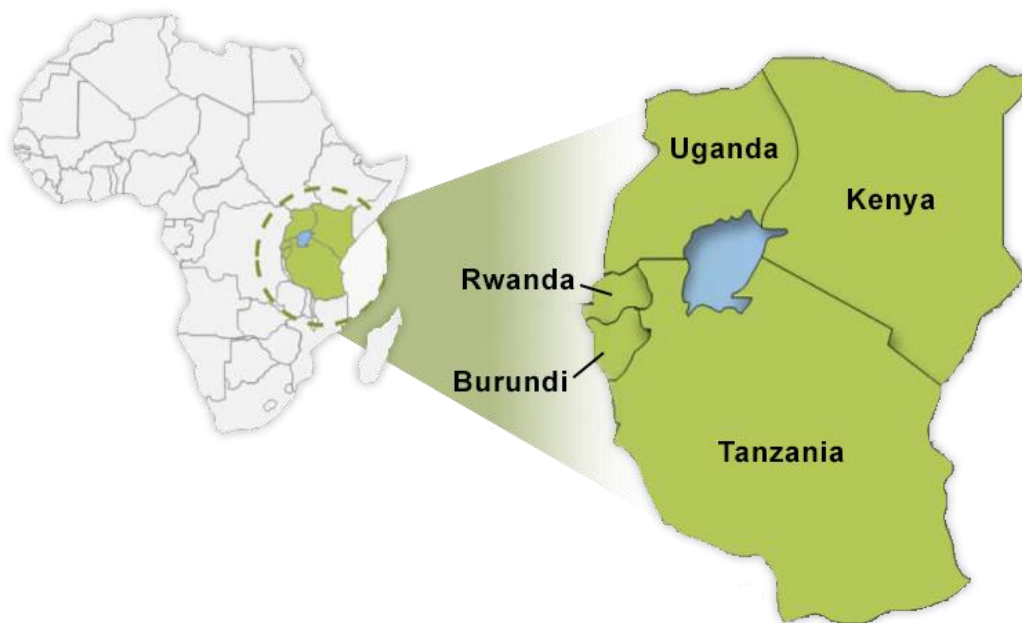
This thesis focuses on the distribution of policy effects on trade costs across manufacturing industries and not on the distribution of the effects across the countries in which the industries are located. A next step would be to study how welfare gains from lower trade costs have been distributed across EAC countries. Going by past experience with the EAC, the equitable distribution of gains from co-operation among members is ultimately what will hold the Community together.

Another next step would be to extend the analysis to agriculture, which is the dominant sector in the EAC. Total bilateral trade costs in agriculture are reported to be much larger than the costs facing manufacturing, and particularly for African countries ([Arvis et al., 2016](#)).

APPENDIX A

Appendix for Chapter 2

Figure A.1: Map of the East African Community (EAC)



Source: EAC Secretariat

APPENDIX A: APPENDIX FOR CHAPTER 2

Table A.1: Composition and trade of manufactured output
(averages for the period 1990-2012)

ISIC code and description	Burundi	Kenya	Rwanda	Tanzania	Uganda
Panel A. Share in total manufactured output (%)					
15 Food and beverages	82	43	71	41	38
16 Tobacco products	1	1	1	6	4
17 Textiles	3	2	2	6	6
18 Wearing apparel, fur	0	2		1	
19 Leather, leather products and footwear	0	2	2	0	1
20 Wood products (excl. furniture)	1	1	0	1	
21 Paper and paper products	0	3	1	2	5
22 Printing and publishing	1	2	6	3	2
23 Coke,refined petroleum products,nuclear fuel		11		1	
24 Chemicals and chemical products	5	7	3	9	8
25 Rubber and plastics products	0	3	1	9	3
26 Non-metallic mineral products	1	5	5	9	7
27 Basic metals	2	3	4	2	12
29 Machinery and equipment n.e.c.		1		1	
34 Motor vehicles, trailers, semi-trailers		4		1	
36 Furniture; manufacturing n.e.c.	0	1	3	1	3
Panel B. Share of manufactured output that was exported to the rest of the world (%)					
15 Food and beverages	0	8	7	9	50
16 Tobacco products	0	12	1	0	1
17 Textiles	7	12	3	25	21
18 Wearing apparel, fur	0	9	0	3	0
19 Leather, leather products and footwear	12	14	14	20	7
20 Wood products (excl. furniture)	0	9	5	20	0
21 Paper and paper products	0	8	2	5	2
22 Printing and publishing	0	9	0	1	8
23 Coke,refined petroleum products,nuclear fuel	0	10	0	23	0
24 Chemicals and chemical products	3	27	6	7	17
25 Rubber and plastics products	0	12	2	3	3
26 Non-metallic mineral products	0	11	4	4	12
27 Basic metals	0	19	13	9	30
29 Machinery and equipment n.e.c.	0	8	0	35	0
34 Motor vehicles, trailers, semi-trailers	0	1	0	20	0
36 Furniture; manufacturing n.e.c.	0	7	1	5	2
Panel C. Share of total exports that went to the EAC (%)					
15 Food and beverages	83	15	89	17	43
16 Tobacco products		53	100	27	94
17 Textiles	11	37	86	51	26
18 Wearing apparel, fur		3		0	
19 Leather, leather products and footwear	38	1	33	5	22
20 Wood products (excl. furniture)	61	32	11	41	
21 Paper and paper products	27	88	52	52	88
22 Printing and publishing	16	48	18	12	53
23 Coke,refined petroleum products,nuclear fuel		68		91	
24 Chemicals and chemical products	64	66	50	27	92
25 Rubber and plastics products		86	91	64	86
26 Non-metallic mineral products	60	81	99	28	97
27 Basic metals	100	86	61	3	77
29 Machinery and equipment n.e.c.		55		2	
34 Motor vehicles, trailers, semi-trailers		45		9	
36 Furniture; manufacturing n.e.c.		47	70	43	66

Note: The difference between total production and exports to the rest of the world is assumed to be domestic consumption.

Source: Author's calculations based on data from INDSTAT2 and COMTRADE online databases.

