JÖNKÖPING UNIVERSITY
Jönköping International Business School

Doctoral Thesis

The Prospects for the East African Monetary Union

An Empirical Analysis

Yvonne Umulisa

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Kigali, January 2020

Yvonne Umulisa

Abstract

This thesis operationalizes the theory of optimum currency areas, which describes the preconditions (criteria) that countries must fulfill prior to forming a monetary union. In light of the different dimensions of the theory that are examined, the empirical findings from the four papers in this thesis seem to favor forming a monetary union among East African Community (EAC) partner states. Hence, the findings are important for EAC policymakers, as they decided to participate in a monetary union by 2024.

The first paper uses a gravity model to determine to what extent membership in the EAC has affected intraregional trade. One common argument is that if there is not much trade between EAC member countries, there is no interest in forming a monetary union. The paper implements the fixed effect filter estimator, which uses a two-step approach and has better performance than the standard fixed effect estimator. The empirical findings in this paper show that EAC membership has a positive and significant effect on intra-trade among member countries. The second paper investigates business cycle synchronization and core-periphery patterns. Greater synchronization is needed for an easy transition towards monetary union. Unlike previous studies, this paper uses wavelet decomposition, a powerful tool for analyzing the comovement of business cycles. It is found that business cycle synchronization is more significant for Kenya, Tanzania, and Uganda, the countries that also form the core of the East African Monetary Union.

The link between business cycle synchronization and trade intensity among EAC countries is established in the third paper. This analysis is relevant, as it is associated with the hypothesis of the endogeneity of the optimum currency area criteria, whereby a monetary union among member countries is predicted to increase trade among them, which, in turn, may lead to more synchronized business cycles. The empirical findings show that trade intensity among the considered countries has indeed led to more synchronized business cycles, suggesting that monetary union among EAC countries may be beneficial.

Moreover, the fourth and last paper uses a similarity index and a rank correlation measure, Kendall's tau, to investigate the movement of inflation rates among EAC countries. The results show that changes in inflation have become more similar over time and that there are high correlations between EAC countries. This paper also investigates the convergence in inflation rate levels among the EAC countries. It is found that these levels have tendency to converge. These findings favor the formation of a monetary union among these countries.

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List of abbreviations

2SLS: Two-Stage Least Square
AMU: African Maghreb Union
APEC. Asian Pacific Economic Cooperation
ASEAN: Association of Southern Asian Nations
CCEMG. Common Correlated Effect Mean Group
CEMAC: Central African Economic and Monetary Community
CFA: " *Coopération financière en Afrique"* (Financial Cooperation in Africa)
COMESA: Common Market for Eastern and Southern Africa
CPI: Consumer Price Index
DOTS: Direction of Trade Statistics
DSGE: Dynamic Stochastic General Equilibrium
EAC: East African Community
EALA: East African Legislative Assembly
EAMI: East African Monetary Institute
EAMU: East African Monetary Union
ECOWAS: Economic Community of West African States
EIAs: Economic Integration Agreements
EMU. European Economic Monetary Union
EU: European Union
FE: Fixed Effect
FEF: Fixed Effect Filter
FTAs: Free Trade Agreements
GDP. Gross Domestic Product
G-PPP: Generalized Purchasing Power Parity
IFS: International Financial Statistics
IMF: International Monetary Fund
MU: Monetary Union
NAFTA: North America Free Trade Agreement
OCA: Optimum Currency Areas
OLS. Ordinary Least Squares
RE: Random Effect
RTAs: Regional Trading Agreements
SADC: Southern African Development Community
SAPs: Structural Adjustment Programmes
UNCTAD: United Nations Conference on Trade and Development
UR: University of Rwanda
US. United States
VAR: Vector Autogressive
WAEMU: West African Economic and Monetary Union
WDI: World Development Indicators
WTO: World Trade Organization

1. Introduction

1.1 Background and motivation

More than three decades ago, the move towards regionalism became a headlong rush, and the growth of regional trading agreements (RTAs) has been one of the major development factors in economic integration. As argued in Soloaga and Winters (2001) and Schiff and Winters (2003), by the late 1990s, all countries in the world were members of at least one regional trading bloc, and for more than two decades, many belonged to more than one bloc (Baier et al., 2008). Moreover, technological progress and globalization continue to make the world increasingly integrated through both trade and capital flows (Stoykova, 2018).

African countries took part in this race to regionalism mainly because from a postcolonial perspective, regionalism has been broadly viewed as a mechanism to promote not only economic development but also political independence (Gibb, 2009). The regional trading blocs in Africa (in particular, the sub-Saharan region) have, therefore, been expected to enable member countries to pool together their small economies into larger markets to benefit, for instance, from economies of scale (Golit & Adam, 2014). Moreover, the agenda of regional integration in Africa also looks to reduce inequalities not only between countries but also within countries (Kayizzi-Mugerwa et al., 2014). Kayizzi-Mugerwa et al. (2014) argue that regional integration in western and central Africa has played a large role in boosting this region's development through trade agreements and economic monetary communities (such as the case of the CFA franc zones, discussed below), which, in turn, increased intraregional trade and improved the quality of production in these parts of Africa. This trend further enabled those countries to fully integrate into the global market and to exploit opportunities with the rest of the world. (For details, see Golit & Adam, 2014 and Kayizzi-Mugerwa et al., 2014.)

As everywhere in the world, regional integration in Africa has, thus far, occurred in line with Balassa's (1961) definition of economic integration as a process that occurs stage by stage: that is, it starts with a free trade area (where tariffs between participating countries are abolished), then expands to a customs union (where in addition to the previous stage, member countries equalize their trade tariffs with nonmember countries), is followed by a common market (where, in addition to trade restrictions, restrictions on movements of factors of production such as labor and capital are abolished), then evolves into an economic union (where national economic policies are harmonized to some degree) and, finally, ends as a political union (where monetary, fiscal, and countercyclical policies are unified). Moreover, as Balassa (1961) puts it:

"*the latter step requires the setting up of a supranational authority whose decisions are binding for the member countries*" *Balassa (1961, p.6)*

In accordance with the above process, the six countries of the East African Community (EAC) (Burundi, Kenya, Rwanda, South Sudan, Tanzania, and Uganda) have, in recent years, moved towards regional economic integration formalized through the free trade area, customs union and common market stages. Currently, the move towards monetary union is well advanced after the adoption of a monetary union (MU) protocol that came into force in 2014, with a single currency expected to be rolled out in 2024. From the point of view of the economic integration process, committing to this further stage is a remarkable achievement (see Balassa, 1961; De Grauwe, 2006 and 2018 and Simons & Jean Louis, 2018). It may thus be conjectured that the creation of the East African Monetary Union (EAMU) cannot occur without strong support from and continuous rational decision making by all stakeholders concerned. The four papers in this thesis, therefore, come together to answer the critical research question of whether the EAMU is economically feasible. All these papers use the theoretical underpinnings of the optimum currency areas (OCA)[1] theory, which is briefly explained in the subsequent paragraphs and further detailed in section two.

It is important to note that the concept of monetary union is not something new to Africa: some African countries have already attained this stage through the unification of their monetary policies (Kayizzi-Mugerwa et al., 2014). On the one hand, we have the CFA[2] franc, which was formally introduced to French colonies in Africa in 1945. Currently, the West African CFA franc is used in eight West African countries, which form the West African Economic and Monetary Union (WAEMU), formed in 1994. In addition, the Central African CFA franc is used among six countries of the Economic and Monetary Community of Central Africa. Both of the CFA francs are pegged to the euro; therefore, they are pegged to each other, and one euro is approximately 655 CFA francs. On the other hand, Lesotho, Namibia, and Eswatini (former Swaziland) have linked their respective currencies to the South African rand under a common monetary area that was established in 1986. This means that the South African rand is legal tender in all these countries, yet they continue issuing their own currencies (see Debrun et al., 2011).

The monetary unification efforts over the last five decades have been supported by OCA theory, which was pioneered by Mundell (1961), the economist who won the 1999 Nobel prize. This theory was further elaborated in the early literature by many other authors, including Kenen (1969), McKinnon (1963) and Mundell (1973). To this day, OCA theory is still the most common framework for discussions of monetary integration, and it has been used by many scholars, such as Aizenman (2018), Bayoumi & Eichengreen (1997), Caporale et al. (2018), Debrun et al. (2011), De Grauwe (2006, 2014 and 2018), De Grauwe

[1] An optimum currency area is defined as a geographic area where welfare is maximized through the use of a common currency (see De Grauwe, 2014 and Mundell, 1961).
[2] From the French "Coopération Financière en Afrique" (CFA).

& Vanhaverbeke (1993), Frankel & Rose (1998, 2005), De Grauwe & Mongelli (2005), Horvath & Komarek (2002), Houssa (2008), Mkenda (2001) and Zhao & Kim (2009), to name but a few. Basically, the theory describes the optimal characteristics (criteria) that countries should fulfill to be able to form a successful monetary union. The theory elaborates on these characteristics by discussing the costs and the benefits to which countries planning to create a monetary union are exposed.

On the one hand, the costs faced by members of a monetary union are mainly reflected in the loss of the ability to conduct a national monetary policy (Mundell, 1961). This is because the adoption of the common currency implies the abandonment of the exchange rate as a monetary policy instrument that can be adjusted (De Grauwe, 2014). For example, when a country joins a monetary union, it can no longer devalue or revalue its currency to determine the money supply or to change the interest rate to bring the economy back into equilibrium. On the other hand, the benefits mostly stem from the reduction of transaction costs associated with the exchange of one currency into another. As De Grauwe (2014) states:

> W*e all experience the costs whenever we exchange currency" De Grauwe (2014, p.53).*

An implication is that the use of a single currency is expected to eliminate the risks coming from uncertainty over the future dynamics of the exchange rate. Moreover, the reduction of transaction costs indirectly leads to price transparency in that consumers using the same currency can compare the prices of the same products on the market and shop around more easily (see De Grauwe, 2014).

In Mundell (1961 and 1973), McKinnon (1963) and Kenen (1969), the criteria that are useful for predicting monetary union success are presented in detail and can be summarized in four points: (1) trade integration, (2) symmetry of shocks, (3) factor mobility (in both labor and capital markets) and (4) risk-sharing mechanisms. Each of these is explained in section two; however, it is worth mentioning that OCA theory claims that better performance on any of the above-mentioned criteria makes the potential members more likely to benefit from forming a monetary union. In other words, if the potential members of a monetary union do not perform well on any of those criteria, the benefits of having a common monetary policy are unlikely to outweigh the costs of abandoning a national monetary policy.

Further refinements to OCA theory have led to two competing ideas with different policy implications. The first is the original idea developed by Mundell (1961), and the second is the idea of the endogeneity of the OCA criteria. The latter, first introduced in Frankel and Rose (1998), emphasizes that countries that fail to fulfill the OCA conditions may first form a monetary union, which in turn will progressively change the economic conditions of those countries in such a way that the OCA criteria are fulfilled. As will be discussed shortly, these two ideas have influenced recent empirical studies on the answer to the complex

economic question of whether a group of countries should join a monetary union or not. Hence, this thesis is inspired by these two ideas, and it applies them focusing on the countries in the EAC as a case study.

Against this background, it may be argued that OCA theory has the potential to assemble different ideas about the readiness for monetary union. Therefore, the overall purpose of this thesis is to operationalize the theory of OCA by investigating in more detail some of its criteria (mentioned above)—criteria that are five decades old but are still fundamental and powerful tools in current research.

1.2 Contribution

A considerable amount of literature on OCA theory and its connection to monetary union has been published, with important coverage of the European Economic and Monetary Union (EMU) and the CFA franc zones, but there is only a relatively small number of studies emphasizing the EAMU. By way of contrast, this thesis employs a novel approach and makes three contributions to the existing literature. *First*, unlike past empirical studies on the feasibility of the EAMU, which for the most part are based on the old EAC sample that excludes Rwanda and Burundi (see Bangaké, 2008, and Mkenda, 2001), this thesis covers more recent years of data for the five countries.[3]

Second, this thesis primarily focuses on not one criterion but two. This is different from previous studies, which have examined the feasibility of the EAMU using only one of the four criteria mentioned above (see, for instance, Asongu, 2014; Buigut, 2011; Buigut &Valev, 2005; Caporale et al., 2018; Kishor & Ssozi, 2011; Muthui et al., 2016; Rusuhuzwa & Masson, 2013; and Sheikh et al., 2011, among others). In this regard, the thesis elaborates more on the endogeneity of the OCA criteria, an issue that has not been fully examined, especially in the context of the EAC. However, discussing this issue offers a richer approach than that of previous work because it emphasizes the potential benefits of monetary union by investigating how the first two OCA criteria, namely, trade integration and business cycle synchronization, are linked. Moreover, from a methodological point of view, the thesis employs recent tools and updated econometric approaches such as the fixed effect filter estimator (Pesaran & Zhou, 2018) and wavelet approach (Aguiar-Conraria & Soares, 2011a, 2011b). This is the *third* contribution.

Overall, it might be argued that the thesis contributes to both research and policy perspectives because it offers some pieces of evidence about the readiness of East Africa for monetary union. Indeed, considering the different dimensions of OCA theory that are examined, the empirical findings of this thesis seem favorable for forming a monetary union; hence, they are important for EAC

[3] Throughout this thesis, South Sudan is excluded due to its late entry in the union and lack of data.

policymakers to be informed of. With respect to the trade integration dimension, the empirical findings in the first paper show that EAC membership has a positive and significant effect on trade among member countries. Regarding the dimension of symmetric shocks, it is found that business cycle synchronization is more significant for Kenya, Tanzania, and Uganda, the countries that also form the core of the East African Monetary Union. The linkage between business cycle synchronization and trade established in the third paper brings the insight that a more synchronized business cycle may result from a greater degree of trade intensity among these countries. This finding also supports the endogeneity of the OCA criteria among EAC countries. Moreover, the empirical evidence in the fourth paper showing the similarity of inflation rates as another source of business cycle synchronization (see Flood and Rose, 2010) is in favor of forming a monetary union.

Based on these empirical findings and keeping in mind the discussion above, one may argue that the implementation of the different stages of integration in the East African Community has brought some economic conditions among member countries to the stage where monetary union is now justified. This also suggests that the benefits of having a monetary union between EAC countries tend to be greater than the costs. Nevertheless, it is reasonable to recognize that this thesis only partially tackles the criteria embodied in OCA theory and, despite the author's wishes to the contrary, does not consider (mainly due to lack of data) other necessary conditions for a successful monetary union. These are, for example, the mobility of factors of production and the flexibility of wages and prices, which have been shown to help solve problems of adjustment, especially when countries in the union are affected by asymmetric shocks. Moreover, the recent crisis in the Eurozone has revealed that both political will and economic conditions might no longer be sufficient for a sustainable monetary union if the related institutional arrangements are still fragile (see De Grauwe, 2014).

In light of these considerations, the general policy recommendation from this thesis is that for better performance on both the OCA criteria and the macroeconomic convergence criteria (explained below), the East African Community partner states should continue focusing on the ongoing harmonization of trade, fiscal and monetary policies. This harmonization is of particular interest during the transition period towards monetary union because it will bring more convergence between member countries, and this, in turn, is expected to increase the likelihood of creating a viable monetary union. Moreover, for effective compliance and enforcement of those policies, there is a need to speed up the establishment of institutional arrangements such as the East African Monetary Institute (EAMI), which has the responsibility for the whole EAMU process. Further research is, therefore, expected in the future, especially as much information on deeper integration becomes available.

1.3 Overview of the East African Community

The current EAC was reestablished in 2000 among the three original EAC founders, namely, Kenya, Tanzania, and Uganda. Rwanda and Burundi became full members of the EAC in July 2007. South Sudan joined the community in April 2016 and became a full member in September 2016. To obtain a bigger picture of the current EAC integration process, the reader should refer to Box 1.1[4] below listing the important dates in the history of the current East African Community. Indeed, the current endeavours to establish the EAMU can be seen as a continuation of a historical development in this region because even prior to the reestablishment of the current EAC, there has been a long history of cooperation among Kenya, Tanzania, and Uganda through many regional integration arrangements.

In 1917, a customs union agreement between Kenya and Uganda was signed, and Tanzania (called Tanganyika at that time) joined that union in 1927. Following lengthy discussions leading its ratification, the treaty setting up the first EAC was signed in 1967, but in 1977 the EAC collapsed Moreover, these three countries made even earlier attempts to create a currency union of some form. In 1905, for example, the establishment of a currency board led to a common currency for Kenya and Uganda, which Tanzania joined after the World War I. In 1919 a new currency board that included these three countries was established, and consequently, the first East African shilling was adopted, albeit with separate central banks. Zanzibar joined in 1936.[5] After all these countries gained independence from Great Britain, local currencies were pegged to the pound sterling. In 1966, a common currency and an EAC central bank were introduced, and the former became fully convertible legal tender in the countries involved. Unfortunately, the pound sterling's depreciation in the late 1960s and early 1970s resulted in the 1972 collapse of the pound sterling area. Moreover, due to a long period of divergence in the strength of political will and continued imbalances on common monetary policy such as exchange rate and inflation rate targets, the East African currency area formally terminated in 1977 (Drummond et al., 2014).

[4] Four of the EAC countries considered here (not Tanzania) are members of Common Market for Eastern and Southern Africa (COMESA), and only Tanzania is a member of the Southern African Development Community (SADC).

[5] Zanzibar was an autonomous region and is still a semiautonomous region of the United Republic of Tanzania/Tanzania, which is currently composed of the former Tanganyika and Zanzibar.

Box 1.1. Important dates in the history of the current EAC

***30 November 1993**: 1st Summit of East African Heads of State –signed an agreement to re-establish the Permanent Tripartite Commission for East African Co-operation in Kampala, Uganda.*
***14 March 1996:** Secretariat of the Commission for East African Co-operation is inaugurated in Arusha, Tanzania.*
***30 November 1999:** Treaty for the Establishment of the East African Community is signed at the 4th Summit of East African Heads of State, conducted in Arusha.*
***7 July 2000:** Treaty for the Establishment of the current East African Community becomes operative.*
***15 January 2001:** The East African Community was formally launched at the 1st Summit of the East African Community that was held in Arusha and two important protocols were signed. These are the Rules of Procedure for the Summit of Heads of State and the Rules of Procedure for the Admission of Other Countries to the East African Community.*
***30 November 2001:** The EAC heads of state inaugurate the East African Legislative Assembly (EALA) and the East African Court of Justice at the 3rd Summit of the EAC, held in Arusha.*
***2 March 2004:** The Protocol for the Establishment of the EAC Customs Union is signed during the EAC summit.*
***1 January 2005:** The Protocol for the Establishment of the EAC Customs Union becomes operative.*
***18 June 2007:** The Republic of Rwanda and the Republic of Burundi become members of the EAC.*
***1 July 2007:** The above-mentioned countries become full members of the EAC.*
***22 October 2008**. The creation of a single free trade area among the three regional blocs, COMESA, EAC and SADC, is discussed at the First COMESA-EAC-SADC Tripartite Summit held in Kampala, Uganda*
***1 July 2009:** Rwanda and Burundi become members of the EAC Customs Union, and the official ceremonies were held at the same time on 6 July 2009 in the two countries' capitals.*
***1 July 2010:** Subsequent to being ratified by all five EAC countries, the EAC Common Market Protocol becomes operative.*
***12 June 2011:** The Second COMESA-EAC-SADC Tripartite Summit held in Johannesburg; South Africa resulted in an agreement to have negotiations initiated for a single free trade area among these three blocks.*
***28 November 2012:** The new EAC Headquarters was officially inaugurated in Arusha by the heads of state of the EAC partner states*
***30 November 2013:** The Protocol for the Establishment of the EAC Monetary Union is signed by the heads of states, and later, in 2014, the protocol comes operative.*
***16 April 2016:** The Republic of South Sudan becomes a member of the EAC, and it became a full member on the 5th of September 2016*

Source: Own compilation based on the information from the webpage of the EAC: https://www.eac.int/eac-history

As specified in Article 5(2) of the treaty that established the current EAC:

> *"The partner states shall undertake to establish among themselves a Customs Union, a Common Market, subsequently a Monetary Union and ultimately a Political Federation" EAC (2002, p.13).*

This explains the developments that have been achieved over the last two decades throughout the EAC integration process presented above. It is worth noting that the implementation of the common market protocol that commenced in 2010 was scheduled to be completed in 2015, but the EAC missed this target. As of now, the five countries are still struggling to fully implement both the customs union and common market protocols (UNECA, 2018). However, the completion of these first two steps is expected to allow the free movement of goods, services, labor, and capital among the partner states.

For the time being, the move towards a monetary union is well advanced, with a tight implementation roadmap for the introduction of the single currency by the end of 2024. Prior to that, EAC countries have agreed upon the need to attain and maintain macroeconomic convergence. Table A1 in the Appendix includes the four key macroeconomic indicators (2010-2018) to be assessed, namely, a headline inflation ceiling of 8%, international reserves coverage of at least 4.5 months of imports, a ceiling of 3% of GDP on the fiscal deficit (including grants),[6] and a gross public debt ceiling of 50% of GDP (for details, see EAC, 2013). The attainment and maintenance of the targets on all indicators are set for 2021 (see the roadmap for the realization of the EAMU in EAC, 2013, p. 25).

A general comment that can be drawn from Table A1 is that over the last five years (2014-2018), the five countries in the EAC have been struggling to meet the targets set regarding the convergence criteria. For example, Kenya and Uganda are the only countries in the region that have so far met and maintained the international reserves requirement, although Kenya slightly missed it in 2017. Regarding the inflation rate ceiling, during the same period, overall, all five countries have been doing well, with the exceptions of 1) Burundi, which showed a large increase in 2017, far above the ceiling, and 2) Rwanda, which nearly surpassed the ceiling during 2017. Rwanda and Tanzania seem to do well in terms of fiscal deficit, although they slightly surpassed the target during 2014 and 2015–2016, respectively. Once again, there are important concerns regarding Burundi and Kenya's public debt ceilings; the situation was worse in Kenya during 2015-2018; moreover, there was a notable increase in Burundi in approximately 2015, and this increase remained until 2018. One could argue that these differences are mainly explained by political events that occurred in these two countries. The issue of inflation convergence among EAC countries is further investigated in the last paper.

It is worth emphasizing that much remains to be done to fully implement both the customs union and common market protocols, yet this is one of the

[6] The ceiling becomes 6% when one excludes grants.

prerequisites for the monetary union.[7] Since the establishment of the common market protocol, the five partner states have adopted the Common Market Scorecard (CMS) as a monitoring tool for the implementation of this protocol. The CMS measures legal compliance with the commitments undertaken under the common market protocol, including the movement of capital, services and goods.

According to the latest report published in 2016, the results are mixed (EAC, 2016). On the positive side, partner states have undertaken several reforms in each of the areas covered by the scorecard. However, numerous barriers remain in the three areas; more worrisome is that new measures that hinder trade and investment in the union have been introduced**.** For example, as evidenced in the report, a total of 46 new nontariff barriers (NTBs) were introduced post-CMS 2014[8] in addition to the 32 NTBs that remained unresolved from that same CMS. As stressed in the report, this is a violation of the provisions of Article 13 of the EAC customs union protocol, which called for the immediate removal of all NTBs upon the entry into force of the protocol and the no introduction of new NTBs.[9]

Moreover, the common market protocol provides for four freedoms, including free movement of people within the region without restrictions. Burundi and Tanzania, however, delayed implementing this, and therefore only citizens from Kenya, Rwanda and Uganda can enjoy this freedom of using their national IDs, student cards and voting cards as travel documents. In addition, with the introduction of one-stop border posts with 24-hour services, there are more efficient border controls. This has reduced the waiting time for transporting goods (EAC, 2016).

In addition, with the help of the IMF and World Bank through structural adjustment programs (SAPs)[10], EAC partner states have managed to restructure their economies over the last two decades (see also Masson & Pattillo, 2004). Consequently, the EAC has become the most integrated regional group in Africa. With the accession of South Sudan, which added nearly twelve million people to the community, the EAC now comprises approximately 172 million people,[11] with an estimated per capita GDP of US$1000. Rwanda and Tanzania displayed the highest average GDP growth in the EAC over the period 2000-2017, at 7.8% and 6.4%, respectively. Among the three remaining countries, Burundi performed worst, with an average GDP growth rate of 2.6%, while Uganda and Kenya recorded rates of 6.3% and 4.6%, respectively (EAC statistics for 2017).[12]

In addition, Figure 1 below shows that intra-EAC trade (the percentage of member countries' GDP that can be assigned to the sum of exports and imports within the EAC; this measures the within-EAC degree of openness as well) has been increasing quite modestly since the restarting of the union. However, one

[7] Article 5(1) of the protocol on the establishment of the EAMU.
[8] This is the previous Common Market Scorecard that was published in 2014.
[9] More details can be found in the Eastern African Common Market Scorecard 2016.
[10]SAPs generally consist of obliging countries to pursue sound macroeconomic policies by using conditional loans, often provided by the IMF or WB to countries that experience an economic crisis in order to adjust their economies.
[11] More on the population statistics are reported in the Appendix (Figures A1to A3).
[12] Available on the EAC website (www.eac.int) and in WDI (2018).

can observe a reduction for all countries in 2009, which is connected to the 2008-2009 financial crisis. The upward trend recovered in 2010 and again started to decline for Rwanda, Tanzania and Uganda during the last three years (2014-2016). As stressed in the WTO Statistical Review (2016),[13] this decline is attributable to various factors, especially the slowing down of the Chinese economy, volatility in exchange rates with the dollar value of exports (goods) declining by 14%, and lower oil prices. Moreover, as an UNCTAD (2016)[14] report highlights, another explanation could be weaker demand in the commodity sector, especially in some parts of the developing world. From Figure 1, one can also see that there is a wide difference in the degree of openness in these countries over the past one and a half decades, with Burundi and Rwanda showing greater openness than Kenya, Tanzania, and Uganda (albeit in the earlier years, Uganda appears more open than Burundi and Rwanda). Exceptionally little openness is apparent in Tanzania's trade.

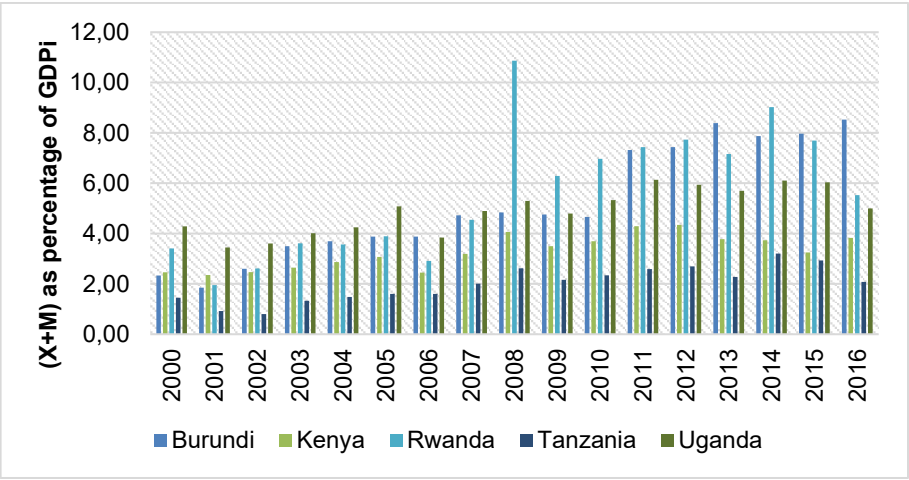

Figure 1. Intra-EAC trade, 2000-2016.

Source: Own calculations based on IMF database, Direction of Trade Statistics (DOTS), and World Development Indicators (WDI), the World Bank database.

Overall, one can argue that in regard to both economics- and noneconomic-related descriptive statistics, the EAC partner states show both homogeneity and heterogeneity. Figures A1 to A3 in the Appendix give noneconomic statistics including total population, population growth rate and infant mortality of the five

[13] World Trade Organization (WTO) Statistical Review report (2016), retrieved on 26th July 2019 https://www.wto.org/english/res_e/statis_e/wts2016_e/wts2016_e.pdf.

[14] United Nations Conference on Trade and Development (UNCTAD) Key Indicators and Trends in International Trade report (2016), retrieved on 27th July 2019 https://unctad.org/en/PublicationsLibrary/ditctab2016d3_en.pdf.

countries.[15] From these figures, it can be seen that compared to Burundi and Rwanda, Tanzania, Kenya, and Uganda are the big economies in terms of the total population, respectively. However, in regard to the population growth rate, all five countries steadied into average annual growth rates between 2.4% and 3.2% over the last five decades. The exception is Rwanda, which experienced a turbulent period during the 1990s (until 2000); during this time, its rate of population growth took a sharp drop of –6.2% in 1994, followed by a sharp peak of 7.3% in approximately 2000. (World Bank: Health Nutrition and Population dataset, updated 2019).

It is worth noting that Rwanda is the most densely populated country in the region, followed by Burundi, Uganda, Kenya and Tanzania, with densities of 479, 414, 183, 91 and 61 persons per sq. km, respectively. Regarding infant mortality rates, the five countries in the EAC have made good progress and are seeming to converge to a low rate. However, Burundi's infant mortality rate of 41 per 1000 live births in 2017 is still high.

Despite the differences above, the EAC partner states are slightly similar when one looks at the sectoral composition of GDP. This can be observed in the data presented in Table 2. Between 2000 and 2017, all countries were highly dependent on the agricultural sector, with the highest dependence observed in Burundi. Furthermore, they were heavily dependent on services, with Uganda having the highest share in 2017, followed by Rwanda, Kenya, Burundi, and Tanzania.

Table 2: Sectoral composition of GDP (2000 and 2017)

Country	Total GDP ($B)		Agriculture		Industry		Services		Manufacturing	
	2000	2017	2000	2017	2000	2017	2000	2017	2000	2017
Burundi	0.9	2.3	48	40	17	17	35	44	12	10
Kenya	12.7	58.3	32	36	17	16	51	45	12	10
Rwanda	1.7	9.3	37	31	14	18	49	51	7	6
Tanzania	10.2	49.8	33	32	19	27	47	41	9	6
Uganda	6.2	28.6	29	26	23	22	48	52	8	9

Note: composition as a percentage of GDP. Industry shares include manufacturing, which is also separately given (last two columns) for comparison purposes. Source: Own compilations based on WDI (2018).

The rest of this chapter is further divided into three sections. In section 2, the theoretical framework and some literature relevant to this thesis are described. The data and methodology employed in the empirical part of this thesis are briefly introduced in section 3, which is finally followed by section 4, summarizing the four individual papers comprising this thesis.

[15] These statistics are also based on the United Nations World Population Prospects 2019, available at https://population.un.org/wpp/.

2. Theoretical Foundations of Optimum Currency Area Theory

As previously mentioned, to this day, the theory of the optimum currency areas is still the most common framework used by many scholars to discuss monetary integration because the theory specifically describes the preconditions that countries must fulfill prior to forming a monetary union if the benefits of the union are to outweigh its costs. In this section, both traditional and new conceptualizations of the theory are discussed in detail. The latter are discussed to emphasize the endogeneity of the optimum currency areas criteria.

2.1 Early contributions to the theory of optimum currency areas

2.1.1 Contribution of Mundell (1961)

As mentioned earlier, following his influential paper entitled “A Theory of Optimum Currency Areas" (Mundell, 1961), in 1999, Robert Mundell received the Noble prize for economics. Since then, he has been considered the originator of OCA theory (De Grauwe, 2014; Horvath, 2003 and Kunroo, 2015). In Mundell’s (1961) thinking, an OCA is defined as a geographic area where both internal balance (full employment as opposed to low inflation)[16] and external balance (balance-of-payments equilibrium) could optimally be achieved. Specifically, he illustrates this idea by using three examples in which a simple model of two entities (countries or regions) is considered. Initially, these entities are assumed to be in both internal and external equilibrium; Mundell (1961) then explains what happens when the entities are affected by an asymmetric demand shock.

In the first example, a situation with two countries with different currencies, country A and country B, is presented. Next, a shift of demand from country B to country A occurs, and country B is adversely influenced by this asymmetric demand shock. This, in turn, causes unemployment in country B and inflation pressure in country A. If prices are flexible in country A, they can rise, and thus the changes in terms of trade help to partially reduce unemployment in country B. However, if, for example, the central bank of country A tightens credit to prevent inflationary pressure, the rise in the prices of country A does not help to lower unemployment in country B. In this situation, the adjustment in country B happens

[16] See Phillips (1958).

through a reduction in its employment level. The same idea is discussed by De Grauwe (2014) using graphical illustrations (see Figures 1.1 and 1.2 in De Grauwe, 2014). In the second example, Mundell (1961) contrasts the previous situation with one in which the entities are two regions within the same country that use the same currency, region A and region B. Again, an asymmetric demand shock negatively affects region B; consequently, unemployment pressure and inflation pressure occur in region B and in region A, respectively. To adjust to the unemployment in region B, the central bank of this country can increase the money supply, albeit at the cost of aggravating inflation pressure in region A.

In the third and last example, he discusses two countries that use different currencies, Canada and the US, and two regions, East and West, which run across these two countries. The Eastern regions in Canada and the US produce timber, while the Western regions in both countries produce cars. Due to a rise in productivity in the East, an asymmetric demand shock occurs, i.e., there is excess supply of timber in the East and excess demand for cars in the West. Consequently, there is unemployment pressure in the Eastern regions and inflation pressure in the Western regions. If the central banks in both countries attempt to prevent unemployment pressure in the Eastern regions, as in the previous example, the inflation pressure in Western regions cannot be avoided and *vice versa*. That is, even if these countries manage to prevent inflation pressure, unemployment pressure in both countries cannot be avoided. Nevertheless, Mundell argues that if these two regions had a fixed exchange rate, then another adjustment mechanism would be required to re-establish the equilibrium. The implication of this is that a trade-off between unemployment and inflation does not necessarily bring back equilibrium (see also Kunroo, 2015).

From these three scenarios, Mundell (1961) claims that a *high degree of factor mobility* and *price and wage flexibility* are essential ingredients of a monetary union because in a world of free factor mobility (especially labor mobility) in which wages and prices are flexible, the exchange rate ceases to be a stabilizing instrument. Therefore, joining an MU, which implies the adoption of a fixed exchange rate, does not lead to costs arising from the loss of the ability to use the exchange rate as an adjustment tool; rather, it brings benefits by eliminating a source of asymmetric shocks.

In accordance with this, Mundell's (1961) conclusion is that in the absence of labor mobility and wage-price flexibility, the presence of asymmetric shocks across countries or regions should be a concern. Considering this, one might imagine that *the symmetry of shocks* should be a criterion for optimality. As is well elaborated in De Grauwe (2014), the intuition behind this criterion is straightforward: countries hit by symmetric shocks (similar macroeconomic shocks; also known as business cycle synchronization) are good candidates for a monetary union as they are affected in a similar way. There is thus no need to use, for instance, the exchange rate as a monetary policy tool to adjust for asymmetric shocks (see also Mundell, 1973). Put differently, once an MU is in place, two different monetary policies are not possible, so it will, therefore, be difficult for two countries in an MU to adjust when affected by asymmetric shocks. All three

criteria discussed above (also highlighted in italics) made the Mundell (1961, 1973) papers highly cited in the literature on monetary unions.

2.1.2 Criticisms of Mundell (1961)

Although Mundell's (1961) work received many citations, a few years later, his paper attracted great criticism. This subsection, therefore, focuses on important contributors to OCA theory, who came up with other criteria by criticizing Mundell's (1961) views. For instance, Kenen (1969) criticized Mundell's definition of a region, arguing that perfect labor mobility between regions requires perfect occupational mobility, which only takes place when labor is homogenous. Doubting the homogeneity of labor, he then concludes that the optimum currency area must be small if it is to fulfill Mundell's (1961) definition of an optimum currency area. As previously mentioned, regarding the factor mobility criterion, McKinnon (1963) advances a contrasting view to Mundell's (1961) by considering a high degree of factor mobility as an outcome of monetary union rather than a precondition.

Subsequently, several scholars, including Giersch (1973), Grubel (1970), and Ingram (1969), disagreed with Mundell's views regarding the importance of factor mobility as an adjustment mechanism. For example, in Giersch (1973), labor mobility is considered a function of time and is therefore likely to be higher in the long run. Accordingly, Giersch (1973) argues that the optimum currency area should be the whole world, not just a small geographic area, as argued in Mundell (1961). This is because, in the long run, labor mobility is expected to prevent disequilibrium problems not only for two countries hit by asymmetric shocks but also for the whole world (for details see also Horvath, 2003). Despite the criticisms of OCA theory, the early literature contributed to its development, especially based on Mundell's view of adjustment mechanisms.

Let us start with McKinnon (1963), an important contributor to the theory, who emphasizes *trade integration/degree of openness* as a crucial criterion for the OCA. In the author's arguments, the openness of the economy is reflected in the ratio of tradable goods (exportable and importable) to nontradable goods. He defines as exportables those goods produced domestically and, in part, exported, while importables are goods both produced domestically and imported (McKinnon, 1963, p.717). He, hence, argues that the more open countries are, the more tradable goods will exceed nontradable goods, and the ratio will become high. In this context, a fixed exchange rate regime between these countries (equivalent to having a common currency) should be favored to decrease the transaction costs associated with currency exchange. In accordance with this, small and open countries are expected to have a high ratio of tradable to nontradable goods and, thus, be more likely to benefit from joining currency areas with large countries. Based on this, McKinnon (1963) suggests that small open countries rely on fiscal policy rather than on exchange rates to bring back equilibrium in the balance of payments (McKinnon, 1963, p.719). This also

implies that it is highly recommended for small countries to efficiently benefit from the stability of large countries by pegging their currencies.

The same idea concerning the size of the potential members of an optimum currency area is highlighted in Ishiyama (1975), who critically reviews the various criteria of OCA theory and comes up with the conclusion that the theory, in particular, helps small countries in regard to the degree of openness. Ishiyama writes:

> *"…Following the move of major countries to general floating in the spring of 1973, there was a brief period in which a majority of small countries favoured a peg against a single currency. Therefore, this move to peg to a basket of currencies by a number of countries can be viewed as a step toward enlightened and more rational economic management…" Ishiyama (1975, pp. 377-378).*

Thus, the authors consider the degree of openness to be one source of benefit from monetary union. It is, therefore, highly recommended for member countries of the union to have a high degree of trade between them to generate the benefits of using the single currency. Unless this is the case, there is no incentive to use the same currency.

Kenen (1969) is another important contributor to OCA theory in that he introduces *product diversification* as a crucial criterion for the OCA. In fact, when he criticizes Mundell's (1961) labor mobility criterion as an adjustment mechanism, he offers this alternative criterion. Kenen (1969) argues that in a well-diversified country, asymmetric shocks are less significant compared to a less-diversified country. This is because, compared to a country with a less-diversified economy, a country with a well-diversified export sector is unlikely to suffer changes in its terms of trade. Therefore, he concludes that countries with a sufficiently diversified economy will not find it difficult to be in a monetary union. The second criterion for an OCA, also emphasized in Kenen (1969), is *fiscal integration*, in which he claims there should be a system of risk-sharing among member countries in the monetary union. As he argues, countries in a currency area hit by a diverse shock can mitigate this through fiscal transfers. The latter is defined as a mechanism that consists of redistributing money to member countries that may be adversely affected by asymmetric shocks due, for instance, to the absence of factor mobility and price and wage flexibility.

From what has thus far been discussed, we summarize the criteria that are useful for a successful monetary union in four points: (1) trade integration / degree of openness; (2) symmetry of shocks; (3) factor mobility; and (4) risk-sharing mechanisms. Nevertheless, it is important to add those policy-oriented criteria that were also highlighted in the early literature on OCA. These include the degree of flexibility of prices and wages (Mundell, 1961), the similarity of inflation rates (see Fleming, 1971 and Ishiyama, 1975) and political will/commitment. See, for example, Ingram (1969), who argues that what matters in addition to the economic criteria of an OCA are the governments' commitments to the decision to form a currency area. Furthermore, Grubel (1970) emphasizes a trade-off required for the

formation of a currency area, arguing that countries should always compare welfare losses and output gains before entertaining any temptation to join a currency union. Moreover, in the 1990s, the promoters of the EMU also emphasized the importance of political will as one of the factors one should consider when planning to form currency areas (see De Grauwe, 1992; Goodhart, 1996 and Tavlas, 1993, among others).

Having said all that, OCA theory claims that better performance on any of the abovementioned criteria makes the potential members more likely to benefit from forming a monetary union. Otherwise, if the potential members of a monetary union do not perform well on any of these criteria, the benefits of a single currency are unlikely to exceed the costs of abandoning a national monetary policy (see, for instance, Grubel, 1970). Similarly, Debrun et al. (2011) develop a model of cost-benefit analysis and apply it to the proposed currency unions in Africa, namely, the EAC, the Economic Community of West Africa States (ECOWAS), and the SADC. Their results show net benefits to some member countries across all three communities, but overall, they note that many other member countries record modest net gains and sometimes losses.