APPENDIX A: APPENDIX FOR CHAPTER 2

Table A.2: List of countries and territories included in the study
(EAC countries in bold)

Albania	Estonia	Latvia	Russian Federation
Algeria	Ethiopia	Lithuania	Rwanda
Australia	Fiji	Luxembourg	Saudi Arabia
Austria	Finland	Macedonia, FYR	Senegal
Azerbaijan	France	Madagascar	Singapore
Bangladesh	Georgia	Malawi	Slovak Republic
Belgium	Germany	Malaysia	Slovenia
Botswana	Greece	Malta	South Africa
Brazil	Hong Kong, China	Mauritius	Spain
Bulgaria	Hungary	Mexico	Sri Lanka
Burundi	Iceland	Morocco	Sweden
Cameroon	India	Namibia	Switzerland
Canada	Indonesia	Netherlands	Tanzania
Chile	Iran	New Zealand	Thailand
China	Ireland	Norway	Tunisia
Colombia	Israel	Oman	Turkey
Congo, Rep.	Italy	Pakistan	Uganda
Costa Rica	Japan	Peru	Ukraine
Cyprus	Jordan	Philippines	United Kingdom
Czech Republic	Kazakhstan	Poland	United States
Denmark	Kenya	Portugal	Vietnam
Ecuador	Korea, Rep.	Qatar	Yemen
Egypt	Kuwait	Romania	Zambia

Table A.3: List of ISIC categories included in the study

ISIC code	Description
15	Manufacture of food products and beverages
16	Manufacture of tobacco products
17	Manufacture of textiles
18	Manufacture of wearing apparel; dressing and dyeing of fur
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear
20	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
21	Manufacture of paper and paper products
22	Publishing, printing and reproduction of recorded media
23	Manufacture of coke, refined petroleum products and nuclear fuel
24	Manufacture of chemicals and chemical products
25	Manufacture of rubber and plastics products
26	Manufacture of non-metallic mineral products
27	Manufacture of basic metals
29	Manufacture of machinery and equipment n.e.c.
34	Manufacture of motor vehicles, trailers, semi-trailers
36	Manufacture of furniture; manufacturing n.e.c.

APPENDIX A: APPENDIX FOR CHAPTER 2

Table A.4: List of dominant suppliers by EAC country and ISIC category

Importer	Dominant supplier	Importer	Dominant supplier
15 Food and beverages		23 Coke, refined petroleum products, nuclear fuel	
Burundi	Italy	Burundi	Kenya
Kenya	Indonesia	Kenya	Singapore
Rwanda	Uganda	Rwanda	Kenya
Uganda	Kenya	Uganda	India
Tanzania	Indonesia	Tanzania	India
16 Tobacco products		24 Chemicals and chemical products	
Burundi	Kenya	Burundi	India
Kenya	India	Kenya	India
Rwanda	Kenya	Rwanda	India
Uganda	Kenya	Uganda	India
Tanzania	India	Tanzania	India
17 Textiles		25 Rubber and plastics products	
Burundi	China	Burundi	China
Kenya	India	Kenya	India
Rwanda	China	Rwanda	Kenya
Uganda	China	Uganda	Kenya
Tanzania	China	Tanzania	China
18 Wearing apparel, fur		26 Non-metallic mineral products	
Burundi	France	Burundi	Zambia
Kenya	Thailand	Kenya	India
Rwanda	United Arab Emirates	Rwanda	Uganda
Uganda	China	Uganda	Kenya
Tanzania	China	Tanzania	China
19 Leather, leather products and footwear		27 Basic metals	
Burundi	United Arab Emirates	Burundi	Kenya
Kenya	India	Kenya	India
Rwanda	United Arab Emirates	Rwanda	Uganda
Uganda	United Arab Emirates	Uganda	Kenya
Tanzania	China	Tanzania	China
20 Wood products (excl. furniture)		29 Machinery and equipment n.e.c.	
Burundi	Kenya	Burundi	France
Kenya	India	Kenya	India
Rwanda	China	Rwanda	China
Uganda	Kenya	Uganda	India
Tanzania	China	Tanzania	China
21 Paper and paper products		34 Motor vehicles, trailers, semi-trailers	
Burundi	United Arab Emirates	Burundi	Japan
Kenya	India	Kenya	Japan
Rwanda	Kenya	Rwanda	Japan
Uganda	Kenya	Uganda	Japan
Tanzania	Kenya	Tanzania	Japan
22 Printing and publishing		36 Furniture; manufacturing n.e.c.	
Burundi	France	Burundi	China
Kenya	India	Kenya	India
Rwanda	Kenya	Rwanda	China
Uganda	United Kingdom	Uganda	China
Tanzania	United Kingdom	Tanzania	China

Notes: The United Arab Emirates is a transit trade route and may not be the true trade partner.

APPENDIX A: APPENDIX FOR CHAPTER 2

Table A.5: Summary statistics for total bilateral trade costs

Exporter	ISIC code	Description	Obs.	Mean	Std. dev.	Min.	Max.
Burundi	15	Food and beverages	23	11.2	6.1	4.2	27.9
Burundi	17	Textiles	9	2.9	1.0	2.1	5.0
Burundi	19	Leather, leather products and footwear	3	14.7	11.2	6.7	27.4
Burundi	20	Wood products (excl. furniture)	8	20.2	7.0	5.4	27.1
Burundi	21	Paper and paper products	7	32.5	24.3	8.7	81.9
Burundi	22	Printing and publishing	16	2.9	0.6	2.0	3.9
Burundi	24	Chemicals and chemical products	8	4.7	2.4	1.8	8.2
Burundi	26	Non-metallic mineral products	8	785.3	1083.9	20.2	3340.9
Burundi	27	Basic metals	2	1.9	0.2	1.8	2.1
Kenya	15	Food and beverages	886	7.3	4.2	1.6	46.7
Kenya	16	Tobacco products	25	1.9	0.4	1.3	2.8
Kenya	17	Textiles	660	3.2	0.9	1.2	8.1
Kenya	18	Wearing apparel, fur	313	5.7	1.9	2.0	20.0
Kenya	19	Leather, leather products and footwear	301	9.8	5.6	2.4	38.7
Kenya	20	Wood products (excl. furniture)	420	17.2	12.4	1.4	157.7
Kenya	21	Paper and paper products	351	29.2	34.8	2.2	460.8
Kenya	22	Printing and publishing	483	2.9	0.7	1.6	6.2
Kenya	23	Coke,refined petroleum products,nuclear fuel	66	102.8	142.2	1.1	968.2
Kenya	24	Chemicals and chemical products	690	5.2	2.6	1.2	22.1
Kenya	25	Rubber and plastics products	524	3.9	1.3	1.2	9.9
Kenya	26	Non-metallic mineral products	627	500.5	1245.3	1.2	14825.9
Kenya	27	Basic metals	250	3.1	1.0	1.0	7.8
Kenya	29	Machinery and equipment n.e.c.	444	2.0	0.3	1.1	4.3
Kenya	34	Motor vehicles, trailers, semi-trailers	291	11.4	5.7	2.1	36.2
Kenya	36	Furniture; manufacturing n.e.c.	579	14.9	9.7	2.3	102.1
Rwanda	15	Food and beverages	108	9.3	4.3	1.6	29.2
Rwanda	16	Tobacco products	1	2.8	.	2.8	2.8
Rwanda	17	Textiles	40	3.3	1.0	1.3	5.7
Rwanda	19	Leather, leather products and footwear	6	9.4	3.7	3.8	15.3
Rwanda	20	Wood products (excl. furniture)	22	18.7	8.1	3.1	35.9
Rwanda	21	Paper and paper products	16	15.0	16.8	2.8	54.4
Rwanda	22	Printing and publishing	66	2.9	0.5	1.7	4.7
Rwanda	24	Chemicals and chemical products	35	4.7	2.2	1.3	10.1
Rwanda	25	Rubber and plastics products	19	3.4	1.3	1.4	5.4
Rwanda	26	Non-metallic mineral products	19	438.1	417.3	3.4	1375.0
Rwanda	27	Basic metals	15	3.3	1.5	1.3	7.0
Rwanda	36	Furniture; manufacturing n.e.c.	24	15.6	9.3	3.3	40.1
Tanzania	15	Food and beverages	528	7.6	4.5	2.2	46.7
Tanzania	16	Tobacco products	12	2.5	0.5	1.7	3.7
Tanzania	17	Textiles	362	3.1	0.8	1.2	5.6
Tanzania	18	Wearing apparel, fur	19	5.0	1.9	2.0	8.1
Tanzania	19	Leather, leather products and footwear	54	8.6	4.5	3.6	24.6
Tanzania	20	Wood products (excl. furniture)	240	18.1	12.7	3.3	91.5
Tanzania	21	Paper and paper products	69	20.8	13.2	2.9	54.4
Tanzania	22	Printing and publishing	221	3.0	0.5	2.0	4.7
Tanzania	23	Coke,refined petroleum products,nuclear fuel	17	57.3	72.1	2.2	268.7
Tanzania	24	Chemicals and chemical products	332	6.3	3.2	1.7	24.4
Tanzania	25	Rubber and plastics products	216	4.0	1.4	1.6	8.7
Tanzania	26	Non-metallic mineral products	250	670.3	1217.2	7.4	9249.8
Tanzania	27	Basic metals	12	3.1	0.7	1.8	4.5
Tanzania	29	Machinery and equipment n.e.c.	80	1.7	0.3	1.1	2.5
Tanzania	34	Motor vehicles, trailers, semi-trailers	42	6.6	3.5	2.6	17.7
Tanzania	36	Furniture; manufacturing n.e.c.	276	16.2	10.9	3.3	95.8
Uganda	15	Food and beverages	208	6.3	2.9	1.7	21.2
Uganda	16	Tobacco products	3	2.2	0.5	1.8	2.7
Uganda	17	Textiles	80	3.2	1.1	1.4	8.7
Uganda	19	Leather, leather products and footwear	20	6.2	1.8	2.9	9.4
Uganda	21	Paper and paper products	58	32.8	23.3	3.4	110.3
Uganda	22	Printing and publishing	110	2.7	0.6	1.7	4.3
Uganda	24	Chemicals and chemical products	212	6.6	3.6	1.4	23.4
Uganda	25	Rubber and plastics products	90	3.8	1.3	1.5	8.3
Uganda	26	Non-metallic mineral products	71	461.0	474.0	6.2	2583.2
Uganda	27	Basic metals	42	3.1	1.0	1.4	6.0
Uganda	36	Furniture; manufacturing n.e.c.	106	18.5	12.0	4.7	84.3

Source: Author's calculations based on data from INDSTAT2 and COMTRADE online databases.

APPENDIX B

Appendix for Chapter 3

Table B.1: List of countries and territories included in the study
(EAC countries in bold)

Algeria	Estonia	Luxembourg	Senegal
Australia	Ethiopia	Madagascar	Singapore
Austria	Finland	Malawi	Slovak Republic
Bangladesh	France	Malaysia	Slovenia
Belgium	Germany	Malta	South Africa
Botswana	Greece	Mauritius	Spain
Brazil	Hong Kong, China	Mexico	Sri Lanka
Bulgaria	Hungary	Morocco	Sweden
Burundi	Iceland	Namibia	Switzerland
Cameroon	India	Netherlands	Tanzania
Canada	Indonesia	New Zealand	Thailand
Chile	Iran	Norway	Tunisia
China	Ireland	Oman	Turkey
Colombia	Israel	Pakistan	Uganda
Congo, Rep.	Italy	Philippines	Ukraine
Costa Rica	Japan	Poland	United Kingdom
Cyprus	Jordan	Portugal	United States
Czech Republic	Kenya	Qatar	Vietnam
Denmark	Korea, Rep.	Romania	Yemen
Ecuador	Kuwait	Russian Federation	Zambia
Egypt	Lithuania	Rwanda	

Table B.2: List of ISIC categories included in the study

ISIC code	Description
15	Manufacture of food products and beverages
16	Manufacture of tobacco products
17	Manufacture of textiles
18	Manufacture of wearing apparel; dressing and dyeing of fur
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear
20	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
21	Manufacture of paper and paper products
22	Publishing, printing and reproduction of recorded media
23	Manufacture of coke, refined petroleum products and nuclear fuel
24	Manufacture of chemicals and chemical products
25	Manufacture of rubber and plastics products
26	Manufacture of non-metallic mineral products
27	Manufacture of basic metals
29	Manufacture of machinery and equipment n.e.c.
34	Manufacture of motor vehicles, trailers, semi-trailers
36	Manufacture of furniture; manufacturing n.e.c.