Different studies have therefore used one OCA criterion to assess the readiness of a group of countries that envisage forming an MU. In this literature, there are also empirical studies that have discussed the feasibility of monetary union in Africa. Given the aim of this thesis, in what follows, studies that have focused on EAC member countries are presented. More on the previous literature is reviewed in the individual papers in the thesis.

Mkenda (2001) presents a case for monetary union among the three EAC countries, namely, Kenya, Tanzania and Uganda, which were the only members of the Community in 2001. She uses a generalized purchasing power parity (G-PPP) method to establish the cointegration between real exchange rates in the EAC countries for the period 1981-1998. The results suggest that these countries tend to be affected by similar shocks. Therefore, she concludes that the East African Community is potentially an optimum currency area.

Buigut and Valev (2005) also assess the similarity of underlying shocks in the EAC based on a vector autoregressive (VAR) approach. Their results indicate that supply and demand shocks are generally asymmetric. They therefore conclude that the EAC does not look like an OCA, although they suggest that more economic integration of EAC countries could result in more favorable conditions for monetary union. Buigut (2011) further applies multivariate cointegration analysis to determine whether the EAC partner states should form a successful monetary union. He analyzes the comovements of four variables: nominal and real exchange rates, the monetary base and real GDP. He finds only partial convergence of policies in the union and argues against a fast-track EAC monetary union process.

Kishor and Ssozi (2011) discuss the limitations in the papers of Buguit & Valev (2005) and Mkenda (2001). They employ an unobserved component model to investigate the degree of business cycle synchronization among the EAC countries. They discover that despite that the degree of synchronization has grown

since 2000, the fraction of shocks that are common across countries continues to be low, suggesting weak synchronization.

Rusuhuzwa and Masson (2013) assess the plans of the EAC to create a single currency by analyzing the business cycle correlation among the five countries. The evidence presented in their paper shows that these countries face asymmetric shocks and have different production structures. They, therefore, conclude that it is not clear that the East African region would form an optimum currency area. Many other scholars have focused on the case of the EAC as well (see Bangaké, 2008; Davoodi et al., 2013 and Sheikh et al., 2011, among others).

In addition, studies on inflation convergence among EAC countries are also numerous. Dridi and Nguyen (2019) discuss a substantial number of studies focusing on the inflation convergence among EAC members, including Carcel et al. (2015), Drummond et al. (2015) and Kishor & Ssozi (2010), to name but a few. Further, the authors investigate inflation convergence in the five EAC countries using the panel unit root test and a global VAR approach. They find that the inflation differentials are not persistent, which implies the convergence of inflation rates and thus favors monetary union among these countries.

That said, one may note that despite using only one OCA criterion, the previous empirical studies have so far generated mixed results. This is mainly because the OCA criteria are endogenous, as argued by Frankel and Rose (1998), in trying to answer a critical question concerning the process and timing of implementing a currency union when there is both political and economic will to create one. The next subsection provides more details on this issue.

2.2 The new thinking on optimum currency area theory

The efforts of many researchers on the question of whether a group of countries should join a currency area have led to new ideas in optimum currency area theory, with the best known in the literature being the notion of the endogeneity of the OCA criteria. As will be discussed shortly, this idea was first elaborated by Frankel and Rose (1998) in their influential paper entitled "The endogeneity of the optimum currency area criteria".

However, even prior to this development, other international and monetary economists had also discussed OCA theory. Most of these scholars focused on the benefits of forming a currency area, which should also be considered when there is a desire to form one. One can thus argue that new ideas on this topic started to be generated in the early 1990s by Bayoumi (1994), De Grauwe (1992), and Tavlas (1993), to name but a few. One of the reasons for the renewal of interest in OCA theory in the early 1990s was the process of European monetary integration, which formally came into force in 1999. Further, Tavlas (1993) argues that OCA theory has been modified to discuss the issues faced by other monetary union, such as credibility, expectations and time inconsistency.

Accordingly, Tvalas (1993) gives the example of similarity in inflation rates, saying that a high-inflation country is expected to gain credibility by pegging its exchange rate to a low-inflation country. This suggests that joining a currency union brings more benefits to a high-inflation country than to a low-inflation country.

Similarly, regarding the time-inconsistency issue, early literature such as De Grauwe (1992) emphasizes the criterion of similarity in inflation rates, arguing that the latter should not be a precondition for joining a currency area but should instead be a desirable outcome or a benefit. Furthermore, De Grauwe (1992) states that monetary authorities may gain some credibility by providing tangible evidence that they are following a monetary policy that will result in low inflation, such as joining a currency area with low-inflation countries.

A paper by Bayoumi (1994) develops a model that allows him to include some OCA factors, such as the size of the country, correlations of the disturbances (shocks), transaction costs and factor mobility, among others. The empirical finding from his analysis is that a small economy benefits more from joining a currency union than the entire currency union benefits from admitting a new member. This suggests that the new member gains from lower transaction costs on trade with the existing members.

Further, Neumeyer (1998) uses a general equilibrium model with the purpose of showing the welfare gains from the adoption of a currency union. In particular, he conducts a cost and benefit analysis by comparing the benefits of reducing exchange rate risks with the costs of lowering the number of financial instruments (including the exchange rate, among others) in the economy. In summary, the author argues that currency unions can be viewed as an attempt to improve welfare, especially in small economies without well-functioning financial markets. Once again, his model points to the higher welfare gains of currency unions for small economies compared to large economies.

2.2.1 The concept of endogeneity of the OCA criteria per se

Frankel and Rose (1998) also build on optimum currency area theory to show the interlinkage of its criteria. Specifically, they use 30 years of data on 21 industrial countries and find strong empirical evidence that economies with stronger trade linkages are inclined to display business cycles that are more tightly correlated. In sum, according to their analysis, early entry into a currency union brings more synchronized business cycles due to trade ties. The main insight here is that the OCA criteria are affected by the decision very early on to initiate an MU. They argue that the OCA test could be successfully met *ex post* even if it is not successfully met in full *ex ante*; that is, an MU that at the start does not satisfy the OCA criteria may over time do so. Thus, the authors call this the "endogeneity of the OCA criteria" (see also Frankel & Rose, 1997). These findings have led to several conclusions on the prospects and desirability of the European Monetary Union.

As further explained by De Grauwe & Mongelli (2005) and Frankel & Rose (1998), the intuition behind the endogeneity hypothesis is that the borders of new currency unions can be drawn larger in expectation that trade integration and symmetry will deepen once a currency union is created, thereby facilitating further movement of countries into the OCA (Umulisa, 2016). Apart from that, there are other mechanisms that can also explain why the OCA criteria are endogenous. For instance, in economic theory, it is assumed that monetary integration affects the functioning of labor markets in terms of increasing their flexibility, thereby reducing the costs of adjusting to asymmetric shocks (De Grauwe, 2006). Further, De Grauwe (2014 and 2018) argues that the introduction of a common currency is expected to affect the integration of the whole banking system, which, in turn, reduces transaction costs and facilitates trade.

Subsequently, many economists, including Rose (2000) and Rose & Stanley (2005), have argued that asymmetries among countries decrease as trade integration increases, but trade increases as well when countries join an MU. In this spirit, Rose (2000) analyzes a panel dataset including bilateral observations for 186 developed and developing countries, with over 100 pairings and 300 observations in which both countries used the same currency. He finds that there is a large positive effect on international trade from currency unions. This effect is statistically significant, with two countries sharing the same currency estimated to trade three times as much as they would with different currencies.

Rose and Stanley (2005) have performed important research clarifying the endogeneity of OCA's phenomenon as well. They specifically use a meta-analysis technique that combines empirical results from thirty-four previous studies on the effects of currency unions on trade. Depending on the exact methods used, the authors find that the estimated effect of currency unions on trade varies between 30 and 90%. This implies a substantial increase in trade, which remains economically important even after the authors control for likely publication bias (Rose and Stanley, 2005, p. 359). Indeed, the estimated trade effect was 47% after correcting for publication bias.

Böwer and Guillemineau (2006) investigate the underlying key factors of business cycle synchronization in the Eurozone over the 1980-2004 period. Their evidence supports the hypothesis of the endogeneity of the OCA criteria. In fact, they find that the implementation of the single market intensified bilateral trade across the eurozone countries and contributed to higher business cycle synchronization. They further claim that endogeneity effects have become more marked since the implementation of the Economic and Monetary Union.

Most recently, Adam and Chaudhry (2014) have also studied the currency union effect on intraregional trade in the ECOWAS using panel dynamic OLS to examine short-term and long-term effects. Their findings suggest a significant positive currency union effect on aggregate intra-ECOWAS trade. In the related literature, Duran and Ferreira-Lopes (2017) study the correlation of business cycles in the eurozone and its determinants. They further analyze the determinants of the lead and lag behavior of business cycles in the same union. Their findings highlight the positive influence of bilateral trade relations on business cycle

correlations. For the determinants of the lead and lag, their results show that the Eurozone member states that lead the cycles are the ones that are better off and form the core countries of the EMU.

Corsetti and Pesenti (2002) use a general equilibrium two-country model to analyze the endogeneity hypothesis. Even though they build on Frankel and Rose's (1998) argument mentioned above, they ask a different question of optimal monetary union, namely:

> "*What would happen if monetary integration fails to boost economic convergence via trade integration*?" (Corsetti & Pesenti, 2002, p.21).

Specifically, the authors assume that when monetary authorities use the exchange rate as an instrument of stabilization, regardless of producers' price-setting strategies, the welfare costs in terms of high import prices and low purchasing power would be excessive. However, with a monetary union, producers adapt their pricing strategies to the new environment, and the monetary authorities are assumed to always avoid any asymmetric policy response to asymmetric shocks. In other words, even if monetary union does not affect trade intensity in the manner empirically shown by Rose (2000), the correlation of national outputs still increases across countries. Accordingly, the authors claim a self-validating optimum currency area. In their words, Corsetti and Pesenti (2002) state that:

> "*a credible policy commitment to monetary union may lead to a change in pricing strategies, making a monetary union the optimal monetary arrangement in a self-validating way". (*Corsetti and Pesenti, *2002, p.21).*

In view of the above, we can see that the effect of a common currency on trade integration, which in turn leads to synchronization of business cycles, is an important dynamic that appears as one of the official motivations behind creating a monetary union, especially in the case of the creation of the EMU. A similar view is also presented by De Grauwe (2014 and 2018), who argues that a monetary union intensifies trade integration and that integration, in turn, reduces asymmetric shocks. According to the author, this should be good news for countries that envisage the formation of a monetary union.

In addition, it is reasonable to mention the existence of the two views on the relationship between trade integration and business cycle synchronization. The first is the European Commission view (also called the optimistic view), which contends there is a positive relationship among these variables, as graphically represented in Figure 2. This is the view the current thesis borrows from. The second (pessimistic) view is that of Krugman (1991), who holds there is a negative relationship between trade integration and symmetry. Krugman's (1991) argument is that when trade integration increases, member countries become more specialized, and this, in turn, brings more asymmetric than symmetric shocks. This view is similar to the point stressed by Kenen (1969) that countries without a diversified economic structure may be subject to more asymmetric shocks, making them vulnerable in forming a sustainable monetary union. (For more on the distinction between these two views, see details in De Grauwe (2014)).

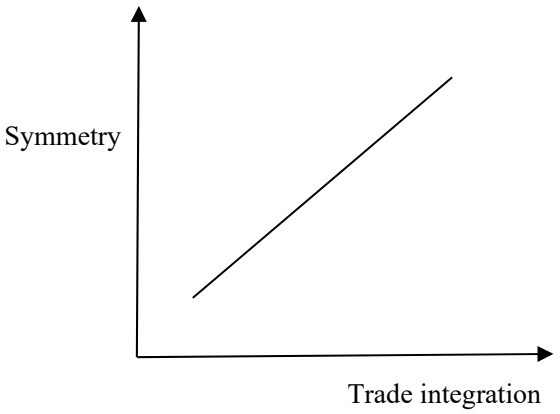

Figure 2. An optimistic view

Note: A similar figure is provided in De Grauwe (2014).

In summary, compared with traditional OCA theory, which focuses on the costs of forming a currency union in terms of the loss of national monetary policy, the new thinking on OCAs heavily emphasizes the benefits associated with currency union. These benefits include policy discipline in terms of gaining credibility with respect to inflation rate management (see Busetti et al., 2007 and Tavlas, 1993) and the avoidance of exchange rate risks (Corsetti & Pesenti, 2002 and Neumeyer, 1998), which, in turn results, in an increase in greater trade integration due to lower transaction costs (Rose, 2000) and more-synchronized business cycles (Frankel & Rose, 1997 and 1998).

Accordingly, considering the political will of EAC authorities to create a monetary union among the partner states, this thesis is inspired by the optimistic view in the literature. Hence, the endogeneity hypothesis is explored (this is specifically addressed in the third paper) to show to what extent the EAC has the potential to be an optimum currency area.

3. Data and Methodology

One can argue that it is not easy to perform research on African countries, especially in regard to data availability (whether at the country level or at the regional level). To ensure uniformity, this thesis is entirely based on data compiled by international organizations. IMF and World Bank databases are mainly used throughout the individual papers. Additionally, some data that are available from different EAC reports are considered.

It is worth mentioning that the thesis uses various econometric approaches that have been used in the previous literature, such as the gravity model of trade, wavelet approach, heterogeneous panel model, and correlation analysis. Nonetheless, given the very recent updates as well as the properties and performance of each of these approaches, the rationale behind these empirical choices and relevance are further elaborated in the individual papers. Therefore, in the following section, only a brief description of the data and approaches used in each paper is presented.

4. Summary and main findings of each paper

As already mentioned, the purpose of this thesis is to empirically analyze the economic feasibility of the proposed EAMU using both traditional and new predictions of OCA theory. All four individual papers summarized below are thus coherent and form the rest of the thesis in four independent chapters.[17]

4.1 Paper 1: Estimation of the East African Community's trade benefits from promoting intraregional trade

Background

The purpose of this first paper is to determine whether EAC membership has helped strengthen trade between partner states since 2000. A common argument is that if there is not much trade between the member countries, there is no interest in forming a monetary union. Thus, the question that the paper seeks to answer is: Has EAC membership had any noticeable effect on trade?

The estimation of EAC trade effects in this paper builds on the previous literature, which is dominated by the use of gravity equations introduced in the early 1960s by Tinbergen (1962). In this literature, trade between two partner countries is assumed to increase proportionally to the countries' size as measured by GDP and to diminish with transportation costs, often proxied by the geographical distance between them. In addition to these two variables, further theoretical and empirical studies in international trade have argued that trade flows between countries can also depend on various factors either fostering or hindering trade between the countries. These include natural barriers (a land border), cultural barriers (common language) and various measures of manmade trade costs, e.g., free-trade agreements, exchange rate movements, and whether or not there is a single currency (see Anderson, 1979; Anderson & Wincoop, 2003; Baldwin, 2006; Bergstrand, 1985 and 1989; Helpman et al., 2008; Kahouli & Maktouf, 2013; Krugman et al., 2012; Rose, 2004a and 2004b, and Vicard, 2011, to name but a few).

A substantial number of empirical studies have estimated the trade effects of economic integration among developed countries (Baier et al., 2008 and Berger & Nitsch, 2008). Some studies have focused on the CFA zone and emerging

[17] Each subsection below re-uses some wording from the associated paper discussed in that subsection. The paper discussed in subsection 4.1 is a slightly revised form of an article with the same title published in *African Development Review* and the paper discussed in subsection 4.2 is a slightly revised form of an article with the same title published in *Journal of Economic Integration*. Details on these journal publications are provided in a footnote on the abstract pages for the associated chapters in this dissertation.

countries (Al-Mawali, 2005; Calderon et al., 2007; Martinez-Zarzoso et al., 2009; Musila, 2005; Rojid, 2006; Salim et al., 2011; Sheng et al., 2014; Yang & Gupta, 2007, among others). A relatively small number of studies have focused on the EAC (Kirkpatrick & Watanabe, 2005 and Nixdorf, 2013), without, however, using an appropriate approach, as is explained later. In contrast, the main contribution of this paper is that it pays much attention to EAC trade effects by using more recent data and updated econometric techniques to avoid the issue of biased estimates, which is mainly due to omitted variable bias (for details see Baier et al., 2008; Baldwin & Taglioni, 2006; Cameron & Trivedi, 2010; Head & Mayer, 2014; Helpman et al., 2008; Kabir et al.,2017 and Yang & Martinez-Zarzoso, 2014).

Data and methodology

In this paper, panel data on the gravity variables (briefly mentioned above) were collected for a sample of 31 African countries for 2000-2016. In particular, for a comprehensive analysis and to capture the net trade effects of the EAC, three different dummies, namely, "both in EAC", "only exporter in EAC" and "only importer in EAC", are included. Moreover, given that the panel used contains time-varying as well as time-invariant variables (the latter including the variables of interest), this paper, unlike previous studies, first discusses the limitations of the fixed effect (FE) estimator in estimating the coefficients of the time-invariant variables. Next, it applies the fixed effect filter (FEF) estimator, a very recent unbiased estimator proposed by Pesaran and Zhou (2018) that is based on a two-step regression to allow for the estimation of time-invariant variables, hence addressing the issue of FE inefficiency.

Main finding

The empirical results in this paper show that membership in the EAC is more likely to increase intra-EAC trade by 122% compared to the level of normal trade expected between countries not belonging to any free trade agreement. Put differently, EAC countries trade more than twice as much with each other as they do with non-EAC members. These findings are in line with previous studies and, more importantly, consistent with the OCA literature claiming that additional trade creation should be a major benefit of having a single currency (Kabir et al., 2017). The paper, therefore, supports the ongoing East African Monetary Union process. However, to improve the likelihood of creating a more sustainable monetary union, the paper recommends that these countries primarily focus on the full implementation of the customs union and common market protocols. The main priority should be for these countries to resolve trade disagreements by removing all nontariff barriers that could slow down or hinder the levels of bilateral trade between these countries.

4.2 Paper 2: Business Cycle Synchronization and Core-Periphery Patterns in the East African Community: A Wavelet Approach

Background

OCA theory claims that a group of countries envisaging creating a monetary union should be sufficiently correlated in terms of macroeconomic shocks. Furthermore, Aguiar-Conraira and Soares (2011b) argue that even though a common business cycle might not be sufficient to ensure the desirability of a monetary union, it is a necessary condition. This makes business cycle synchronization an important factor to take into consideration before making decisions on joining an MU (De Grauwe, 2018).

In accordance with the above, the purpose of this paper is to investigate the degree of business cycle synchronization among five EAC partner states before the monetary union is established. As Rua (2010, p.690) puts it, "*The degree of co-movement can change across frequencies and over time and to be able to capture such evolving features is crucial for a richer co-movement assessment*."

Accordingly, unlike previous studies, which have been conducted in the time domain (see Asongu et al., 2017 for ample literature on existing and proposed African monetary unions, and for more recent EMU literature, see Duran and Ferreira-Lopes, 2017), this paper applies wavelet analysis, which merges the time-frequency domain. This paper is, to our knowledge, the first to apply this type of time-frequency analysis to EAC partner states. One can, therefore, claim that to a large extent, the contribution of this paper is methodological.

Data and methodology

Following the existing literature, we measure economic activity by real GDP. The dataset used consists of annual real GDP growth rates for five EAC countries (Burundi, Kenya, Rwanda, Tanzania and Uganda), extracted from WDI and covering the common period 1989-2015. In this paper, we mainly follow the wavelet approach developed in Aguiar-Conraria et al. (2008), Aguiar-Conraria and Soares (2011a, 2011b) and Rouyer et al. (2008).

The application of wavelet tools to business cycle analysis is recent in the economic literature (see, for example, Aguiar-Conraria & Soares, 2011b; Fidrmuc et al., 2014; Halle & Richter, 2006 and Yogo, 2008). Intuitively, wavelet analysis is an alternative and suitable tool to analyze signals whose frequencies change with time, such as business cycles. This is because this type of analysis provides a time-frequency localization and allows researchers to decompose nonstationary time series and to uncover structural changes. For instance, this helps us assess the gradual effect of economic integration on business cycle synchronization. Specifically, three wavelet tools, wavelet power spectrum, cross-wavelet coherency, and wavelet spectra clustering, are utilized. The paper further highlights the rationale behind the use of the wavelet approach; hence, the

different equations used, and their derivations are explained in the individual paper.

Main finding

The empirical results in this paper reveal the presence of asymmetric shocks and the prevalence of core-periphery patterns among the five EAC countries. Cross-wavelet coherency suggests that the business cycles of Tanzania and Uganda were in phase with those of Kenya at high and medium frequencies in the early 1990s and after the establishment of the customs union in 2005. Wavelet spectra clustering shows that Kenya, Tanzania, and Uganda would form the core of the monetary union, whereas Burundi and Rwanda would form the periphery. Existing literature suggests that the core-periphery pattern threatens the viability of a monetary union because the core is expected to exercise a disproportionate influence on monetary policy decisions, to the detriment of the periphery. This casts doubt on the eventual viability of a monetary union among all five EAC countries. However, the three countries that form its core seem to be the candidates with the most potential for the proposed East African Monetary Union.

4.3 Paper 3: Trade integration and business cycle synchronization among East African Community countries

Background

As previously mentioned, the question of how trade intensity affects the symmetry of shocks is an important issue to consider regarding the endogeneity of the OCA criteria. The purpose of this paper is, therefore, to investigate this endogeneity hypothesis in EAC countries that must decide whether to join an MU.

The linkage between trade intensity and business cycle synchronization has been stressed in a number of papers (see Baxter & Kouparitsas, 2005; Calderon et al., 2007; Canova & Dellas, 1993; Frankel & Rose, 1998 and Gianelle et al., 2017, among others). Substantial empirical research in this area focuses on European countries, and most of them support a positive and strong correlation between trade intensity and business cycle synchronization. This paper thus contributes to this literature, which has very few studies (see Tapsoba, 2010) analyzing this relationship among African countries, particularly EAC countries. The research question is therefore: Are trade integration and business cycle synchronization among EAC countries truly related?

As already mentioned, this paper builds considerably on the empirical findings in Frankel and Rose (1998). It also borrows from studies by Baxter and Kouparitsas (2005) and Calderon et al. (2007). The former study finds that bilateral trade is a variable that is robust in explaining comovement of business cycles, and the latter study, while focusing on the comparison between developing

and developed countries, finds a positive and significant impact of trade intensity on business cycles among developing countries, albeit smaller than the impact among developed countries.

Data and Methodology

The analysis in this paper relies on two major variables, namely, business cycle synchronization and trade intensity. Previous studies have often used the correlation coefficients of the cyclical components of economic activity (mostly using GDP) to measure the synchronization among countries. In contrast, this paper proposes a similarity index not only to measure business cycle synchronization *per se* but also to focus on its change over time. Accordingly, data on the annual real GDP over the period of 2000-2016 are extracted from the WDI database and used to measure that index as the negative of the absolute value of the two countries' real GDP growth rate difference. The latter measure eliminates the volatility of GDP growth, which makes it an ideal measure of synchronization (Giannone et al., 2008 and Kalemli-Ozcan et al., 2013).

The other key variable is the bilateral trade intensity, measured using data from the IMF-DOTS and WDI databases. Here, to build a robust analysis, this variable is measured in two different ways. First, bilateral trade (the sum of total exports and imports between the two countries) is normalized by the countries' GDP, and second, it is normalized by the countries' total trade.

In this paper, a panel model regressing bilateral trade on business cycle synchronization is employed; in addition, other potential determinants of bilateral trade are considered. Given the endogeneity of the trade variable, a 2SLS technique is used. Moreover, to address the cross-sectional dependence and heterogeneity assumed to be present across the countries in the EAC, a common correlated effect mean group (CCEMG) estimator was applied. The latter outperforms traditional panel estimators such as FE and random effect (RE), especially in a short panel, which is the case in the current thesis. (See Baltagi et al., 2000; Eberhardt, 2012; Pesaran & Smith, 1995 and Pesaran, 2006.)

Main finding

The CCEMG estimates reveal a positive and significant relationship between bilateral trade and business cycle synchronization among African countries. The same applies to countries in the East African Community. Additionally, from a graphical visualization, it is shown that alongside EAC membership, country pairs with higher bilateral trade tend to have more synchronized business cycles.

These results confirm Frankel and Rose's (1998) findings, and they have implications at the EAC policy level as well. They suggest that monetary union might be good for EAC countries. The paper further suggests that trade integration among EAC countries may continue to lead to a more synchronized business cycle, as these countries are expected to integrate more through the full implementation of the protocol on the establishment of the monetary union. This serves as an empirical recommendation to be considered by EAC authorities regarding the readiness of the Community for the East African Monetary Union.

4.4 Paper 4: Commonalities in the levels and movements of inflation rates among countries in the East African Community

Background

This paper comes back to the issue of macroeconomic convergence criteria by investigating the degree to which inflation rates among the five EAC countries have become similar. The question of differences in inflation rate movements reflects differences in economic shocks in different countries. Larger differences in these movements is not supportive of initiatives to move towards a common monetary policy, as pointed out in Mundell's (1961) OCA theory. Further, Fleming (1971) and Ishiyama (1975) emphasize that it is important to have similar inflation rates between countries that envisage forming a currency area. Accordingly, two research questions are answered throughout the paper. These are the following: Do the inflation rate levels among EAC countries show a tendency to converge? Have the EAC countries become more closely related regarding variations in their inflation rates?

This paper contributes to the literature dealing with monetary union inflation convergence, which has been substantially investigated for the Eurozone countries (see Busetti et al., 2007; Kočenda & Papell, 1997; Lagoa, 2017; Lopez & Papell, 2012 and Siklos & Wohar, 1997 among others). In addition, related studies among African countries are also numerous; for ample literature, see Carcel et al. (2015) and Dridi and Nguyen (2019), who have focused on EAC countries. However, the unit root and cointegration techniques often used to study inflation convergence are not able to capture how inflation rates are changing (rising and falling) together among a group of countries. In the current paper, we address this problem by investigating the similarity index of the inflation rate changes between pairs of countries and inflation rate rank correlations (see Giannone et al., 2008 and Kendall, 1938, respectively).We also investigate whether the inflation-rate levels of the EAC countries show a tendency to converge. This analysis is based on stationarity tests on inflation differentials between the member countries' inflation rates.

Data and methodology

Based on monthly CPI data (1995M5-2018M12, collected from the IMF's International Financial Statistics (IFS) database, we computed monthly inflation rates. These data are, thus, used throughout the paper. Kendall's tau, as a rank correlation measure, is used to investigate inflation correlations among EAC countries. Moreover, to capture the similarity of monthly inflation rate changes, a similarity index was used. For the purpose of providing a robust analysis, we perform a number of unit root and stationarity tests based on the inflation

differentials. Moreover, the results both with and without seasonal adjustment are presented. In addition, inflation correlations for countries in the EMU and WAEMU are computed and compared to those calculated for EAC countries.

Main finding

The results from the convergence in inflation rates support the stationarity in the inflation differentials over 2013M11-2018M12. The exploration of how inflation rate movements of EAC countries have evolved over time shows that for most country pairs among the five EAC countries, the changes in the inflation rate between consecutive months became more similar between 1995 and 2018. Moreover, by analyzing the development in inflation rate correlations over the same period, we find that in the last period investigated (2013M11-2018M12.), the inflation correlations are among the highest compared to earlier periods for all EAC countries. This observation leads to an overall conclusion that a monetary union between these countries seems favorable. This conclusion also builds on a comparative analysis between these countries' correlations and the analogous correlations shown for the EMU and WAEMU countries.

References

Adam, A. M., & Chaudhry, I. S. (2014). The currency union effect on intra-regional trade in Economic Community of West African States (ECOWAS). *Journal of International Trade Law and Policy*, *13*(2), 102-122.

Aguiar-Conraria, L., & Soares, M.J. (2011a). The continuous wavelet transform: A Primer. NIPE Working Paper Series No. 16/2011.

Aguiar-Conraria, L., & Soares, M.J. (2011b). Business cycle synchronization and the Euro: a wavelet analysis. *Journal of Macroeconomics*, 33, 477–489.

Aguiar-Conraria, L., Azevedo, N., & Soares, M. J. (2008). Using wavelets to decompose the time–frequency effects of monetary policy. *Physica A: Statistical Mechanics and its Applications,* 387(12), 2863-2878.

Aizenman, J. (2018). Optimal Currency Area: A twentieth Century Idea for the twenty-first Century? *Open Economies Review*, 29(2), 373-382.

Al-Mawali, N. (2005). Country-Specific Determinants of Vertical and Horizontal Intra-Industry Trade of South Africa: An Empirical Investigation. *South African Journal of Economics*, 73(3), 406-425.

Anderson, J. E., & Van Wincoop, E. (2003). Gravity with gravitas: a solution to the border puzzle. *American Economic Review*, 93(1), 170-192.

Anderson, J.E. (1979). A Theoretical Foundation for the Gravity Equation. *American Economic Review*, 69: 106-116.

Asongu, S. (2014). Are proposed African monetary unions optimal currency areas? Real, monetary and fiscal policy convergence analysis. *African Journal of Economic and Management Studies*, 5(1), 9-29.

Asongu, S., Nwachukwu, J., & Tchamyou, V. (2017). A literature survey on proposed African monetary unions. *Journal of Economic Surveys*. 31(3), 878-902.

Baier, S. L., Bergstrand, J. H., Egger, P., & McLaughlin, P. A. (2008). Do economic integration agreements work? Issues in understanding the causes and consequences of the growth of regionalism. *The World Economy*, 31(4), 461-497.

Balassa, B. (1961). Towards a theory of economic integration. *Kyklos*, 14(1), 1-17.

Baldwin, R. (2006). The Euro's trade effects. Working Paper Series No. 594. European Central Bank, Frankfurt.

Baldwin, R., & Taglioni, D. (2006). Gravity for dummies and dummies for gravity equations. Working Paper Series (No. w12516). National Bureau of Economic Research.

Baltagi, B. H., Griffin, J. M., & Xiong, W. (2000). To pool or not to pool: Homogeneous versus heterogeneous estimators applied to cigarette demand. *Review of Economics and Statistics*, *82*(1), 117–126

Bangaké, C. (2008). Exchange rate volatility and optimum currency area: evidence from Africa. *Economics Bulletin*, 6(12), 1-10.

Baxter, M., & Kouparitsas, M. A. (2005). Determinants of business cycle comovement: a robust analysis. *Journal of Monetary Economics*, 52(1), 113-157.

Bayoumi, T. (1994). A formal model of optimum currency areas. Staff Papers, 41(4), 537–554. International Monetary Fund.

Bayoumi, T., & Eichengreen, B. (1997). Ever closer to heaven? An optimum-currency-area index for European countries. *European Economic Review.* 41(3), 761-770.

Berger, H., & Nitsch, V. (2008). Zooming out: The trade effect of the euro in historical perspective. *Journal of International Money and Finance*, 27(8), 1244-1260.

Bergstrand, J.H. (1985). The Gravity Equation in International Trade: some Microeconomics foundations and empirical evidence. *Review of Economics and Statistics*, 67: 474-81

Bergstrand, J.H. (1989). The Generalized Gravity Equation, Monopolistic Competition, and Factor- proportions Theory in International Trade. *Review of Economics and Statistics,* 71: 143-53

Böwer, U., and Guillemineau, C. (2006). Determinants of Business Cycle Synchronization Across Euro Area Countries. European Central Bank Working Paper No. 587. European Central Bank.

Buigut, S. (2011). A Fast-Track East African Community Monetary Union? Convergence Evidence from a Cointegration Analysis. *International Journal of Economics and Finance*. 3(1), 255

Buigut, S. K., & Valev, N. T. (2005). Is the proposed East African monetary union an optimal currency area? A structural vector autoregression analysis. *World Development*. 33(12), 2119-2133.

Busetti, F., Forni, L., Harvey, A., & Venditti, F. (2007). Inflation Convergence and Divergence within the European Monetary Union. *International Journal of Central Banking*, *3*(2), 95–121.

Calderon, C., Chong, A., Stein, E. (2007). Trade intensity and Business cycle synchronization: are developing countries any different? *Journal of International Economics*. 71: 2-21

Cameron, A. C., & Trivedi, PK. (2010). *Microeconometrics Using Stata*, Revised edition. Texas: Stata press

Canova, F., & Dellas, H. (1993). Trade interdependence and the international business cycle. *Journal of International Economics*, 34(1-2), 23-47.

Caporale, G. M., Carcel, H., & Gil-Alana, L. A. (2018). Prospects for a Monetary Union in the East Africa Community: Some Empirical Evidence. Working Papers (7073). Ludwigs-Maximilians University's Center for Economic Studies and the ifo Institute

Carcel, H., Gil-Alana, L. A., & Madigu, G. (2015). Inflation convergence in the East African Community: a fractional integration and cointegration study. *Global Economy Journal*, *15*(4), 507–524.

Corsetti, G., 1999& Pesenti, P. (2002). Self-validating optimum currency areas. Working Paper (No. 8783). National Bureau of Economic Research.

Davoodi, M. H. R., Dixit, M. S., & Pinter, G. (2013). Monetary transmission mechanism in the East African Community: *An empirical Investigation* (No. 13-39). IMF.

De Grauwe, P. (1992). *Economics of monetary union*.1st edition. Oxford University Press.

De Grauwe, P. (2006). What have we learnt about monetary integration since the Maastricht Treaty? *Journal of Common Market Studies*, 44(4), 711-730.

De Grauwe, P. (2014). Economics of Monetary Union. 10thedition. Oxford University Press.

De Grauwe, P. (2018). Economics of Monetary Union. 12thedition. Oxford University Press.

De Grauwe, P., & Vanhaverbeke, W. (1993). Is Europe an optimum currency area? Evidence from regional data. *Policy Issues in the Operation of Currency Unions*. 111-29.

De Grauwe, P., and Mongelli, F. P. (2005). Endogeneities of optimum currency areas: What brings countries sharing a single currency closer together? Working Paper (468), European Central Bank, Frankfurt

Debrun, X., Masson, P. R., & Pattillo, C. (2011). Should African Monetary Unions be expanded? An empirical investigation of the scope for monetary integration in Sub-Saharan Africa. *Journal of African Economies*, 20(2), 104-150.

Dridi, J., & Nguyen, A. D. (2019). Assessing Inflation Convergence in the East African Community. *Journal of International Development*, *31*(2), 119–136.

Drummond, M. P., Aisen, M. A., Alper, M. C. E., Fuli, M. E., & Walker, M. S. (2015). *Toward a monetary union in the East African Community: asymmetric shocks, exchange rates, and risk-sharing mechanisms* (No. 15-16). International Monetary Fund. Washington, DC.

Drummond, P., Wajid, K., & Williams, O. (2014). *The quest for regional integration in the East African Community*. IMF Publications.

Duran, H. E., & Ferreira-Lopes, A. (2017). Determinants of co-movement and of lead and lag behavior of business cycles in the Eurozone. *International Review of Applied Economics,* 31(2), 255–282.

EAC (2002). The Treaty for the Establishment of the East African Community. Amended on 14th of December 2006

EAC (2013). The protocol on the establishment of the East African Monetary Union

EAC (2016). Common Market Scorecard. EAC report

Eberhardt, M. (2012). Estimating panel time-series models with heterogeneous slopes. *The Stata Journal*, 12(1), 61–71.

Fidrmuc, J., Korhonen, I., & Poměnková, J. (2014). Wavelet spectrum analysis of business cycles of China and G7 countries. *Applied Economics Letters*, 21(18), 1309-1313.

Fleming, J. M. (1971). On exchange rate unification. *The Economic Journal*, *81*(323), 467-488.

Flood, R. P., & Rose, A. K. (2010). Inflation targeting and business cycle synchronization. *Journal of International Money and Finance*, *29*(4), 704-727.

Frankel, J.A., & Rose, A. K. (1997). Is EMU more justifiable *ex post* than *ex ante? European Economic Review*, *41*(3-5), 753-760.

Frankel, J.A., & Rose, A. K. (1998). The endogeneity of the optimum currency area criteria. *The Economic Journal,* 108(449), 1009-1025.

Frankel, J.A., & Rose, A. K. (2005). Real convergence and euro adoption in Central and Eastern Europe: trade and business cycle correlations as endogenous criteria for joining the EMU. Euro Adoption in Central and Eastern Europe: *Opportunities and Challenges*, 9-21.

Gianelle, C., Montinari, L., & Salotti, S. (2017). Interregional Trade, Specialization, and the Business Cycle: Policy Implications for the EMU. *Journal of Business Cycle Research*, 13(1), 1-27.

Giannone, D., Lenza, M., & Reichlin, L. (2008). Business cycles in the euro area. Working paper No. 14529. National Bureau of Economic Research.

Gibb, R. (2009). Regional Integration and Africa's Development Trajectory: meta-theories, expectations and reality. *Third World Quarterly*, *30*(4), 701-721.

Giersch, H. (1973). On the desirable degree of flexibility of exchange rates. *Review of World Economics*, 109(2), 191-213.

Golit, P. D., & Adamu, Y. (2014). Regional Integration Models and Africa's Growth in the 21st Century: A Fitness Evaluation. *African Development Review*, 26(S1), 111-121.

Goodhart, C. (1996). European monetary integration. European. *Economic Review,* 3(40), 1083–1090

Grubel, H. G. (1970). The theory of optimum currency areas. *The Canadian Journal of Economics*, 3(2), 318-324.

Halle, A. H., & Richter, C. (2006). Measuring the degree of convergence among European business cycles. *Computational Economics*, 27(2), 229-259

Head, K., & Mayer, T. (2014). Gravity equations: Workhorse, toolkit, and cookbook. In Handbook of international economics, (4)1, 31-195.

Helpman, E., Melitz, M., & Rubinstein, Y. (2008). Estimating trade flows: Trading partners and trading volumes. *The Quarterly Journal of Economics*, 123(2), 441-487.

Horvath, J. (2003). Optimum currency area theory: A selective review. Discussion Papers (15). Institute for Economies in Transition, Bank of Finland.

Horvath, R., & Komarek, L. (2002). Optimum Currency Area Theory: An approach for thinking about Monetary Integration. Economic research papers (647). University of Warwick, Department of Economics.

Houssa, R. (2008). Monetary union in West Africa and asymmetric shocks: A dynamic structural factor model approach. *Journal of Development Economics*, 85(1-2), 319-347.

Ingram, J. C. (1969). Comment: the currency area problem. In Robert A. Mundell and Alexander R. Swodoba (eds.), *Monetary Problems of the International Economy* (pp. 95-100). The university of Chicago Press, Chicago and London.

Ishiyama, Y. (1975). The theory of optimum currency areas: a survey. *Staff papers*, *International Monetary Fund*, 22(2), 344-383.

Kabir, M., Salim, R., & Al-Mawali, N. (2017). The gravity model and trade flows: Recent developments in econometric modeling and empirical evidence. *Economic Analysis and Policy*, *56*, 60–71.

Kahouli, B., & Maktouf, S. (2013). Regional trade agreements in Mediterranean area: Econometric analysis by static gravity model. *Journal of East-West Business,* 19(4), 237-259.

Kalemli-Ozcan, S., Papaioannou, E., & Peydro, J. L. (2013). Financial regulation, financial globalization, and the synchronization of economic activity. *The Journal of Finance*, *68*(3), 1179–1228

Kayizzi-Mugerwa, S., Anyanwu, J. C., & Conceição, P. (2014). Regional integration in Africa: an introduction. *African Development Review*, 26(1), 1-6.

Kendall, M. G. (1938). A new measure of rank correlation. *Biometrika*, *30*(1–2), 81–93.

Kenen, P. (1969). The theory of optimum currency areas: an eclectic view. *Monetary Problems of the International Economy*, 41-60.

Kirkpatrick, C., & Watanabe, M. (2005). Regional Trade in Sub-Saharan Africa: An Analysis of East African Trade Cooperation, 1970–2001. *The Manchester School*, *73*(2), 141–164.

Kishor, N.K, & Ssozi, J. (2011). Business cycle synchronization in the proposed East African Monetary Union: An unobserved component approach. *Review of Development Economics*, 15(4), 664-675.

Kishor, N.K, & Ssozi, J. (2010). Inflation convergence and currency unions: the case of the East African community. *Indian Growth and Development Review*, 3(1), 36–52.

Kočenda, E., & Papell, D. H. (1997). Inflation convergence within the European Union: A panel data analysis. *International Journal of Finance & Economics*, 2(3), 189–198.

Krugman, P. R., Obstfeld, M. and Melitz, M.J. (2012). *International economics: Theory and policy*, 9th ed. Pearson

Krugman, P.R. (1991). *Geography and Trade*. MIT Press

Kunroo, M. H. (2015). Theory of optimum currency areas: a literature survey. *Review of Market Integration*, 7(2), 87–116.

Lagoa, S. (2017). Determinants of inflation differentials in the euro area: Is the New Keynesian Phillips Curve enough? *Journal of Applied Economics*, *20*(1), 75–103.