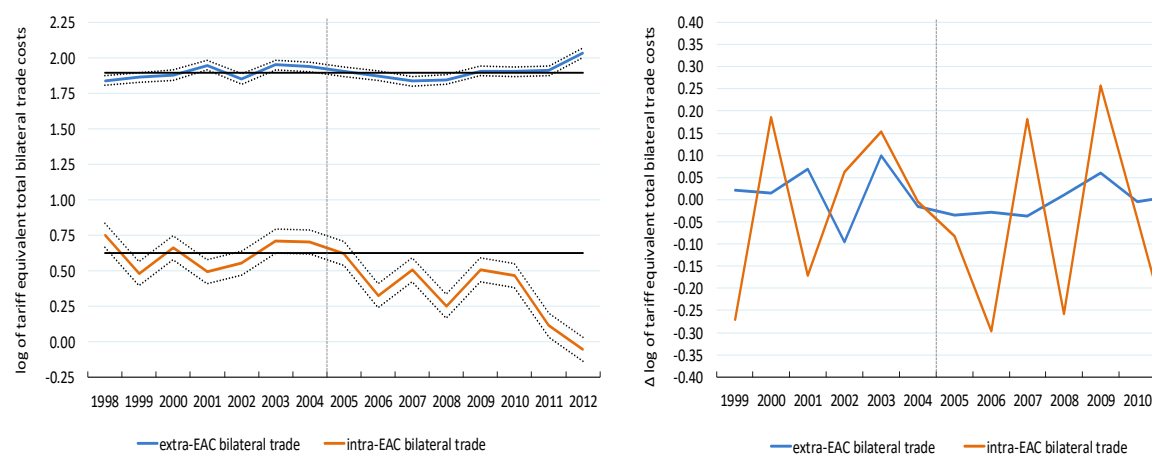
APPENDIX B: Appendix for Chapter 3

Table B.3: Means of total bilateral trade costs and import tariff rates
before and after the EAC customs union (EACU) took effect

ISIC code and description	tariff equivalent total bilateral trade costs			import tariff rate		
	before EACU: 2000-2004	during EACU: 2005-2012	diff.	before EACU: 2000-2004	during EACU: 2005-2012	diff.
<i>Panel A. Full sample</i>						
15 Food and beverages	5.7	6.4	0.7	21.0	22.2	1.2
16 Tobacco products	1.2	1.1	-0.1	20.3	16.9	-3.4
17 Textiles	2.2	2.1	0.0	23.1	20.3	-2.8
18 Wearing apparel, fur	4.8	5.0	0.2	33.1	23.1	-9.9
19 Leather, leather products and footwear	7.5	9.0	1.5	24.7	20.8	-3.9
20 Wood products (excl. furniture)	15.4	17.2	1.8	26.2	20.8	-5.4
21 Paper and paper products	23.9	29.9	6.1	22.4	15.9	-6.5
22 Printing and publishing	2.0	1.9	-0.1	13.9	12.9	-1.1
23 Coke, refined petroleum products, etc.	68.3	89.7	21.4	9.7	3.9	-5.7
24 Chemicals and chemical products	4.5	4.7	0.2	8.8	5.9	-2.9
25 Rubber and plastics products	3.0	2.9	-0.1	20.0	13.4	-6.6
26 Non-metallic mineral products	341.3	649.2	307.8	19.5	15.6	-3.9
27 Basic metals	1.9	2.2	0.2	10.6	10.1	-0.5
29 Machinery and equipment n.e.c.	0.9	1.0	0.1	11.1	5.7	-5.4
34 Motor vehicles, trailers, semi-trailers	9.9	9.9	0.0	17.0	8.8	-8.2
36 Furniture; manufacturing n.e.c.	14.1	15.6	1.6	23.5	20.7	-2.9
<i>average across industries</i>	<i>38.2</i>	<i>61.8</i>	<i>23.6</i>	<i>18.8</i>	<i>15.7</i>	<i>-3.1</i>
<i>Panel B. Extra-EAC trade</i>						
15 Food and beverages	6.0	6.6	0.7	21.6	23.6	2.0
16 Tobacco products	1.4	1.5	0.1	27.5	27.3	-0.2
17 Textiles	2.3	2.3	-0.1	23.9	22.0	-1.9
18 Wearing apparel, fur	4.8	5.0	0.2	33.1	23.1	-9.9
19 Leather, leather products and footwear	7.9	9.5	1.6	26.3	22.9	-3.5
20 Wood products (excl. furniture)	16.3	18.1	1.9	26.8	22.0	-4.8
21 Paper and paper products	27.6	33.5	5.9	23.6	18.0	-5.5
22 Printing and publishing	2.1	2.0	-0.1	14.4	13.9	-0.5
23 Coke, refined petroleum products, etc.	68.3	93.7	25.3	9.7	4.1	-5.6
24 Chemicals and chemical products	4.7	5.0	0.3	8.7	6.4	-2.4
25 Rubber and plastics products	3.2	3.1	-0.1	20.5	14.8	-5.7
26 Non-metallic mineral products	365.6	709.5	343.9	19.9	17.0	-2.9
27 Basic metals	2.0	2.4	0.4	10.8	11.4	0.6
29 Machinery and equipment n.e.c.	0.9	1.0	0.1	11.3	5.9	-5.4
34 Motor vehicles, trailers, semi-trailers	10.5	10.2	-0.3	17.2	9.2	-8.0
36 Furniture; manufacturing n.e.c.	15.2	16.7	1.5	24.2	22.4	-1.8
<i>average across industries</i>	<i>41.0</i>	<i>66.6</i>	<i>25.6</i>	<i>19.3</i>	<i>17.0</i>	<i>-2.4</i>
<i>Panel C. Intra-EAC trade</i>						
15 Food and beverages	1.7	2.2	0.5	11.8	0.7	-11.1
16 Tobacco products	0.8	0.6	-0.2	6.0	2.0	-4.0
17 Textiles	0.6	0.7	0.1	13.8	0.4	-13.3
18 Wearing apparel, fur						
19 Leather, leather products and footwear	3.1	4.0	0.9	10.0	2.0	-8.1
20 Wood products (excl. furniture)	2.7	2.3	-0.4	15.8	0.3	-15.5
21 Paper and paper products	3.5	3.4	-0.2	16.2	0.2	-16.0
22 Printing and publishing	0.8	1.0	0.1	7.0	0.1	-6.9
23 Coke, refined petroleum products, etc.		0.6			0.1	
24 Chemicals and chemical products	1.2	0.9	-0.3	9.3	0.8	-8.5
25 Rubber and plastics products	1.1	0.8	-0.3	16.4	0.6	-15.8
26 Non-metallic mineral products	26.0	19.6	-6.4	14.5	0.7	-13.7
27 Basic metals	0.6	0.6	-0.1	5.6	0.1	-5.5
29 Machinery and equipment n.e.c.	0.4	0.3	-0.1	3.3	0.1	-3.2
34 Motor vehicles, trailers, semi-trailers	2.2	2.2	0.0	14.2	0.3	-13.9
36 Furniture; manufacturing n.e.c.	4.1	2.9	-1.2	18.3	0.3	-18.0
<i>average across industries</i>	<i>4.1</i>	<i>3.4</i>	<i>-0.7</i>	<i>13.2</i>	<i>0.6</i>	<i>-12.7</i>

Notes: Total bilateral trade costs reflect all the costs of trading goods between two countries relative to the cost of trading goods in each country of the trading pair. The import tariff rate is the effectively applied tariff rate of an EAC country. Intra-EAC trade refers to trade between two EAC countries. Extra-EAC trade refers to trade between an EAC and a non-EAC country. **Source:** Author's calculations based on data from INDSTAT2, COMTRADE and WITS/TRAINS online databases.

Figure B.1: Trend in total bilateral trade costs (including outliers),
averaged across industries and country-pairs



Notes: The figures shows the logarithm of tariff equivalent total bilateral trade costs, which measures all the costs of trading goods between two countries relative to the cost of trading goods in each country of the trading pair. The figure includes data for 16 manufacturing industries. In the left panel, the trend lines for the logarithm of total bilateral trade costs are bound by 95% confidence bands. The horizontal black lines shows the average logarithm of total bilateral trade costs in period 1998-2004. The right panel shows the annual change in the logarithm of total bilateral trade costs. **Source:** Author's calculations based on data from INDSTAT2 and COMTRADE online databases.

Figure B.2: Trend in total bilateral trade costs (excluding outliers),
averaged across industries and country-pairs



Notes: The figure shows the logarithm of tariff equivalent total bilateral trade costs, which measures all the costs of trading goods between two countries relative to the cost of trading goods in each country of the trading pair. The figure excludes data for ISIC codes 23 and 26 as these have very high trade costs. In the left panel, the trend lines for the logarithm of total bilateral trade costs are bound by 95% confidence bands. The horizontal black lines shows the average logarithm of total bilateral trade costs in period 1998-2004. The right panel shows the annual change in the logarithm of total bilateral trade costs. **Source:** Author's calculations based on data from INDSTAT2 and COMTRADE online databases.

APPENDIX C

Appendix for Chapter 4

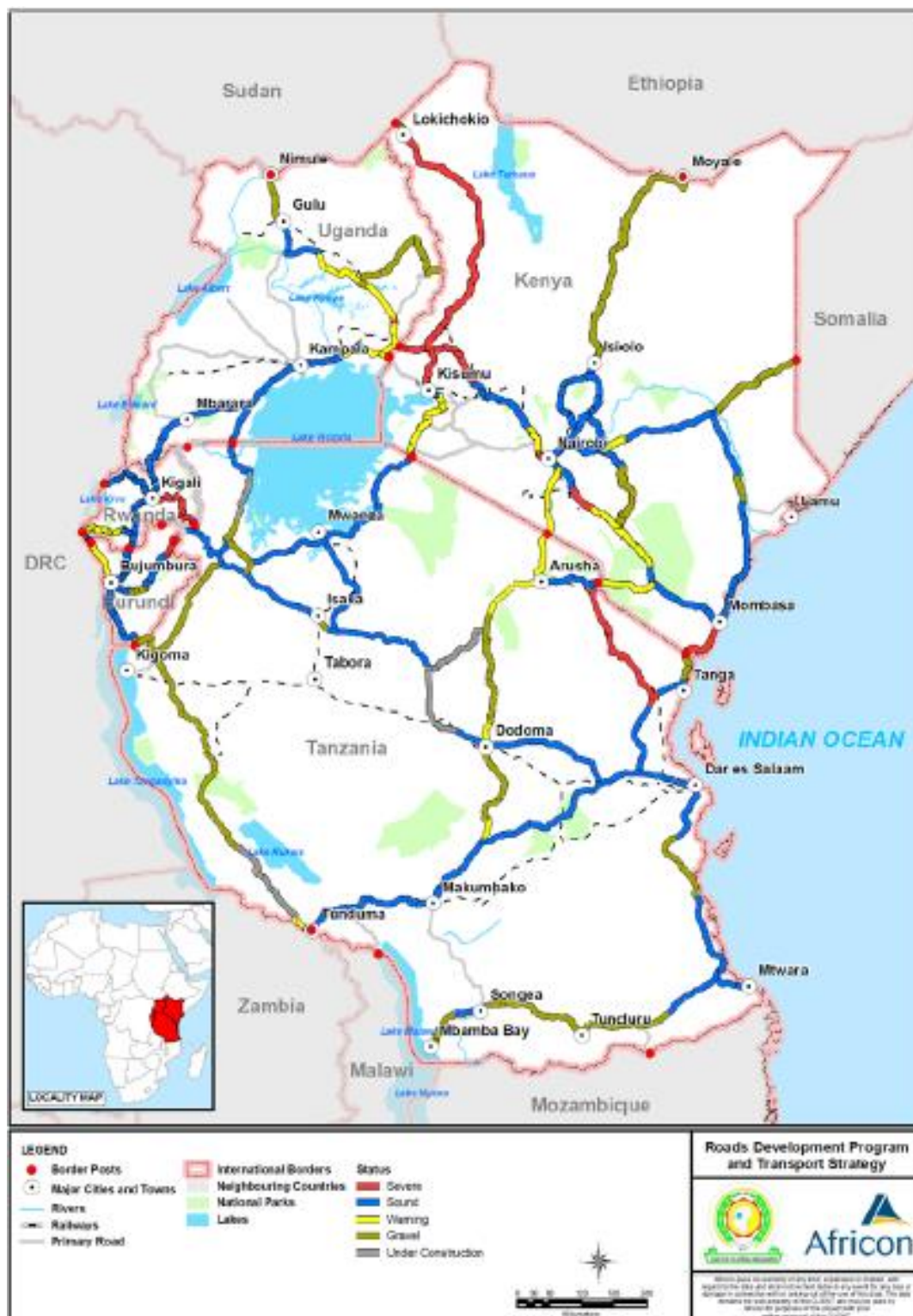
Table C.1: List of countries and territories included in the study
(EAC countries in bold)

Australia	Hong Kong, China	Madagascar	Senegal
Austria	Hungary	Malaysia	Singapore
Belgium	Iceland	Malta	Slovak Republic
Botswana	India	Mauritius	Slovenia
Brazil	Indonesia	Mexico	South Africa
Bulgaria	Iran, Islamic Rep.	Morocco	Spain
Burundi	Ireland	Namibia	Sri Lanka
Canada	Israel	Netherlands	Sweden
China	Italy	New Zealand	Switzerland
Colombia	Japan	Norway	Tanzania
Costa Rica	Jordan	Oman	Tunisia
Cyprus	Kazakhstan	Peru	Turkey
Czech Republic	Kenya	Philippines	Uganda
Denmark	Korea, Rep.	Poland	Ukraine
Egypt, Arab Rep.	Kuwait	Portugal	United Kingdom
Finland	Latvia	Qatar	United States
France	Lithuania	Romania	Vietnam
Germany	Luxembourg	Russian Federation	
Greece	Macedonia, FYR	Rwanda	

Table C.2: List of ISIC categories included in the study

ISIC code	Description
15	Manufacture of food products and beverages
16	Manufacture of tobacco products
17	Manufacture of textiles
18	Manufacture of wearing apparel; dressing and dyeing of fur
19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear
20	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
21	Manufacture of paper and paper products
22	Publishing, printing and reproduction of recorded media
23	Manufacture of coke, refined petroleum products and nuclear fuel
24	Manufacture of chemicals and chemical products
25	Manufacture of rubber and plastics products
26	Manufacture of non-metallic mineral products
27	Manufacture of basic metals
29	Manufacture of machinery and equipment n.e.c.
34	Manufacture of motor vehicles, trailers, semi-trailers
36	Manufacture of furniture; manufacturing n.e.c.