Lopez, C., & Papell, D. H. (2012). Convergence of euro area inflation rates. *Journal of International Money and Finance*, *31*(6), 1440–1458.

Martinez-Zarzoso, I., Felicitas, N. L. D., & Horsewood, N. (2009). Are regional trading agreements beneficial? Static and dynamic panel gravity models. *The North American Journal of Economics and Finance*, 20(1), 46-65.

Masson, P. R., & Pattillo, C. (2004). *The monetary geography of Africa*. Brookings Institution Press.

McKinnon, R. I. (1963). Optimum currency areas. *The American Economic Review*, 53(4), 717-725.

Mkenda, K. B. (2001). Is East Africa an optimum currency area? Working Papers in Economics (41). University of Göterborg, Department of Economics.

Mundell, R. A. (1961). A theory of optimum currency areas. *The American Economic Review,* 51(4), 657-665.

Mundell, R. A. (1973). Uncommon arguments for common currencies, in H.G. Johnson and A.K. Swoboda (eds), *The economics of common currencies,* (pp.114-132). Routledge, London

Musila, J. W. (2005). The intensity of trade creation and trade diversion in COMESA, ECCAS and ECOWAS: A comparative analysis. *Journal of African Economies*, 14(1), 117-141.

Muthui, J. N., Okara, G. A., Makambi, S. A., & Musyoka, P. K. (2016). A G-PPP Analysis to the EAC Monetary Integration Process. *International Journal of Business Science, 4(5), 12-35.*

Neumeyer, P. A. (1998). Currencies and the allocation of risk: The welfare effects of a monetary union. *American Economic Review*, 88(1), 246–259.

Nixdorf, L. (2013). Regional integration and informal cross-border trade in the East African community. In Lorenz-Carl, U. & Rempe, M. (eds); *Mapping agency: Comparing regionalisms in Africa* (pp.133-147). London and New York. Routledge-Taylor& Francis Group.

Pesaran, M. H. (2006). Estimation and inference in large heterogeneous panels with a multifactor error structure. *Econometrica*, *74*(4), 967–1012.

Pesaran, M. H., & Smith, R. (1995). Estimating long-run relationships from dynamic heterogeneous panels. *Journal of Econometrics*, *68*(1), 79–113.

Pesaran, M. H., & Zhou, Q. (2018). Estimation of time-invariant effects in static panel data models. *Econometric Reviews*, *37*(10), 1137–1171.

Phillips, A. W. (1958). The relation between unemployment and the Rate of change of money wage rates in the United Kingdom, 1861–1957. *Economica*, 25(100), 283-299.

Rojid, S. (2006). COMESA trade potential: a gravity approach. *Applied Economics Letters*, 13(14), 947-951.

Rose, A. K. (2000). One money, one market: the effect of common currencies on trade. *Economic Policy,* 15(30),08-45.

Rose, A. K. (2004a). Do we really know that the WTO increases trade? *American Economic Review*, 94(1), 98-114.

Rose, A. K. (2004b). Do WTO members have more liberal trade policy? *Journal of International Economics*, 63(2), 209-235.

Rose, A. K., & Stanley, T. D. (2005). A Meta-Analysis of the Effect of Common Currencies on International Trade. *Journal of Economic Surveys*, 19(3), 347-365

Rouyer, T., Fromentin, J. M., Stenseth, N. C., & Cazelles, B. (2008). Analysing multiple time series and extending significance testing in wavelet analysis. *Marine Ecology Progress Series*, 359, 11-23.

Rua, A. (2010). Measuring comovement in the time–frequency space. *Journal of Macroeconomics*, 32(2), 685–691.

Rusuhuzwa, T. K., & Masson, P. R. (2013). Design and implementation of a common currency area in the East African Community. *African Journal of Business Management.* 7(36), 3575-3590.

Salim, R., Kabir M. and Al Mawali N. (2011). Does More Trade Potential Remain in Arab States of the Gulf? *Journal of Economic Integration*, 26(2), 217–243.

Schiff, M. W., & Winters, L. A. (2003). Regional integration and development. World Bank Publications.

Sheikh, K. A., Azam, M. N., Rabby, T. G., Alam, G. M., & Khan, I. (2011). Monetary union for the development process in the East African community: Business cycle synchronization approach. *African Journal of Business Management*, 5(17), 7632-7641

Sheng, Y., Tang, H. C., & Xu, X. (2014). The impact of the ACFTA on ASEAN–PRC trade: estimates based on an extended gravity model for component trade. *Applied Economics*, 46(19), 2251-2263.

Siklos, P. L., & Wohar, M. E. (1997). Convergence in interest rates and inflation rates across countries and over time. *Review of International Economics*, *5*(1), 129–141.

Simons, D., & Jean Louis, R. (2018). Monetary union in West Africa and business cycles synchronicity: New evidence. *The World Economy*, *41*(10), 2828-2848.

Soloaga, I., & Winters, L. A. (2001). Regionalism in the nineties: What effect on trade? *The North American Journal of Economics and Finance*, 12(1), 1-29.

Stoykova, O. (2018) Optimum Currency Areas: Theory and Applications. *Myśl EkonoMiczna i Polityczna*, 17–53. DOI:10.26399/meip.4(63) .2018.43/o.stoykova

Tapsoba, S. J. A. (2010). Trade intensity and business cycle synchronicity in Africa. *African Development Review*, 22(1), 149-172.

Tavlas, G. S. (1993). The 'new' theory of optimum currency areas. *World Economy*, 16(6), 663–685.

Tinbergen, J. (1962). *Shaping the world economy; suggestions for an international economic policy*. New York: The Twentieth Century Fund

Umulisa, Y. (2016). Effects of a Common Currency on Intra-regional Trade in Africa: Perspectives on the East African Community Monetary Union. In Heshmati, A. (ed.) *Economic Integration, Currency Union, and Sustainable and Inclusive Growth in East Africa* (pp. 77-96). Springer, Cham.

UNCTAD [United Nations Conference on Trade and Development] (2016). Key indicators and trends in international trade. UNCTAD report.

UNECA [United Nations Economic Commission for Africa] (2018). The East African Monetary Union: ready or not? UNECA report.

Vicard, V., (2011). Determinants of successful regional trade agreements. Economics Letters, 111(3), 188-190.

Vieira, C., & Vieira, I. (2012). Assessing the endogeneity of OCA conditions in EMU. *The Manchester School,* 80(s1), 77-91.

WTO [World Trade Organization] (2016). World trade statistical review. WTO report

Yang, S., & Martinez-Zarzoso, I. (2014). A panel data analysis of trade creation and trade diversion effects: The case of ASEAN–China Free Trade Area. *China Economic Review*, 29, 138-151.

Yang, Y., & Gupta, S. (2007). Regional trade arrangements in Africa: Past performance and the way forward. *African Development Review*, *19*(3), 399–431

Yogo, M. (2008). Measuring business cycles: a wavelet analysis of economic time series. *Economics Letters*, 100 (2), 208–212.

Zhao, X., & Kim, Y. (2009). Is the CFA Franc zone an optimum currency area? *World Development*, 37(12), 1877-1886.

Appendix

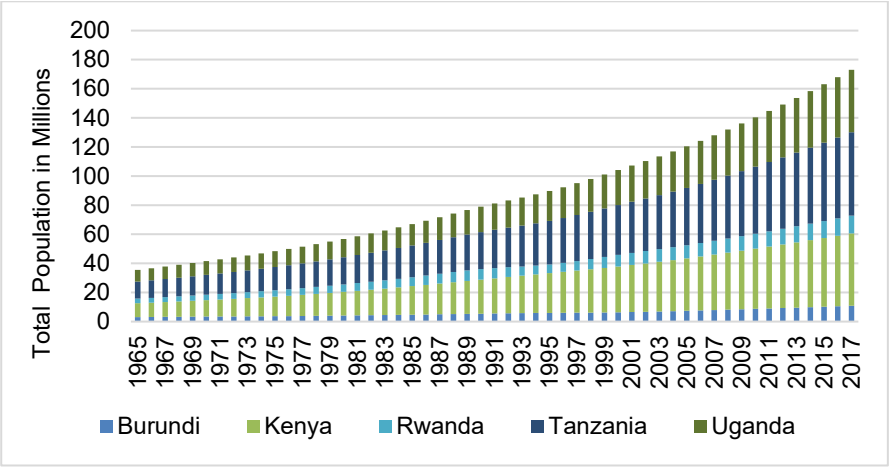

Figure A1: Population distribution in the five EAC countries.

Note: expressed as total population in millions. Calculations are based on the World Bank online dataset: Heath, Nutrition and Population (HNP).

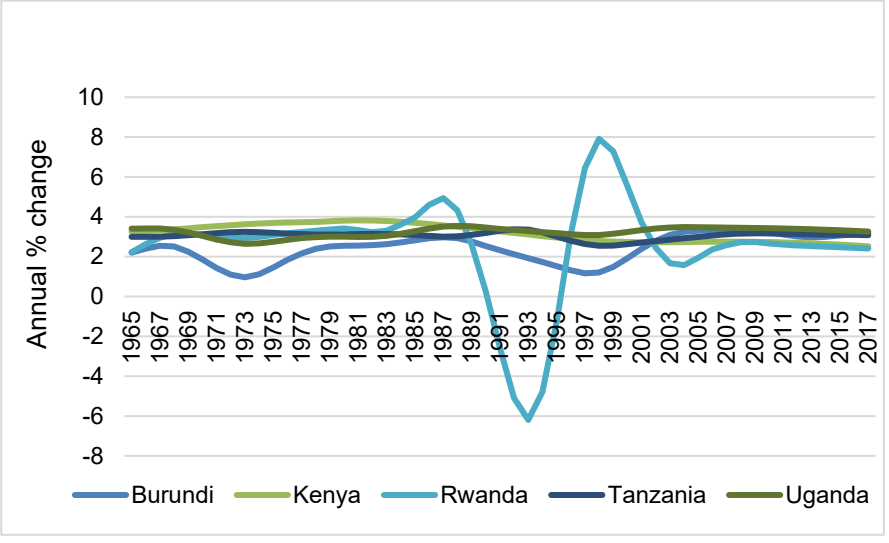

Figure A2: Population growth rates in the five EAC countries (1965-2017)

Note: expressed in annual percentage change. Calculations are based on the World Bank online dataset: Heath, Nutrition and Population (HNP).

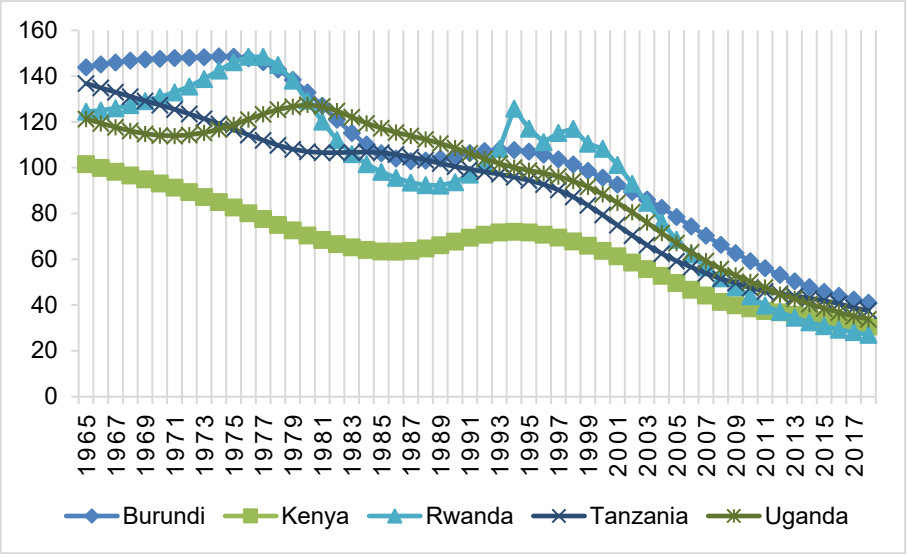

Figure A3: Infant mortality rate in the five EAC countries (1965-2017)

Note: expressed as per 1000 live births. Calculations are based on the World Bank online dataset: Heath, Nutrition and Population (HNP).

Table A1: Macroeconomic convergence indicators of EAC countries (2010-2018)

Indicator	Target	Country	2010	2011	2012	2013	2014	2015	2016	2017	2018
Inflation	8%	Burundi	6.5	9.6	18.	7.9	4.4	4.6	5.5	17	12
		Kenya	4.3	14	9.4	5.7	6.9	6.6	6.3	8.0	5.0
		Rwanda	2.3	5.7	6.3	4.2	1.8	2.5	7.2	8.2	3.3
		Tanzania	7.2	13.	16.	7.9	6.1	5.6	5.2	5.3	3.8
		Uganda	3.7	15.	13	4.9	3.1	5.4	5.5	5.6	3.8
Reserves (in months of imports)	4.5	Burundi	4.1	3.2	3.4	3.4	3.5	4.2	1.9	1.3	2.6
		Kenya	2.9	2.8	3.7	3.9	5.3	5.1	4.8	4.3	4.6
		Rwanda	5.2	6.5	5.6	4.8	3.9	3.5	4.0	4.6	4.3
		Tanzania	4.1	3.5	3.6	4	4.3	4	3.7	5.5	3.7
		Uganda	3.9	3.7	4.5	4.8	5.1	4.8	4.5	4.3	4.7
Fiscal deficit, (% of GDP)	-3% incl. grants	Burundi	-3.6	-3.9	-3.7	-1.7	-3.4	-5.3	-6.2	-7.8	-8.6
		Kenya	-4.4	-4.1	-5.0	-5.7	-7.4	-8.2	-7.3	-7.9	-6.6
		Rwanda	-0.7	-0.9	-2.5	-1.3	-4.0	-2.8	-2.4	-2.5	-2.0
		Tanzania	-4.8	-3.6	-4.1	-3.9	-3.0	-3.3	-3.8	-1.4	-2.9
		Uganda	-5.8	-2.6	-3	-3.9	3.3	-2.7	-3.6	-3.8	-4.7
Public debt (% of GDP)	50 %	Burundi	47	43	41	36	36	46	47	52	58
		Kenya	44	43	41	42	49	52	54	53	54
		Rwanda	20	20	20	27	29	33	38	41	43
		Tanzania	28	28	29	31	33	37	39	37	36
		Uganda	24	23	25	27	30	33	37	43	35

Source: own compilations from EAC central banks statistics, EAC reports and UNECA (2018)

Collection of Papers

Paper 1
Estimation of the East African Community's trade benefits from promoting intra-regional trade
Yvonne Umulisa

Paper 2
Business Cycle Synchronization and Core-Periphery Patterns in the East African Community: A Wavelet Approach
Yvonne Umulisa & Olivier Habimana

Paper 3
Trade Integration and Business Cycle Synchronization among East African Community Countries
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Paper 4
Commonalities in the levels and movements of inflation rates among Countries in the East African Community
Scott Hacker & Yvonne Umulisa

Paper 1: Estimation of the East African Community's trade benefits from promoting intra-regional trade

Yvonne Umulisa

An earlier version of this paper was published in African Development Review

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Estimation of the East African Community's trade benefits from promoting the intra-regional trade[18]

Yvonne Umulisa

ABSTRACT

In the literature on economic integration, the optimum currency area (OCA) theory says that there should be a high degree of trade between potential members of a monetary union for them to benefit from the use of a single currency. This study uses an augmented gravity model of trade to estimate the East African Community's (EAC) trade effects, as this community decided to participate in a monetary union by 2024. The paper uses the fixed effect filter (FEF) estimator, which follows a two-step approach and outperforms standard fixed effects (FE) estimator. The results indicate that EAC has the potential to increase trade among partner states by 122 percent than expected from the normal trade levels. Considering this finding, the study recommends that full implementation of the customs union and common market protocols should continue to be the primary focus of these countries to improve the likelihood of creating a sustainable monetary union.

[18] This paper is slightly revised version of the following publication: "Umulisa, Y., (2020). Estimation of the East African Community's trade benefits from promoting the intra-regional trade, *African Development Review*, 32(1), 55-66. "

Estimation of the East African Community's trade benefits from promoting the intra-regional trade

Yvonne Umulisa

1. Introduction

The optimum currency area (OCA) theory is the most common framework used by scholars while discussing monetary integration in literature on economic integration (De Grauwe, 2014). Early studies, such as those by Mundell (1961, 1973); McKinnon (1963); and Kenen (1969), present the economic conditions that are relevant for a successful monetary union and can be summarized under four points: (1) trade integration; (2) symmetry of shocks; (3) mobility (in both labor and capital markets); and (4) risk-sharing mechanisms. Regarding the first criterion, the OCA theory asserts that there should be a high degree of trade between the member countries of the union for them to benefit from using a single currency. Accordingly, this study assesses the criterion of trade integration among the East Africa Community's (EAC) countries, a region that has undertaken steps to establish a monetary union.

This six-country[19] economic community was re-established in 2000.[20] It started with Kenya, Tanzania, and Uganda; later in July 2007, Rwanda and Burundi joined the community. In September 2016, South Sudan became full member of the union. Currently, the EAC is seen as one of the most successful regional integrations in Africa (Charaf-Eddine & Strauss, 2014). The EAC first step was the protocol on the establishment of the customs union which was signed in 2004 and came into force at the beginning of 2005. The second step was the common market protocol which was initiated in 2010 and is still being implemented. As of now, the EAC is pushing ahead with the third step, an ambitious plan of creating a monetary union and adopting a single currency in 2024 (see Umulisa & Habimana, 2018).

[19] EAC member countries are now Burundi, Kenya, Rwanda, South Sudan, Tanzania, and Uganda.
[20] The EAC project was first introduced in 1967 but it collapsed in 1977 due to political differences among the participating countries. It was re-established by a 1999 treaty and came into force in 2000.

Figure 1 gives a graphical illustration of the intra-EAC trade.[21] It shows that intra-EAC trade has increased quite modestly since the union re-started. Rwanda showed a dramatic increase in 2008 which was associated with a big increase in its total trade to Kenya, which more than doubled from US$ 207 million in 2007 to US$ 550 million in 2008. However, there was a decline in 2009 for all countries, which was undoubtedly associated with the financial crisis of 2008-09. The upward trend recommenced in 2010, and again all member countries reported a decline during 2014-16. The explanation of this drop, as the UNCTAD (2016)[22] report highlights, could be weaker demand in the commodity sector, especially in some parts of the developing world.

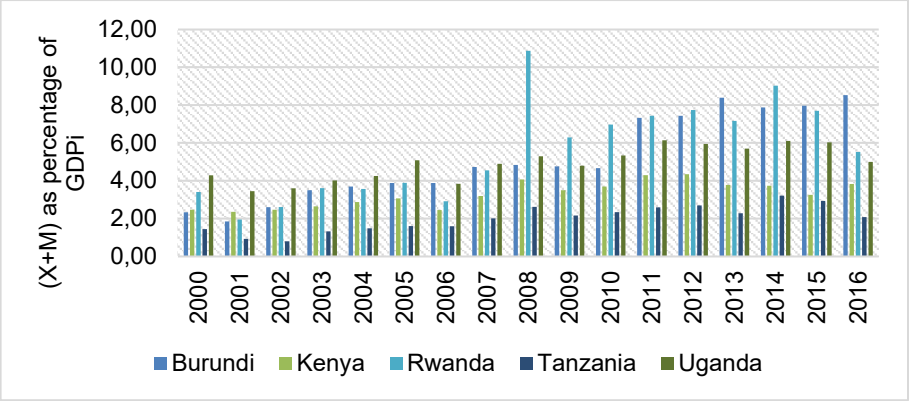

Figure 1. Degree of openness within EAC for its partner states (2000-16)

Note: Shown for each country is the sum of exports to and imports from other EAC members as a percentage of that country's GDP.
Source: Author's calculations based on IMF, Direction of Trade Statistics (DOTS); EAC facts and figures 2016 report, and the World Development Indicators (WDI) from the World Bank database.

Figure 1 also shows considerable differences in the degree of openness in these countries. The degree of openness indicates how trade with the rest of the area is important for a given country's economy. Typically, small countries are more open than larger ones. This can also be seen in Figure 1 which shows that Burundi and Rwanda are considerably more open than Kenya, Tanzania, and Uganda. Although Uganda seemed to be more open than Burundi and Rwanda in the earlier years, these three countries show less openness, with very little openness observed in Tanzania's trade.

[21] The statistics are for all the EAC countries, except South Sudan.
[22] United Nations Conference on Trade and Development (UNCTAD), key indicators and trends in international trade report (2016) retrieved on 27th July 2019 https://unctad.org/en/PublicationsLibrary/ditctab2016d3_en.pdf

Figure 2 gives the evolution of intra-EAC trade for each year and for each country. This figure indicates that trade by the larger countries is more important to the overall EAC area than that by the smaller countries. Trade by Kenya, Uganda, and Tanzania, for instance, is more important than trade by Rwanda and Burundi within the EAC area.

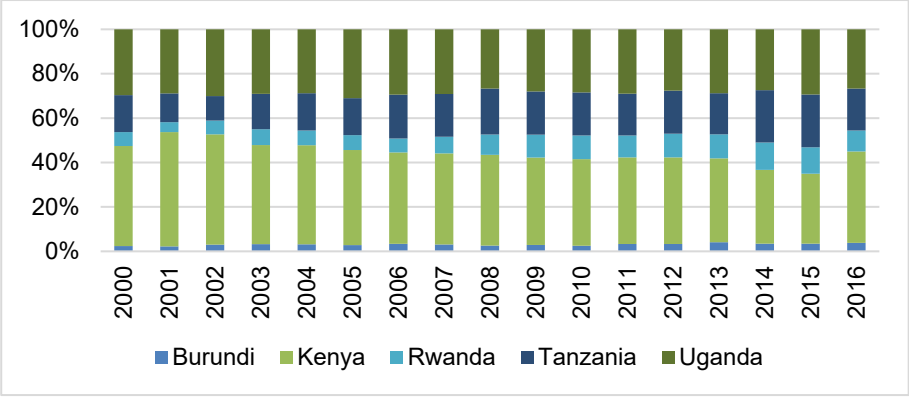

Figure 2. Evolution of intra-EAC trade (2000-16)

Note: Shown for each year and each country is the sum of exports to and imports from other EAC members as a percentage of intra-EAC total trade (in US$).
Source: Author's calculations based on IMF, Direction of Trade Statistics (DOTS).

Having said this, it is believed that an investigation of EAC's trade effects is relevant for generating policy recommendations for the future development of the community. Hence, the main purpose of this paper is determining whether trade cooperation helped strengthen trade between the EAC partner states. Thus, the principal research question that this paper answers is: Has membership to the EAC had any noticeable effect on intra-regional trade? Given that some of the African countries have already signed other economic integration agreements (EIAs),[23] the paper also briefly discusses the issue of the trade effects of other EIAs, such as free trade agreements (FTAs) and currency unions in Africa.

[23] As mentioned in Baier et al. (2014), economic integration agreements refer to preferential trade agreements, free trade agreements, customs unions, common markets, and economic unions, such as a monetary union.

To answer the research question, the paper estimated an augmented gravity equation (which is explained in the next section) of bilateral trade flows among the 31 African countries in 2000 - 2016.[24] This period was chosen not only because regionalism increased in Africa during this time and there was the re-establishment of EAC, but also because data were available for this period. An additional reason for choosing this period was Baier and Bergstrand's (2007) finding that the full trade effects of economic integration agreements take an average of 10 - 15 years to appear. Hence, the period of study in this paper covers 17 years, 12 of which are after the EAC customs union came into force; this is important for capturing EAC's effects.

Studies in international trade have often applied a gravity equation to explain trade flows and patterns between countries. So far, this literature has been dominated by studies on developed countries (Baier et al., 2008; Berger & Nitsch, 2008; Frankel & Rose 1997, 2002; Micco et al., 2003; Rose, 2004a). There has been some research on Asian and African countries (see, for instance, Al-Mawali, 2005; Calderon et al., 2007; Martinez-Zarzoso et al., 2009; Musila, 2005; Rojid, 2006; Salim et al*.,* 2011; Sheng et al., 2014; Yang & Gupta, 2007, among others). A relatively small number of studies have focused on EAC,[25] without, however, using an appropriate approach as explained later.

Hence, the main contribution of this paper is that it concentrates on the effects of EAC on intra-regional trade for documenting whether EAC's membership on the part of one or both of two trading partners influences the likelihood that they will trade. For this, the paper uses an augmented gravity model that includes three separate EAC dummies. As argued by Martinez-Zarzoso et al. (2009), Kabir et al. (2017) and Yang & Martinez-Zarzoso (2014), this specification helps capture trade levels resulting from a free trade agreement that are above or below normal levels. Moreover, compared with previous studies that have focused on the Eastern African region, this paper uses more recent data and more appropriate techniques to avoid unbiased estimates. It does so by following the very recent specification of the gravity model developed in a series of papers by Baier and Bergstrand, (2004, 2007) and Baier et al. (2014). In addition, it controls the impact of other free trade agreements between African countries to which EAC members also belong (for details see Martinez-Zarzoso et al., 2009 and Martinez-Zarzoso, 2013).

[24] See Table A5 in the Appendix for the list of countries. This paper's intention was studying all 54 countries in Africa. However, to avoid inconsistency in data, only 31 African countries were included while the other 23 were excluded due to lack of data (for example, huge missing data on bilateral trade). It is a coincidence that the sample is representative of the entire African continent (it represents the four corners of Africa).

[25] Unpublished works such as working papers or reports have looked at this issue, and mostly used old data and conducted simulations for only a group of two to three countries or just one country (see, for example, McIntyre, 2005). There are also some published works, but these only assess the three original countries (Kirkpatrick & Watanabe, 2005). It is worth noting that a few papers assess the feasibility of EAMU using the other OCA criteria of business cycle synchronization. This literature is not discussed because it does not have much to do with this study.

By comparing the panel estimators used in this study, the fixed effect filter (FEF) results based on a two-step approach to capture the effects of the time invariant variables are robust and reasonable. Focusing on the real EAC trade effects by including the time invariant EAC dummies from the beginning of the sample (that is, capturing the EAC trade effects' membership regardless of when the two small economies joined the community), the EAC net trade effects are positive with a strong significance. The point estimates indicate that the EAC has the potential to increase trade among its partner states by 122 percent of the normal trade level.

Moreover, when the EAC membership dummy is allowed to vary a little during the sample period (the fact that Burundi and Rwanda joined in 2007) the robustness remains regarding the sign of the EAC dummy-coefficient estimates matching the expected sign. Confirming earlier results that a common membership of the EAC is likely to increase intra-EAC exports, albeit not yet significantly strong in these two countries. Even the other EAC dummies have point estimates that are indicative of trade diversion effects, also interpreted as a decrease in welfare for non-members. Hence, this study recommends a deeper integration in terms of full implementation of the customs union and the common market protocol, to increase the likelihood of creating a viable and sustainable monetary union.

The rest of the paper is organized as follows. Section 2 briefly summarizes the theoretical and empirical literature on the gravity model of trade. Section 3 describes the data and the model's specifications used in this paper. Section 4 discusses the empirical findings. Section 5 gives a conclusion and some policy implications of this study's findings.

2. Related literature

2.1 A gravity model of trade

There is vast empirical literature on the estimation of trade flows between countries which is dominated by the gravity equation introduced in the early 1960s by Tinbergen (1962). Subsequently, the application of the gravity equation became the main econometric model for analyzing bilateral trade flows. In its basic form, the gravity equation assumes that trade between countries can be compared to the gravitational force between two objects where the force of gravity between the two objects is proportional to the product of the masses of the two objects divided by the square of the distance between them. In trade theory, the force of gravity is replaced by the value of bilateral trade and the masses with the trade partners' GDP (for more details, see Frankel & Rose, 1997; Helpman, Melitz, and Rubinstein, 2008 henceforth HMR, 2008; Krugman et al., 2012; Van Bergeijk & Brakman, 2010 and Vicard, 2011). These authors further argue that the gravity model is useful because it enables us to identify anomalies in estimating the volume of trade between countries. This is because, as stressed by Tinbergen (1962) the coefficients estimated from the trade flow equation (given below) describe the average trade flows for both developed and developing countries.

Discussing previous literature on the use of the gravity model, Kepaptsoglou et al. (2010) surveyed over 75 papers that used the gravity model to analyze trade flows among different groups of countries in the early 2000s. Their conclusion highlights the suitability of the model, which exhibited a range of novel applications. However, they add that fixed and random effects models are extensively used in research in this area. Kabir et al. (2017) also argue that the gravity model is frequently applied in international trade literature due to its empirical success in assessing the trade effects of geographic locations and trade agreements. A basic standard gravity model used in existing literature is of the form:

$$T_{ij} = \frac{C \times Y_i^{\alpha} \times Y_j^{\beta}}{D_{ij}^{\gamma}} \quad (1)$$

where T_{ij} is the value of trade flows between country i and country j. Y_i and Y_j are the size of the two countries i and j respectively, D_{ij} is the distance between the two countries, and c, α, β and γ are constant parameters to be estimated. From this, trade between two partner countries is assumed to increase proportionally to the countries' sizes, measured by their GDP, and diminishes with transportation costs as proxied by the distance between them. However, in addition to these variables, theoretical and empirical studies have also found that trade flows between countries can also depend on various other factors either aiding or limiting trade between the countries, such as natural barriers (a land border), cultural barriers (common language), and various measures of manmade trade costs (for example, free trade agreements, exchange rate movements, and whether or not there is a single currency) (see Anderson, 1979; Anderson & Wincoop, 2003; Bergstrand, 1985, 1989; HMR (2008) and Kahouli & Maktouf, 2013).

The methodology used in studies using the gravity model has been subjected to various criticisms. An issue commonly raised is biased estimates. For example, as stressed in Baldwin and Taglioni (2006), the omission of some relevant determinants of bilateral trade and other common errors such as the inappropriate computation of bilateral trade variables may produce invalid estimates. HMR (2008) also show that the traditional gravity model's estimates may be biased due to the omission of some important determinants of trade, such as the number of exporters, especially when firm-level data can be used.

Further arguments on the issue of biased estimates are highlighted in Anderson and Wincoop (2003) who hold that to properly estimate the gravity equation, bias resulting from omitted variables should always be avoided. Among other issues that may yield biased estimates are endogeneity, heterogeneity, heteroscedasticity, and autocorrelation. All these problems are well elaborated by Baier and Bergstrand (2007), Kabir et al. (2017) and further argued in Baier et al., (2008, p. 464) who state that the market for bilateral Economic Integration Agreements (EIAs) exists contemporaneously with the market for bilateral trade flows, obscuring ex-post evaluation of the effects of EIAs on trade.

To address the issue of the biased estimates of trade effects, Baier et al. (2008) proposed a gravity equation that is specified to capture the ex-post trade effects of EIAs. They particularly examined some specific agreements by applying ex-post techniques that allowed them to change the membership variable over the 40-year period 1960 - 2000. They also proposed a panel approach to account for the endogeneity of EIAs' variables. Their empirical findings show that European economic integration had a greater effect on trade over the 40-year period and that other FTAs considered in their study had a statistically significant effect on members' trade. These findings are consistent with those of Baier et al. (2014) who used a specific panel dataset for 1962 - 2000 to study the trade effects of EIAs. Their dataset had many countries, various EIAs, and different categories of products. Their empirical findings gave the first evidence of the effects of several EIAs on both intensive and extensive margins of trade. Their results are robust even after correcting for potential sample selection, heterogeneity of firms, and the EIAs' endogeneity biases.[26]

2.2 Previous trade studies

Existing literature suggests two main approaches for measuring the trade effects of EIAs. An ex-ante approach which is also theoretical uses the general equilibrium models to predict the effect of EIAs on trade flows (see, for example, Baier & Bergstrand, 2004, 2007; Baldwin & Forslid, 2010; Baldwin & Taglioni, 2006). The second approach consists of ex-post analyses of bilateral trade flows using the empirical gravity model (see, for instance, Baier et al., 2014 and Elliott & Ikemoto, 2004). There are many examples of the application of the gravity model of trade in literature, and the findings suggest a positive relationship between trade flows and regional free trade agreements. It is important to note that these studies use different groups of countries (samples) and different model specifications regarding the time period and model variables, hence it is difficult to summarize and compare them in a table. However, the following paragraphs discuss trade studies that are relevant for the present paper.

The first is 'Gravity with Gravitas' by Anderson and Wincoop (2003) who used a general equilibrium model and developed a method for consistently and efficiently estimating a theoretical trade gravity model. Their findings suggest that border barriers considerably reduced bilateral trade at the national level. Further, they argue that the trade effect of border barriers is by nature large for small countries and show that omitted variables may bias the estimated border effect upwards. Hence, they conclude that their approach can be applied for investigating the trade effects of many other potential determinants of bilateral flows.

[26] The authors specifically eliminate these kinds of biases by using the first differencing and pair FE in their model specifications.

In a related theoretical study, Baldwin and Forslid (2010) examined the various aspects of trade liberalization using heterogeneous firms. Among their several findings, exports for large countries increase with trade liberalization; this effect does not hold for small countries. Despite this, their model highlights aggregate welfare gains of trade liberalization.

Baldwin and Taglioni (2006) reviewed the theory behind the gravity equation from a microeconomic and theoretical perspective and argue that the gravity equation is a 'workhorse' in a range of empirical trade studies. Therefore, with the aim of showing several mistakes made by researchers in this field, and to what extent these errors may bias the results, they came up with key elements that should always be considered in a gravity model of trade. For example, they propose the use of panel estimators for reducing bias. They further argue that the estimator should include year dummies to control for idiosyncratic year-specific shocks, and time-invariant country-pair dummies to remove the correlation between the omitted variables and the included regressors.

Accordingly, these authors examined the trade effect of the euro using different regression models. Specifically, when they compared a model that includes only year dummies and a model that includes years dummies along with country-pair dummies, they found that these models yield different results. The latter model reduces the euro's trade effect substantially from 0.17 to 0.10.[27] Hence, they conclude that it is always wise to consider both time and country-pair dummies, which the current study does.

Elliott and Ikemoto (2004) used a structural equation that is different from the standard gravity equation. To study the impact of the ASEAN[28] free trade agreement (AFTA) on intra- and extra-regional bilateral trade flows and how these relationships have evolved over time, they selected 35 countries worldwide based on data availability and existing regional trade blocs. It is important to note that their structural equation includes other FTAs as well. These are Asian Pacific Economic Cooperation (APEC), the European Union (EU), and the North America Free Trade Area (NAFTA). In addition to the traditional variables described earlier, these authors augmented the gravity model by including a specific variable to capture the differences in factor endowments among the countries that they studied.

[27] i.e. the point estimate of the euro membership fell from 0.17 to 0.10.

[28] ASEAN is the Association of Southeast Asian Nations. It currently comprises of 10 countries, but was originally founded by Indonesia, Thailand, Philippines, Malaysia, and Singapore.

This specification is highly recommended, for example, when trade data on commodity composition is available and accurate (for discussions on factor endowments, see Bergstrand 1985, 1989, and Helpman & Krugman, 1985 who used price indices as factor endowment variables). Elliott and Ikemoto's (2004) two main findings are: first, trade flows were not significantly affected in the years immediately following the signing of the agreement. Second, when they estimated the gravity model with the intra-ASEAN variable only, they found a positive trade effect of AFTA, which increased gradually. These findings are consistent with previous trade studies and in line with this study's results that use the time varying EAC dummy.

Carrère (2006) shows that when the EIAs' dummies are correctly introduced in a gravity model of trade they allow a good identification of both trade creation and trade diversion effects. It is important to explain what both terms mean with reference to Viner's (1950) theory. This theory assumes that trade liberalization leads more efficient firms to move to large markets where prices are normally high. As a result, consumer choices or preferences and competition among the firms increase and lead to lower prices. This underlines the benefits of trade agreements because trade become freer (See Baldwin & Forslid, 2010 and Yang & Martinez- Zarzoso, 2014). In this sense, we talk of trade creation when there is additional trade created between countries within the union that might not have been created in the absence of a trade agreement. However, trade diversion happens when countries within the union divert trade away from a more efficient producer who is outside the union towards a less efficient producer within the union. This may also result in a decrease in welfare for non-union members. Specifically, Carrère (2006) used a gravity model to investigate ex-post regional trade agreements with panel data for 130 countries covering a long span of time (35 years from 1962 to 1996). After considering the unobservable characteristics of each country pair, endogeneity, and potential selection bias, the author used a Hausman Taylor panel estimation to correct the FE bias. The results showed a significant and positive trade effect of a regional agreement between member countries. Moreover, this effect was also associated with a reduction in both exports and imports to the rest of the world, indicating trade diversion.

Baier and Bergstrand (2007) are among the most cited scholars in international trade literature because of their influential paper on the trade effects of FTAs. Their study was based on a theoretical gravity equation that included both country and time effects. They showed that when FTAs' endogeneity was addressed by using a panel data approach, the gravity model of trade yielded strong empirical evidence. Hence, they empirically examined the average effect of FTAs on bilateral trade over 40 years for 96 countries and their findings showed that a free trade agreement doubled trade between member countries over 10 years.

Kahouli and Maktouf (2013) used a gravity model to analyze the influence of FTAs in Mediterranean countries. They used panel data for 27 countries over the period 1980-2011. Their regional dummies include the EU (15 European Union countries), the European Monetary Union (EMU) commonly known as the eurozone, and the Arab Maghreb Union (AMU) among others. They used these dummies to see whether they contributed to trade creation/ diversion. Their results showed a strong positive relationship between FTA and trade flows among the countries studied. Specifically, their findings showed that memberships to EU and EMU had more influence on exports than membership of AMU.

Anderson and Wincoop's work led Yang and Martinez-Zarzoso (2014) to investigate the effects of the ASEAN-China free trade agreement (ACFTA) on exports. Their study focused on trade creation and diversion effects using a sample of 31 countries over a 16-year period (1995 to 2010). The uniqueness of their study is the use of aggregated and disaggregated export data for agricultural and manufactured goods. Moreover, to get unbiased estimates, their study also included multilateral trade resistance terms defined as all bilateral and time-varying trade barriers often proxied by relative prices.[29] As also proposed by Baier and Bergstrand (2007) this specification makes it possible to control for price differentials between countries and to capture all unobserved time-varying variables that may influence trade between countries. In addition, it addresses the endogeneity bias of economic integration agreements' variables included in the model. Their findings reveal substantial, significant, and robust trade creation due to ACFTA. Even when using disaggregated data, the effect does not change in the case of agricultural and manufactured goods.

In summary, several papers have investigated various aspects of international trade using a gravity equation as the suitable model. As argued by most of these authors (see, for instance, Baier & Bergstrand 2007; Baldwin & Taglioni, 2006; HMR, 2008), from an econometric point of view, gravity models using OLS to test trade effects of EIAs are mis-specified. This means that OLS estimated parameters corresponding to economic integration agreements' dummies may be biased. Hence, all these studies propose the use of panel data estimators that include both country-time/country-pair and time-specific effects.

[29] This specification is highly recommended when price indices data is available for trading partners. Otherwise one can include the exporter-time and importer-time fixed effects, to capture the unobserved trade costs (see also Nilsson, 2007)

Moreover, whereas the issue of the trade effects of EIAs, such as FTAs and currency unions, has been thoroughly discussed in literature this discussion remains an empirical one because, as Kabir et al. (2017), Rose (2000), and Soloaga & Winters (2001) argue none of the researchers generate a general equation to be used in any empirical work. This bears important empirical implications that when heterogeneity is correctly accounted for, gravity models can efficiently estimate the effects of regional integration on the volume of trade flows. The current study, therefore, follows the model specifications proposed earlier, that is, it considers a specific gravity model that controls not only for time and country-pair fixed effects but also for country time-varying effects while retaining the country-pair fixed effects. Unlike most of the existing empirical studies, this paper only uses a sample of African countries with emphasis on EAC countries.

3. Data and Methodology

3.1 Data

As mentioned earlier, this paper estimates the gravity equation using data for 31 African countries over 17 years (2000 - 2016). According to the panel dataset, there should normally be (15,810 =31×30×17) observations for (930=31×30) pairs of countries. However, some countries lack export values with a partner, and these observations are identified with a missing value. Hence, the actual number of observations is 11,335 for 913 pairs of countries after the observations with missing values are dropped.[30] Compared to analogous studies, this number is acceptable and enough to produce unbiased results.

Data on bilateral exports is taken from the IMF's Direction of Trade Statistics, whereas data on GDP is taken from the World Bank's World Development Indicators. Data on common dummies, distance, and EIAs' membership was obtained from the "Centre d'Etudes Prospective et d'Informations Internationales (CEIIP)" database and WTO websites respectively.

[30] More on this see Table A2 in the Appendix.

3.2 Model specification

In this study, a gravity model was chosen due to its importance in 'bilateral trade' analyses (cfr, Baier & Bergstrand, 2007; Baier et al., 2008; Baldwin & Taglioni, 2006; HMR, 2008; Driscoll & Kraay, 1998; Head et al., 2010; Head & Mayer, 2014; Yang & Martinez-Zarzoso, 2014). All these authors propose the use of panel data estimators which include both country-specific effects (bilateral fixed effects) and time effects. Accordingly, to estimate the effects of various EIAs on trade flows in Africa, and more particularly intra-EAC trade effects, a dataset comprising each of the variables described below was constructed. As a result, the baseline augmented gravity equation in its log linear form was estimated as:

$$lnEX_{ijt} = \beta_0 + \beta_1 lnGDP_{it} + \beta_2 lnGDP_{jt} + \beta_3' X_{ij} + \beta_4 lnEx_{rowt} + \delta_1' EIA_{ijt} + \delta_2' EAC_{ij} + \varepsilon_{ijt} \quad (2)$$

where EX_{ijt} are exports from i to j in year t ,[31] GDP_{it} (GDP_{jt}) indicates the GDP of the exporter (importer) in year t. ε_{ijt} is the usual error term. X_{ij} is a vector of unvarying gravity equation variables. In this paper, the vector includes distance (in log form), and the two dummy variables common border and common language. The 'common border' variable takes a value of 1 when both countries in the pair share a border (0 otherwise) and the 'common language' variable takes a value of 1 when both countries share a common official language (0 otherwise). β_1, β_2 and the three elements of β_3 are constant parameters of the model and are all expected to be positive, except for the distance variable, which is a proxy for trade costs and for which a negative coefficient is expected. EIA_{ij} is a vector of two dummy variables each of which takes a value of 1 when both countries in the pair are members of the same EIAs, the first being the CFA[32] zone ('CFA members') and the second being other existing trade agreements between African countries ('free trade area'). Hence, both the parameters included in δ_1 are expected to be positive, that is, a common currency and free trade area are expected to reduce the transaction costs of trade within member countries and increase trade flows between them.

[31] Following Abiad et al. (2014, p. 240), the behavior of exports can be better explained by the determinants of standard gravity. Moreover, as emphasized by Helpman et al., (2008), unidirectional trade data can be used when bilateral trade flows are asymmetric $X_{ij} \neq X_{ji}$. This is the case for the data at hand. Further, Baldwin and Taglioni (2006), argue that the gravity model still holds for unidirectional trade flows. Using this helps avoid the silver medal mistake where most researchers mistake the log of the average of bilateral exports and imports for the average of the logs.

[32] CFA franc is a common currency used in some Western and Central African countries (see Appendix Table A5), in French CFA stands for Communauté Financière en Afrique (English translation: Financial Community in Africa).

The EAC_{ij} vector is included to see whether EAC's membership matters for bilateral trade. It includes three different dummies, the coefficients of which are the primary interest of this paper. The first dummy, 'both in the EAC' captures intra EAC-trade, taking a value of 1 when both countries in the pair belong to the EAC (0 otherwise). Its coefficient is expected to be positive, showing that membership of both trading partners in EAC increases trade between the partners. The second dummy, 'only exporter in EAC' captures the effect of EAC members' exports to non-members, taking a value of 1 when only the exporting country is a member of EAC (0 otherwise). The third dummy, 'only importer in EAC' captures the effect of EAC members' imports from non-members, taking a value of 1 if only the importing country is a member of EAC (0 otherwise).

This specification enables us to see whether there is trade creation or diversion among EAC countries. If the coefficient sign of both the dummies is positive, it means there is trade creation; a negative sign of the coefficients of the last two dummies indicates trade diversion. All three of these coefficient values are needed to compute the net trade creation among these countries (see Baier et al., 2014; Carrère 2006; Frankel & Rose, 1997; Martinez-Zarzoso et al., 2009; Soloaga & Winters, 2001; Yang & Martinez-Zarzoso, 2014).

Unlike previous studies, an additional analysis is considered. Given that the EAC_{ij} vector contains the variables of interest, these three dummies are used in two ways. First, all the three dummies take the value of 1 from the beginning of the sample (2000).[33] The point here is capturing the real trade effect of EAC for all member countries (hence the vector remains EAC_{ij}). Second, to consider the fact that Rwanda and Burundi joined the union in 2007, the three dummies take the value of 1 after that year (hence the vector become EAC_{ijt}). This specification is seen and used as a robustness check because it changes the variables of interest in the model's equations.

Further, previous literature on trade emphasizes that intra-Africa trade is small, that is, African countries trade much more with other countries around the globe than among themselves, which can justify the low levels of bilateral African trade (see Charaf-Eddine & Strauss, 2014; Foroutan & Pritchett, 1993; Geda & Seid, 2015; Head et al., 2010; Longo & Sekkat, 2004 and Wood & Mayer, 2001 among others). To account for this, a new variable Ex_{rowt} ('exports to ROW') is introduced, which controls for the exporter country's exports to the rest of the world (that is, outside Africa) at time t. Having its coefficient, β_4, as positive (negative), indicates that more exports to the rest of the world are positively (negatively) associated with bilateral trade among African countries. In line with existing literature, a negative sign can be expected for this variable, supporting the small intra-Africa trade findings in literature.

[33] The year that marks the beginning of EAC. Even though Rwanda and Burundi joined seven years later, one can assume that there could be trade effects (with spill-over effects to these neighbouring countries) of EAC among the three big economies and original founders of EAC), which should not be ignored.

3.3 Econometric estimators

To capture all possible time-invariant and time-varying heterogeneity among the trading partners and for avoiding the endogeneity and omitted variables' biases, different versions of the gravity Equation (2) are estimated. Accordingly, the model in Equation (3) includes the α_{ij} country-pair dummy variable as proposed by Angrist & Pischke (2009); Baier et al. (2008); Brun et al. (2005); Cameron &Trivedi (2010); Sheng et al. (2014) and Yang & Martinez-Zarzoso (2014) among others. Moreover, the D_t dummy variable for year t is introduced to capture time-specific effects, enabling the controlling of various factors that may affect all countries' trade simultaneously such as a global crisis, climate change, or uncertainty and global trends in inflation rates (HMR, 2008 and Baldwin & Taglioni, 2006).

$$lnEX_{ijt} = \beta_0 + D_t + \alpha_{ij} + \beta_1 lnGDP_{it} + \beta_2 lnGDP_{jt} + \beta_3' X_{ij} + \beta_4 lnEx_{rowt} + \delta_1' EIA_{ij} + \delta_2' EAC_{ij} + \varepsilon_{ijt} \quad (3)$$

Specifically, two-panel estimators, namely fixed effects (FE) and random effects (RE), are used along with pooled OLS estimates for comparison purposes. From the methodological point of view the fixed and random effects models differ in their treatment of α_{ij}. The main question here is whether the omitted variables captured by a variation in α_{ij} are correlated with the regressors. If they are correlated, then the fixed effects model is likely to produce consistent estimates, and if they are not then the model in Equation (3) should be estimated by a random effects' regression (see Cameron & Trivedi, 2010). As claimed by several authors (see, for example, Baier et al., 2008 and Kepaptsoglou et al., 2010) FE's results can be expected to be more plausible than RE's results, because the omitted variables are often correlated with the regressors.

Further, in Anderson and Wincoop's (2003) spirit, Yang and Martinez-Zarzoso (2014) argue that a gravity model that ignores multilateral resistance terms, that is, all kinds of trade barriers faced by each country when trading with all its partners, could lead to biased estimates. Hence, to avoid a biased estimation of the parameters, in addition to the country-pair fixed effects, the time-varying parameters for exporter and importer dummies α_{it} and α_{jt}, respectively are included in the baseline model as proxy for multilateral resistance (see Anderson & Wincoop, 2003; Baier & Bergstrand, 2007; Baldwin & Taglioni, 2006; Camarero et al., 2018; Cheng & Wall, 2005; Martinez-Zarzoso et al, 2009; and Yang & Martinez-Zarsozo, 2014 for details). This specification is given in Equation (4):

$$lnEX_{ijt} = \beta_0 + \alpha_{ij} + \alpha_{it} + \alpha_{jt} + \beta_1 lnGDP_{it} + \beta_2 lnGDP_{jt} + \beta_3' X_{ij} + \beta_4 lnEx_{rowt} + \delta_1' EIA_{ijt} + \delta_2' EAC_{ij} + \varepsilon_{ijt} \quad (4)$$

As the models in Equations (2) - (4) include country-specific variables that are likely to be correlated with unobserved omitted variables (GDPs), the FE estimates in this paper are expected to be consistent. However, given that the model includes time-invariant explanatory variables, such as distance, common language, common border, and CFA dummies, the efficiency of the FE estimator is doubtful as it uses within transformation for which the effects of the time-invariant variables on the dependent variable are not captured. Moreover, with FE you cannot see the real trade effects of being in EAC for all five countries, because the coefficients for the time unvarying EAC dummy, are not estimated.

In addressing the issue of FE's inefficiency and estimating the time-invariant effects in a static model, a paper by Hausman and Taylor (1981) (henceforth HT) is the most cited in gravity trade model literature. As stressed by these authors, their estimator is efficient in correcting the bias of the FE estimator because it enables a recapturing (through an IV estimation) of the effects of the time-invariant variables that are naturally eliminated by the within transformation. This addresses the issue of a potential correlation between explanatory variables and unobserved fixed effects. Subsequently, the same issue has been encountered and addressed in several studies using an HT estimator (for such applications see Baltagi & Bresson, 2012; Baltagi & Khanti-Akom, 1990; Baltagi & Pesaran, 2007; Baltagi et al., 2003; Brun et al., 2005; Carrère, 2006 and Kabir et al., 2017).The argument in all these studies is that the HT estimator is consistent and more efficient than the FE estimator. It, however, is so by implementing a strong assumption that some of the regressors are uncorrelated with FE, whereas others are endogenous due to their correlation with the fixed effects but not with the error term (see Baum, 2006 and Cameron & Trivedi, 2010).

In summary, the HT estimator allows complementarity of the FE and RE models. However, its strong assumption makes it unlikely to provide consistent estimates, especially when none of the time-varying regressors can be used as valid instruments.[34] Moreover, HT assumes serial uncorrelation and homoscedasticity for both individual FE and the error term, which again makes it inappropriate for the current study, given that serial correlation and heteroscedasticity are detected in the model (see Table A3 in the Appendix).

[34] Different HT alternatives were applied and corresponding overidentification tests were performed, for which all the null hypotheses were rejected, implying that the instrumented variables were not valid as instruments. For brevity, the results are not reported here.

In a recent paper, Pesaran and Zhou (2018), discuss the same issue and propose different estimators which they investigate using Monte Carlo experiments. Among others, the fixed effect filter estimator performed well. Moreover, in their discussion, these authors raise the same concerns about the main disadvantage of the HT approach. They specifically claim that HT's strong assumption is restrictive because in a panel data with FE, it is unlikely that time-varying variables will be uncorrelated with the individual effects, which makes them weak instruments for the time-invariant regressors. In this sense, the HT specification yielded biased estimates in their study. It is worth noting that Martinez-Zarzoso and Nowak-Lehmann, (2003) also deal with the FE bias by regressing the individual effects on time invariant regressors, in a second step.

Considering the panel model at hand, that contains time-varying as well as time-invariant variables, the current paper follows Pesaran and Zhou (2018) and employs FEF. The latter, in a two-step regression, allows for a certain degree of correlation between time-varying regressors with individual FE. Accordingly, in the first step, the model in Equation (4) is used for computing the FE estimates for the time-varying variables and their associated residuals. Next, these residuals are averaged over time and regressed on the vector of time-invariant regressors using cross-section OLS that includes an intercept (for details see, Pesaran & Zhou, 2018).[35] Mathematically, the FEF estimator is computed in two steps as follows:

Step1: Use Equation (4) to estimate the vector of the parameters for the time varying regressors as $\hat{\beta}'$, and their associated residuals as: $\hat{\varepsilon}_{ijt} = lnEX_{ijt} - \hat{\beta}'T_{ijt}$,

Step 2: The time averages of the above residuals are computed as $\bar{\hat{\varepsilon}}_{ij} = T^{-1}\sum_{t=1}^{T}\hat{\varepsilon}_{ijt}$. Next, they are regressed on Z'_{ij}, a vector of time-invariant regressors along with an intercept.

[35] Stata version 15.1 was used to generate the regression results presented in this paper

4. Main results and discussion

Using residuals from the RE results in Equation (4), the Breusch-Pagan Lagrange Multiplier test—with a large statistic of 25858.60 and a p-value of 0.0000—led to the rejection of the null hypothesis that variance across countries is constant, implying that RE is preferred to pooled OLS. In addition, the standard Hausman test (see Hausman, 1978), was performed to decide whether FE or RE was more appropriate. This led to the rejection of the null hypothesis that the RE estimator was likely to produce consistent coefficient estimates,[36] indicating that FE was preferred to RE. Table A3 in the Appendix[37] compares the results obtained from OLS, FE, and RE, including their associated standard errors (SEs).

As the preferred regression results of this paper derive from the FEF estimator applied to Equation (4), the discussion that follows mainly focuses on its estimation results. However, the RE regression results for Equation (4) are also reported in Table 1, Column 1 for comparison purposes. What we see is the robustness of both expected signs and their statistical significance, except for the estimated coefficient of 'only importer' variable which is insignificant.

[36] Under the null hypothesis, the test assumes that the coefficients for both estimators are not systematically different, which if true, indicates that the RE estimator is more appropriate than the FE estimator. The test yields a statistic (146.52) with a p-value (0.0000) less than the generally used criterion of 0.05.

[37] Table A3 indicates that although the estimated coefficients remain the same under the pooled OLS estimator, the associated SEs change considerably. That is, robust SEs for the OLS model exceed the default SEs for all variables. As argued by Cameron and Trivedi (2010), when SEs become larger in this way, it is evidence that the panel has a serial correlation. Further, Angrist and Pischke (2009), argue that when robust SEs are greater than default SEs, it implies heteroscedasticity. Hence, one can confirm the presence of both serial correlation and heteroscedasticity in the model. These findings are consistent with existing studies, such as Kabir et al. (2017), who also highlight the presence of heteroscedasticity and autocorrelation in a gravity model of trade, which is mainly due to cross-sectional data spread over time. To deal with the issue of both heteroscedasticity and autocorrelation, this paper follows Cameron and Trivedi (2010), and uses FE and RE estimators assuming both across panels and serial autocorrelation of the error (the results are presented in columns 3 and 4 of Table A3, respectively).

Table 1 reports the main results using EAC_{ij} (the same results using EAC_{ijt} are reported in Table A1). First, Equation (3) is estimated using the FE technique. Although the estimated results are not reported, when they are compared to the regression results reported in Table 1, Column 2, obtained from the model in Equation (4), they are slightly similar. However, in Table 1, Column 2, the R-squared coefficient improves, and given that the model considers the time varying parameters for exporter and importer dummies and country-pair fixed effects, these estimated results are preferable. However, only time-varying regressors are estimated in Table 1, Column 2, implying that the standard FE results draw inferences by ignoring information on time-invariant variables. Hence, such results are not fully efficient (see Baum, 2006; Cameron &Trivedi, 2010; Wooldridge, 2010). Moreover, the distance, common language, common border, and currency union variables have been widely shown to impact trade flows between countries. Thus, being able to capture their effects is crucial for a richer analysis. Accordingly, to control for FE's inefficiency and provide more consistent results, the specification in Equation (4) is reconsidered, and the FEF estimator is applied with the aim of computing time-invariant coefficient estimates (Pesaran & Zhou, 2018). The last column in Table 1 reports FEF estimates. [38] To some extent these results are in line with expectations, all variables have the expected signs and a strong significance is observed.

Focusing on the variables of interest, from the results reported in Table 1, Column 3, one can see that the coefficient estimates of 'both in EAC', 'only exporter in EAC', and 'only importer in EAC' variables are as expected. The positive and statistically significant point estimate on EAC membership has a size of 1.861. Moreover, the coefficient estimates of 'only exporter in EAC', and 'only importer in EAC' show the expected signs (negative for trade diversion), with a magnitude of -0.415 and -0.649 respectively. These results are statistically significant at the 1 percent level, which also indicates a welfare loss for the countries outside the EAC. Taking the size of these estimates, the net trade creation of EAC membership can be computed, which equals 122 percent = [exp (1.861-0.415-0.649)-1] ×100,[39] implying that intra-EAC trade flows increased by 122 percent than what was expected from normal trade,[40] which is consistent with previous studies (see Yang & Martinez-Zarzoso, 2014).

[38] These results are from the second step, the first step regressions are reported in column 2

[39] A positive sign associated with a negative sign implies a combination of both trade creation and trade diversion, hence trade creation is offset to some extent. Therefore, using the size of the estimates for 'both in EAC' compared to 'only exporter in EAC' and 'only importer in EAC' dummies, one can compute the net trade creation (see also Yang & Martinez-Zarzoso, 2014 for such calculations).

[40] here, normal trade means any amount of bilateral trade between countries without being member of a trade agreement

Table 1: Main results (dependent variable - logged bilateral exports)

	(1)	(2)	(3)
Variables	RE	FE	FEF
ln_gdp_exporter	1.209***	0.873***	
	(0.059)	(0.159)	
ln_gdp_importer	0.691***	0.281**	
	(0.052)	(0.117)	
ln exports to ROW	0.364***	0.150	
	(0.101)	(0.116)	
ln_distance	-1.481***		-1.498***
	(0.151)		(0.053)
Common border	1.339***		1.592***
	(0.263)		(0.100)
Common language	0.799***		0.632***
	(0.152)		(0.057)
CFA members	1.492***		0.670***
	(0.243)		(0.096)
Free trade agreement	0.847***	0.136	
	(0.158)	(0.218)	
Both in EAC1	2.361***		1.861***
	(0.492)		(0.193)
Only exporter	-0.505***		-0.415***
	(0.191)		(0.075)
Only importer	-0.377		-0.649***
	(0.231)		(0.087)
αij	Yes	Yes	Yes
dt	No	No	No
αit, αjt	Yes	Yes	Yes
N	11335	11335	11335
R^2	0.514	0.129	0.290

Notes: Robust and clustered standard errors are given in parentheses. *, **, *** denote significance at the 10,5, and 1 percent levels, respectively. The RE regression results from the model in Equation (4) are presented in column 1. αij denotes time invariant country pair FE, dt denotes time dummies, and αit, αjt: exporter and importer time-varying fixed effects. FEF uses a two-step approach. The first is the standard FE in column 2, and in the second step, the residuals from the FE in column 2 are regressed on the vector of time-invariant regressors. 1 As all EAC variables take the value of 1 starting in 2000 to 2016 (the entire period of the sample), they become time-invariant and are not considered by the FE estimator.

The results in Table 1 show that the estimated coefficients of the other gravity variables have the expected signs and are significant at the 1 percent level, except for free trade agreements and exports to ROW coefficient estimates which are insignificant, albeit the former has the expected sign. The elasticities of trade with respect to exporter GDP and to importer GDP are positive and highly significant, indicating that bilateral exports' increase with exporter GDP and with importer GDP, but elasticity of trade to importer GDP is not close to unity as suggested by common trade theories (see Baier et al., 2008 and Tinbergen, 1962).[41] The respective elasticities imply that, all else being equal, a 1 percent increase in a country's GDP will increase its exports to another country in the sample by 0.9 percent and will increase its imports from another country in the sample by 0.3 percent. Moreover, all the estimated coefficient estimates for the traditional gravity time-invariant variables have the expected signs and are strongly significant. The estimated coefficient for logged distance is negative as suggested in trade theory, which reflects the negative effect of distance on bilateral exports flows among African countries (see Baldwin & Taglioni, 2006 and Brun et al., 2005). The effect of a currency union on trade is positive and statistically significant. This suggests that, Western and Central African countries using CFA, trade more than other African countries which do not use that single currency.

Table A4 in the Appendix shows simple correlations between bilateral trade and the different regressors of the model in which the same patterns as above can be observed, except for the correlation coefficient for CFA members, which exhibits a negative sign. Although these results are suggestive, they support the regression results to some extent. It is important to also note that the correlation coefficient between bilateral trade and the exports to ROW variable, is negative and significant at the 5 percent level. Though different from the regression results, it is consistent with findings in literature on small intra-Africa trade (see Calderon et al., 2007).

[41]This could be evidence that African countries import more outside Africa as their GDP increases. Or put another way, a big portion of African countries' GDP is spent on imports from outside Africa.

As mentioned earlier, for robustness checks and a comparison with the main results presented in Table 1, Table A1 in the Appendix reports regression results using EAC_{ijt}. The results in Column 2, Table A1 provide non-zero coefficient estimates for the three variables of interest (both in EAC, only exporter in EAC, and only importer in EAC). Most importantly, the signs of the coefficient estimates included in δ_2' are robust across alternative uses of the three variables of interest. Although the EAC membership dummy loses its strong significance (from the 1 percent to the 10 percent level), the fact remains that EAC increases bilateral trade among partner states (the estimated coefficient for 'both in the EAC' variable is positive). Moreover, the negative signs of these coefficients are indicative of trade diversion effects, which may also show a decrease in welfare for non-members, albeit the coefficient estimates are insignificant. This is not surprising since this specification only captures little variation between the two small economies of Rwanda and Burundi. Accordingly, one can argue that EAC's net trade effect on member states is positive, though this is not yet significantly strong for these two countries.

For the estimated coefficients of the free trade agreement and exports to ROW variables, one can observe the same patterns as discussed earlier. Regarding the time-invariant variables, the FEF estimates have the expected signs and are significant at the 1 percent level. Though these estimates are rather slightly large, they confirm analogous estimates in Table 1. Overall, the results in Table A1 reconfirm robustness in terms of the sign, which reassures the main results. Accordingly, keeping in mind the assumptions made about the variables of interest, the estimated results in Table 1 may anticipate potential trade benefits of EAC, as the five EAC countries are expected to trade more among themselves.

5. Conclusions and policy implications

This paper followed recent developments in panel data studies to analyze EAC's trade effects. To do so, it estimated an augmented gravity model of trade using a panel of 31 African countries over 2000-16. Moreover, for a comprehensive analysis and to capture EAC's net trade effects, it included three different dummies. First, the standard panel models RE and FE were used and compared. Nevertheless, the FE model was preferable to the RE model. Second, for a deep and novel analysis, a FEF or two-steps FE estimator was applied. Its choice is motivated by Pesaran and Zhou's (2018) findings, which indicate that FEF performs well in estimating time-invariant effects in a static panel model. In this way, FEF's results are robust and plausible and reveal that the gravity model's predictions apply to African countries. Or put another way, intra-African exports increase with the GDP of the member countries and decrease with the distance between them. A common language and a common border have positive effects on exports among African countries. Consistent with previous studies, this study also finds that a common currency intensified intra-trade among the currency union's member countries (Böwer & Guillemineau, 2006; Micco et al., 2003; Rose, 2004b and Umulisa, 2016).

More importantly, considering the main purpose of this paper and addressing the right policy question, that is, what is the impact of being in EAC on bilateral trade between member countries? the inclusion of the time-invariant EAC dummies (not ignoring the three big economies and original founders of EAC) shows interesting results. EAC net trade creation is present and is strongly significant. That is, the point estimate computed at 0.797 = (1.861 - 0.415 - 0.649) indicates that EAC has the potential to increase trade among partner states by 122 percent of the normal trade level. This finding is in line with Yang and Martinez-Zarzoso's (2014) results which found an average pure trade creation of 118 percent among Asian-China free trade agreement countries.

In summary, matching the descriptive exercise of the evolution of the intra-EAC trade (Figures 1 and 2) and the evidence from this empirical study, in addition to further expected trade integration (through different policies being implemented towards a monetary union, and policies aiming at fostering both financial and goods & services markets' integration) the degree of support for the EAMU process can be partially considered. This is consistent with existing OCA literature that asserts that additional trade creation should be a major benefit of a monetary union (De Grauwe, 2018).

These empirical findings bear some policy implications for EAC. First, given the brief history of the integration of the five countries and the monetary union protocol that is being implemented prior to the adoption of the single currency, it is recommended that with respect to EAC trade policies, the ongoing monetary harmonization in terms of full implementation of the customs union and the common market protocol, should continue to be the primary focus of the partner states if they are to bring more welfare gains of EAC to this region. This will further improve the chances of creating a sustainable monetary union.

Second, a report of the governors maintains that obstacles remain in the realization of the East African Community Monetary Union as initially planned (EAC, 2018).[42] These also include lack of full implementation of the customs union and the common market protocol and the establishment of the East African Monetary Institute (EAMI), which is a crucial institution that is responsible for supporting the entire EAMU process in terms of enforcement, compliance, and surveillance.[43] Hence, it is recommended that the EAMI should be formed to speeding up on policy coordination among the EAC countries. It would, therefore, be useful for policymakers at the East African Community level to consider this paper's findings as a point of departure about the future stability of EAMU. Further studies should be done to answer the questions unanswered in this study, such as what specific and adequate policies should be framed and followed by these countries to support themselves mutually by learning from the European monetary union's failure so that it can become a more successful monetary union.

[42] In accordance with the EAMU protocol, the Monetary Affairs Committee (MAC) meets twice a year and reviews progress on the implementation of the priority activities for EAMU's operationalization. The outcomes of the meeting are further presented to the Governors of the member countries' central banks, who are responsible to endorse the final MAC report.

[43] It is worth noting that EAMI, which was initially supposed to be in place in 2015 has still not been established.

References

Abiad, A., Mishra, P., & Topalova, P. (2014). How Does Trade Evolve in the Aftermath of Financial Crises? *IMF Economic Review*, 62(2), 213-247.

Al-Mawali, N. (2005). Country-Specific Determinants of Vertical and Horizontal Intra-Industry Trade of South Africa: An Empirical Investigation. *South African Journal of Economics,* 73(3), 406-425.

Anderson, J. E., & Van Wincoop, E. (2003). Gravity with gravitas: a solution to the border puzzle. *American Economic Review,* 93(1), 170-192.

Anderson, J.E. (1979). A Theoretical Foundation for the Gravity Equation. *American Economic Review*, 69, 106-116.

Angrist, J.D., and Pischke, J.S. (2009). Mostly harmless econometrics: an empiricist's comparison. Princeton and Oxford: Princeton University Press.

Baier, S. L., & Bergstrand, J. H. (2004). Economic determinants of free trade agreements. *Journal of International Economics,* 64(1), 29-63.

Baier, S. L., & Bergstrand, J. H (2007). Do free trade agreements actually increase members' international trade? *Journal of International Economics*, 71(1), 72-95.

Baier, S. L., Bergstrand, J. H., Egger, P., & McLaughlin, P. A. (2008). Do economic integration agreements work? Issues in understanding the causes and consequences of the growth of regionalism. *The World Economy,* 31(4), 461-497.

Baier, S. L., Bergstrand, J. H., & Feng, M. (2014). Economic integration agreements and the margins of international trade. *Journal of International Economics*, 93(2), 339-350.

Baldwin, R. E., & Forslid, R. (2010). Trade liberalization with heterogeneous firms. *Review of Development Economics,* 14(2), 161-176.

Baldwin, R., & Taglioni, D. (2006). Gravity for dummies and dummies for gravity equations. Working paper (No. w12516). National Bureau of Economic Research.

Baltagi, B. H., & Bresson, G. (2012). A robust Hausman–Taylor estimator. Working paper (40) Center for Policy Research - Syracuse university. Available at: https://surface.syr.edu/cpr/190.

Baltagi, B. H., & Khanti-Akom, S. (1990). On efficient estimation with panel data: An empirical comparison of instrumental variables estimators. *Journal of Applied Econometrics*, 5(4), 401-406.

Baltagi, B. H., Bresson, G., & Pirotte, A. (2003). Fixed effects, random effects or Hausman–Taylor? A pretest estimator. *Economics Letters*, 79(3), 361-369.

Baltagi, B. H., & Pesaran, M. H. (2007). Heterogeneity and cross section dependence in panel data models: theory and applications introduction. *Journal of Applied Econometrics*, 22(2), 229–232.

Baum, C. F. (2006). An introduction to modern econometrics using Stata. Stata press.

Berger, H., & Nitsch, V. (2008). Zooming out: The trade effect of the euro in historical perspective. *Journal of International Money and Finance,* 27(8), 1244-1260.

Bergstrand, J.H. (1985). The Gravity Equation in International Trade: some Microeconomics foundations and empirical evidence. *Review of Economics and Statistics*, 67: 474-81.

Bergstrand, J.H. (1989). The Generalized Gravity Equation, Monopolistic Competition, and Factor- proportions Theory in International Trade. *Review of Economics and Statistics*, 71: 143-53.

Böwer, U., & Guillemineau, C. (2006). Determinants of business cycle synchronisation across euro area countries. Working Paper, No 587, European Central Bank.

Brun, J. F., Carrère, C., Guillaumont, P., & De Melo, J. (2005). Has distance died? Evidence from a panel gravity model. *The World Bank Economic Review*, 19(1), 99-120.

Calderon, C., Chong, A., & Stein, E. (2007). Trade intensity and business cycle synchronization: Are developing countries any different? *Journal of International Economics*, 71(1), 2–21.

Camarero, M., Gómez-Herrera, E., & Tamarit, C. (2018). New evidence on Trade and FDI: how large is the Euro effect? *Open Economies Review*, 29(2), 451–467.

Cameron, A. C., & Trivedi, P.K. (2010). Microeconometrics Using Stata, Revised edition. Texas: Stata Press.

Carrère, C. (2006). Revisiting the effects of regional trade agreements on trade flows with proper specification of the gravity model. *European Economic Review*, 50(2), 223-247.

Charaf-Eddine, N., & Strauss, I. (2014). The ten commandments of applied regional integration analysis: the African case. *African Development Review,* 26(S1), 7–20.

Cheng, I. H., & Wall, H. J. (2005). Controlling for heterogeneity in gravity models of trade and integration. Federal Reserve Bank of St. Louis Review, 87(1), 49-63.

De Grauwe, P. (2014). *Economics of monetary union*. 10th edition. Oxford University Press.

De Grauwe, P. (2018). *Economics of monetary union*. 12th edition. Oxford university press.

Driscoll, J. C., & Kraay, A. C. (1998). Consistent covariance matrix estimation with spatially dependent panel data. *Review of Economics and Statistics*, 80(4), 549-560.

Drummond, P., Wajid, K., & Williams, O. (eds) (2014). The quest for regional integration in the East African Community. Washington, DC: IMF

EAC (2016). Facts and Figures report. East African community. Available at https://www.eac.int/documents/category/key-documents

EAC (2018), *The 22nd ordinary meeting of the Monetary Affairs Committee (MAC). Report of the Governors*. 24th August. EAC Secretariat, Arusha, Tanzania.

Elliott, R. J., & Ikemoto, K. (2004). AFTA and the Asian Crisis: Help or Hindrance to ASEAN Intra-Regional Trade? *Asian Economic Journal*, 18(1), 1-23.

Foroutan, F., & Pritchett, L. (1993). Intra-sub-Saharan African trade: is it too little? *Journal of African Economies*, 2(1), 74-105.

Frankel, J. A., & Rose, A. K. (1997). Is EMU more justifiable ex post than ex ante? *European Economic Review*, 41(3), 753-760.

Frankel, J. A., & Rose, A. K. (2002). An estimate of the effect of common currencies on trade and income. *The Quarterly Journal of Economics*, 117(2), 437–466.

Geda, A., & Seid, E. H. (2015). The potential for internal trade and regional integration in Africa. *Journal of African Trade*, 2(1-2), 19-50.

Hausman, J. A. (1978). Specification tests in econometrics. *Econometrica*: *Journal of the Econometric Society*, 46(6), 1251-1271.

Hausman, J. A., & Taylor, W. E. (1981). Panel data and unobservable individual effects. *Econometrica: Journal of the Econometric Society*, 1377-1398.

Head, K., & Mayer, T. (2014). Gravity equations: Workhorse, toolkit, and cookbook. In Handbook of international economics, (4)1, 31-195.

Head, K., Mayer, T., & Ries, J. (2010). The erosion of colonial trade linkages after independence. *Journal of International Economics,* 81(1), 1-14.

Helpman, E., & Krugman, P. R. (1985). Market structure and foreign trade: Increasing returns, imperfect competition, and the international economy. MIT Press.

Helpman, E., Melitz, M., & Rubinstein, Y. (2008). Estimating trade flows: Trading partners and trading volumes. *The Quarterly Journal of Economics*, 123(2), 441-487.

Kabir, M., Salim, R., & Al-Mawali, N. (2017). The gravity model and trade flows: Recent developments in econometric modeling and empirical evidence. *Economic Analysis and Policy*, 56, 60–71.

Kahouli, B., & Maktouf, S. (2013). Regional trade agreements in Mediterranean area: Econometric analysis by static gravity model. *Journal of East-West Business*, 19(4), 237-259.

Kenen, P.B. (1969). The optimum currency area: An eclectic view, Mundel, Robert/Swoboda. *In Monetary problems of the international economy*, 41-60. Chicago: University of Chicago Press.

Kepaptsoglou, K., Karlaftis, M. G., & Tsamboulas, D. (2010). The gravity model specification for modeling international trade flows and free trade agreement effects: a 10-year review of empirical studies. *The Open Economics Journal*, 3(1), 1–13.

Kirkpatrick, C., & Watanabe, M. (2005). Regional Trade in Sub-Saharan Africa: An Analysis of East African Trade Cooperation, 1970–2001. *The Manchester School*, 73(2), 141–164.

Krugman, P. R., Obstfeld, M., & Melitz, M.J. (2012). *International economics*: Theory and policy, 9th ed. Pearson.

Longo, R., & Sekkat, K. (2004). Economic obstacles to expanding intra-African trade. *World Development*, 32(8), 1309-1321.

Martínez-Zarzoso, I. (2013). The log of gravity revisited. *Applied Economics*, 45(3), 311-327.

Martínez-Zarzoso, I., & Nowak-Lehmann, F. (2003). Augmented Gravity Model: An Empirical Application to Mercosur-European Union Trade Flows. *Journal of Applied Economics*, 6(2), 291-316

Martinez-Zarzoso, I., Nowak-Lehmann, F., & Horsewood, N. (2009). Are regional trading agreements beneficial? Static and dynamic panel gravity models. *The North American Journal of Economics and Finance*, 20(1), 46-65.

McKinnon, R. I. (1963). Optimum currency areas. *The American Economic Review*, 53(4), 717-725.

McIntyre, M. M. A. (2005). Trade integration in the East African Community: an assessment for Kenya. Working Paper (No. 5-143). International Monetary Fund.

Micco, A., Stein, E., & Ordoñez, G. (2003). The currency union effect on trade: early evidence from EMU. *Economic Policy*, 18(37), 315-356.

Mundell, R. A. (1961). A theory of optimum currency areas. *The American Economic Review*, 51(4), 657-665.

Mundell, R. A. (1973). Uncommon arguments for common currencies, in H.G. Johnson and A.K. Swoboda (eds), The economics of common currencies, (pp.114-132). London: Routledge.

Musila, J. W. (2005). The intensity of trade creation and trade diversion in COMESA, ECCAS and ECOWAS: A comparative analysis. *Journal of African Economies*, 14(1), 117-141.

Nilsson, D. (2007). Essays on trade flows, demand structure and income distribution (Doctoral dissertation, Jönköping International Business School).

Pesaran, M. H., & Zhou, Q. (2018). Estimation of time-invariant effects in static panel data models. *Econometric Reviews*, 37(10), 1137–1171.

Rojid, S. (2006). COMESA trade potential: a gravity approach. *Applied Economics Letters*, 13(14), 947-951.

Rose, A. K. (2000). One money, one market: the effect of common currencies on trade. *Economic Policy*, 15(30),08-45.

Rose, A. K. (2004a). Do we really know that the WTO increases trade? *American Economic Review*, 94(1), 98–114.

Rose, A. K. (2004b). Do WTO members have more liberal trade policy? *Journal of International Economics*, 63(2), 209-235.

Salim, R., Kabir M., & Al Mawali N. (2011). Does More Trade Potential Remain in Arab States of the Gulf? *Journal of Economic Integration*, 26(2), 217–243.

Sheng, Y., Tang, H. C., & Xu, X. (2014). The impact of the ACFTA on ASEAN–PRC trade: estimates based on an extended gravity model for component trade. *Applied Economics,* 46(19), 2251-2263.

Soloaga, I., & Winters, L. A. (2001). Regionalism in the nineties: What effect on trade? *The North American Journal of Economics and Finance*, 12(1), 1-29.

Tinbergen, J. (1962). Shaping the world economy; suggestions for an international economic policy. New York: The Twentieth Century Fund.

Umulisa, Y. (2016). Effects of a Common Currency on Intra Regional Trade in Africa: Perspectives on the East African Community Monetary Union. In Economic Integration, Currency Union, and Sustainable and Inclusive Growth in East Africa (pp. 77-96). Springer, Cham

Umulisa, Y., & Habimana, O. (2018). Business Cycle Synchronization and Core-Periphery Patterns in the East African Community: A Wavelet Approach. *Journal of Economic Integration*, 33(4), 629–658.

Van Bergeijk, P. A., & Brakman, S. (eds). (2010). The gravity model in international trade: Advances and applications. Cambridge University Press.

Vicard, V. (2011). Determinants of successful regional trade agreements. *Economics Letters*, 111(3), 188-190.

Viner, J. (1950). The customs union issue. New York: Carnegie Endowment for International Peace.

Wood, A., & Mayer, J. (2001). Africa's export structure in a comparative perspective. *Cambridge Journal of Economics*, 25(3), 369-394.

Wooldridge, J. M. (2010). Econometric analysis of cross section and panel data. MIT Press.

Yang, Y., & Gupta, S. (2007). Regional trade arrangements in Africa: Past performance and the way forward. *African Development Review,* 19(3), 399–431.

Yang, S., & Martinez-Zarzoso, I. (2014). A panel data analysis of trade creation and trade diversion effects: The case of ASEAN–China Free Trade Area. *China Economic Review*, 29, 138-1.

Appendix

Table A1: Regression results using time varying EAC

	(1) RE	(2) FE	(3) FEF
ln_gdp_exporter	1.216***	0.878***	
	(0.060)	(0.162)	
ln_gdp_importer	0.693***	0.280**	
	(0.052)	(0.117)	
ln exports to ROW	0.374***	0.153	
	(0.100)	(0.116)	
ln_distance	-1.593***		-1.557***
	(0.154)		(0.050)
Common border	1.515***		1.720***
	(0.263)		(0.099)
Common language	0.774***		0.601***
	(0.154)		(0.057)
CFA members	1.440***		0.695***
	(0.234)		(0.091)
Free trade agreement	0.797***	0.144	
	(0.153)	(0.219)	
Both in EAC[1]	0.613***	0.425*	
	(0.223)	(0.256)	
Only exporter	-0.213	-0.182	
	(0.136)	(0.171)	
Only importer	-0.245	-0.124	
	(0.209)	(0.273)	
α_{ij}	Yes	Yes	Yes
d_t	No	No	No
α_{it}, α_{jt}	Yes	Yes	Yes
N	11335	11335	11335
R^2	0.508	0.129	0.280

Note: Robust and clustered standard errors are given in parentheses. *, **, *** denote significance at the 10,5, and 1 percent levels respectively. α_{ij} denotes time invariant country pair FE, d_t denotes time dummies, and α_{it}, α_{jt}: exporter and importer time-varying fixed effects. [1]The only difference with Table 1 is that the EAC variables (both in EAC, only exporter and only importer) take the value of 1 starting in 2007 to 2016 and become time-varying for Rwanda and Burundi only, who joined the EAC in 2007. The dependent variable is logged bilateral export.