Figure C.1: Condition of roads in the East African Community in 2010



Notes: Grading of road conditions is according to the International Roughness Index, which ranges from 0=good to 20=very poor. The Index is based on road surface that contributes to an undesirable or uncomfortable ride. Key: Sound=2 to 6, Warning=6 to 10, Severe>10. **Source:** [United Republic of Tanzania and Japan International Cooperation Agency \(2014, p. 4-2\).](#)

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Figure C.3: Condition of roads in Kenya in 2002

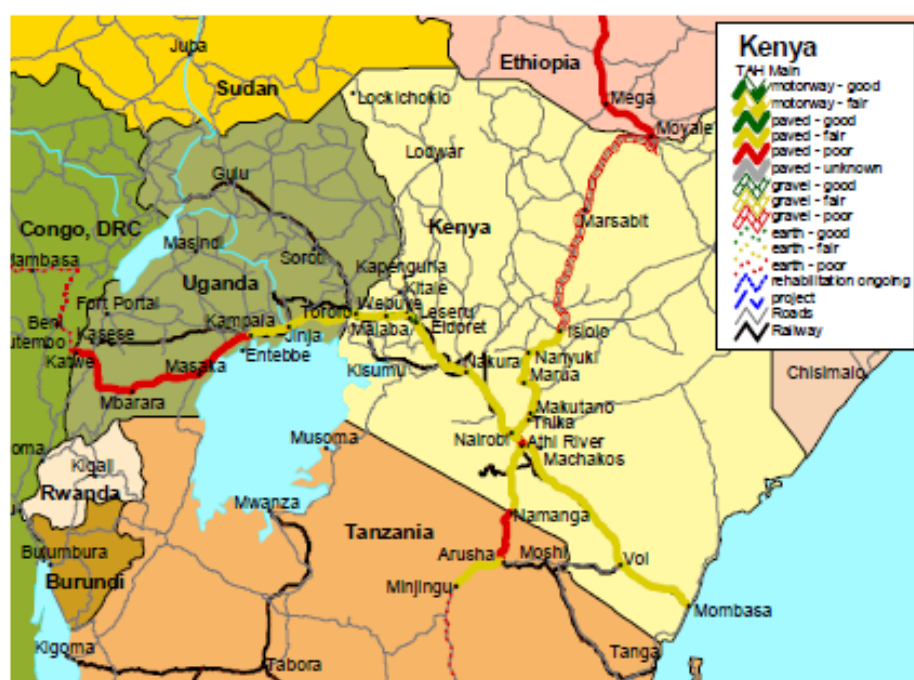


Table 8.2.6 Lagos - Mombasa Highway in Kenya

Kenya	Type				Condition					Road parameters (existing or in ongoing improvement)				Traffic flow	
	length	paved	gravel	track	good	fair	poor	construct ed	main- tained	paved width	shoulder gravel	shoulder paved	total width	total	heavy vehicles
Section	km	km	km	km	km	km	km	year	year	m	m	m	m	ADT	%
Malaba-Webuye	33	33	0	0	0	33	0			6,5		2*1,5	9,5	740	43
Webuye-Lesseru	62	62	0	0	0	62	0			6,5		2*1,5	9,5	899	35
Lesseru-Eldoret	15	15	0	0	15	0	0			6,5		2*1,5	9,5	2738	50
Eldoret-Nakuru	154	154	0	0	32	40	82			6,5		2*1,5	9,5	2166	34
Nakuru-Kamandura	124	124	0	0	40	34	50	1999		6,5		2*1,5	9,5	4309	36
Kamandura-Nairobi	32	32	0	0	0	32	0			6,5		2*1,5	32	4309	36
Nairobi-JKIA Turn off	14	14	0	0	0	14	0			2*6,5		4*1,5	19	6997	3
JKIA Turn off-Athi River	11	11	0	0	0	0	11			6,5		2*1,5	9,5	7276	16
Athi River-Machakos Turn off	22	22	0	0	0	22	0			6,5	2*1,5		9,5	2684	55
Machakos Turn off-Voi	283	283	0	0	12	126	145	1999		6,5	2*1,5		9,5	1899	70
Voi-Mombasa	152	152	0	0	72	40	40	2001		6,5		2*1,5	9,5	1911	57
Summary Kenya	902	902	0	0	171	403	328								

Source: African Development Bank and United Nations Economic Commission for Africa (003b, p. 190).

Figure C.4: Condition of roads in Uganda in 2002



Table 8.2.5 Lagos - Mombasa Highway in Uganda

<u>Uganda</u>		Type			Condition					Road parameters (existing or in ongoing improvement)				Traffic flow	
Section	length	paved	gravel	track	good	fair	poor	construct ed	maintained	paved width	shoulder gravel	shoulder paved	total width	total	heavy vehicle
	km	km	km	km	km	km	km	year	year	m	m	m	m	ADT	%
Kasindi-Mbarara	168	168	0	0	0	0	168								
Mbarara-Kampala	282	282	0	0	0	141	141								
Kampala-Mbalala	24	24	0	0	24	0	0								
Mbalala-Jinja	74	74	0	0	74	0	0								
Jinja-Bugiri	78	78	0	0	0	0	78								
Bugiri-Malaba	70	70	0	0	0	0	70								
<i>Summary Uganda</i>	696	696	0	0	98	141	457								

Source: African Development Bank and United Nations Economic Commission for Africa (003b, p. 188).