Table A2: Descriptive statistics showing within and between variations

Variables		Mean	Std. Dev.	Min	Max	Obs.
Exportij	overall	4.65E+07	2.30E+08	6.08E-02	5.40E+09	N = 11335
	between		2.07E+08	7.17E+01	4.43E+09	n = 919
	within		1.07E+08	-1.77E+09	3.44E+09	T = 12.33
gdp,exporter	overall	4.06E+10	8.19E+10	7.85E+08	5.68E+11	N = 15810
	between		7.00E+10	1.57E+09	2.69E+11	n = 930
	within		4.25E+10	-1.70E+11	3.55E+11	T = 17
gdp,importer	overall	4.06E+10	8.19E+10	7.85E+08	5.68E+11	N = 15810
	between		7.00E+10	1.57E+09	2.69E+11	n = 930
	within		4.25E+10	-1.70E+11	3.55E+11	T = 17
exports to ROW	overall	34.4483	30.1609	0.6029	288.6854	N = 11335
	between		28.4356	9.0292	260.6564	n = 919
	within		15.2835	-93.2571	183.0760	T = 12.33
Distance	overall	3536.9640	1915.3120	162.1818	9072.1310	N = 15810
	between		1916.2820	162.1818	9072.1310	n = 930
	within		0	3536.9640	3536.9640	T = 17
Common border	overall	0.0989	0.2986	0	1	N = 15810
	between		0.2987	0	1	n = 930
	within		0	0.0989	0.0989	T = 17
Common language	overall	0.4710	0.4992	0	1	N = 15810
	between		0.4994	0	1	n = 930
	within		0	0.4710	0.4710	T = 17
CFA members	overall	0.0968	0.2957	0	1	N = 15810
	between		0.2958	0	1	n = 930
	within		0	0.0968	0.0968	T = 17
Free Trade Agreement	overall	0.2342	0.4235	0	1	N = 15810
	between		0.4186	0	1	n = 930
	within		0.0655	-0.7070	1.1754	T = 17
Both in EAC	overall	0.0148	0.1208	0	1	N = 15810
	between		0.1053	0	1	n = 930
	within		0.0591	-0.5734	0.8972	T = 17
Only exporter in EAC	overall	0.1283	0.3344	0	1	N = 15810
	between		0.3144	0	1	n = 930
	within		0.1144	-0.8129	0.5989	T = 17
Only importer in EAC	overall	0.1349	0.3416	0	1	N = 15810
	between		0.3177	0	1	n = 930
	within		0.1261	-0.8063	0.5467	T = 17

Table A3: Regression results from OLS, FE, and RE- dependent variable is logged bilateral exports

	(1)	(2)	(3)	(4)
Variables	OLS	OLS_Rob	FE	RE
ln_gdp, exporter	1.203***	1.203***	0.873***	1.209***
	(0.018)	(0.056)	(0.159)	(0.059)
ln_gdp, importer	0.669***	0.669***	0.281**	0.691***
	(0.017)	(0.051)	(0.117)	(0.052)
ln exports to ROW	0.750***	0.750***	0.150	0.364***
	(0.044)	(0.105)	(0.116)	(0.101)
ln distance	-1.209***	-1.209***		-1.481***
	(0.055)	(0.154)		(0.151)
Common border	1.144***	1.144***		1.339***
	(0.093)	(0.275)		(0.263)
Common language	0.800***	0.800***		0.799***
	(0.053)	(0.162)		(0.152)
CFA members	1.185***	1.185***		1.492***
	(0.090)	(0.247)		(0.243)
Free Trade agreements	1.554***	1.554***	0.136	0.847***
	(0.067)	(0.198)	(0.218)	(0.158)
Both in EAC	2.576***	2.576***		2.361***
	(0.181)	(0.464)		(0.492)
Only exporter in EAC	-0.054	-0.054		-0.505***
	(0.070)	(0.170)		(0.191)
Only importer in EAC	-0.282***	-0.282		-0.377
	(0.081)	(0.241)		(0.231)
N	11335	11335	11335	11335
R-squared[1]	0.484	0.484	0.129	0.514

Note: Robust standard errors are given in parentheses and *, **, *** denote significance at the 10,5, and 1 percent levels. However, default (i.i.d.) standard errors for the OLS regressions from Equation 3 are presented in Column 1. The latter are smaller than robust SEs, presented in Column 2. This is an indication of heteroscedasticity and serial correlation as argued by Angris and Pischke (2009). FE and RE's regression result along with their robust SEs are from Equation 4. [1]Within and overall R-squared are reported for FE and RE estimators, respectively.

Table A4: Correlations coefficient matrix of the dependent variable and the regressors that enter the model (in levels)

	1	2	3	4	5	6	7	8	9	10	11	12
1 Bilateral export	1											
2 GDP exporter	0. 3182*	1										
3 GDP importer	0.1620*	0.0217*	1									
4 exports to ROW	-0.0458*	-0.1498*	0.0441*	1								
5 Distance	-0.1162*	0.0641*	0.0641*	0.0022	1							
6 Common language	0.0588*	-0.0751*	-0.0752*	-0.0127	-0.2691*	1						
7 Common borders	0.1701*	-0.0247*	-0.0246*	-0.0230*	-0.4412*	0.1924*	1					
8 CFA members	-0.0243*	-0.1236*	-0.1236*	0.1238*	-0.3360*	0.3469*	0.1839*	1				
9 Free Trade agreements	0.1871*	0.0151	0.0067	0.0516*	-0.4934*	0.1493*	0.4335*	0.2312*	1			
10 Both in EAC	0.0371*	-0.0448*	-0.0448*	-0.0694*	-0.2208*	0.0680*	0.2985*	-0.0485*	0.0168*	1		
11 Only export in EAC	-0.0474*	-0.1202*	-0.0187*	-0.1228*	-0.1145*	0.0226*	0.0054	-0.1581*	-0.1368*	0.3068*	1	
12 Only import in EAC	-0.0249*	0.0038	-0.1145*	-0.0329*	-0.0974*	0.0609*	0.0336*	-0.1260*	-0.0587*	0.2967*	-0.0549*	1

Note: * denotes statistical significance at the five percent.

Table A5: List of Countries

EAC member countries	CFA member countries	Other African countries
Burundi		Algeria
Kenya		Angola
Rwanda	Benin	Egypt
Tanzania	Botswana	Ethiopia
Uganda	Burkina Faso	Madagascar
	Cameroon	Malawi
	Central African Republic	Mauritania
	Gabon	Mauritius
	Guinea	Morocco
	Ivory Coast	Mozambique
	Mali	Nigeria
	Niger	South Africa
	Senegal	Zambia
	Togo	Zimbabwe

Source: Author's elaboration based on the information from the World Trade Organization's website.

Paper 2: Business Cycle Synchronization and Core-Periphery Patterns in the East African Community: A Wavelet Approach

Yvonne Umulisa & Olivier Habimana

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2

BUSINESS CYCLE SYNCHRONIZATION AND CORE-PERIPHERY PATTERNS IN THE EAST AFRICAN COMMUNITY: A WAVELET APPROACH[44]

Yvonne Umulisa & Olivier Habimana

ABSTRACT

Optimum currency area theory suggests that various characteristics are needed for a successful monetary union, including similarities in economic structures for both shocks and business cycles. Accordingly, this study uses continuous wavelets to investigate business cycle synchronization among countries of the East African Community, which is, a region working toward the establishment of a monetary union by 2024. Wavelet decomposition is an alternative and powerful tool for analysing the comovement of business cycles. Cross-wavelet coherency suggests that the business cycles of Tanzania and Uganda were in phase with that of Kenya's at high and medium frequencies in the early 1990s and after the establishment of the customs union in 2005. Wavelet spectra clustering shows that Kenya, Tanzania, and Uganda form the core of the monetary union, whereas Burundi and Rwanda form the periphery. Overall, the wavelet analysis highlights the significance of asymmetric shocks and the prevalence of core-periphery patterns, which casts doubts on the eventual viability of a monetary union in the EAC as a whole. However, the three countries that form its core seem the most potential candidates for the proposed EAMU.

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Business Cycle Synchronization and Core-Periphery Patterns in The East African Community: A Wavelet Approach

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1. Introduction

The extent to which economies are affected by similar shocks is the key to determining whether a group of countries is ready for a monetary union. Optimum Currency Area (OCA) theory, which was pioneered by Mundell (1961) and later explored by McKinnon (1963), Kenen (1969), Eichengreen (1990), De Grauwe and Vanhaverbeke (1993), Frankel and Rose (1998, 2005), and De Grauwe (2014) suggests that a geographical area needs four characteristics to create an optimal single currency: similarities in economic structures (for both shocks and business cycles), trade integration, factor mobility, and a strong mechanism for risk sharing. The greater the extent to which these characteristics exist, the more the partner states are likely to benefit from a common currency.

OCA literature highlights that once a monetary union is in place, the enactment of two different monetary policies will not be possible because it will be difficult for countries in a monetary union to adjust when affected by asymmetric shocks. Therefore, business cycle synchronization must be considered when making monetary policy decisions, such as creating a monetary union. Several studies have addressed this issue by assessing business cycle synchronization and examining the degree to which business synchronization has been attained by any group of countries that envisages the creation of a common currency area or by countries that are already in a monetary union. Asongu et al. (2017) surveyed 70 empirical papers published in the past 16 years that discussed the proposed African monetary zones including the West African Monetary Zone (WAMZ), the East African Monetary Union (EAMU), the Southern African Monetary Union, and the African Monetary Union. Other authors have focused on existing monetary unions, namely, the European Monetary Union (EMU) and CFA zones (Duran & Ferreira-Lopes, 2017).

Furthermore, Aguiar-Conraira and Soares (2011a) argue that although a common business cycle might be insufficient to ensure the desirability of a monetary union, it is a necessary condition. The intuition behind this condition is straightforward: countries with similar macroeconomic shocks are good candidates for a monetary union because they are affected similarly, and there will be no need to use the exchange-rate to adjust for asymmetric shocks once they join a monetary union.

The main aim of our paper is to investigate the degree of business cycle synchronization among East African Community (EAC) member countries before their scheduled monetary union is established in 2024.

The EAC was re-established in 2000[45] and currently comprises six countries: Burundi, Kenya, Rwanda, South Sudan, Tanzania, and Uganda. The union began with just Kenya, Tanzania, and Uganda before it was joined by Rwanda and Burundi in July 2007. South Sudan joined the EAC in April 2016.

Kenya, Tanzania, and Uganda have enjoyed a long history of cooperation under several regional integration arrangements. Kenya and Uganda signed a customs union agreement in 1917, and Tanzania (called Tanganyika at the time) joined this union 10 years later. Following the long process of ratification, the first treaty establishing the EAC was signed in 1967; however, it collapsed a decade later in 1977. These countries also tried forming a currency union at different times. In 1905, a currency board was established to create a common currency for Kenya (called the East Africa Protectorate at that time) and Uganda (called the Uganda Protectorate at that time); Tanzania joined the board after the First World War. In 1919, the three countries constituted a new currency board, and the first East African shilling was adopted. Zanzibar joined this currency board in 1936. After independence, national currencies were pegged to the pound sterling (it is worth noting that these countries were all under British rule). In 1966, the common currency became a fully convertible legal tender in Kenya, Uganda, and Tanzania. Unfortunately, the depreciation of the sterling in the 1960s and 1970s led to the disintegration of the sterling area in 1972. The East African currency area formally ended in 1977 owing to a period of divergence in both inflation targets and exchange rates (Drummond et al., 2014).

[45] The EAC project was first introduced in 1967 but collapsed in 1977 owing to political differences among participating countries. It was reestablished by the 1999 treaty and came into force in 2000.

The EAC is a key driver of the regional integration process in Eastern Africa, and it has gone through several steps for economic integration over the years. The protocol on the establishment of the EAC customs union was signed in 2004 and was formally established the following year. The implementation of the common market protocol in 2010 and the monetary union protocol came into force in 2014[46] with a clear road map for the realization of the monetary union and the circulation of a single currency in 2024.[47] The former EAC Secretary General stated that these stages of integration are being implemented in a progressive manner and major strides are being made to establish a political federation (Drummond et al., 2014). One can argue that the current efforts in forming the EAMU are built on a long history of economic and monetary arrangements in the region, and this situation explains why the three countries form the core of the monetary union, as evidenced by the findings of the current study.

Trade has significantly expanded within the EAC region, and this improvement is attributed to the implementation of the customs union and common market protocols. For example, the total exports from intra-EAC trade amounted to US dollar 3,327.6 million in 2015 from US dollar 1,206.2 million in 2006, an increase of 176% over just 9 years.[48] In addition to the improvement in intraregional trade, EAC countries also strived to achieve macroeconomic convergence via the harmonization of fiscal and monetary policies among partner states and by reducing major divergences (e.g., by reducing inflation, placing an 8% ceiling on headline inflation, and maintaining the fiscal deficit, including grants, below the deficit ceiling of 3% of GDP) that can threaten the monetary union once it is in place (EAC 2013).[49]

However, despite considerable progress and the political will that has been gaining momentum, empirical evidence on the feasibility of a single currency is mixed. Some studies suggest that the EAMU is not feasible (Buigut 2011; Drummond et al., 2014; Kishor & Ssozi, 2011 and Rusuhuzwa & Masson, 2013), whereas others find evidence in favor of it (Asongu, 2013; Bangaké, 2008; Mkenda, 2001 and Sheikh et al., 2011). Asongu et al. (2017) provided ample literature on the proposed African monetary unions.

Our study uses annual real GDP growth over the period of 1989~2015 for the five EAC member countries to analyze the feasibility of a monetary union. Unlike previous studies, we apply wavelet analysis, which combines time and frequency domain analyses. Wavelets are localized in time and frequency; therefore, they are ideal tools for analyzing nonstationary (nonperiodic) and transient time series. Wavelet analysis uncovers cyclicality and structural changes in a time series and can help assess the gradual effect of economic integration on the degree of business cycle synchronization. Rua (2010) indicated the following:

[46] It is worth noting that the monetary union that was scheduled to begin in 2012 missed its targets, and the partner states decided to postpone its implementation to 2024.
[47] Based on the information from the EAC website (www.eac.int)
[48] East African Community Facts and Figures, 2016 (www.eac.int)
[49] See the Protocol on the Establishment of the East African Monetary Union

> "*The degree of comovement can change across frequencies and over time and being able to capture such evolving features is crucial for a richer comovement assessment" Rua (2010, p. 690).*

To the best of our knowledge, the current study is the first study to apply this type of analysis to EAC countries. Another strength of wavelet analysis is its ability to uncover core and periphery groups among potential monetary union members. The core forms a coherent group of countries that are characterized by synchronous business cycles, whereas countries in the peripheral group are less strongly advised to participate in the monetary union because their business cycles are less correlated with those of the core. This idea, which originated with Bayoumi and Eichengreen (1994) and was explored in other studies (see Aguiar-Conraira and Soares, 2011a), stresses that the existence of core and periphery patterns is detrimental to a monetary union. Accordingly, we take it a step further and apply wavelet cluster analysis to uncover core-periphery patterns in the EAC. Overall, our wavelet analysis results show significant asymmetric shocks that affect economic activities in EAC countries and show the prevalence of core-periphery patterns. Kenya, Tanzania, and Uganda form the core, whereas Burundi and Rwanda tend to cluster together into a peripheral group. Taken together, our findings cast doubts on the readiness of EAC countries as a whole for a common monetary policy.

The remainder of this paper is organized as follows. Section 2 briefly reviews the related literature. Section 3 describes the wavelet methodology. Section 4 presents and discusses our empirical findings. Section 5 concludes.

2. Related Literature

Several studies have focused on cyclical comovements in a region that seeks the establishment of a common currency. The focus of these studies is on developed countries, particularly countries in Europe. For instance, before the establishment of EMU, various studies analyzed business cycle synchronization among EU countries. Artis and Zhang (1997) investigated the effects of the exchange-rate mechanism (ERM) of the European Monetary System on the international business cycle in terms of both linkages and cyclical fluctuation synchronization between countries. They found evidence of strong correlations between the business cycles of European countries after they started ERM, whereas the correlations of these countries' cycles with those of the United States and other nonparticipating ERM countries were weak. Angeloni and Dedola (1999) presented empirical evidence on the increase in the cyclical correlations of European countries with Germany before the EMU; this finding indicates a tendency toward the fulfilment of one of the OCA conditions. Dickerson et al. (1998) found that prior to the formation of the EMU, there was a huge difference in business cycles between European countries, thus leading them to conclude that there were two groups in existence: core countries (the Netherlands, France, Belgium, Luxembourg, and Germany) and the periphery (Greece, Ireland, Italy, Portugal, Denmark, the United Kingdom, and Spain).

To examine business cycle synchronization for the Czech economy and the 12 economies in the euro area, Slanicay (2013) applied a two-country DSGE model, decomposed the observed variables into contributions of structural shocks, and computed conditional correlations. He further examined how these correlations evolved over time by using quarterly data for 2000~2011. His findings suggest that productivity shocks in the tradable sector were the driving force behind the different business cycle behaviors, whereas investment efficiency shocks contributed to the symmetric behavior of the two economies.

Empirical literature on the feasibility of the EAMU differs in terms of the criteria of interest, the methodology, and the sample period. Mkenda (2001) used the generalized purchasing power parity (G-PPP) method to investigate the cointegration between the real exchange rates of EAC countries (excluding Rwanda and Burundi) for 1981~1998. Her findings suggest that EAC countries tended to be affected by similar shocks. Hence, she concludes that the EAC is an OCA. However, Buigut and Valev (2005) argue that the G-PPP method does not distinguish shocks from responses. Following Xu (2006), Kishor and Ssozi (2011) argue that if market prices and nominal exchange rates are often controlled by governments, the long-term exchange rates are unlikely to reflect common trends in market forces as expected in an OCA. Hence, inferences based on G-PPP should be interpreted with caution.

By using the vector autoregressive (VAR) methodology, Buigut and Valev (2005) investigated the similarity of underlying shocks in all five EAC countries. Their results indicate that supply and demand shocks were generally asymmetric. However, they found that the speed and magnitude of adjustment to shocks was similar across the countries. Therefore, they concluded that the further integration of EAC economies might lead to more favorable conditions for EAMU.

In light of the OCA criteria, Rusuhuzwa and Masson (2013) investigated the business cycle correlation and macroeconomic convergence among other aspects in EAC countries. They report that EAC member countries differ in several respects, namely, responses to asymmetric shocks and production structures. They further argue that these countries have had difficulties meeting the convergence criteria, particularly when it comes to fiscal deficits. The authors conclude that there is no clear evidence that the EAC is an OCA.

Kishor and Ssozi (2011) used an unobserved component model to measure business cycle synchronization as the proportion of structural shocks that are common across EAC countries. They also employed a time-varying parameter model to examine the evolution of business cycle synchronization. They found that although the degree of synchronization has increased since 2000 (when the re-established treaty of the EAC came into effect), the proportion of shocks common across countries is still small, thus implying weak synchronization.

Buigut (2011) applied multivariate cointegration analysis to determine whether the EAC member countries would form a successful monetary union. The author covered a short period from 1997 to 2010 and analyzed comovements with respect to four variables: nominal and real exchange rates, monetary base, and real GDP. He found only a partial convergence of policies in EAC member countries. The author argues against a fast-track EAC monetary union process. Based on the evidence, he suggests that EAC member countries allow for a period of monetary policy coordination to promote further convergence and improve the chances of a credible and sustainable monetary union.

Thus far, we have discussed previous studies that were conducted in the time domain. We now present a review of studies that were conducted in the time-frequency domain by using wavelets. Aguiar-Conraira and Soares (2011a) argued that wavelets are suitable for analyzing the degree of business cycle synchronization because they reveal how the different periodic components of a time series evolve over time by estimating the spectral characteristics of a time series as a function of time. Accordingly, by comparing the wavelet spectra of two countries, one can check for a similarity in cycles and identify when and at what frequencies the cycles are synchronous. These authors used wavelets to study the degree of business cycle synchronization across EU-12 countries (countries already in the euro zone) and EU-15 countries (including the United Kingdom, Denmark, and Sweden). They found that the strength of business cycle synchronization varied across countries: France and Germany were the most synchronized with the rest of Europe, whereas Portugal, Greece, Ireland, and Finland did not show statistically relevant degrees of synchronization with Europe. They further computed the wavelet spectra distance matrix and derived a euro-core and a euro-periphery in terms of business cycle synchronization. They argued that France and Germany form the core of the euro zone, whereas Portugal, Greece, Ireland, and Finland form the periphery.

Aloui et al. (2016) examined business cycle synchronization among the Gulf Cooperation Council (GCC) countries. Their time-frequency analysis showed that the business cycles were asynchronous not only among the existing GCC countries but also between existing and potential country members. Albulescu (2017) employed wavelets to investigate business cycle synchronization among the United Kingdom, the United States, and Germany. He found that the United Kingdom was more synchronized with the United States than with Germany. His wavelet analysis showed strong medium and long-term comovements between the United Kingdom and the United States and short-term comovements between the United Kingdom and Germany.

Unlike business cycle synchronization, relatively fewer studies have investigated the core-periphery patterns in monetary unions. Artis and Zhang (1998) applied cluster analysis to a dataset comprising ten countries joining the first wave of EMU and countries with prospective membership to the EMU; they added Canada, the United States, and Japan as controls. Their analysis divides the countries studied into two groups: the core (Germany, France, Austria, Belgium, and the Netherlands) and two peripheral groups (northern group: the Scandinavian countries, the United Kingdom, and Ireland; southern group: Greece, Spain, Italy, and Portugal).

Ferreira-Lopes and Pina (2011) used fuzzy clustering techniques to analyze the core periphery patterns and their evolution over time in a wide and long sample. On the basis of annual data for 1950~2005 and three monetary unions (comparing Europe with the United States and Canada on business cycle synchronization and core-periphery patterns), they found that European countries have progressed more toward a viable monetary union than the United States.

In summary, the literature discussed in this section highlights the importance of investigating the (ex-ante) degree of business cycle synchronization and core-periphery patterns for an eventual well-functioning monetary union, as suggested by OCA theory. Our study is a contribution to this strand of literature because, to our knowledge, this is the first study to uncover the core-periphery patterns among EAC countries by using time-frequency analysis.

3. A Wavelet analysis

Economic time series are often nonstationary (Harvey 1985, 1989). A major issue in the study of business cycles is finding appropriate techniques to isolate the cyclical components of macroeconomic time series. In a seminal paper on business cycles, Burns and Mitchell (1946) estimated the cycle by taking average monthly data. This approach was subsequently criticized by Koopmans (1947), who referred to it as measurement without theory. Nevertheless, three decades later, Stock (1987) indicated that the logic was to estimate the value that a variable would attain if it were observed at regular intervals in a business cycle time. The search for better techniques to decompose macroeconomic time series intensified in the 1980s. Several filtering techniques have been developed since the development of *inter alia* high-pass filters (Hodrick and Prescott 1997) that block the lower-frequency components of stochastic cycles and band-pass filters (Baxter & King, 1999 and Christiano & Fitzgerald, 2003) that let the components pass in a given frequency range. However, Pedersen (2001) indicated that it is an impossible task to devise an ideal filter in the presence of finite observations because filters inevitably entail distortionary effects (Caraiani, 2012).

The application of wavelet tools for analyzing business cycles is very recent in economic literature (Aguiar-Conraria &Soares, 2011a; Fidrmuc et al., 2014; Hallet & Richter, 2006 and Yogo, 2008,). Wavelet analysis is an alternative and suitable tool for analyzing signals such as business cycles whose frequencies change with time. This is because it provides time-frequency localization and allows researchers to decompose nonstationary time series and uncover structural changes. Moreover, it is possible to identify leading or lagging relationships among the series. In the current study, we mainly follow the methodology of Aguiar-Conraria et al. (2008) and Aguiar-Conraria and Soares (2011a, 2011b). We then introduce wavelet transform and describe the different tools that we use wavelet power spectra (WPS), cross-wavelet coherency, phase differences, and wavelet spectra distances.

According to Rouyer et al. (2008), wavelet transform is an interaction between the time series and a mathematical function, which is called a daughter wavelet, which is derived from a mother wavelet $\psi_{(t)}$. The latter is assumed to be a function of time with zero mean and satisfies a decaying property (Aguiar-Conraria and Soares 2011a). Hence, for a given set of parameters s and τ, the wavelet function is defined as follows:

$$\psi_{\tau,s(t)} = \frac{1}{\sqrt{|s|}}\,\psi\left(\frac{t-\tau}{s}\right), s, \tau \epsilon \mathbb{R}, s \neq 0, \tag{1}$$

where τ is the translation parameter that controls the location of the wavelet, and s is the scaling parameter that controls its width. To ensure the comparability of the continuous wavelet transform (CWT) in time and in frequency, we apply the normalization factor $\frac{1}{\sqrt{|s|}}$. Thereafter, by using Equation (1), the CWT of a time series $x(t) \epsilon\, L^2\,(\mathbb{R})$ is given by the following:

$$W_x(\tau, s) = \int_{-\infty}^{+\infty} x(t)\psi^*_{\tau,s(t)}(t)dt, = \frac{1}{\sqrt{|s|}}\int_{-\infty}^{+\infty} x(t)\psi^*\left(\frac{t-\tau}{s}\right)dt, \tag{2}$$

where * denotes the complex conjugate, and $L^2\,(\mathbb{R})$ denotes a set of square integrable real-valued functions. Several types of wavelets can be used for CWT. In line with previous studies, we opt for the Morlet wavelet (Goupillaud et al., 1984) for its advantages and its popularity as the mother wavelet over other wavelets such as the Paul, Mexican Hat, and derivative of Gaussian wavelets. The Morlet wavelet is a complex-valued wavelet whose corresponding transform contains information on both amplitude and phase; this property is essential for studying business cycle synchronism between different time series (Aguiar-Conraira et al., 2008; Aguiar-Conraria & Soares, 2011b and Rouyer et al., 2008). The Morlet wavelet is defined as follows:

$$\psi_{\omega_0} = \pi^{\frac{-1}{4}} e^{i\omega_0 t} e^{\frac{-t^2}{2}}, \tag{3}$$

where $\omega_0 = 6$ is the most common choice for achieving the optimal time-frequency balance by minimizing the Heisenberg uncertainty (Aguiar-Conraria & Soares 2011b; Grinsted et al., 2004 and Olayeni, 2016).

We then apply the CWT to define the WPS, which is also known as the wavelet periodogram. This gives us a measure of the variance distribution of the time series as a function of time and period/frequency in a 2D graph. The WPS is given by the following:

$$(WPS)_x(\tau, s) = |W_x(\tau, s)|^2, \tag{4}$$

where W_X is the wavelet transform of $x(t)$ in Equation (2). Accordingly, from wavelet transforms W_x and W_y of $x(t)$ and $y(t)$, respectively, one obtains the cross-wavelet transform $W_{xy} = W_x W_Y^*$.

This cross-wavelet transform is used to obtain the cross-wavelet power (CWP), which is defined as $(CWP)_{xy} = |W_{xy}|$, and is interpreted as the local covariance between two time series at each time and frequency (Aguiar-Conraria and Soares, 2011b). From the CWP, it is then possible to compute the cross-wavelet coherency R_{xy}, which is equivalent to the coefficient of correlation in a time-domain analysis. Cross-wavelet coherency depicts the regions where the two-time series move together in time and in frequency. It is defined as follows:

$$R_{xy} = \frac{|S(W_{xy})|}{\left[S(|W_x|^2)S(|W_y|^2)\right]^{\frac{1}{2}}}, \tag{5}$$

where $0 \leq R_{xy}(\tau, s) \leq 1$ and S is the smoothing operator in both time and scale. Without smoothing, the coherency would be one at all scales and times (see Aguiar-Conraria and Soares, 2011b).

However, wavelet coherency does not tell us which series leads or lags the other, and this information is necessary when analyzing business cycles. The wavelet phase difference allows us to analyze synchronization and the delays of cycles between series across frequencies and time scales (Aguiar-Conraria and Soares, 2011b). It is an angle that is computed as follows:

$$\phi_{xy} = tan^{-1}\frac{\Im(W_{xy})}{\Re(W_{xy})}, \tag{6}$$

where $\Im$ and $\Re$ are the imaginary and real parts, respectively, with $\phi_{xy} \in [-\pi, \pi]$. Following Aguiar-Conraria and Soares (2011b), the interpretation of the phase difference is straightforward: when $\phi_{xy} \in (-\frac{\pi}{2}, \frac{\pi}{2})$, the time series x(t) and y(t) are in phase (positive correlation); when $\phi_{xy} \in \left\{\left[-\pi, -\frac{\pi}{2}\right) \cup \left(\frac{\pi}{2}, \pi\right]\right\}$, the two series move antiphase (negative correlation). When $\phi_{xy} \in \left\{(0, \frac{\pi}{2}) \cup \left(-\frac{\pi}{2}, -\pi\right]\right\}$, x(t) leads y(t); when $\phi_{xy} \in \left\{(-\frac{\pi}{2}, 0) \cup (\frac{\pi}{2}, \pi)\right\}$, y(t) leads x(t).[50]

[50] For a simplified and intuitive interpretation of the phase differences, see Figure 4 in Aguiar-Conraria and Soares (2011b, p. 17).

For a deeper understanding of business cycle synchronization and to uncover core-periphery patterns, we clustered the wavelet spectra on the basis of the measures of dissimilarities and distance matrices. Following Aguiar-Conraria and Soares (2011a) and Rouyer et al. (2008), the distance between spectra W_X and W_y is computed as follows:

$$dist(W_x, W_y) = \frac{\sum_{k=1}^{K} w_k \left[d\left(I_x^k,\ I_y^k\right) + d\left(u_x^k,\ u_y^k\right) \right]}{\sum_{k=1}^{K} w_k}, \tag{7}$$

where u_x^k and u_y^k are the singular vectors, I_x^k and u_y^k are the leading patterns, and w_k is the weight that is equal to the amount of the covariance explained by each axis. If the business cycles of each pair of countries are similar, we expect the distance to be close to zero.

4. Data and Empirical Results

We use data extracted from the World Development Indicators (WDI) of the World Bank. Following existing literature, we measured real economic activity by real GDP. The extracted dataset consists of annual real GDP growth rates for five EAC countries: Burundi, Kenya, Rwanda, Tanzania, and Uganda (i.e., excluding South Sudan, for which sufficient data is unavailable). The series of available data span the period of 1961~2015 for Burundi, Kenya, and Rwanda; 1983~2015 for Uganda; and 1989~2015 for Tanzania. For this study, only the resulting common sample period is used, namely, 1989~2015.[51]

It is always useful to start with a time-domain descriptive analysis. Table 1 reports the descriptive statistics of growth rates for the five EAC countries. For the common period, Burundi had the lowest mean growth rate at 1.2%, whereas Uganda had the highest at 6.6%, followed by Rwanda and Tanzania. Judging by the coefficient of variation (the ratio of the standard deviation to the mean), Uganda and Tanzania were by far the most stable economies, followed by Kenya. Burundi had the most unstable economic growth, which was mainly due to periods of civil war.

[51] One would argue that the sample size might be small for the ideal analysis of business cycles. This is because, cycles in economics are assumed between 8 to 10 years, for longer cycles, between 4 to 6 years and 1 to 2 years for standard and shorter cycles, respectively. These points of view have been argued by scholars such as Baxter and King (1999) and Canova (1998) while using alternative detrending methods, to be able to establish business cycles facts. Moreover, Aguiar-Conraria and Soares (2011a) report the length of cycles that varies among the countries, the shorter (longer) cycles range between 1.5-4.5 years (4.5-8 years). The sample size in this paper contains 27 years of observations per country, which implies five cycles during the whole sample period. This is potentially a caveat regarding the economic interpretation of business cycles in the current study.

Table 1: Descriptive statistics for economic growth rates (1989~2015)

Country	Mean	Std. Dev.	CV	Min	Max
Burundi	1.23	4.17	338.88	-8.00	5.38
Kenya	3.65	2.39	65.32	-0.80	8.40
Rwanda	5.31	13.37	251.67	-50.25	35.22
Tanzania	5.26	2.21	42.04	0.58	8.46
Uganda	6.64	2.20	33.07	3.14	11.52

Overall, the descriptive information in Table 1 shows that conflicts had a negative shock on the growth of East African economies, particularly Burundi, Rwanda, and—to a lesser extent—Kenya, because they experienced negative growth rates during conflict periods.

Figure 1 plots the real economic growth rates in EAC countries. The worst period was 1993~2000 because it was characterized by negative economic growth in Burundi. The Burundian economy showed a period of sustained recovery during 2006~2014, but this was interrupted because of the political unrest that followed, and the Burundian economy decreased by 4% in 2015. Similarly, the economy of Rwanda experienced negative growth during 1990~1994, which was a period characterized by civil war. The worst year was 1994, during which the Rwandan genocide took place and the economy plummeted by 50%. The economic recovery of Rwanda started in 1995, with the economy growing at 35%. These two years (1994 and 1995) stand out in Figure 1 as outliers that result in excessive variations (Table 1). However, the economy of Rwanda has been growing steadily since 1995. In addition to the economies of Rwanda and Burundi, which have been affected by conflicts, the 2007~2008 Kenyan postelection crisis severely affected its economy, but there was a quick recovery in 2009. Overall, Figure 1 indicates that there have been relatively fewer variations after 1998; the gap has narrowed, and the economies seem to converge.

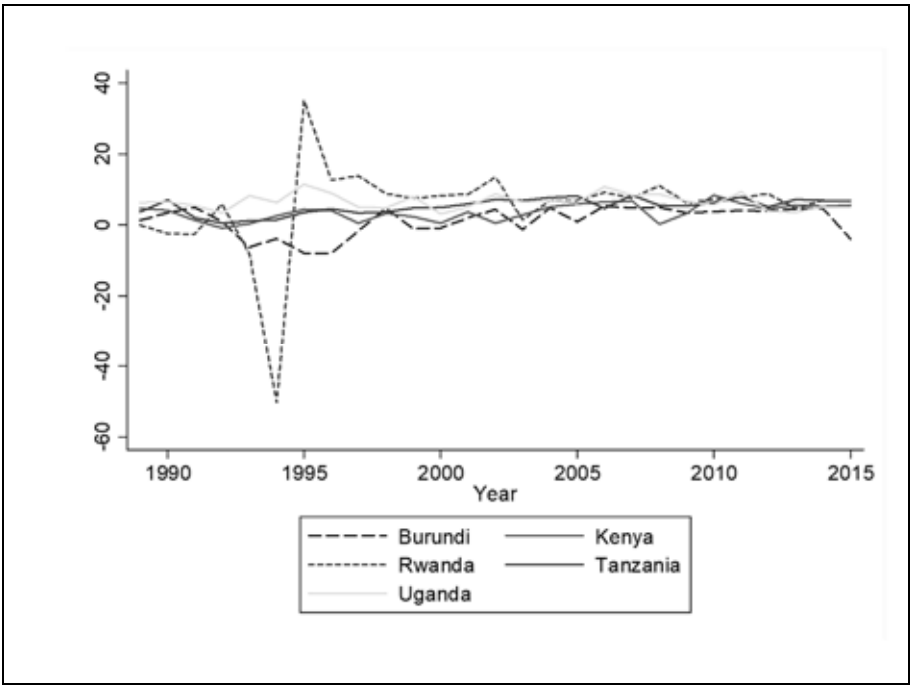


Figure 1. Time series plot of real economic growth (EAC Countries, 1989~2015)

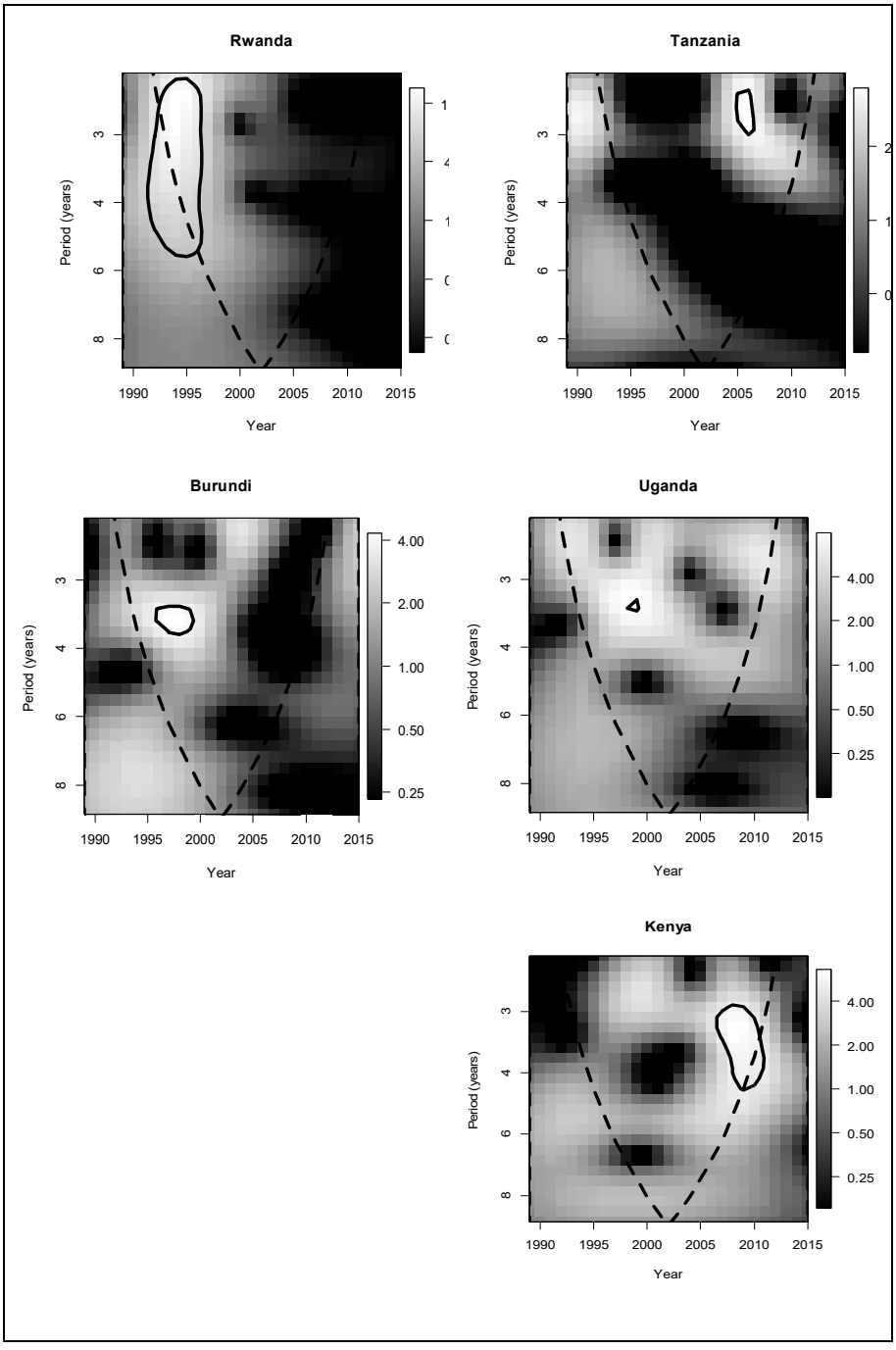


Figure 2. WPSs of real economic growth (1989~2015)

Note: The power ranges from black (low variability) to white (high variability). The thick black contour indicates significance at the 5% level and encompasses an area with significance below that level. The cone of influence (COI) where the edge effects might distort the picture is shown as a discontinued thick black line, which is estimated by Monte Carlo simulations with 10,000 replicates using phase-randomized surrogate series. These plotted spectra are bias-corrected following Liu et al. (2007) and Veleda et al. (2012).[52] The horizontal axis indicates the year. The vertical axis indicates the frequency in terms of periods: long and short periods correspond to low and high frequencies, respectively.

Figure 2 presents the WPSs of real economic growth of each of the five EAC countries. A WPS shows the local variance of the time series and helps localize the periods that contributed more to the overall variance in the series both in time and frequency. In terms of economic growth, high variability (white shade in the figure) can arise owing to policy changes or other major events that affect economic activity, such as instability. Looking at Burundi, there was high power at around 1993~2002 at cycles of three to four years. The thick black contour that designates the 5% significance level (and encompasses an area with significance below that level) fell in 1996~2000 at a cycle of three and one- half to around four years. During this period, Burundi experienced civil war, and as suggested by the time-domain descriptive analysis, this war took a toll on the economic activities of the country. The same pattern is observed in the Kenyan postelection violence in 2007, and in the turbulent period in Rwanda during the 1990s (until 1996). In the latter case, this is reflected by the high wavelet spectra at higher and medium frequencies of up to a six-year cycle. For Uganda, the variance looks more or less equally distributed across time but with relatively high power for cycles of up to four years. Tanzania experienced less volatile economic growth, except after 2005 when the power increased, and there is significance in the region corresponding to cycles of two to three years.

This analysis of the WPSs shows that conflicts were the main factor that negatively affected economic growth in some EAC countries. The long-time absence of countrywide conflicts in Tanzania, Uganda, and—to a lesser extent—Kenya explains stable economic activities in these countries.

[52] These authors rectify the bias in the WPS version of Torrence and Compo (1998). The bias results in the reduction of power at low periods. This correction is available in biwavelet package version 0.14. Computations were performed using R version 3.1.3.

To investigate the comovement and lag/lead relationships among EAC economies, Figure 3 depicts the pairwise wavelet coherency of business cycles for the five countries, with its subfigures sorted on the basis of economy size: the wavelet coherencies of the largest economy (Kenya) versus the second-, third-, fourth-, and fifth-largest economies are listed first, the wavelet coherencies of the second-largest economy (Tanzania) versus economically smaller economies are given subsequently, and so on. The shading ranges from black (low coherency) to white (high coherency). The thick black contour indicates significance at the 5% level and encompasses an area with significance below that level.

The arrows in Figure 3 indicate the phase difference between the economic growth series of two countries. The arrows pointed to the right and up indicate that the cycles are in phase with the cycle of the first-listed country leading that of the second listed country (imagine two sine curves of the same frequency with the peak of the first sine curve occurring slightly before that of the second; the sine curves are then in phase with the first leading the second). The arrows pointed to the right and down indicate that the cycles are in phase with the cycle of the second listed country leading that of the first; if the arrow points directly to the right, the cycles are completely in phase without either country's cycle leading the other. The arrows pointed to the left and up indicate that the cycles are antiphase with the second listed country's cycle leading that of the first (imagine two sine curves of the same frequency with the trough of the second sine curve occurring slightly before the peak of the second; the sine curves are then antiphase with the second leading the first). The arrows pointed to the left and down indicate that the cycles are antiphase with the cycle of the first-listed country leading that of the second; if the arrow points directly to the left, the cycles are completely antiphase without either country's cycle leading the other.

When significant coherence (below the 5% level) occurred, the business cycle of the Kenyan economy was in phase with those of Tanzania and Uganda, with Kenya leading both after 2000. It is important to mention that these three economies (Kenya, Tanzania, and Uganda) account for 92% of the total GDP of EAC. The GDPs of Kenya, Tanzania, and Uganda in 2017 were US dollar 74.9 billion, US dollar 52.1 billion, and US dollar 25.9 billion according to WDI data, respectively, whereas the GDPs of Rwanda and Burundi were only US dollar 9.1 billion and US dollar 3.5 billion, respectively.

The Kenyan economy also led the Rwandan economy in phase at cycles of eight years until 2005 (albeit outside the area of significant wavelet coherence). Similarly, the business cycles of Kenya and Tanzania were in phase at long cycles of eight to nine years outside the area of significant wavelet coherence; this comovement shifted to short cycles of three to four years (with significant wavelet coherence) after 2005, which is the year that corresponds to the establishment of the EAC customs union. Kenya and Uganda were in phase at medium cycles of four to six years in the late 1980s and early 1990s, and this comovement re-emerged in 2005 after a long break since 1995.

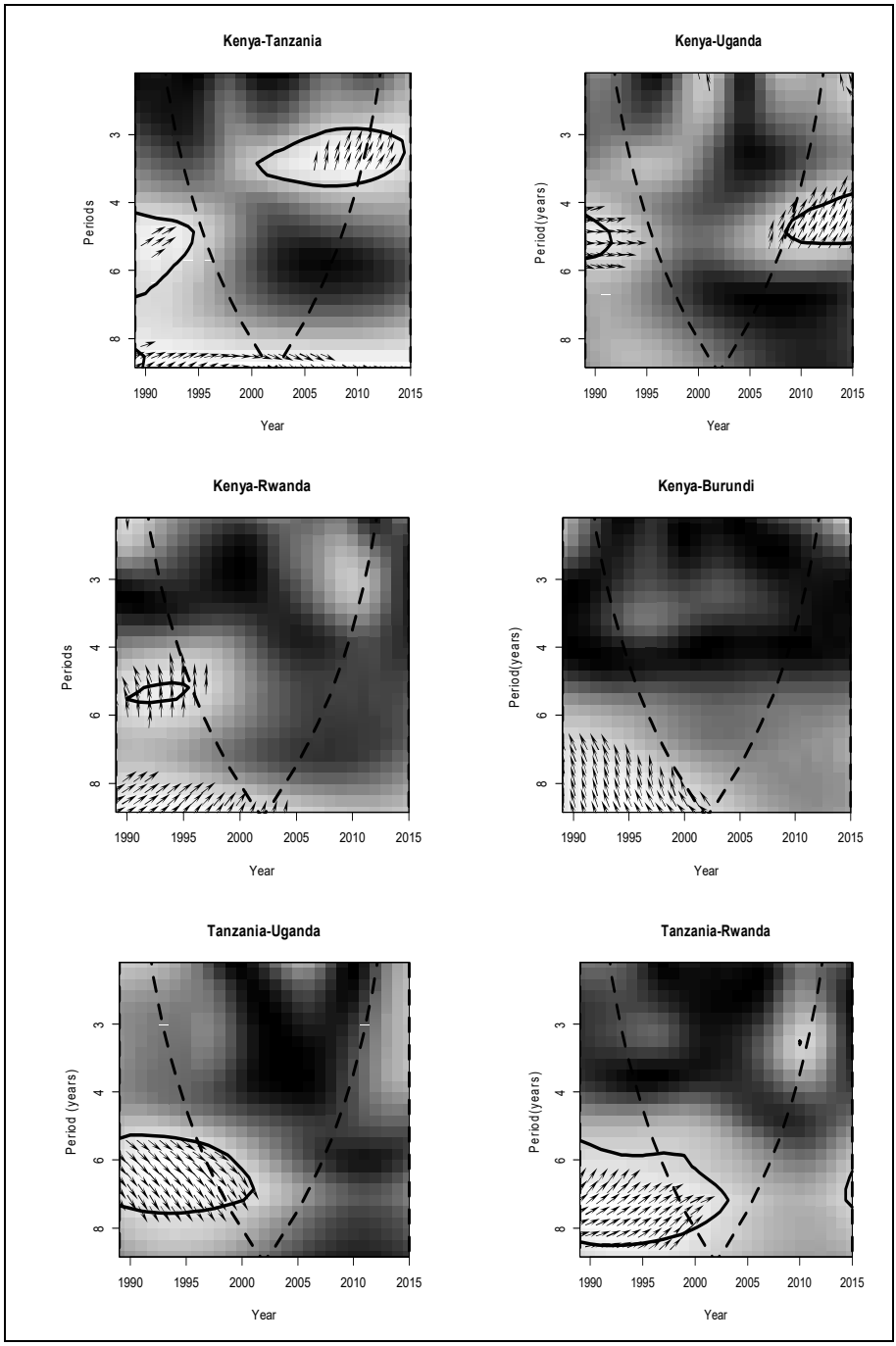
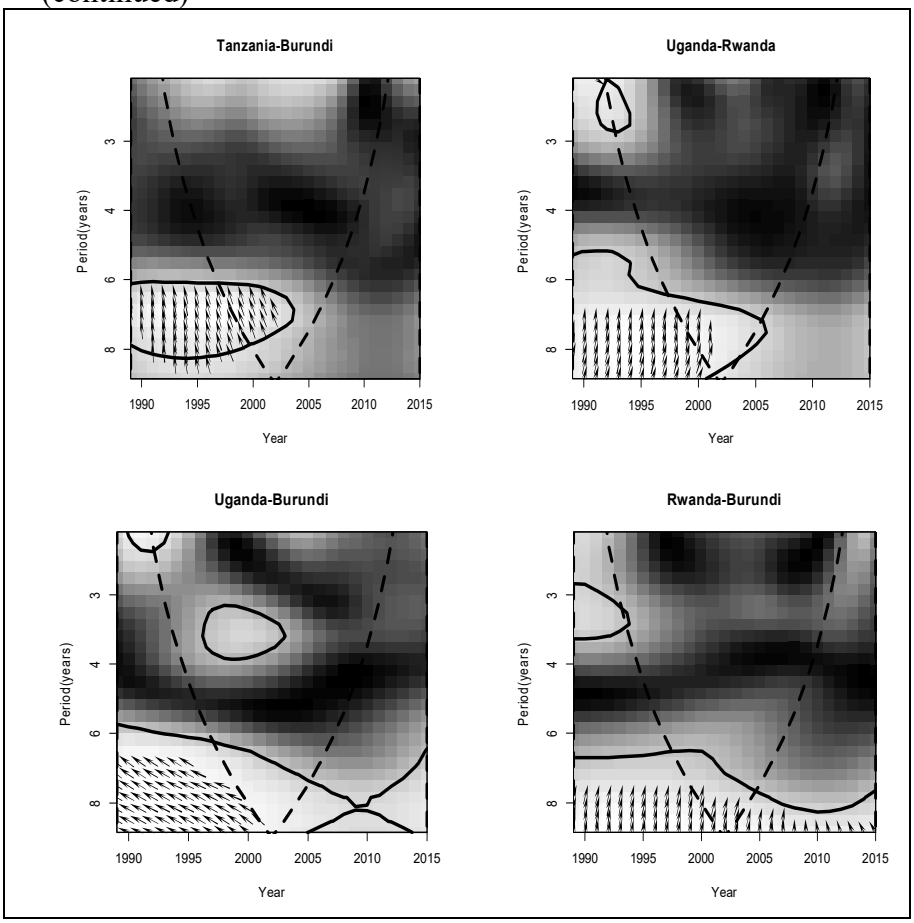


Figure 3. Wavelet coherency of real economic growth (1989~2015)

(continued)



Note: The power ranges from black (low coherency) to white (high coherency). The thick black contour indicates significance at the 5% and encompasses an area with significance below that level. The COI where edge effects might distort the picture is shown as a discontinued thick black line, which is estimated by Monte Carlo simulations with 10,000 replicates by using phase- randomized surrogate series. These plotted spectra are bias-corrected following Liu et al. (2007) and Veleda et al. (2012). The arrows indicate the phase difference between the economic growth series of two countries. The arrows pointed to the right and up (left and down) indicate that the series are in phase (antiphase) with the first series leading. The arrows pointed to the right and down (left and up) indicate that the series are in phase (antiphase) with the second series leading. The arrows pointing directly right (left) indicate that the series are completely in -phase (antiphase) with neither series leading the other.

In Burundi, the business cycle was leading the business cycles of Kenya, Tanzania, and Uganda antiphase prior to 2001 at a very low frequency (long cycles of around seven to eight years, but not in an area of significant wavelet coherence with Kenya). The business cycle of Rwanda led that of Burundi in phase for the whole period at long cycles of 8 to 10 years until 2008, and the Burundi business cycle led the antiphase of Rwanda in these long cycles. These findings show how the business cycle of Burundi was detached from the rest of the EAC, except from Rwanda. Moreover, the fact that the business cycles of Burundi and Rwanda were in phase at long cycles for the whole period prior to 2008 implies that the two economies are historically more or less affected by common shocks, but this situation may be changing given the post-2008 information.

Considering that our study, to the best of our knowledge, is the first study that looks at the time-frequency comovement among the EAC countries, comparisons with time-domain studies that have been conducted thus far cannot be established in a straightforward manner. However, the wavelet coherency analysis given earlier suggests that after the establishment of EAC in 2005, the Ugandan and Tanzanian economies became more synchronized with Kenya, with the economy of Kenya being the leader. As mentioned earlier, these countries have historically enjoyed the benefits of long cooperation under several regional integration arrangements; this situation explains the comovement.

The rest of the EAC (Rwanda and Burundi) has had long-period business cycle synchronization. One tentative explanation for this synchronization is the similarity in the history of conflicts in the two countries with the possibility of spillovers from one country to another.[53] Although the economy of Rwanda recovered in 1995 and experienced fast growth thereafter, the Burundian civil war continued until 2006. Just recently, instability erupted again in the country, thus resulting in a deceleration in growth. Furthermore, the fact that Rwanda and Burundi joined the EAC seven years later in 2007 may explain the lack of synchronization between the two countries and the rest of EAC. However, even after joining EAC, there is no evidence that the economies of Rwanda and Burundi are catching up.

[53] It is worth mentioning that these countries had been under Belgian control before getting their independency in 1962. Prior to that they both were Germany colonies.

For further analysis, Figure 4 plots the pairwise wavelet spectra distances during 1989~2015 and after the establishment of EAC in 2000. Distances are computed on the basis of Equation (7). Table A1 in the Appendix 1 reports the wavelet spectra matrices. The logic behind these distances is that if two countries have similar business cycles, they also have similar wavelet spectra, thus indicating that the contribution (at each time and frequency) of cycles to the total variance is the same and that the ups and downs of each cycle occur simultaneously (Aguiar-Conraria and Soares 2011a). Even though there is evidence that synchronization improved after 2000, there are still significant differences among the business cycles of EAC countries. Considering the period after the establishment of EAC in 2000, the most similar business cycle pairs are Kenya and Uganda (13.4578), Tanzania and Uganda (14.0328), and Burundi and Rwanda (14.8130), and the least similar are Rwanda and Uganda (18.5268), Kenya and Rwanda (18.2599), and Burundi and Tanzania (17.4169).

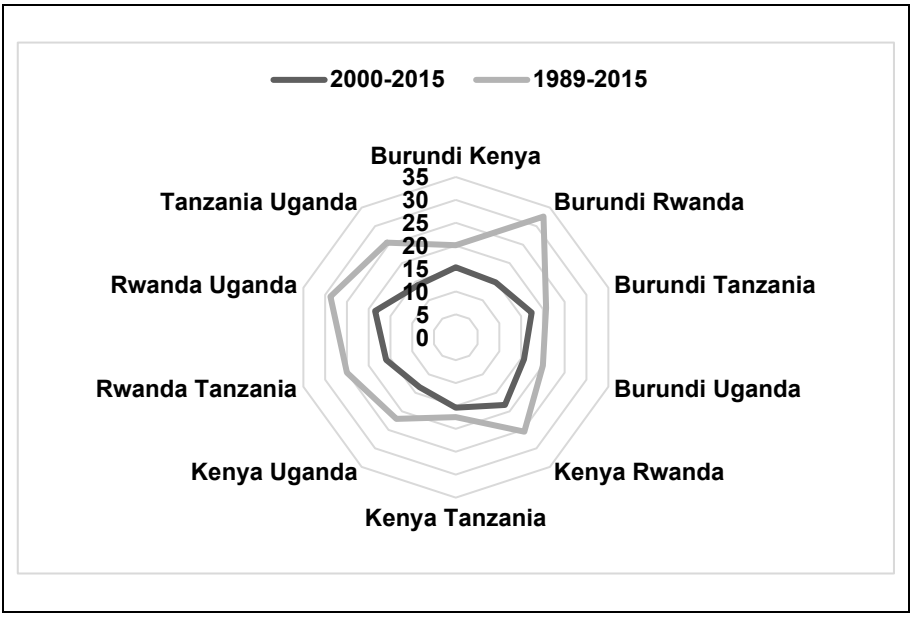


Figure 4. Wavelet spectra distances

To deepen our analysis, we now investigate the core-periphery pattern in the proposed EAMU. A homogeneous subset qualifies as the core of the monetary union if it accounts for a major share of the total output. The next wavelet tool helps us group wavelet spectra on the basis of spectra similarities in time and frequency. Figure 5 plots the cluster trees that are based on the wavelet spectra distance matrix. As illustrated in this figure, among the members of the proposed EAMU, Kenya, Uganda, and Tanzania are linked to each other at smaller distances, thus indicating that their economies face common shocks. Moreover, this group accounts for approximately 90% of the total EAC GDP and qualifies as the core of the monetary union. On the contrary, Rwanda and Burundi form another group, thus indicating that they also share similar business cycles (common shocks) and qualify as the periphery of EAMU. The core is expected to exercise a disproportionate influence on the common monetary policy to the detriment of the peripheral regions (Ferreira-Lopes and Pina 2011). These findings highlight that the core/periphery divide is another threat to the viability of EAMU, in addition to the low degree of synchronization among EAC economies.

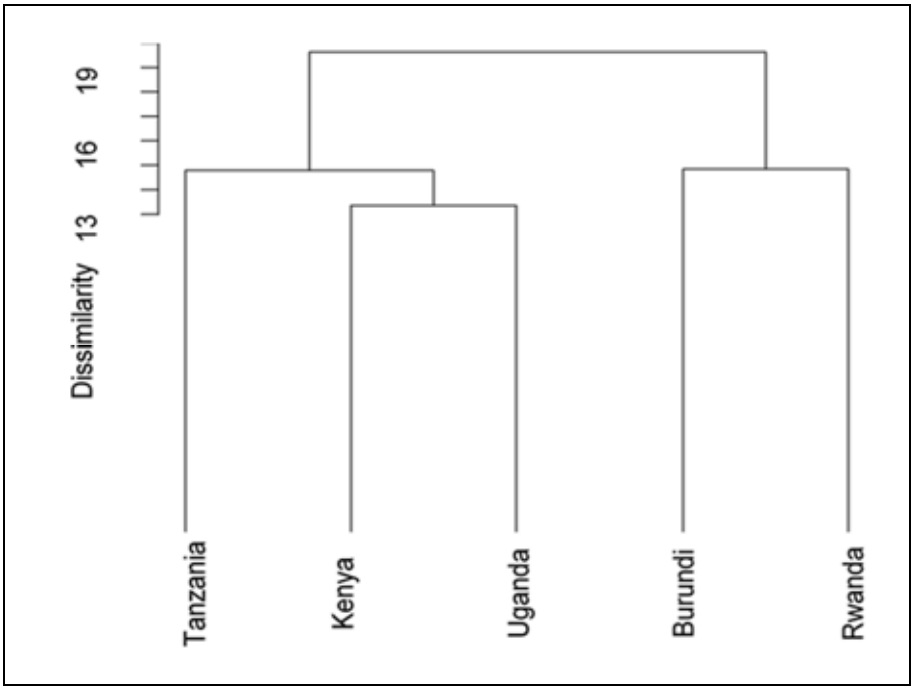


Figure 5. Wavelet cluster tree of EAC business cycles (2000~2015)

Note: The cluster tree groups wavelet spectra based on time-frequency similarities. The tree is based on the computed distance (wavelet dissimilarity) matrix that sets the covariance threshold at 99% of the total covariance.

5. Summary and Conclusion

OCA theory suggests that various criteria need to be fulfilled for an eventual successful monetary union. We investigated the degree of synchronization of growth cycles among the potential members of EAMU and assessed the prevalence of core-periphery patterns. The novelty of our analysis is that we applied wavelet analysis, which is a powerful computational tool for assessing comovements with information on both time and frequency localizations. Accordingly, we used three wavelet tools: WPS, cross-wavelet coherency, and wavelet spectra clustering.

The WPSs showed volatile periods of growth cycles that were mainly due to conflicts, particularly in Rwanda and Burundi, and to postelection violence in Kenya to a lesser extent. A pairwise analysis of growth cycle comovements via cross-wavelet coherency highlighted important variations both in time and frequency, thus showing that when there is significant wavelet coherency with in phase business cycles, Kenya typically leads all countries in its business cycle (except it was completely in phase with Uganda at four- to six-year periods in the early 1990s), Uganda leads Tanzania, Tanzania leads Rwanda, and Rwanda leads Burundi. The evidence also suggests that the establishment of a customs union in 2005 improved synchronization among the Kenyan, Tanzanian, and Ugandan economies, with the Kenyan economy as the leader.

Furthermore, wavelet clustering based on a measure of dissimilarity via the matrix of distances between the wavelet spectra of the five countries highlighted the prevalence of core-periphery patterns in the EAC. The business cycles of Kenya and Uganda were synchronized with the business cycle of Tanzania. Considering that these three countries accounts for approximately 90% of the total EAC GDP, it qualifies as the core of the EAMU, whereas Rwanda and Burundi form the peripheral cluster. The core-periphery divide implies that the core is expected to play an anchor role in the proposed monetary union.

In summary, the presence of asymmetric shocks that affect the EAC economies and the prevalence of core-periphery patterns among these countries cast doubts on the readiness and eventual viability of the EAMU. However, the three countries that form its core seem to be potential candidates for the proposed EAMU.

References

Aguiar-Conraria, L., & Soares, M.J. (2011a). Business cycle synchronization and the Euro: a wavelet analysis. *Journal of Macroeconomics*. 33(3), 477–489.

Aguiar-Conraria, L., & Soares, M.J. (2011b). The continuous wavelet transform: A primer. NIPE Working Paper Series (No.16). University of Minho

Aguiar-Conraria, L., Azevedo, N., & Soares, M. J. (2008). Using wavelets to decompose the time–frequency effects of monetary policy. *Physica A: Statistical Mechanics and its Applications*, 387(12), 2863-2878.

Albulescu, C. T. (2017). UK business cycle synchronization with Germany and the US: New evidence from time–frequency domain and structure of economic growth. *Applied Economics Letters*, 24(1), 67-71.

Aloui, C., Hkiri, B., & Nguyen, D. K. (2016). Real growth co-movements and business cycle synchronization in the GCC countries: Evidence from time-frequency analysis. *Economic Modelling*, 52, 322-331.

Angeloni, I., & Dedola, L. (1999). From the ERM to the euro: new evidence on economic and policy convergence among EU countries. European Central Bank Working paper (No.4). European Central Bank.

Artis, M. J., & Zhang, W. (1997). International business cycles and the ERM: Is there a European business cycle? *International Journal of Finance & Economics*, 2(1), 1–16.

Artis, M. J., & Zhang, W. (1998). Core and periphery in EMU: A cluster analysis. Robert Schuman Center Working paper (No. 37). Florence: European University Institute.

Asongu, S. A. (2013). A short-run Schumpeterian trip to embryonic African monetary zones. *Economics Bulletin,* 33(1), 853-873.

Asongu, S., Nwachukwu, J., & Tchamyou, V. (2017). A literature survey on proposed African monetary unions. *Journal of Economic Surveys*, 31(3), 878-902.

Bangaké, C. (2008). Exchange rate volatility and optimum currency area: evidence from Africa. *Economics Bulletin*, 6(12), 1-10.

Baxter, M., & King, R. G. (1999). Measuring business cycles: approximate band-pass filters for economic time series. *Review of Economics and Statistics*, 81(4), 575-593.

Bayoumi, T., & Eichengreen, B. (1994). One money or many? On analyzing the prospects for monetary unification in various parts of the world. *Princeton Studies in International Economics*,76 International Economics, Princeton University, US.

Buigut, S. (2011). A fast-track east African community monetary union? convergence evidence from a cointegration analysis. *International Journal of Economics and Finance*, 3(1), 255-261.

Buigut, S. K., & Valev, N. T. (2005). Is the proposed East African monetary union an optimal currency area? A structural vector autoregression analysis. *World Development*, 33(12), 2119-2133.

Burns, A. M., & Mitchell, W. C. (1947). *Measuring business cycles*. National Bureau of Economic Research Books. New York

Canova, F. (1998). Detrending and business cycle facts. *Journal of Monetary Economics*, *41*(3), 475-512.

Caraiani, P. (2012). Stylized facts of business cycles in a transition economy in time and frequency. *Economic Modelling*, 29(6), 2163-2173.

Christiano, L. J., & Fitzgerald, T. J. (2003). The band pass filter. *International Economic Review*, 44(2), 435-465.

De Grauwe, P. (2014). *Economics of monetary union*. Oxford: Oxford University Press.

De Grauwe, P., & Vanhaverbeke, W. (1993). Is Europe an optimum currency area? Evidence from regional data, in P.R. Masson and M.P. Taylor (eds), *Policy issues in the operation of currency unions.* Cambridge: Cambridge University Press. 111-129.

Dickerson, A. P., Gibson, H. D., & Tsakalotos, E. (1998). Business cycle correspondence in the European Union. *Empirica*, 25(1), 49–75.

Drummond, P., Wajid, K., & Williams, O. (eds) (2014). *The quest for regional integration in the East African Community*. Washington, DC: IMF

Duran, H. E., & Ferreira-Lopes, A. (2017). Determinants of co-movement and of lead and lag behavior of business cycles in the Eurozone. *International Review of Applied Economics*, 31(2), 255-282.

EAC (2013). *Protocol on the Establishment of the East African Monetary Union*. East African community. Available at https://www.eac.int/documents/category/key-documents

EAC (2016). Facts and Figures report. East African community. Available at https://www.eac.int/documents/category/key-documents

Eichengreen, B. (1990). One money for Europe? Lessons from the US currency union. *Economic Policy*, 5(10), 117-187.

Ferreira-Lopes, A., & Pina, Á. M. (2011). Business cycles, core, and periphery in monetary unions: comparing Europe and North America. *Open Economies Review*, 22(4), 565-592.

Fidrmuc, J., Korhonen, I., & Poměnková, J. (2014). Wavelet spectrum analysis of business cycles of China and G7 countries. *Applied Economics Letters*, 21(18), 1309-1313.

Frankel, J. A., & Rose, A. K. (1998). The endogeneity of the optimum currency area criteria. *The Economic Journal*, 108(449), 1009-1025.

Frankel, J. A., & Rose, A. K. (2005). Real convergence and euro adoption in Central and Eastern Europe: trade and business cycle correlations as endogenous criteria for joining the EMU. In Schadler, S. (ed.), *Euro Adoption in Central and Eastern Europe: Opportunities and Challenges*. Washington DC: IMF, pp. 9-21.

Goupillaud, P., Grossmann, A., & Morlet, J. (1984). Cycle-octave and related transforms in seismic signal analysis. *Geoexploration*, 23, 85–102.

Grinsted, A., Moore, J. C., & Jevrejeva, S. (2004). Application of the cross wavelet transform and wavelet coherence to geophysical time series. *Nonlinear Processes in Geophysics*, 11(5/6), 561-566.

Hallett, A. H., & Richter, C. (2006). Measuring the degree of convergence among European business cycles. *Computational Economics*, 27(2), 229-259.

Harvey, A.C. (1985). Trends and cycles in macroeconomic time series. *Journal of Business and Economic Statistics,* 3 (3), 216–227.

Harvey, A.C. (1989). *Forecasting, Structural Time Series Models and the Kalman Filter*. Cambridge: Cambridge University Press.

Hodrick, R. J., & Prescott, E. C. (1997). Postwar US business cycles: an empirical investigation. *Journal of Money, Credit, and Banking*, 1-16.

Kenen, P. (1969). The Theory of Optimum Currency Areas: An Eclectic View. in Mundell, R.A., and Swoboda, A.K., (ed.), *Monetary Problems of the International Economy.* The University of Chicago Press, pp. 41-60.

Kishor, N. K., & Ssozi, J. (2011). Business cycle synchronization in the proposed East African Monetary Union: An unobserved component approach. *Review of Development Economics*, 15(4), 664-675.

Koopmans, T. C. (1947). Measurement without theory. *The Review of Economics and Statistics*, 29(3), 161-172.

Liu, Y., San Liang, X. & Weisberg, R.H. (2007). Rectification of the Bias in the Wavelet Power Spectrum. *Journal of Atmospheric and Oceanic Technology*, 24, 2093-2102.

McKinnon, R. I. (1963). Optimum currency areas. *The American Economic Review*, 53(4), 717-725.

Mkenda, B.K (2001). Is East Africa an optimum currency area? Göteborg University, Department of Economics. Working paper (No. 41).

Mundell, R. A. (1961). A theory of optimum currency areas. *The American Economic Review*, 51(4), 657-665.

Olayeni, O. R. (2016). Causality in Continuous Wavelet Transform Without Spectral Matrix Factorization: Theory and Application. *Computational Economics*, 47(3), 321-340.

Pedersen, T. M. (2001). The Hodrick–Prescott filter, the Slutzky effect, and the distortionary effect of filters. Journal of Economic Dynamics and Control, 25(8), 1081-1101.

Rouyer, T., Fromentin, J. M., Stenseth, N. C., & Cazelles, B. (2008). Analysing multiple time series and extending significance testing in wavelet analysis. *Marine Ecology Progress Series*, 359, 11-23.

Rua, A. (2010). Measuring co-movement in the time–frequency space. *Journal of Macroeconomics*, 32(2), 685-691.

Rusuhuzwa, T. K., & Masson, P. R. (2013). Design and implementation of a common currency area in the East African Community. *African Journal of Business Management*, 7(35), 3575-3590.

Sheikh, K. A., Azam, M. N., Rabby, T. G., Alam, G. M., & Khan, I. (2011). Monetary union for the development process in the East African community: Business cycle synchronization approach. *African Journal of Business Management,* 5(17), 7632-764

Slanicay, M. (2013). Business Cycle Synchronization through the Lens of a DSGE Model. *Finance a Uver -Czech Journal of Economics and Finance*, 63(2), 180-196.

Stock, J. H. (1987). Measuring business cycle time. Journal of Political Economy, 95(6), 1240-1261.

Torrence, C., & Compo, G. P. (1998). A practical guide to wavelet analysis. *Bulletin of the American Meteorological Society*, 79(1), 61-78.

Veleda, D., Montagne, R., & Araujo, M. (2012). Cross-Wavelet Bias Corrected by Normalizing Scales. *Journal of Atmospheric and Oceanic Technology*, 29:1401-1408.

Xu, X. (2006). A currency union for Hong Kong and Mainland China? *Journal of International Money and Finance,* 25(6), 894-911.

Yogo, M. (2008). Measuring business cycles: a wavelet analysis of economic time series. *Economic letters*, 100 (2), 208–212.

Appendix

Table A1: Distance matrix

Country	Burundi	Kenya	Rwanda	Tanzania	Uganda
Burundi		15.31518	14.81301	17.4169	15.64802
Kenya	20.10593		18.25999	15.35453	13.4578
Rwanda	32.62151	25.47166		15.98849	18.52685
Tanzania	20.71753	17.45358	24.98175		14.03283
Uganda	20.00013	22.04568	28.80181	25.55958	

Notes: The lower part shows wavelet spectra distances during the period 1989-2015. The upper part shows distances after the establishment of EAC (2000~2015).

Paper 3: Trade Integration and Business Cycle Synchronization among the East African Community Countries

Yvonne Umulisa

3

TRADE INTEGRATION AND BUSINESS CYCLE SYNCHRONIZATION AMONG THE EAST AFRICAN COMMUNITY COUNTRIES

Yvonne Umulisa

ABSTRACT

The question of how trade intensity affects the synchronization of business cycles is an important issue to consider for entry into a monetary union. This paper uses a panel of thirty-one African countries for the period 2000–2016 to assess whether trade integration among these countries has led to synchronization of the business cycle. Unlike most previous studies that estimated business cycle synchronization with correlation coefficients, in this paper, a time-varying index is applied to measure business cycle synchronization. From a methodological viewpoint, the common correlated effects mean group (CCEMG) estimates reveal a positive relationship between bilateral trade and business cycle synchronization among African countries. The same is true for East African Community countries. Therefore, it seems plausible to suggest that trade intensity among these countries may lead to a more synchronized business cycle; this empirical finding should be considered by EAC authorities for further debate on the readiness of the East African Monetary Union.

Trade Integration and Business Cycle Synchronization among the East African Community Countries

Yvonne Umulisa

1. Introduction

Following the regional integration of the East African Community (EAC), which is currently receiving considerable attention, the creation of the East African Monetary Union (EAMU) is now experiencing robust political and economic effort. However, the creation of such a monetary union cannot succeed without strong support and continuous rational decision making by all the actors concerned. This is because when countries decide to create a monetary union (MU), they expose themselves to both costs and benefits. Whereas the costs faced by members of an MU are reflected in the loss of the ability to conduct a national monetary policy, the benefits mostly occur in the reduction of transaction costs associated with the exchanging of national currencies (De Grauwe 2018).

1.1. The role of Optimum Currency Area theory

To date, two connected theories have been put forward on the question of "whether a group of countries is ready to join a Monetary Union or not". On the one hand, the pioneering work by Mundell (1961) on the Optimum Currency Area (OCA) theory considered trade integration among the potential members and the degree of symmetry of their business cycles among the key criteria necessary for deciding whether to join an MU (see also De Grauwe, 2014, 2018). On the other hand, efforts by many researchers to answer that question have led to new ideas on the OCA theory, with the best known in the literature concerning the endogeneity of the OCA. This idea was first approached by Frankel and Rose (1998) in an influential paper claiming that the OCA criteria are affected by the decision to start an MU early on. In their argument, they stressed that the OCA test could be satisfied ex post even if it is not fully satisfied ex ante. Thus, they called it the “endogeneity of OCA”; that is, countries that initially do not fulfill the criteria of an OCA may, over time, evolve towards an OCA.

A similar view was also presented by De Grauwe & Mongelli (2005) and De Grauwe (2014, 2018), who argued that a monetary union intensifies trade integration and that integration, in turn, reduces asymmetric shocks. According to the authors, this should be good news for countries that envisage the forming of a monetary union. Thus, one could argue that the "endogeneity of OCA" hypothesis suggests a positive link between business cycle correlation and trade integration. This hypothesis was also confirmed in other works, including Baxter and Kouparitsas (2005), Calderon et al. (2007), Glick and Rose (2002), and Rose (2000), among others. All these authors further suggested that countries with strong trade linkages and positively correlated business cycles are more likely to be members of an OCA.[54]

It is important to note that the literature in this area also stresses that the impact of trade integration on the business cycle could theoretically be ambiguous. It has thus far been empirically shown that if, on the one hand, the demand channel is the dominant force that drives the business cycles, i.e., if intra-industry trade is more pervasive, then greater trade intensity is expected to increase cycle correlation (this view is labeled the European Commission view in De Grauwe, 2014). If, on the other hand, the supply shocks are the dominant force in explaining cyclical output, then inter-industry trade will deepen due to the increasing specialization in production; hence, the relationship would be negative (which is also labeled the Krugman (1993) view). For a more detailed discussion on both views, see Calderon et al. (2007), De Grauwe (2014), Fiess (2007) and Frankel & Rose (1998).

Furthermore, in a recent theoretical study by Juvenal and Monteiro (2017), it was shown that the effect of bilateral trade on output synchronization is not direct. As these authors argued, the effect depends on the extent to which trade intensity affects what Juvenal and Monteiro (2017, p.385) call: "three key factors"—the correlation between each country's total factor of productivity, the correlation between each country's share of expenditure on domestic goods, and a cross-correlation between these two factors". This again confirms the ambiguous effect that trade integration may have on business cycle synchronization. One can thus argue that from a theoretical point of view, the impact of trade integration on business cycle synchronization may differ in developing countries compared to developed countries, where intra-industry trade is more observed than in the former (for such a distinction, see Calderon et al., 2007).

[54] An OCA is defined as a geographic area that could benefit from using a common currency.

Against this background, the current study is an attempt to provide empirical evidence to the East African Community (EAC) member countries currently deciding whether to join a monetary union. The paper contributes to a body of literature that has very few studies analyzing this relationship among African countries, particularly among EAC countries.[55] This study concentrates on the general research question whether there is a positive relationship between trade integration and business cycle synchronization among African countries. By focusing on the EAC partner states, this paper also investigates the extent to which the EAC has an ex ante potential of an OCA, which may favor a well-functioning proposed East African Monetary Union. Unlike previous studies that have analyzed developing countries primarily through cross-sectional analysis (Tapsoba (2010), among others), this study uses a panel analysis to focus on changes over time within thirty-one African countries over a period from 2000 to 2016.[56] In particular, this study employs heterogeneous panel estimators, which aggressively address the problem of cross-sectional dependence and unobserved heterogeneity among panel units (Pesaran, 2006). Indeed, cross-sectional dependence is assumed among EAC countries, given that the linkages among these economies have been increasing throughout the implementation of different stages of their economic integration.

More specifically, the current study's analysis is based on the empirical model in Frankel and Rose (1998). This paper was the first to introduce and support the endogeneity of the OCA criteria by investigating the relationship between trade links and business cycle correlation. Moreover, it continues to be cited in subsequent and more recent research assuming business cycle synchronization as a general requirement for membership in optimal currency areas (e.g., Caetano & Caleiro, 2018; Gianelle et al., 2017 and Juvenal & Monteiro, 2017). Furthermore, trade has been shown to be the most important channel through which business cycles are transmitted from one country to another (Baxter & Kouparitsas, 2005; Canova & Dellas, 1993; Caporale & Girardi, 2016; Fiess, 2007 and Frankel & Rose, 1998).

The foregoing should be emphasized at the beginning of this paper because the focus of the current study is not primarily to explore the other channels through which trade intensity affects the synchronization of business cycles among African countries. This avoids addressing econometric problems regarding the measurement of variables to be used, an issue that is widely discussed in this study's literature (see a survey paper by De Haan et al., 2008) and briefly approached in the subsequent section. However, this measurement procedure would also be quite demanding in terms of data, which might not be available for the studied countries. Moreover, even if this approach was possible, it would remain beyond the scope of the current study.

[55] To our knowledge, only Tapsoba (2010) discusses the same issue among 53 countries. However, he uses correlation coefficients to measure the business cycle synchronization.

[56] The sample and study period choices depend on the availability of data, which must be available for the variables considered in the current study. The list of countries is provided in Table A6 in the Appendix.

1.2. Background on the EAC

The current EAC that was re-established in 2000 between the three original founders of EAC namely Kenya Tanzania and Uganda, is currently composed of 6 countries. Rwanda and Burundi became full members of the EAC in July 2007, and South Sudan joined the union in September 2016, the latter, however, is not considered in this study. The community has undertaken several economic integration steps over the past eighteen years. A customs union was established in 2004 and came into force in early 2005; a common market protocol was established in 2010, following its ratification by the five partner states at that time. At present, the EAC has agreed to a third step of forming a monetary union and adopting a single currency by 2024 (for more details, see EAC, 2013).[57] This plan is somewhat ambitious, given that the community still struggles with the full implementation of the first two steps, which obviously makes the third step more vulnerable (Drummond et al., 2014 and EAC, 2018).

1.3. Descriptive statistics in the EAC

A descriptive analysis that shows the features of the business cycles and trade openness in the EAC countries is given in Figures 1 and 2. A comovement of GDP per capita business cycles among the EAC countries is presented in Figure 1. Overall, the graphical analysis shows that over the past seventeen years, movements in the economic activities in the EAC have fluctuated in similar directions, although there were times where some countries experienced different economic conditions. For example, a large recession and boom occurred in Kenya, which experienced a dramatic recession from 26 to -32 points over the period from 2007 to 2009. The predominant reason for this recession is related to Kenya's post-election violence in 2007 and its aftermath, although the 2008 to 2009 financial crisis might have deepened the situation. It is worth noting that the civil wars and political tensions that Burundi experienced during 2005 and 2015 also affected its economic activities.

[57] The protocol on the establishment of the EAMU showing the different steps for the adoption of a single currency in 2024, was signed and came into force in 2014 (EAC, 2013).

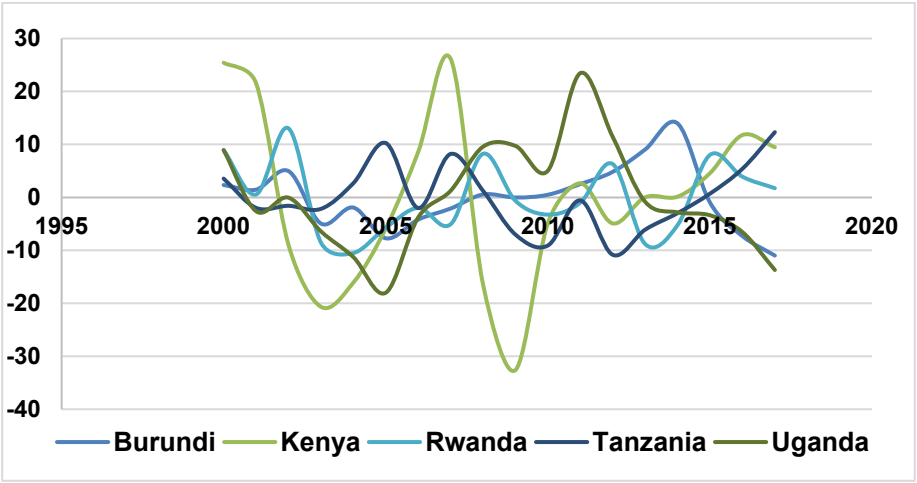


Figure 1. EAC business cycles over time (2000-2016)

Note: the figure plots the evolution of business cycles among EAC countries. The ratio is expressed as cyclical components of the GDP per capita for each member country. Deviations from trends are obtained from using the Hodrick-Prescott (HP) Filter.
Source: calculations are based on World Development Indicators (WDI), Word Bank online dataset.

Another case is observed in Rwanda from 2002 to 2003, with a higher and positive deviation in 2002 followed by a dramatic recession with an almost similar amplitude in 2003. A tentative explanation for the expansion in 2002 corresponds with the economic recovery in Rwanda after the 1994 genocide recession. However, this situation was followed by low economic performance in 2003, mostly due to unfavorable weather conditions.[58]

Moreover, a recession and boom also occurred in Uganda for the periods 2005 and 2011, respectively. Although it is hard to relate these events to economic and political events that occurred in Uganda over the two periods, from 2010 to 2012, growth in Uganda can be associated with the recovery of economic activities after the global financial crisis.

[58]African Economic Outlook (2005-2006), downloaded from https://www.oecd.org/dev/36741760.pdf on 13/01/2019

The analysis in Figure 2 shows that intra-EAC trade (the sum of exports to and imports from other EAC members as a percentage of each member's GDP, which is a measure of the degree of openness within the EAC),[59] has increased markedly after the implementation of the customs union in 2005. This may suggest little support that membership in the EAC promotes trade among partner states. The remarkable increase of 165 percent (from US$207 to US$550 million) in 2008 for Rwanda is a result of its total trade (exports plus imports) with Kenya after Rwanda became a full member in 2007. One could argue that the downward trend observed in 2009 for all countries, is associated with the financial crisis of 2008-2009. Despite this decline, EAC trade continued to grow slowly until 2015. However, once again, all member countries reported a decline during 2015–2016. This slowdown, as stressed in the WTO (2016) statistical review is due to a number of factors, including the slowdown in the Chinese economy, the decrease in oil prices, and exchange rate volatility, where the dollar value for exports (goods) declined by 14 percent.