Table C.3: Data on road quality by route and source

Country	Year	Road section	length km	Type			Condition			source
				paved km	gravel km	track km	good km	fair km	poor km	
Kenya	2003	Malaba-Webuye	33	33	0	0	0	33	0	1
Kenya	2003	Webuye-Lesseru	62	62	0	0	0	62	0	1
Kenya	2003	Lesseru-Eldoret	15	15	0	0	15	0	0	1
Kenya	2003	Eldoret-Nakuru	154	154	0	0	32	40	82	1
Kenya	2003	Nakuru-Kamandura	124	124	0	0	40	34	50	1
Kenya	2003	Kamandura-Nairobi	32	32	0	0	0	32	0	1
Kenya	2003	Nairobi-JKIA Turn off	14	14	0	0	0	14	0	1
Kenya	2003	JKIA Turn off-Athi River	11	11	0	0	0	0	11	1
Kenya	2003	Athi River-Machakos Turn off	22	22	0	0	0	22	0	1
Kenya	2003	Machakos Turn off-Voi	283	283	0	0	12	126	145	1
Kenya	2003	Voi-Mombasa	152	152	0	0	72	40	40	1
			902	902	0	0	171 19%	403 45%	328 36%	
Kenya	2010	Malaba-junction at A104/C36	176	176					176	2
Kenya	2010	junction at A104/C37 - junction at Gatundu-Kinare road	204	204			204			2
Kenya	2010	junction at Gatundu/Kinare road-Nairobi	59	59				59		2
Kenya	2010	Nairobi-Mukaa	88	88			88			2
Kenya	2010	Mukaa-Tsavo	201	201				201		2
Kenya	2010	Tsavo-Mombasa	194	194			194			2
			922	922	0	0	486 53%	260 28%	176 19%	

Source key:1 - [African Development Bank and United Nations Economic Commission for Africa \(003b](#), p. 190)2 - Google Maps and [United Republic of Tanzania and Japan International Cooperation Agency \(2014](#), p. 4-2)

Table C.3: Data on road quality by route and source (...continued)

Country	Year	Road section	length km	Type			Condition			source
				paved km	gravel km	track km	good km	fair km	poor km	
Tanzania	2003	Lusahunga, Tanzania-Uganda/Tanzania border	288		288				288	3
Tanzania	2003	Lusahunga, Tanzania-Isaka, Tanzania	242	242			242			3
Tanzania	2003	Rusumo, Rwanda-Isaka	351	351			351			3
Tanzania	2003	Kobero, Burundi-Isaka	367	367			367			3
Tanzania	2003	Isaka-Dodoma	539		539				539	3
Tanzania	2003	Dodoma-Dar es Salaam port	454	454			454			3
		<i>to Uganda</i>	<i>1,523</i>	<i>696</i>	<i>827</i>	<i>0</i>	<i>696</i>	<i>0</i>	<i>827</i>	
		<i>to Rwanda</i>	<i>1,344</i>	<i>805</i>	<i>539</i>	<i>0</i>	<i>805</i>	<i>0</i>	<i>539</i>	
		<i>to Burundi</i>	<i>1,360</i>	<i>821</i>	<i>539</i>	<i>0</i>	<i>821</i>	<i>0</i>	<i>539</i>	
							<i>60%</i>	<i>0%</i>	<i>40%</i>	
							<i>60%</i>	<i>0%</i>	<i>40%</i>	
Tanzania	2010	Lusahunga, Tanzania-Uganda/Tanzania border	288	78	210		78	210		2
Tanzania	2010	Lusahunga, Tanzania-Isaka, Tanzania	242	242			242			2
Tanzania	2010	Rusumo, Rwanda-Isaka	351	351			351			2
Tanzania	2010	Kobero, Burundi-Isaka	367	367			367			2
Tanzania	2010	Isaka-Dodoma	539	282	257		282	257		2
Tanzania	2010	Dodoma-Dar es Salaam port	454	454			454			2
		<i>to Uganda</i>	<i>1,523</i>	<i>1,056</i>	<i>467</i>	<i>0</i>	<i>1056</i>	<i>467</i>	<i>0</i>	
		<i>to Rwanda</i>	<i>1,344</i>	<i>1,087</i>	<i>257</i>	<i>0</i>	<i>1087</i>	<i>257</i>	<i>0</i>	
		<i>to Burundi</i>	<i>1,360</i>	<i>1,103</i>	<i>257</i>	<i>0</i>	<i>1103</i>	<i>257</i>	<i>0</i>	
							<i>81%</i>	<i>19%</i>	<i>0%</i>	
							<i>81%</i>	<i>19%</i>	<i>0%</i>	

Source key:2 - Google Maps and [United Republic of Tanzania and Japan International Cooperation Agency \(2014, p. 4-2\)](#)3 - Google Maps and [African Development Bank \(2001, Annex I\)](#)

Notes: I presume the map in [African Development Bank \(2001, Annex I\)](#) is valid up to 2003 since projects to upgrade roads along the Central Corridor were completed after 2004 ([United Republic of Tanzania, 2010, p. 57](#)). The dataset for this study has generally more observations on total bilateral trade costs in 2003 than in 2002, hence the preference for 2003. Particularly, there are 73 per cent more observations for intra-EAC trade with Rwanda and with Uganda in 2003 as compared with 2002.

Table C.3: Data on road quality by route and source (...continued)

Country	Year	Road section	length km	Type			Condition			source
				paved km	gravel km	track km	good km	fair km	poor km	
Uganda	2003	Kampala-Gatuna border post	426	426				426		4
Uganda	2003	Kampala-Mbalala	24	24	0	0	24	0	0	5
Uganda	2003	Mbalala-Jinja	74	74	0	0	74	0	0	5
Uganda	2003	Jinja-Bugiri	78	78	0	0	0	0	78	5
Uganda	2003	Bugiri-Malaba	70	70	0	0	0	0	70	5
			672	672	0	0	98 15%	426 63%	148 22%	
Uganda	2010	Kampala-Gatuna border post (with Rwanda)	426	426			426			2
Uganda	2010	Kamuli road junction-Kampala	84	84			84			2
Uganda	2010	Malaba-Kamuli road junction	136	136					136	2
			646	646	0	0	510 79%	1 0%	136 21%	
Rwanda	2003	NC: Kigali - Gatuna border post (with Uganda)	80					78	3	6
Rwanda	2003	NC: Kigali - Butare (near border with Burundi)	156				45		111	6
Rwanda	2003	CC: Kigali - Rusumo border with Tanzania	152					72	80	6
Rwanda	2003	CC: Kigali - Rwanda/Congo border	158					158		6
		<i>Northern Corridor (NC)</i>	236	0	0	0	45 19%	78 33%	114 48%	
		<i>Central Corridor (CC)</i>	310	0	0	0	0 0%	230 74%	80 26%	