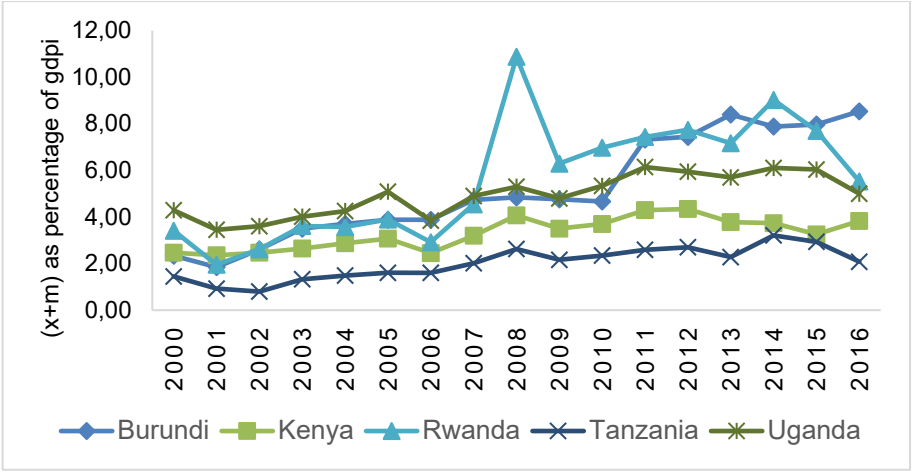


Figure 2. Intra-EAC trade over time (2000-2016)

Note: the figure plots the evolution of trade integration measure, expressed in percentage as the sum of intra-EAC exports and intra-EAC imports normalized by the member country's GDP.
Source: calculations are based on the IMF online dataset: Direction of Trade Statistics (DOTS) and WDI

The descriptive analysis above suggests that the evolution of economic activities (shown in Figure 1) in these countries is the result of increasing trade because trade among them has evolved for one and a half decades (also shown in Figure 2). However, it is shown that while some countries have differences in terms of

[59] Figure 2 indicates the degree of openness of each country with respect to the rest of the EAC.

business cycles comovement, they also have similar patterns in terms of trade integration. One could therefore argue there might be other factors that simultaneously affect trade integration and business cycle synchronization in these countries. Hence, given the key question of this study (mentioned above) of whether business cycle synchronization has increased as a result of trade integration, there is a need for regression analysis to assess the relationship between these two variables over the period 2000–2016.

Accordingly, using a panel of seventeen years of data from thirty-one African countries, the link between trade and business cycle synchronization is examined. A Two-Stage Least Squares (2SLS) approach that uses heterogeneous parameters is applied to control not only the potential endogeneity of the variable of interest but also the country-specific heterogeneities and cross-sectional dependence. The regression results show a positive and significant relationship between bilateral trade and business cycle synchronization among African countries. This is even visualized for the five member countries of the EAC. These results have implications at the EAC policy level, suggesting that monetary union may be good for the EAC countries; hence, these results can be used for further debate on the readiness of the EAMU.

The remainder of this paper is structured as follows. In section 2, relevant studies that motivate both the theory and methodology used in the current study are presented. Section 3 presents the data and discusses the methodology in detail. The empirical results are discussed in section 4, and finally, section 5 provides concluding remarks.

2. Previous literature

There has been substantial research on how trade integration and business cycle synchronization are related. A large part of the empirical evidence showing a positive relationship between business cycle synchronization and trade integration exists among developed countries and has used cross-sectional data. The following presents literature relevant to the current paper.

It is important to begin this section by providing an economic definition of business cycles. As stressed in Bjørnland & Thorsrud (2015), the term business cycles refers to the regular periods of expansion and contraction in macroeconomic variables such as real GDP, employment rates and price levels, among others, indicating that they are fluctuations of an economic variable around its long-run trend. In Canova and Dellas (1993), it is assumed that the development of any country may be transmitted to other countries, mainly through the trade channels between those countries. This economic interdependence, together with external or internal disturbances that may affect both economies, is assumed to produce similar patterns of economic fluctuations, and authors have referred to this as the international business cycles.

From this point of view, trade links and international business cycle have received considerable attention in the analysis of the generation or transmission of disturbances across countries. For example, in the early 1990s, Canova and Dellas (1993) developed a theoretical and simple general equilibrium model to empirically analyze how the international business cycle is related to trade interdependence. They specifically used data from ten industrial countries and applied various detrending techniques to compute the cyclical component of output as a measure of the business cycle. Their study revealed a positive relationship between the international business cycle and trade interdependence. However, the significance depends on the detrending method used. According to their findings, for quarterly data, the correlations tend to be most significant when the Hodrick-Prescott (HP) and the Beveridge-Nelson (BN) detrending methods are used. For annual data, the correlations are significant with random walk (RW) and BN detrending methods.

Subsequently, the linkage between these two variables has been stressed in several papers (see Baxter & Kouparitsas, 2005; Calderon et al., 2007; Gianelle et al., 2017; Fiess, 2007; Frankel & Rose, 1998; Juvenal & Monteiro, 2017; Lee & Azali, 2010; Tapsoba, 2010 and Vieira C. & Vieira I., 2012, among others). De Haan et al. (2008) provided ample literature on EMU countries. The findings in all these studies, though using different approaches, show that trade intensity leads to increased business cycle synchronization.

In their influential paper, Frankel and Rose (1998) investigated the relationship between trade intensity and business cycle correlation among twenty-one industrialized countries over thirty years. The empirical model in this paper built only on the relationship between business cycle synchronization (measured as the bilateral correlation of the real economic activity among the studied countries) and bilateral trade intensity. In addition to the transformation of the different dependent variables using several detrending methods (four in total),[60] they used an instrumental variable (IV) approach to address the endogeneity of the bilateral trade variable. In summary, the IV estimates showed strong evidence that trade intensity increases business cycle comovements; that is, countries with strong trade links tend to have more synchronized business cycles. Based on this finding, the authors suggested the endogeneity of OCA criteria, arguing that if trade promotes business cycle synchronization, a single currency that boosts trade would endogenously lead to higher synchronized business cycles in the monetary union (see also Böwer and Guillemineau, 2006).

In the same spirit, Baxter and Kouparitsas (2005) discussed the determinants of business cycle comovements between countries. They found that bilateral trade is a variable that is robust in explaining the comovement of business cycles. Other variables considered were (1) the structure of sectors of production; (2) a similarity index in export and import products; (3) the total trade of each country; (4) different variables of factor endowment (proxied by average years of schooling, bilateral capital per work and bilateral arable land among others); and (5) standard gravity variables including currency union, common language and common border dummies and distance between countries. Although these variables were found not to be robust (called fragile in their paper), the literature suggested that some of them (sectoral structure and currency unions) were important in explaining business cycles. According to the Baxter and Kouparitsas approach (2005, p.114), "a variable is said to be a robust determinant of business cycle comovement if the variable has a significant coefficient in a regression when all other potential explanatory variables have had a chance to knock the variable out of the equation". Important to note is that this study included over 100 countries, both developed and developing. Another reason for analyzing trade intensity and business cycle development among African countries following these authors.

Böwer and Guilleminaeu (2006) investigated the key factors underlying business cycle synchronization in a Eurozone context. Among a variety of potential determinants, they found that trade has been a major determinant of deep integration between the countries in the Euro zone. An intensification of bilateral trade linkages was revealed not only prior to the formation of an economic and monetary union (EMU) but also after an EMU, with a higher increase in intra-industry trade. In keeping with the endogeneity of the OCA criteria hypothesis, the authors thus support Frankel and Rose's (1998) finding.

[60] They use different macroeconomic variables including real GDP, index of industry production, total employment and unemployment rate.

Calderon et al. (2007) studied the link between trade intensity and business cycles with a comparison between developing and developed countries. They found that increased trade intensity significantly enhances the synchronization of business cycles among developing countries, albeit, slowly, compared to industrial countries. According to their findings, this is because the patterns of specialization and bilateral trade among industrial countries are quite different from those followed among developing countries. The implication is that these two groups of countries have different production structures, which again confirms Frankel and Rose's (1998) findings.

Tapsoba (2010) was among the first scholars to empirically investigate the relationship between trade intensity and business cycle synchronicity in Africa. With the main purpose of evaluating the endogeneity of an OCA, the paper specifically followed the same methodology as in Frankel and Rose (1998). The author started by assuming that business cycle synchronicity may not be strong within African countries, especially those in the process of forming monetary unions. Furthermore, he argued that having a common currency may be endogenous during the integration process. i.e., a common currency may increase the similarity of economic activities through bilateral trade. Hence, the paper tested such an effect among 53 African countries from 1965 to 2004. Their findings suggest that trade intensity increases the synchronization of business cycles in Africa, albeit more slowly than among industrial countries.[61]

As already mentioned, Juvenal and Monteiro (2017) discussed the link between trade intensity and business cycle synchronicity. The authors specifically developed the theoretical framework discussed earlier, which they empirically investigated using a panel of 21 OECD countries spanning over 20 years (1988–2007). Their empirical findings showed that countries with strong trade linkages exhibit a higher total factor productivity correlation. Additionally, the shares of their expenditures on domestic goods are highly correlated. They concluded that these two channels largely explain the relationship between trade intensity and business cycle synchronization.

[61] As a robustness check, the author includes OECD countries in the sample to compare developed to developing countries

Gianelle et al. (2017) examined the effects of trade and specialization on regional business cycle comovement in Europe. In addition to the endogenous trade integration variable, their model specification had the novelty of including more exogenous variables controlling for differences in economic structures across regions and countries, such as the level of development and financial and monetary integration. As their main purpose was to provide policy implications for the EMU, their results emphasized two suggestions. On the one hand, the authors argued that policies that foster regional specialization (in terms of trade) may reduce the synchronization of business cycles across regions and countries (the same findings as in Krugman, 1993). This is bad for the effectiveness of common monetary policy because it may generate macroeconomic tensions in the Euro zone. On the other hand, they argued that single market integration policies, such as a policy to enhance the common regulatory framework that supports factor mobility (a condition also stressed in this paper's literature), have the potential to foster regional business cycles. This is in support of a well-functioning monetary union.

As mentioned earlier, the issue of computing a dependent variable of an empirical model is much discussed in this paper's literature; from computing the cyclical component of economic activity (from which the measure of business cycle synchronization is calculated, GDP being the most comprehensive measure of economic activity), to measuring business cycle synchronization per se. Alternative methods have been used to extract the cyclical component of economic activity, and some prefer the bandpass detrending technique proposed by Baxter and King in the late 1990s (see Baxter & Kouparitsas, 2005 for more details). The Hodrick-Priscott (HP) linear filter is also commonly used in some papers, such as Baxter (1995); Canova & Dellas (1999); De Haan et al. (2008) and Frankel and Rose (1998), among others. As Bjørnland & Thorsrud (2015, p.136) noted, the latter filter is preferred because of its capability of rendering as stationary any integrated time series up to a fourth order. However, except for the findings noted above in Canova and Dellas (1993), researchers who previously employed various detrending techniques in their investigation have often concluded that the detrending technique does not dramatically change the results, especially when the comparison is made across countries (Baxter & Kouparitas, 2005; Calderon et al., 2007; De Hann et al., 2008 and Frankel & Rose, 1998).

Further discussions on this matter are offered by Bjørnland & Thorsrud (2015), who suggested that when selecting an appropriate detrending method, it is always good to start with an analysis of the data at hand. This enables researchers to discern the nature of the underlying dynamic properties of the data and hence judge whether one should use stochastic trends or linear trends when detrending. Moreover, to avoid spurious cycles, the authors suggested the use of complementary filters as a way of checking the robustness of the results.

After obtaining the cyclical components, the correlation of these cycles across countries must be measured; yet again, another exercise that requires a good choice of a measurement method. For that purpose, De Haan et al. (2008) showed that most studies continue using correlation coefficients of the cyclical components of real GDP between two trading partners, despite their complications.[62] Nevertheless, these authors provided a few other measures (measured as index) that have been used in the literature suitable for panel analysis. In addition, a measure to distinguish recessions and expansions of real GDP across countries was discussed. For instance, an index of the growth rate differential given as the absolute difference between two trading partners' real GDP growth rates at time t is explained and used in Giannone et al. (2008). As these authors argued, the latter index can be a rough measure of business cycle desynchronization between two countries. Furthermore, in panel estimation, a similar index was considered by Gianelle et al. (2017) and used as a robust proxy for business cycle synchronization when they analyzed the comovement of business cycles in an EMU. Thus, the current study follows the developments in Giannone et al. (2008) to measure business cycle synchronization in Africa (see also Kalemli-Ozcan et al., 2013).

It is worth emphasizing that the main reason for choosing this index is that it enables us to analyze not only a time-varying (year to year) relation but also how these countries' growth rates change together (i.e., simultaneous occurrences of ups and downs). This helps uncover to what extent their business cycles are similar. Moreover, the choice has the advantage of dealing with concerns regarding the measure of business cycle synchronization present in previous studies, hence, one of the contributions of the current study. More details on the index computation are offered below.

[62] The correlation coefficients between two countries are often estimated over a given time spanning between 5 to 10 years. They are then used as the dependent variable in the regression model, and all other regressors must be averaged over the same time span as well. This is suitable for cross-sectional analysis but not for panel data estimations, where a time-varying measure is strongly required. (e.g., Gianelle et al., 2017). Moreover, the bias of various filtering methods has been deeply criticized in the current study's literature (see Canova and Dellas, 1993 and Canova, 1999).

3. Data and methodology

3.1. Data and measurement of key variables

3.1.1 Measuring business cycle synchronization

To measure the synchronization of business cycle, which is the dependent variable of this study's empirical model, data (drawn from WDI) on annual real GDP at a constant 2010 price for 31 African countries over the period of 2000–2016 are used. Thus, a balanced panel where the number of observations equals 7905 = {(31×30×17)/2}. However, for some countries, data on the included variables are not complete for the entire period, and in addition to log and further transformations, the number of observations is reduced between 4336–7440 for the main and presented results.[63]

As argued in De Haan et al. (2008), GDP represents the widest measure of output and is thus suitable to measure business cycle development. Moreover, data on GDP and its components are generally available for African countries. Accordingly, this paper mainly follows Giannone et al. (2008) [64]and computes the measure of the business cycle synchronization given below as the negative of the absolute value of the two countries' real GDP growth rates difference:

$$SIM_{ijt} = -\left|\Delta\, GDP_{it} - \Delta\, GDP_{jt}\right|, \tag{1}$$

where Δ is the difference operator. SIM_{ijt} is an index measuring business cycle similarity between exporting country i and importing country j. GDP_{it} and GDP_{jt} are the logged GDP in country i and country j, at time t, respectively. The index states that the similarity of the business cycle occurs when the two trading countries have closer GDP growth rates because if they are identical, the index will be zero. Hence, the closer the GDP growth rates are, the more synchronized the business cycles are. As further stressed in Kalemli-Ozcan et al. (2013), this index mitigates the volatility of GDP growth, again making it an ideal measure of synchronization

[63] See to what extent the number of observations differs in summary statistics reported in Table A2 in the appendix.
[64] For this application, also see Gianelle et al., 2017 and Kalemli-Ozcan et al., 2013

3.1.2 Measuring bilateral trade intensity

The other key variable is the bilateral trade intensity, measured using data from both the IMF and WDI datasets. Different proxies for bilateral trade are used by different authors; some use exports or imports only and others use both, which is the case in this paper.[65] Thus, the following variable is computed to measure the bilateral trade intensity:

$$BT_{ijt} = \frac{X_{ijt}+M_{ijt}}{Y_{it}+Y_{jt}}, \quad (2)$$

where X_{ijt} (M_{ijt}) are total nominal exports (imports) from (to) country i to (from) country j during year t, and Y_{it} and Y_{jt} denote total nominal outputs (GDPs) for the corresponding countries. As Calderon et al. (2007, p.7) noted, "this normalized bilateral trade measure captures with more accuracy the effective degree of integration between two countries." It is worth mentioning that in other studies, the bilateral trade is normalized by either total trade or GDP. For most papers, this distinction is used for robustness purposes, and it mostly leads to similar results; put another way, the results remain insensitive to the different measures of bilateral trade (De Haan et al., 2008; Frankel & Rose, 1998 and Gianelle et al., 2017). In the same spirit, and to build a robust analysis that is based on two different indicators, this paper takes a further step and uses the measure given in equation (3), where the bilateral trade is normalized by the countries' total trade as follows:

$$BT_{ijt} = \frac{X_{ijt}+M_{ijt}}{(X_{it}+M_{it}+X_{jt}+M_{jt})}, \quad (3)$$

where X_{it} (M_{it}) and X_{jt} (M_{jt}) are total nominal exports (imports) from (to) country *i* and country *j* during year *t*. Practically, natural logarithms of both ratios are used. The empirical model also includes the net inflows of foreign direct investment (FDI) and export dependency (EXD) indices constructed using data collected from WDI (2018) statistics. The FDI is expressed as a percentage of GDP, and the EXD is the export of goods and services also expressed as a percentage of GDP for country *i* and country *j*.

[65] The main reason is to capture as much trade as possible among these countries, which import more than export between themselves.

3.2. Empirical model and estimation methods

The analysis in the current study relies on the two major variables defined above, which are needed for the estimation of the structural equation that takes the following form:

$$SIM_{ijt} = \beta_0 + d_t + \beta_1 lnbt_{ijt} + \beta_2 EAC_{ij} + \beta_3 SIMFDI_{ijt} + \beta_4 SIMEXD_{ijt} + \alpha_{it} + \alpha_{jt} + \varepsilon_{ijt}, \quad (4)$$

$$\text{where } lnbt_{ijt} = \beta_0 + \gamma_1' Z_{ij} + \gamma_2' Z_{ijt} + \varphi' X_{ijt} + d_t + \alpha_{it} + \alpha_{jt} + u_{ijt}. \quad (5)$$

In equation (4), SIM_{ijt} is an index measured in equation (1); it captures the business cycle synchronization between country *i* and country *j* at time *t*. $lnbt_{ijt}$, as the primary explanatory variable of interest, denotes the logged bilateral trade intensity between country i and country j at time t and is measured differently in equations (2) and (3). The latter variable is also the dependent variable in equation (5), which equation include Z_{ij} and Z_{ijt} as vectors of both time-unvarying and time-varying instruments, respectively. The latter are taken from the standard gravity variables used in the literature as determinants of trade.[66] Specifically, this paper includes real GDP for country *i* and country *j* at time *t* and a free trade agreement between these countries as time-varying instruments. In addition, distance between country *i* and *j*, dummies for a common language, a common border, and a currency union between these countries are included as time-unvarying instruments. Each of these variables is expected to be correlated with bilateral trade, obviously with different signs (see Table A1 in the Appendix for details). X_{ijt} denotes a vector of other controls also used in equation (4) (each of the variables is described below) that are not instruments. To control for any unobserved time-varying heterogeneity and cross-sectional dependence that may affect bilateral trade and output correlation, exporter and importer time-varying fixed effects α_{it} and α_{jt} are respectively included. This specification enables the capturing of other omitted variables.[67] d_t is also included in both equations to control for time-period effects.

[66] In an IV estimation, Frankel and Rose (1998) used distance, common border, common language and additional dummies of RTAs as valid instrumental variables (Table 1-3, p. 1020-1023). Subsequently other studies continued following them (see Böwer and Guillemineau, 2006; De Haan et al., 2008; Juvenal & Monteiro, 2017 and Tapsoba, 2010). In addition, the gravity approach corrects some of the limitations of using the bilateral trade indicators used in the current study. This is because it provides a way of estimating the potential levels of trade based on a specific series of other determinants of bilateral trade (Bouët et al., 2017).

[67] As stressed in Baldwin and Taglioni (2006), these dummies absorb the time dummies, hence eliminating the omitted variables bias and any other bias from incorrect computations of the included regressors.

Returning to equation (4), EAC_{ij} is a dummy variable for EAC membership, i.e., whether both countries are in the EAC or not. Given that the EAC_{ij} is a variable of interest to some extent, for the current study, the dummy is used in two ways. First, it takes a value of 1 from 2000 onwards (i.e., it is time-invariant for all five member countries).[68] Second, the dummy takes a value of 1 after 2007 for only Rwanda and Burundi (i.e., the EAC membership variable has time-varying elements for only these two countries who joined in 2007, hence, the dummy becomes EAC_{ijt}). As this specification allows us to change the variable of interest of the model in equation (4), it is, thus, considered as a robustness check.

The latter equation also includes $SIMFDI_{ijt}$ and $SIMEXD_{ijt}$, measured as the similarity indices for FDI and EXD, respectively.[69] These two variables are additionally included to control for other explanatory variables of business cycle comovement across countries and are considered exogenous variables.[70] First, a similarity index, measured as the negative absolute value of FDI differences between countries, is used to reflect how similar these countries are in attracting FDI. The more similar two countries are in FDI may result in a more synchronized business cycle. This has been supported by various scholars claiming that financial integration, often proxied by capital flows such as FDI, increases the degree of business cycle synchronization among countries over time. That is, financial integration amplifies international spillovers of macroeconomic fluctuations, which in turn lead to more synchronized business cycles (for instance, see Baxter & Kouparitsas, 2005; Böwer & Guillemineau, 2006; Camarero et al., 2018; Caporale & Girardi, 2016; Erden & Ozkan, 2014; Gianelle et al., 2017 and Lee & Azali, 2010). Second, in line with international trade theory, previous literature has argued that countries exporting similar baskets of goods would tend to be affected similarly by shocks to the international prices of their exports. Thus, in the current study, a similarity index for export dependency, measured in a similar way, is taken as a potential determinant of business cycle comovement (Allegret & Essaadi, 2011; Baxter & Kouparitsas, 2005; Juvenal & Monterio, 2017 and Tapsoba, 2010). In this way, a similarity in FDI and EXD is expected to have a positive impact on business cycle synchronization; hence, β_3 and β_4 will show a positive sign. ε_{ijt} and u_{ijt} are the disturbances in equations (4) and (5), respectively.

[68] The year 2000 marks the beginning of the EAC between the three big economies and original founders of the EAC. Thus, one could assume that there could be trade effects with spill-over effects to these neighbouring countries (Rwanda and Burundi, who joined 7 years later), which should not be ignored.
[69] Based on the bilateral characteristic of the variables of interest, and to avoid the endogeneity with the dependent variable, both indices are calculated in a similar way.
[70] First-stage regression results in Table A1 of the appendix show that both variables do not have any explanatory power on bilateral trade. Hence, they are taken as exogenous variables.

Regarding the primary focus of the paper, β_1 and β_2 are the main two effects. A positive relationship between trade intensity and business cycle synchronization is reflected in a positive β_1, which may also indicate the possible existence of the endogeneity of an OCA among African countries, explained above on page 2 (Frankel & Rose, 1998). A positive β_2 would indicate that EAC membership has tended to increase business cycle synchronization between partner states beyond that generally associated with greater bilateral trade.

The trade intensity variable in equation (4) is considered endogenous. This is because countries with higher synchronized business cycles are likely to trade more (less) during periods of expansion (contraction); moreover, factors included in the error term are assumed to be correlated with bilateral trade. Regarding this type of endogeneity, a simple OLS estimator is inconsistent (for details see Angrist & Pischke, 2009 and Cameron & Trivedi, 2010). Therefore, in this study, the OLS estimates will combine the direct effect of trade intensity on business cycle synchronization with the indirect effect that all factors captured in the error term of equation (4) have on the business cycle. The straightforward solution is to include as many control variables as possible; however, some relevant explanatory variables may not be observable, and even if they are, they may not be available.

Therefore, to consistently estimate the parameters of a system of linear simultaneous equations, such as the one above, much of the previous literature uses instrumental variable (IV) estimators as an alternative and powerful tool to address endogeneity. Among others, a 2SLS estimator, where the estimation is computed in two steps, is widely used. The first step regresses the endogenous variable on instruments, and the second step estimates the structural model with the endogenous variable replaced by the predicted values from the first step (see Anderson, 1979; Angrist & Pischke, 2009; Bergstrand, 1985, 1989; Cameron & Trivedi, 2010; Frankel & Rose, 1998; Gianelle et al, 2017; Greene, 2012; Herrero & Ruiz, 2008; Micco et al., 2003 and Rose & Stanley, 2005). Thus, in the current study, the 2SLS approach is used, and equation (4) becomes:

$$SIM_{ijt} = \beta_0 + \beta_1 ln\widehat{bt}_{ijt} + \beta_2 EAC_{ij} + \beta_3 SIMFDI_{ijt} + \beta_4 SIMEXD_{ijt} + \alpha_{it} + \alpha_{jt}, \quad (6)$$

where $\widehat{bt}_{ijt}$ denotes the predicted value of the bilateral trade variable, estimated from equation (5) using a pooled OLS with clustered robust standard errors. Again, the specification in equation (6) enables us to consistently estimate the direct effects of trade integration on business cycle synchronization, which is the focus of the current paper.

Theoretically, the IV approach is used to overcome serious endogeneity bias, but in practice, one needs valid and relevant instruments for the IV estimated coefficients to be consistent. The validity of the instruments used in this paper relies not only on economic theory but also on the previous related empirical studies mentioned earlier. Additionally, the relevance of the instruments used is tested using available diagnostic tests. This is discussed in more detail in the following section.

First, the model in (6) is estimated using a homogeneous panel estimator; however, the regression results though not reported, are small and not significant. As argued in Pesaran & Smith (1995) and Baltagi et al. (2000), in a static panel model, as in (6), it is unlikely that empirical estimators that assume the homogeneity of coefficients give consistent estimates when the coefficients across countries differ. This is the reason why these authors favor heterogeneous estimators rather than homogeneous ones, especially in the case of a short panel, where the cross-section dimension (N) is greater than the time-series dimensions (T). Further, De Hoyos and Sarafidis (2006) also claimed that a short panel dataset is likely to have cross-sectional dependence; hence, homogenous parameter methods such as the traditional FE and RE would not be appropriate. Given the short panel dataset in this paper, ignoring parameter heterogeneity and cross-sectional dependence may generate inconsistent estimates. The model in (7) was thus finally considered to consistently estimate the effect of bilateral trade on business cycle synchronization:

$$SIM_{ijt} = \beta_0 + \beta_{1i} ln\widehat{bt}_{ijt} + \beta_{2i} EAC_{ij} + \beta_{3i} SIMFDI_{ijt} + \beta_{4i} SIMEXD_{ijt} + u_{ijt}, \quad (7)$$

where
$$u_{ijt} = \alpha_{it} + \alpha_{jt} + \alpha_{1i} + \alpha_{1j} + \varepsilon_{ijt} \quad (8)$$

The parameters in (7) are country-specific slopes for the four explanatory variables discussed earlier. α_{1i} and α_{1j} are added to capture time-invariant heterogeneity across countries. Two panel estimators that assume heterogeneous slopes across countries are thus used: the augmented mean group (AMG) estimator proposed in Eberhardt (2012) and the Pesaran (2006) common correlated effects mean group (CCEMG) estimator. In Eberhardt (2012), it is further noted that these estimators perform well in terms of bias in panels with nonstationary and noncointegrated variables and cross-sectional dependence.[71]

[71] Following De Hoyos & Sarafidis (2006), the Pesaran (2004) CD test, which is suited for both balanced and unbalanced panels, is applied under the null hypothesis of cross-sectional independence / weak cross-sectional dependence; large values indicate that there is strong correlation between panel units. For most of the estimated models, the null hypothesis is rejected, indicating that that there is cross-sectional dependence in the residuals. The tests are respectively presented in the bottom of the results tables.

In practice, both estimators are simply mean-group estimators. That is, for the CCEMG estimator, cross-sectional (weighted) averages for all observed variables (both dependent and independent variables) and the individual-specific regressors are computed and then included as regressors in each of the regression equations, which in combination can account for the unobserved common factor.[72] Next, the estimated coefficients are averaged across panel units to obtain the unbiased and consistent estimates of the parameters related to the observed variables. The AMG estimator does not add the cross-sectional averages for observed variables as regressors; it is only augmented with a common dynamic process, estimated from the cross-sectional averages of the evolution of unobservable factors over time, i.e., year dummies (for this application, see Eberhardt, 2012).

4. Estimation results and discussion

Before discussing the regression results, let us look at the correlation coefficients of the variables included in the structural model, as reported in Table 1.

Table 1: Correlation between the model variables

	1	2	3	4	5
1 Sim index (GDP)	1				
2 Bilateral Trade 1	0.0479*	1			
3 Bilateral Trade 2	0.0605*	0.9944*	1		
4 Sim index (FDI)	0.0684*	0.0256	0.0187	1.0000	
5 Sim index (EXD)	0.0721*	0.1868*	0.1802*	0.0698*	1.0000

Note: * denotes statistically significant at the five percent level. Bilateral Trade 1 (BT1) normalizes with GDPs compared to Bilateral Trade 2 (BT2), which normalizes with the total trade.

In all columns, the coefficients show expected signs, and the regressors are weakly correlated with each other, except for the bilateral trade proxies (defined in (2) and (3), respectively), which are highly correlated. This is not surprising, given that both variables have the same numerator. Although the correlation coefficients show the expected signs, they are only informative and suggestive in supporting this study's structural model.

[72] As explained in Pesaran (2006), the intuition behind this estimation procedure is to filter the individual-specific regressors using cross-sectional aggregates, such that as the number of units tends to infinity, the differential effects of unobserved common factors are eliminated. For brevity, the estimated coefficients of the cross-sectional averages of observed and unobserved variables are not reported.

As mentioned earlier, the system of equations (4) and (5) is fitted using 2SLS. The first-stage regression results are reported in Table A1 in the Appendix. The first two columns of this table contain the results with different bilateral trade definitions used. Overall, the estimated coefficients in these columns have the expected signs. Moreover, from the tests of the weak instruments, with the corresponding F-statistics (p-values) of 593.68 (0.000) and 610.02 (0.000) using BT1 and BT2, respectively,[73] it is observed that these statistics are larger than 10 as the rule of thumb. This leads to the firm rejection of the null hypothesis of weak instruments and confirms the relevance and validity of the instruments. Hence, one could argue that the chosen instruments fit the model well and agree with the previous studies (for a detailed discussion, see Cameron & Trivedi, 2010).

Tables 2 and 3 present the main results that correspond to the two proxies of bilateral trade BT1 and BT2, respectively (analogous results using EAC_{ijt} are reported in Tables A4 and A5 in the Appendix). For comparative purposes, the results from the homogenous panel estimation (pooled OLS and GLS) of equation (4) are reported in the first two columns; their estimated coefficients, along with their robust standard errors, provide an idea of the correlation between dependent and independent variables in terms of expected results. However, from the performed Durbin-Wu-Hausman tests of endogeneity (see Hausman, 1978), the corresponding chi-sq. tests (p-values) are 6.69 (0.010) and 4.76 (0.029) using BT1 and BT2 variables, respectively. This leads to a rejection of the null hypotheses that both variables are exogenous and concludes that they must be considered endogenous in the estimated model.

Consequently, the 2SLS is employed as an alternative tool (Baltagi et al, 2000; Baum, 2006 and Angrist & Pischke, 2009), and the heterogeneous panel estimators AMG and CCEMG are used; the resulting regression results are presented in columns (3)-(6) of Tables 2 and 3. Moreover, a small sensitivity analysis including and excluding the FDI and EXD variables is performed because, as illustrated in columns (3) and (4), the estimated coefficients for these two exogeneous variables are insignificant and at some point show the unexpected signs; hence, they can be deleted from the model.[74] When both variables are excluded, the estimated coefficients of the predicted bilateral trade improve in both tables. This illustrates firmly the dominant role played by bilateral trade on business cycle synchronization (Baxter & Kouparitsas, 2005). Additionally, the Wald tests reported at the bottom of the regression results show that models without FDI and EXD fit well compared to those that include both variables.

[73] Specifically, the test of weak instruments follows the developments and discussions in Stock and Yogo (2002). As further explained in Baum (2006), the proposed test performs well when diagnosing instrument relevance in a model with one endogenous variable, which is the case in the current paper. For this application, see Bjørnland & Thorsrud (2015).

[74] This is in line with the findings of Böwer & Guilleminaue (2006) showing that financial integration (in terms of FDI flows) may appear not robust (fragile) in terms of business cycle synchronization. Caporale &Girardi (2016) also found a limited role of capital flows in business cycle comovement.

Table 2: Estimation results - dependent variable is the similarity index of GDP growth

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	OLS	GLS	AMG1	CCEMG1	AMG2	CCEMG2
BT1	0.0008*	0.0007*				
	(0.0004)	(0.0004)				
Both in EAC5	0.0147***	0.0136**				
	(0.0050)	(0.0063)				
Sim (FDI)	0.0012	0.0014**	-0.0002	0.0032		
	(0.0008)	(0.0006)	(0.0009)	(0.0027)		
Sim (EXD)	0.0035***	0.0025***	-0.0027	0.0088		
	(0.0010)	(0.0008)	(0.0041)	(0.0061)		
Predicted BT1			0.0376***	0.0194	0.0363***	0.0300***
			(0.0052)	(0.0167)	(0.0050)	(0.0059)
N	4336	4336	6700	6700	7440	7440
R2	0.059	0.058				
Wald tests			54.91	4.21	53.81	25.60
P-values			0.000	0.239	0.000	0.000
RMSE			0.0341	0.0243	0.0378	0.034
CD tests	6.124	8.085	10.222	4.667	9.804	1.459
P-values	0.000	0.000	0.000	0.000	0.000	0.145

Note: clustered-robust standard errors in parentheses. *, **, ***, denote significance at the 10, 5 and 1 percent levels, respectively. The dependent variable is measured as the absolute value of the real GDP growth difference between two trading partners. The bilateral trade is normalized by the sum of the trading country GDPs (BT1). The first column includes time dummies. In addition to the time dummies, country-time specific FE for both countries, are included in the second column. AMG is the augmented (with country trend) mean group estimator. CCEMG is the common correlated effect mean group estimator. Both estimators use predicted values for the BT variable. The Wald tests show that models without FDI and EXD indices fit well. whereas the RMSE values show that the CCEMG estimator performs well. This note applies to other tables, with minor differences explained in the following tables.

Moreover, the RMSE values (also reported at the bottom of the regression results) show that the CCEMG estimators outperform the AMG estimators (i.e., the lower the value, the better the model). This makes the results from the CCEMG estimators more consistent. Interestingly, the corresponding coefficients on the variable of interest, along with the robust standard presented in the last column of all tables, are as expected. Additionally, the cross-dependence tests described in Pesaran (2004) and Pesaran (2015) for cross-sectional dependence in the residuals of the estimated models are applied; the test results are also presented at the bottom of the regression results. From these tests, in almost all the models, there is strong evidence of cross-sectional dependence in the residuals, with the exception being the CCEMG2 models using BT1 (estimated p-values are greater than 0.05).

Table 3: Estimation results - dependent variable is the similarity index of GDP growth

Variables	(1) OLS	(2) GLS	(3) AMG1	(4) CCEMG1	(5) AMG2	(6) CCEMG2
BT2	0.0011***	0.0010**				
	(0.0003)	(0.0004)				
Both in EAC5	0.0139***	0.0128***				
	(0.0036)	(0.0048)				
Sim (FDI)	0.0012	0.0014*	-0.0008	-0.0008		
	(0.0008)	(0.0008)	(0.0009)	(0.0017)		
Sim (EXP)	0.0034***	0.0025**	-0.0031	0.0156		
	(0.0008)	(0.0010)	(0.0044)	(0.0116)		
Predicted BT2			0.0384***	0.0201	0.0368***	0.0314***
			(0.0055)	(0.0139)	(0.0048)	(0.0061)
N	4336	4336	6700	6700	7440	7440
R^2	0.061	0.060				
Wald tests			51.73	3.83	57.59	26.37
P-values			0.000	0.281	0.000	0.000
RMSE			0.0346	0.0239	0.0383	0.0343
CD tests	6.124	8.814	9.507	2.526	8.012	2.099
P-values	0.000	0.000	0.000	0.012	0.000	0.040

Note: clustered-robust standard errors in parentheses. *, **, ***, denote significance at the 10, 5 and 1 percent levels, respectively. Analogous results as in Table 2, except that the bilateral trade variable is normalized by the total trade.

Accordingly, one could argue that the regression results presented in columns (6) of Tables 2 and A4 (in the Appendix) are consistent and robust. It is important to note that the coefficients of the bilateral trade variable normalized by GDP (BT1) are slightly lower than those normalized by total trade (BT2). This is unsurprising given that the two ratios are slightly different from a computational point of view (Frankel & Rose, 1998 and Tapsoba, 2010 found the same results).

More importantly, the main and direct effects of bilateral trade on business cycle synchronization are maintained and appear insensitive to alternative specifications. The estimated coefficients of 0.0300 (using BT1) for the trade intensity variable in the 31-country sample (which includes EAC countries) are positive and statistically significant at the one percent level. Although this coefficient is small, which is unsurprising given that for the African countries, bilateral trade is a very small fraction of the sum of their GDPs, it implies a strong relationship between the two variables. This suggests that for the current study, using BT1 seems to result in a robust measure of the effect of bilateral trade on the similarity in GDP growth. Moreover, the result is consistent with this study's literature, such as the empirical evidence from Calderon et al. (2007) and Tapsoba (2010), showing that the effect of trade integration on cycle correlation among developing countries is small compared to that among industrial countries.

Bearing in mind the endogeneity hypothesis by Frankel and Rose (1998) given on page 130, the positive sign of the estimated coefficient for the trade intensity variable may indicate the possible occurrence of OCA endogeneity among these countries. This suggests that a monetary union among these countries would lead to trade intensity, which in turn would lead to more synchronized business.[75]

Turning to time-unvarying EAC membership, which shows the trade effects on business cycle synchronization for the five EAC members compared to non-EAC members, the estimated coefficients for that variable have the expected signs in traditional homogeneous estimators; however, they are not estimated when heterogeneous estimators are used. Nevertheless, from the graphical visualizations shown in Figures 4.a and 4.b using both predicted values and logged values of BT1 (the same analysis using BT2 is shown in Appendix Figure A7a and Figure A7b), one can see that, alongside EAC membership, country pairs with higher bilateral trade tend to have more synchronized business cycles.

Indeed, from both figures, the largest and smallest values of both trade intensity and business cycle synchronization are shown. The largest values correspond to the original founder country pairs, namely, Kenya-Tanzania, Kenya-Uganda, and Tanzania-Uganda. The small values are mostly taken from the Burundi-Rwanda pair, who joined the union later. Moreover, pairings of these two countries with the rest of the EAC show a low correlation.

[75] The reader should also refer to Table A1 in the Appendix showing the positive estimated coefficient of "CFA members" variable, indicating that countries using CFA trade more compared to countries that do not use CFA.

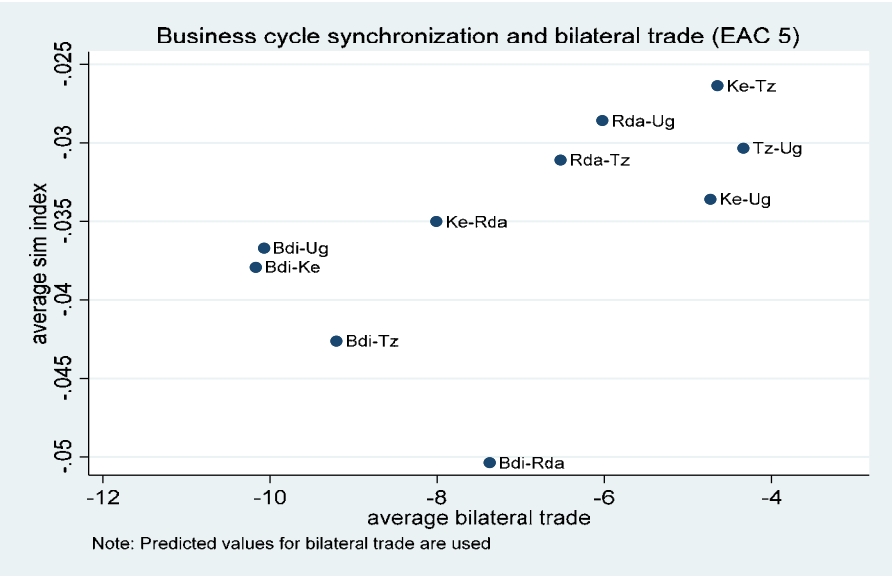


Figure 4.a. Business cycle synchronization and bilateral trade in the EAC countries.

Source: own computation using average values (predicted values) for BT1.