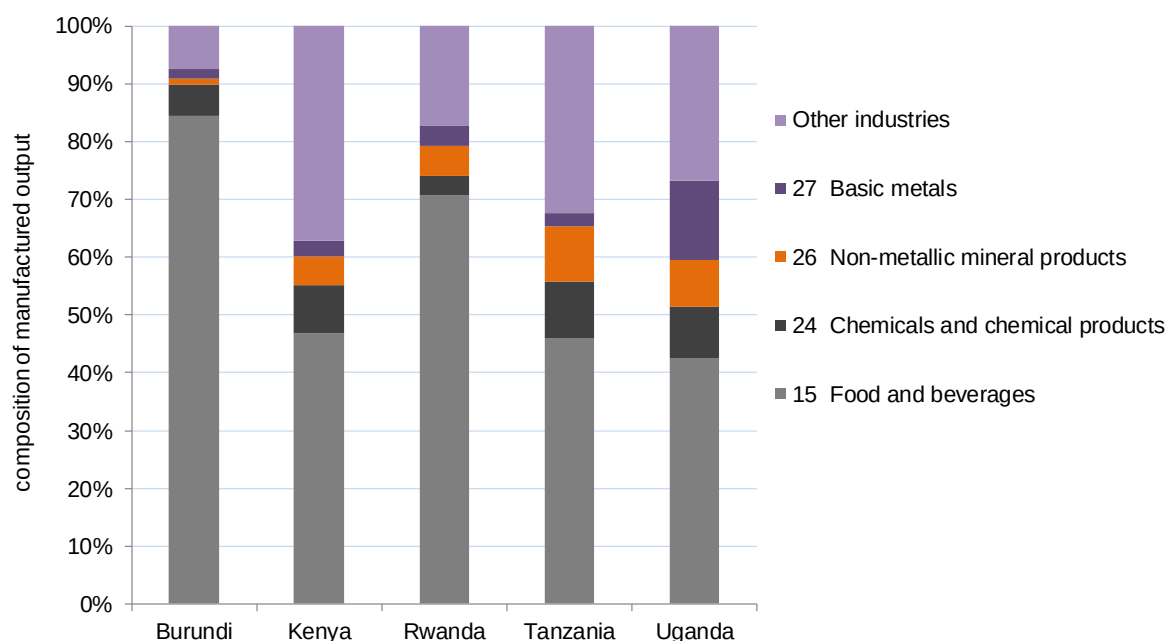
Source key:2 - Google Maps and [United Republic of Tanzania and Japan International Cooperation Agency \(2014, p. 4-2\)](#)4 - [International Conference on the Great Lakes Region \(2006\)](#)5 - [African Development Bank and United Nations Economic Commission for Africa \(003b, p. 188\)](#)6 - [World Investment News \(2003\)](#)

Table C.3: Data on road quality by route and source (...continued)

Country	Year	Road section	length km	Type			Condition			source
				paved km	gravel km	track km	good km	fair km	poor km	
Rwanda	2010	NC: Gatuna border post-Burundi/Rwanda border	234	234			234			2
Rwanda	2010	CC: Kigali - Rusumo border with Tanzania	152		152				152	2
	2010	CC: Kigali - Rwanda/Congo border	158	158			158			2
		<i>Northern Corridor (NC)</i>	<i>234</i>	<i>234</i>	<i>0</i>	<i>0</i>	<i>234</i>	<i>0</i>	<i>0</i>	
							<i>100%</i>	<i>0%</i>	<i>0%</i>	
		<i>Central Corridor (CC)</i>	<i>310</i>	<i>158</i>	<i>152</i>	<i>0</i>	<i>158</i>	<i>0</i>	<i>152</i>	
							<i>51%</i>	<i>0%</i>	<i>49%</i>	
Burundi	2003	Bujumbura-RN1 turnoff	51	51				51		7
	2003	RN1 turnoff-RN 15	44			44			44	7
	2003	RN 15-near Ngozi	16		16				16	7
	2003	near Ngozi-Kobero/Kabanga border (with Tanzania)	97	97				97		7
			<i>208</i>	<i>148</i>	<i>16</i>	<i>44</i>	<i>0</i>	<i>148</i>	<i>60</i>	<i>7</i>
							<i>0%</i>	<i>71%</i>	<i>29%</i>	
Burundi	2010	Bujumbura-Kobero border with Tanzania	208	69	69	69	69		139	2
							<i>33%</i>	<i>0%</i>	<i>21%</i>	

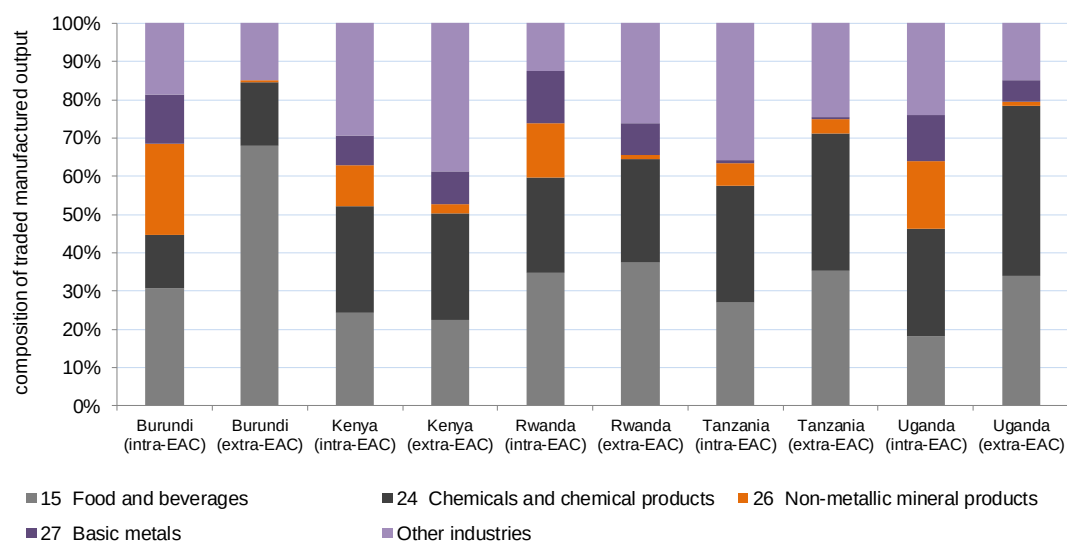
Source key:2 - Google Maps and [United Republic of Tanzania and Japan International Cooperation Agency \(2014, p. 4-2\)](#)7 - Google Maps and [World Bank \(2004\)](#)

Figure C.5: Composition of manufactured output of EAC countries in the period 1990-2012



Source: Author's calculations based on data from INDSTAT2 online database.

Figure C.6: Composition of the total value of trade by EAC countries in the period 1990-2012



Source: Author's calculations based on data from COMTRADE online database.

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