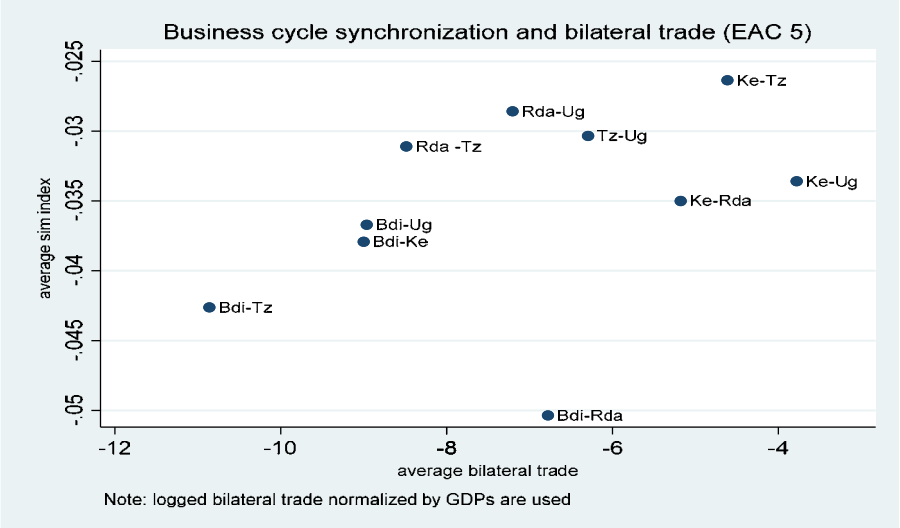


Figure 4.b. Business cycle synchronization and bilateral trade in the EAC countries.

Source: own computation using average values (logged bilateral trade) for BT1.

In summary, the scatter plots show a positive correlation between business cycle synchronization and bilateral trade among the five EAC member states. Although the correlation is weak for the Rwanda and Burundi pair, it is strongly positive among Kenya, Tanzania and Uganda. This suggestively supports the assumption that the positive effect of trade intensity on business cycle synchronization is associated with membership in the EAC.

Moreover, for comparison purposes, a scatter analysis for the West and Central African monetary unions (CFA zones) is also plotted. Interestingly, Figure A8a and Figure A8b (using BT1)[76] in the Appendix uses the observations for CFA country pairs and illustrates a positive correlation between trade intensity and business cycle synchronization among these countries. This suggests OCA endogeneity in Africa, given that the positive correlation of trade intensity and business cycle synchronization is still present after the creation of a monetary union.

It should be recalled that this study focuses on the relationship between trade intensity and business cycle synchronization among the EAC countries. Thus, for further sensitivity analysis, the EAC membership dummy is allowed to vary slightly. The regression results from this specification are presented in Tables A4 and A5 in the Appendix and confirm the prior results. Interestingly, for the preferred estimator, the estimated coefficients remain positive and significant at the one percent level. The importance of the heterogeneity slopes has been tested, and the RMSEs are reported; the results suggest that the CCEMG estimator fits the model well. Overall, the results from the sensitivity analysis show that the estimated coefficients remain unchanged in both signs and significance, suggesting that this study's main results are robust despite the different specifications applied. Once again, this evidence could be considered a confirmation that greater bilateral trade is associated with business cycle synchronization in Africa and that membership in the East African Community may lead to a more synchronized business cycle, as these countries will continue implementing trade integration policies. Hence, the empirical answer to this paper's question is that bilateral trade is positively associated with business cycle synchronization in studied African countries and in the EAC countries as well.

[76] There are too many pairings (each dot refers to a different country pair) for countries in CFA zones compared to EAC countries. Thus, for clarity, only some are shown.

5. Conclusion and policy implications

This paper investigates how trade intensity and business cycle synchronization are related to provide support to the EAC countries, who must decide whether to join a monetary union. A panel consisting of thirty-one African countries from the years 2000 to 2016 is used. A conclusion drawn from this research is that there is a positive relationship between trade intensity and business cycle synchronization among these countries. This has been found after controlling for endogeneity using a static CCEMG - 2SLS estimator that allows for heterogeneous slope coefficients and further corrects for cross-sectional dependence. Overall, the estimation results are robust to the alternative specifications, and they do not conflict with those of previous studies.

From the regression results, the complementarity of the effects of bilateral trade and EAC membership on business cycle synchronization is not explicitly found, which finding would indicate the level at which the trade intensity effect on business cycle synchronization differs for EAC member countries versus non-EAC member countries. Nonetheless, from the scatter analysis one can argue that being a member of the EAC may reduce asymmetric shocks between the partner states. Put differently, EAC membership increases the synchronization of the business cycle between the partner states through their trade ties.

In accordance with the above, it is possible to argue that the impact of trade intensity on business cycle synchronization (found among the sample of 31 African countries, which also include the five EAC member countries) reveals that a monetary union may be good for these countries. With respect to this result, the primary policy implication is that policymakers at the EAC level should carefully examine integration policies aimed at opening these countries to trade, as this may result in a higher synchronized business cycle, which in turn will provide more chances of creating a sustainable monetary union. The study thus recommends the strengthening of both customs union and common market protocols while sustaining current trade policies.

Due to the potential limitations in both data and econometric estimation methods, the results in this paper might be preliminary and could raise doubts about the future sustainability of the proposed East African Monetary Union. Nevertheless, they partially provide academic support to both the political and economic will of strengthening the integration of the EAC. The study should thus be of interest for further debate and policy decisions on the readiness of the East African Monetary Union, such as an early entry into a monetary union as predicted by the new OCA theory (Frankel and Rose, 1998). Further empirical analysis of the channels through which trade affects the synchronization of business cycles would be needed to better explore OCA endogeneity among EAC countries. However, such an analysis was not the focus of the present study, although it is likely a relevant topic for future research.

References

Allegret, J. P., & Essaadi, E. (2011). Business cycles synchronization in East Asian economy: Evidences from time-varying coherence study. *Economic Modelling*, *28*(1–2),351–365.

Anderson, J.E. (1979). A Theoretical Foundation for the Gravity Equation. *American Economic Review*, 69: 106-116.

Angrist, JD. And Pischke, J.S. (2009). *Mostly harmless econometrics: an empiricist's comparison*. Princeton and Oxford: Princeton University Press

Baldwin, R., & Taglioni, D. (2006). *Gravity for dummies and dummies for gravity equations*. Working paper (No.12516). National bureau of economic research.

Baltagi, B. H., Griffin, J. M., & Xiong, W. (2000). To pool or not to pool: Homogeneous versus heterogeneous estimators applied to cigarette demand. *Review of Economics and Statistics*, *82*(1), 117–126.

Baum, C. F. (2006). *An introduction to modern econometrics using Stata*. Stata Press.

Baxter M and Kouparitsas M.A. (2005). Determinants of business comovement: a robust analysis. *Journal of Monetary Economics,* 52 (1) 113-157.

Baxter, M. (1995). International Trade and Business Cycles, Handbook of International Economics, vol. Grossman, GM, and K. Rogoff, 1801-1864.

Bergstrand, J.H. (1985). "The Gravity Equation in International Trade: some Microeconomics foundations and empirical evidence", *Review of Economics and Statistic,* 67: 474-481.

Bergstrand, J.H. (1989). "The Generalized Gravity Equation, Monopolistic Competition, and Factor- proportions Theory in International Trade", *Review of Economics and Statistic,* 71: 143-153

Bjørnland, H. C. and Thorsrud, L.A. (2015). Applied time series for macroeconomics. 2nd edition. Gyldendal Akademisk

Bouët, A., Cosnard, L., & Laborde, D. (2017). Measuring trade integration in Africa. *Journal of Economic Integration*, 937–977.

Böwer, U., & Guillemineau, C. (2006). Determinants of business cycle synchronisation across euro area countries Working Paper (No. 587). European Central Bank.

Caetano, J. M., & Caleiro, A. B. (2018). On Business Cycles Synchronization: Some Directions for The Eurasia. *Eurasian Journal of Economics and Finance*, *6*(3), 13-33.

Calderon, C., Chong, A., Stein, E. (2007). Trade intensity and Business cycle synchronization: are developing countries any different? *Journal of International Economics*, 71: 2-21

Camarero, M., Gómez-Herrera, E., & Tamarit, C. (2018). New evidence on Trade and FDI: how large is the Euro effect? *Open Economies Review*, 29(2), 451-467.

Cameron, A. C., & Trivedi, PK. (2010). *Microeconometrics Using Stata*. Revised edition. Texas: Stata Press

Canova, F. (1999). Does detrending matter for the determination of the reference cycle and the selection of turning points? *The Economic Journal*, *109*(452), 126–150.

Canova, F., & Dellas, H. (1993). Trade interdependence and the international business cycle. *Journal of International Economics*, 34(1-2), 23-47.

Caporale, G. M., & Girardi, A. (2016). Business cycles, international trade and capital flows: evidence from Latin America. *Empirical Economics*, *50*(2), 231–252.

De Grauwe, P. (2014). *Economics of monetary union*. 10th edition. Oxford University Press.

De Grauwe, P. (2018). *Economics of monetary union*. 12th edition. Oxford University Press.

De Grauwe, P., & Mongelli, F. (2005). Endogeneities of optimum currency areas: What brings countries sharing a single currency closer together? Working paper, No 468, European Central Bank.

De Haan, J., Inklaar, R., & Jong-A-Pin, R. (2008). Will business cycles in the euro area converge? A critical survey of empirical research. *Journal of Economic Surveys*, *22*(2), 234-273.

De Hoyos, R. E., & Sarafidis, V. (2006). Testing for cross-sectional dependence in panel-data models. *The Stata Journal*, *6*(4), 482–496.

Drummond, P., Wajid, K., & Williams, O. (eds) (2014). *The quest for regional integration in the East African Community*. Washington, DC: IMF

EAC (2013), the protocol on the establishment of the East African Monetary Union. Available from the EAC website (www.eac.int)

EAC (2018). The 22nd ordinary meeting of the Monetary Affairs Committee (MAC). Report of the Governors. Available from the EAC website (www.eac.int)

Eberhardt, M. (2012). Estimating panel time-series models with heterogeneous slopes. *The Stata Journal*, 12(1), 61–71.

Erden, L., & Ozkan, I. (2014). Determinants of international transmission of business cycles to Turkish economy. *Economic Modelling*, *36*, 383–390.

Fiess, N. (2007). Business cycle synchronization and regional integration: a case study for Central America. *The World Bank Economic Review*, *21*(1), 49–72.

Frankel, J., Rose, A. (1998), "The Endogeneity of the optimum currency Criteria", *Economic Journal*, 108, 1009-1025

Gianelle, C., Montinari, L., & Salotti, S. (2017). Interregional Trade, Specialization, and the Business Cycle: Policy Implications for the EMU. *Journal of Business Cycle Research*, 13(1), 1-27.

Giannone, D., Lenza, M., & Reichlin, L. (2008). Business cycles in the euro area. Working paper No. 14529. National Bureau of Economic Research. Retrieved from: https://www.nber.org/papers/w14529

Glick, R., & Rose, A. K. (2002). Does a currency union affect trade? The time-series evidence. *European Economic Review*, 46(6), 1125–1151.

Greene, W. H. (2012). *Econometric Analysis*. International edition, Seventh Edition New York: Pearson Education Limited.

Hausman, J. A. (1978). Specification tests in Econometrics. *Econometrica,* 46 (6),1251-1271.

Herrero, A. G., & Ruiz, J. M. (2008). Do trade and financial linkages foster business cycle synchronization in a small economy? Working Paper No. 0810. Bank of Spain,

Juvenal, L., & Monteiro, P.S. (2017). Trade and Synchronization in a Multi-Country Economy. *European Economic Review*, 92 (2017) 385–415.

Kalemli-Ozcan, S., Papaioannou, E., & Peydro, J. L. (2013). Financial regulation, financial globalization, and the synchronization of economic activity. *The Journal of Finance*, *68*(3), 1179–1228.

Krugman, P. (1993). "Lessons of Massachusetts for EMU". In Torres F., and Giavazzi. F. (eds). *Adjustment and growth in the European Monetary Union*: Cambridge University Press, pp.241-261.

Lee, G. H., & Azali, M. (2010). The endogeneity of the optimum currency area criteria in East Asia. *Economic Modelling*, *27*(1), 165–170.

Micco, A., Stein, E., & Ordoñez, G. (2003). The currency union effect on trade: early evidence from EMU. *Economic Policy,* 18(37), 315-356.

Mundell, R., 1961, "A Theory of Optimum Currency Areas", *American Economic Review* 51(4) 657-665

Pesaran, M. H. (2006). Estimation and inference in large heterogeneous panels with a multifactor error structure. *Econometrica*, *74*(4), 967–1012.

Pesaran, M. H (2004). General diagnostic tests for cross section dependence in panels. discussion paper No 1240, IZA. Retrieved from: http://ftp.iza.org/dp1240.pdf

Pesaran, M. H (2015). Testing weak cross-sectional dependence in large panels. Econometric Reviews, 34(6–10), 1089–1117.

Pesaran, M. H., & Smith, R. (1995). Estimating long-run relationships from dynamic heterogeneous panels. *Journal of Econometrics*, *68*(1), 79–113.

Rose, A. K. (2000). One money, one market: the effect of common currencies on trade. *Economic Policy*, *15*(30), 9-45.

Rose, A. K., & Stanley, T. D. (2005). A meta-analysis of the effect of common currencies on international trade. *Journal of Economic Surveys*, *19*(3), 347–365.

Stock, J. H., Wright, J. H., & Yogo, M. (2002). A survey of weak instruments and weak identification in generalized method of moments. *Journal of Business & Economic Statistics*, *20*(4), 518–529.

Tapsoba, S. J. A. (2010). Trade intensity and business cycle synchronicity in Africa. *African Development Review*, 22(1), 149-172.

Vieira, C., & Vieira, I. (2012). Assessing the endogeneity of OCA conditions in EMU. *The Manchester School,* 80(s1), 77-91.

WTO [World Trade Organization] (2016). World trade statistical review. WTO report. Retrieved on 26th July 2019 from https://www.wto.org/english/res_e/statis_e/wts2016_e/wts2016_e.pdf

Appendix

Table A1: First-stage regressions - Dependent variable is the logged bilateral trade

	(1)	(2)	(3)	(4)
Variables	BT1	BT2	BT1	BT2
ln_rgdp_exporter	0.2860***	0.3064***	0.2789***	0.2980***
	(0.0899)	(0.0923)	(0.0900)	(0.0925)
ln_rgdp_importer	0.3065***	0.3584***	0.2993***	0.3522***
	(0.0750)	(0.0743)	(0.0752)	(0.0745)
Ln distance	-0.9301***	-0.9837***	-1.0172***	-1.1107***
	(0.2088)	(0.2071)	(0.2044)	(0.2058)
Common border	1.8162***	1.7942***	1.8741***	1.8825***
	(0.3807)	(0.3871)	(0.3792)	(0.3886)
Common language	0.9098***	0.9556***	0.9098***	0.9583***
	(0.2144)	(0.2190)	(0.2147)	(0.2197)
Free trade agreement	0.8747***	0.7439***	0.8308***	0.6806***
	(0.1807)	(0.1836)	(0.1772)	(0.1799)
Both in EAC5	1.2279**	1.5677***		
	(0.6153)	(0.5993)		
CFA members	1.2439***	1.3337***	1.1360***	1.1796***
	(0.3515)	(0.3480)	(0.3400)	(0.3378)
Similarity index (FDI)	0.0034	-0.0056	0.0027	-0.0063
	(0.0211)	(0.0206)	(0.0211)	(0.0206)
Similarity index (EXD)	-0.0069	-0.0234	-0.0054	-0.0218
	(0.0449)	(0.0455)	(0.0449)	(0.0455)
Both in EAC[1]			0.3976	0.2562
			(0.2439)	(0.2435)
N	4561	4561	4561	4561
R^2	0.402	0.398	0.400	0.393

Notes: cluster-robust standard errors are provided in parentheses. *, **, ***, denote significance at the 10, 5 and 1 percent levels, respectively. When the similarity indices for FDI and EXD are added in the equation, they seem to have no explanatory power in explaining bilateral trade between African countries and are thus taken as exogenous variables in the current study. Time dummies and time-varying country-specific dummies are included in all models. [1,] The EAC variable takes a value of 1 starting in 2007, hence becoming a time-varying factor for Rwanda and Burundi. BT1 is the bilateral trade normalized by NGDPs, whereas BT2 shows bilateral trade normalized by total trade.

Table A2: Summary statistics of the variables in the structural model

Variables	Obs	Mean	Std. Dev.	Min	Max
Sim index (GDP)	7,440	-0.0476	0.0495	-0.5390	0.0000
BT1	5,017	-9.8747	2.9487	-22.6154	-2.7560
BT2	5,017	-9.1343	2.9799	-22.3132	-1.9159
Sim index (FDI)	7,140	-1.3611	1.2875	-9.8084	-0.0004
Sim index (EXD)	7,905	-0.7841	1.0290	-6.5972	-0.0001

Table A3: Summary statistics of the other variables used

Variables	Obs	Mean	Std. Dev.	Min	Max
Ln_rgdp exporter	7,905	23.4935	1.3928	21.0597	26.8545
Ln_rgdp-importer	7,905	23.5017	1.3659	21.0597	26.8545
Ln_distance	7,905	7.9856	0.6691	5.0887	9.1130
Common border	7,905	0.0989	0.2986	0	1
Common language	7,905	0.4710	0.4992	0	1
FTA	7,905	0.2404	0.4273	0	1
CFA members	7,905	0.0968	0.2957	0	1
Both in EAC	7,905	0.0215	0.1451	0	1

Table A4: Estimation results - dependent variable is the similarity index of GDP growth

Variables	(1) OLS	(2) GLS	(3) AMG1	(4) CCEMG1	(5) AMG2	(6) CCEMG2
BT1	0.0008**	0.0007*				
	(0.0003)	(0.0004)				
Both in EAC	0.0155***	0.0116***	0.0006*	-0.0003	0.0001	-0.0003
	(0.0033)	(0.0033)	(0.0003)	(0.0017)	(0.0003)	(0.0003)
Sim (FDI)	0.0012	0.0013	-0.0003	-0.0010		
	(0.0008)	(0.0008)	(0.0009)	(0.0013)		
Sim (EXP)	0.0035***	0.0026***	-0.0024	0.0019		
	(0.0008)	(0.0010)	(0.0041)	(0.0069)		
Predicted BT1			0.0392***	0.0007	0.0389***	0.0316***
			(0.0053)	(0.0147)	(0.0051)	(0.0074)
N	4336	4336	6700	6700	7440	7440
R^2	0.059	0.057				
Wald test			62.72	0.68	57.08	19.26
P-values			0.000	0.953	0.000	0.000
RMSE			0.0341	0.0246	0.0377	0.0334
CD tests	8.181	8.551	10.445	2.984	8.816	1.872
P-values	0.000	0.000	0.000	0.003	0.000	0.061

Notes: cluster-robust standard errors in parentheses. *, **, ***, denote significance at the 10, 5 and 1 percent levels, respectively. The only difference with Table 2 is that the regression results presented in this table use the time varying EAC dummy.

Table A5: Estimation results - dependent variable is the similarity index of GDP growth

	(1)	(2)	(3)	(4)	(5)	(6)
Variables	OLS	GLS	AMG1	CCEMG1	AMG2	CCEMG2
BT2	0.0011***	0.0011***				
	(0.0003)	(0.0004)				
Both in EAC	0.0147***	0.0111***	0.0005	-0.0005	-0.0000	0.0008**
	(0.0033)	(0.0032)	(0.0004)	(0.0017)	(0.0003)	(0.0004)
Sim (FDI)	0.0012	0.0013	-0.0009	-0.0007		
	(0.0008)	(0.0008)	(0.0009)	(0.0016)		
Sim (EXP)	0.0034***	0.0025**	-0.0026	-0.0046		
	(0.0008)	(0.0010)	(0.0044)	(0.0067)		
			0.0392***	0.0033	0.0386***	0.0370***
Predicted BT2			(0.0057)	(0.0120)	(0.0050)	(0.0071)
N	4336	4336	6700	6700	7440	7440
R^2	0.061	0.059				
Wald tests			58.18	1.01	59.70	31.58
P-values			0.000	0.907	0.000	0.000
RMSE			0.0345	0.0246	0.0382	0.0333
CD tests	8.096	6.967	10.178	2.116	7.556	2,201
P-values	0.000	0.000	0.000	0.034	0.000	0.030

Notes: cluster-robust standard errors in parentheses. *, **, ***, denote significance at the 10, 5 and 1 percent levels, respectively. The notes in Table 3 apply here, except that the regression results presented in this table use the time varying EAC dummy.

Table A6: List of countries

Algeria	Gabon**	Niger
Angola	Guinea**	Nigeria
Benin**	Ivory Coast**	Rwanda*
Botswana**	Kenya*	Senegal
Burkina Faso**	Madagascar	South Africa
Burundi*	Malawi	Tanzania*
Cameroon**	Mali	Togo
Central African Republic**	Mauritania	Uganda*
Egypt	Mauritius	Zambia
Ethiopia	Morocco	Zimbabwe

Source: Author compilation. Countries are shown in alphabetical order with * and ** denoting member countries of EAC and countries using CFA francs

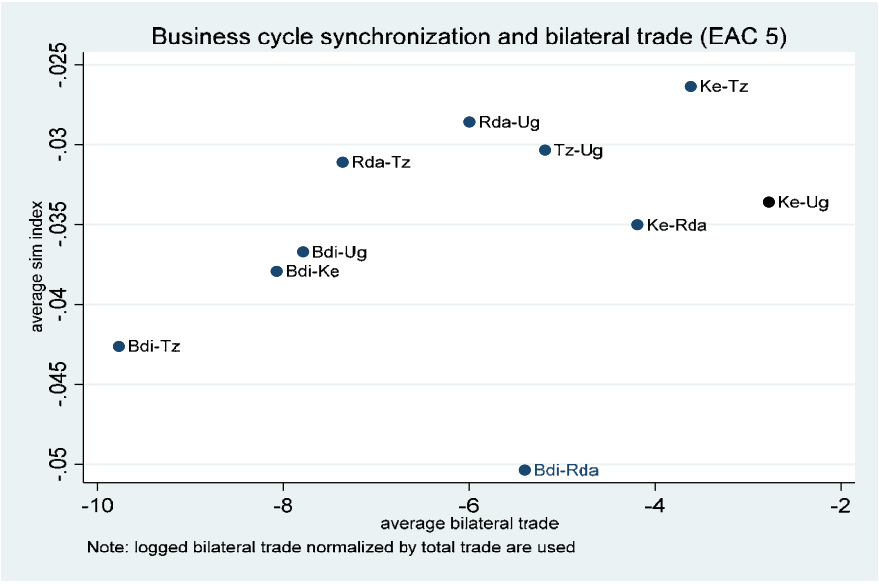


Figure A7a. Business cycle synchronization and bilateral trade (normalized by total trade) in the EAC countries

Source: own computation using average values (logged bilateral trade) for BT2.

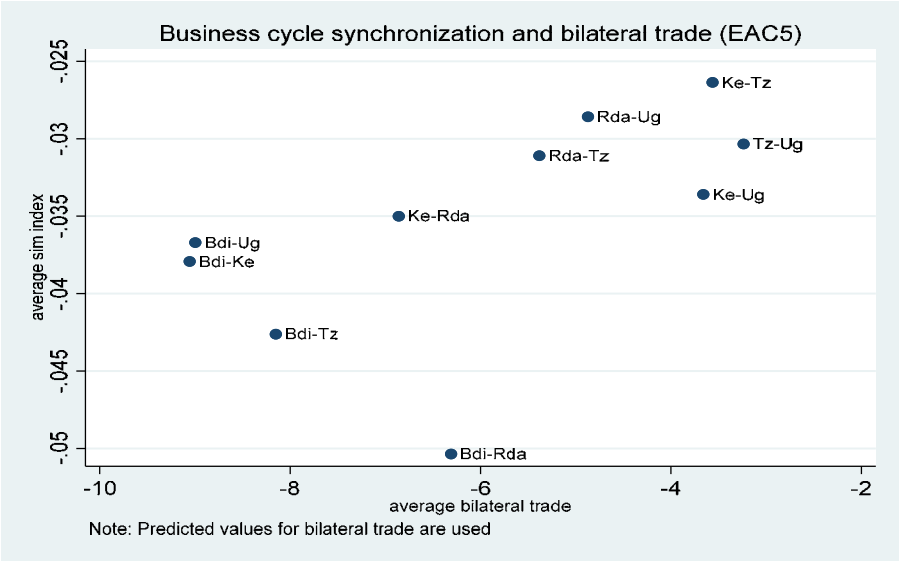


Figure A7b. Business cycle synchronization and bilateral trade (normalized by total trade) in the EAC countries

Source: own computation using average values (predicted values) for BT2.

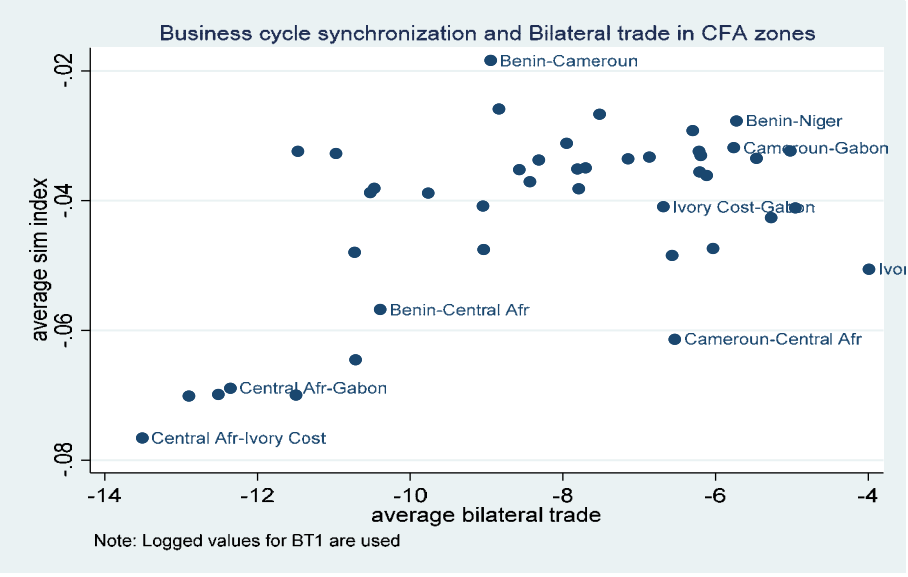


Figure A8a. Business cycle synchronization and bilateral trade (normalized by total trade) in the CFA zone countries (2000-2016)

Source: own computation using average values (logged values) for BT1.

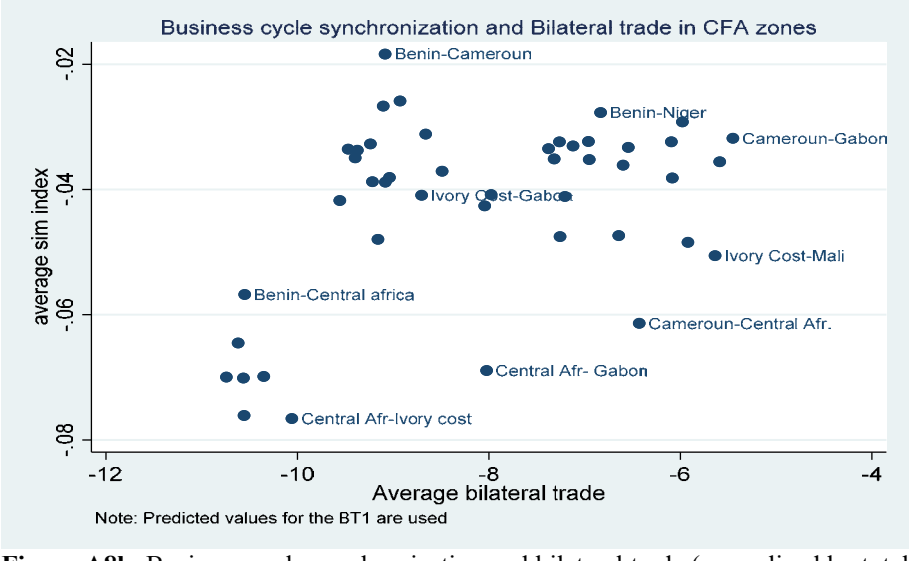


Figure A8b. Business cycle synchronization and bilateral trade (normalized by total trade) in the CFA zone countries (2000-2016)

Source: own computation using average values (predicted values) for BT1.

Paper 4: Commonalities in the Levels and Movements of the Inflation rates among Countries in the East African Community

Scott Hacker & Yvonne Umulisa

4

COMMONALITIES IN THE LEVELS AND MOVEMENTS OF INFLATION RATES AMONG COUNTRIES IN THE EAST AFRICAN COMMUNITY

Scott Hacker & Yvonne Umulisa

ABSTRACT

In this study, we investigate the degree to which inflation rates and their movements for countries in the East African Community (EAC) have become more similar, which is an important issue for the EAC's goal of creating a common currency. We find that the five EAC countries (excluding South Sudan) have had a tendency to converge in their inflation-rate levels, and we show through an inflation-movement similarity index that inflation-rate changes between consecutive months trended toward becoming more similar between 1995 and 2018 for most country pairs from these EAC countries. We also find that the inflation correlations between these EAC countries seem favorable for monetary union when comparing these correlations to analogous ones for the 2001 European Monetary Union countries prior to the creation of the euro and to analogous ones for the West African Economic Monetary Union countries.

Commonalities in the Levels and Movements of Inflation Rates among Countries in The East African Community

1. Introduction

In November 2013, the five East African Community (EAC) member countries at that time[77] – Burundi, Kenya, Rwanda, Tanzania, and Uganda – agreed to create a monetary union within ten years. The Protocol on the Establishment of the East African Monetary Union (EAMU) indicates the macroeconomic convergence criteria that need to be achieved and sustained for at least three consecutive years prior to the 2024 introduction of the single currency. The criteria include, inter alia, a core inflation ceiling of 5% as well as a headline inflation ceiling of 8% (for more details, see EAC, 2013). These criteria as well as the other three key criteria provided subsequently are rooted in theoretical considerations as to what conditions support a common currency, as discussed in optimum currency area (OCA) theory (early contributions to this theory are Mundell, 1961; McKinnon, 1963; and Kenen, 1969).

Discussions of the costs of having a single currency often focus on the issue of the monetary-policy dilemma that faces a central bank when asymmetric shocks affect member regions in a common currency area; e.g., should the central bank pursue an expansionary policy to help a member region experiencing unemployment difficulties if this policy leads to greater inflation in another member region (see, for example, Mundell, 1961)? Differences in inflation-rate movements are reflective of differences in economic shocks and/or differences in individual countries' responses to economic shocks. Pairs of countries that face similar inflation-rate changes are more likely to have similar goals regarding monetary policy than other country pairs. Having such similar goals is important for a smoothly operating monetary union. For these reasons, this paper aims to answer the following two questions:

[77] The EAC (an intergovernmental organization) is now composed of six countries, as South Sudan joined it in September 2016. The EAC was re-established between Kenya, Tanzania, and Uganda in July 2000 following a previous version of it that existed in 1967–1977. Burundi and Rwanda joined the EAC in July 2007.

1) Do the inflation-rate levels among EAC countries show a tendency to converge?
2) Have the EAC countries become more closely related regarding variations in their inflation rates?

To answer these questions, we explore monthly EAC inflation data from 1995 to 2018. The EAC data we consider are for the five countries that agreed to form the EAMU in 2013; hence, in this paper, the term "EAC" refers to these five countries. The first question is addressed by considering whether there is a tendency for the inflation rate in each country to converge to a weighted average of the inflation rates of the other EAC members. The second question is addressed in two ways. The first way is through an inflation-movement similarity index, which measures the similarity in inflation rate changes between two consecutive time periods. This index takes a very short-term perspective by considering only similarity in movement between consecutive periods. We investigate the development of this index over time for pairs of EAC countries. The second way is by measuring over multiple-year time spans the correlation between the monthly inflation rate in each country and a weighted average of the inflation rates of the other EAC members. This allows us to consider how similar the up-and-down movements in inflation are across the countries over a larger time span than just consecutive periods. To consider the relevance of these correlations for the EAC's planned monetary union, we investigate similar correlations in the European Monetary Union (EMU) and the West African Economic and Monetary Union (WAEMU).

The issue of convergence in inflation levels is connected to the issue of similarity of inflation movements, but they are not the same issue. Convergence in inflation levels refers to inflation rates being closer to each other and, in the case of monetary-union goals, being closer at low or moderate levels. This issue was recently investigated by Dridi and Nguyen (2019), who found that inflation rates have been converging among the EAC countries. Similarity of inflation movements, which this paper investigates in addition to convergence in inflation-rate levels, has more to do with the degree to which inflation rates in different countries rise and fall together. This is important since the more similar countries are in this way, the less likely they are to have conflicts in how monetary policy should proceed.

Complete convergence in inflation levels naturally leads to complete convergence in inflation-rate movements, but converging inflation levels is not necessarily associated with converging inflation-rate movements. Consider, for example, two countries that both have regular inflation cycles, but one country has inflation troughs at the same times that the other country has inflation peaks and has inflation peaks at the same times that the other country has inflation troughs. Suppose the first country initially has far higher inflation on average than the second, and subsequently, the first country's average inflation becomes closer to, but not identical to, the second country's inflation rate with no other changes in the inflation cycle in either country. This can be characterized as some

convergence in the two countries' inflation levels with no convergence in their inflation-rate movements.

Our results indicate that inflation levels showed a tendency to converge among the EAC members from the time when the future EAMU was agreed upon to the end of 2018. This convergence tendency was not new, however – such a tendency had existed previously among these countries. Additionally, through the inflation-movement similarity index noted above, we show that inflation-rate changes between consecutive months trended toward becoming more similar between 1995 and 2018 for most country pairs from the five EAC countries. Furthermore, based on a rank-correlation measure, Kendall's tau, we observe a strengthening in the inflation-rate correlations of the EAC countries between 2001 and 2018, with the possible exception of Rwanda and the rest of the EAC. The inflation-rate correlations for the EAC countries in 2014-2018 are typically stronger than the analogous ones for the 2001 EMU countries in the five years prior to the creation of the euro and the analogous ones in 2013-2018 for the WAEMU countries. These results are favorable to the success of the proposed monetary union among the EAC countries.

The rest of this study is organized as follows. The next section provides background on inflation-convergence targets and reviews previous empirical studies on inflation-rate convergence in actual or proposed monetary unions. Section 3 provides background on the EAC economies and their inflation movements over time. Section 4 describes the data that are used for the empirical work. Section 5 presents our empirical results regarding convergence in inflation levels among the EAC countries. Section 6 provides our findings on similarity indices for the EAC countries, and Section 7 presents our results regarding inflation-rate correlations among these countries. Section 8 provides conclusions for the study.

In November 2013, the five East African Community (EAC) member countries at that time[78] – Burundi, Kenya, Rwanda, Tanzania, and Uganda – agreed to form a monetary union within a decade. The protocol on the establishment of the East African Monetary Union (EAMU) highlights the macroeconomic convergence criteria that must be attained and maintained at least three consecutive years before the introduction of the single currency in 2024. The criteria include, inter alia, a core inflation ceiling of five percent as well as a headline inflation ceiling of eight percent (for more details see EAC, 2013). These criteria together with the other three key criteria provided subsequently are all rooted in theoretical considerations as to what conditions are supportive of having a common currency, as discussed in Optimum Currency Area (OCA) theory (early contributions to this theory are Mundell, 1961; McKinnon, 1963; and Kenen, 1969).

[78] The EAC (an intergovernmental organization) is now composed of six countries, with South Sudan which joined in September 2016. The EAC was re-established between Kenya, Tanzania, and Uganda in July 2000, following a previous version of it in 1967 – 1977. Burundi and Rwanda joined the EAC in July 2007.

2. Inflation convergence in agreements and practice

Traditionally, when countries decide to participate in a monetary union, they also agree to implement policies to support reaching their specified macroeconomic convergence targets, which must be achieved at least two or three years before the adoption of the single currency. For example, the treaty founding the European Union (EU), the Maastricht Treaty, highlights four key criteria regarding inflation, public debt, interest rates and exchange rates that countries had to meet before joining the European Monetary Union (see Busetti et al., 2007 for details on the European Union inflation-convergence criterion). Similar criteria apply to the countries of the Economic Community of West African States (ECOWAS) (which consists of 15 countries, including the 8 WAEMU countries already using the CFA franc) in their discussions of creating a monetary union (for details, see Nkwatoh, 2018 and Saka et al., 2015).

In the same spirit, when the EAC partner states decided to create the monetary union in 2013, they agreed to monitor a few macroeconomic convergence criteria as well. These criteria are split into two types, namely, indicative and performance convergence criteria. The former, taken as early warning indicators, are a ceiling of 5% for core inflation, a ceiling for the fiscal deficit (grants excluded) at 6% of gross domestic product (GDP), and a tax-to-GDP ratio ceiling at 25%. However, to enable an easy assessment of these indicative criteria, the following performance convergence criteria were also set: a ceiling at 8% for headline inflation, international reserves coverage of at least 4.5 months of imports, a 3%-of-GDP ceiling for the fiscal deficit (grants included), and a ceiling for gross public debt at one-half of GDP (for details, see EAC, 2013).

Most previous studies dealing with monetary-union inflation convergence have investigated the EU countries using pre-euro and post-euro information. Busetti et al. (2007), for example, studied the convergence properties of inflation rates among the countries of the eurozone over the period 1980–2004. After splitting the sample into two parts (before and after the birth of the euro), they applied unit-root tests to inflation differentials. Their results showed that these countries were converging over the pre-euro period, 1980–1997. Next, they applied stationarity tests to inflation differentials and found that, contrary to theoretical expectations, after the adoption of the euro, the member countries showed some divergence in their inflation levels. They detected two separate convergence groups, with Italy excluded from both: (1) a lower-inflation group consisting of Austria, Belgium, France, Finland, and Germany and (2) a higher-inflation group consisting of Greece, Ireland, Portugal, Spain, and the Netherlands (Busetti et al., 2007). Other studies have investigated the inflation-convergence issue for a period either just prior to the adoption of the euro (see Kočenda & Papel, 1997 and Siklos & Wohar, 1997, among others) or for a period just after the creation of the euro (see, for instance, Lagoa, 2017 and Lopez & Papell, 2012).

In addition to research on inflation convergence among EU members, studies on inflation convergence among African countries are also numerous. Dridi and Nguyen (2019), who focused on EAC countries, reviewed a substantial number of studies focusing on African monetary unions, especially those focusing on the inflation convergence among the EAC members (their reviewed studies involving the EAC included Kishor & Ssozi, 2010; Drummond et al., 2015; and Carcel et al., 2015, to name but a few).

These EAC inflation-convergence studies have used mostly panel unit-root tests and cointegration approaches to check the patterns and persistence of inflation rates. Some previous studies, such as Kishor and Ssozi (2010) and Carcel et al. (2015), have discussed the limitations of panel unit roots and panel cointegration models and applied various powerful techniques to deal with these problems. For instance, Kishor and Ssozi (2010) used an unobserved dynamic factor model to decompose the variation in inflation into two components, one that is common across the EAC countries and another that is country specific. This approach led to results showing that the common regional component increased significantly after the EAC treaty and suggested convergence in inflation in the EAC. However, their study did not cover the last decade (2010-2019), which includes the current EAC agreement, signed in 2013, to have a common currency. Furthermore, Carcel et al. (2015) went beyond traditional cointegration and panel unit-root analysis by applying a fractional integration technique developed in Gil-Alaña (2003) as an alternative and powerful tool for testing the no-cointegration null hypothesis against the alternative hypothesis of fractional cointegration. For this, they used, for each EAC country pair, the residuals resulting from regressing one country's inflation against another's. Moreover, these authors followed Marinucci and Robinson (2001) and used a Hausman test of no cointegration. According to their findings, based on monthly inflation data from 2004-2013, these newer approaches provided a clearer result regarding cointegration in inflation levels between the five countries. They found pairwise fractional cointegrating relationships in the inflation levels among Burundi, Kenya, Rwanda, and Uganda. Only Tanzania displayed a different pattern, with no cointegrating relationship found between its inflation level and the inflation levels of the other countries.

The unit-root and cointegration techniques often used to study inflation convergence are not able to capture how the inflation rates change together (rising and falling) among a group of countries. One way to fill that gap in the current paper is by investigating the development over time of the inflation-movement similarity index for pairs of countries regarding their monthly inflation-rate changes. Another way to fill that gap is by investigating multiple-year inflation correlations. Although it was not the main focus of their study, Kishor and Ssozi (2010) presented Pearson correlations between quarterly inflation rates for pairs of EAC countries for 1981:3–2000:2 and 2000:3–2009:1. In the current study, a nonparametric correlation measurement is applied to monthly EAC inflation data that extend much later in time (a decade) than the data used in the Kishor and Ssozi (2010) paper.

3. Inflation over time for the EAC countries

This section briefly presents the structure of the EAC economies and recent time paths for the EAC countries. It also discusses some reasons for common movements.

The EAC country ranking by GDP from largest to smallest is Kenya, Tanzania, Uganda, Rwanda and Burundi ($55.41 B, $46.58 B, $27.52 B, $8.82 B, and $2.31 B, respectively, in current dollars for 2016).[79] In 2017, coffee, tea, and gold were products that often appeared prominently in the exports of the five EAC countries as of 2015.[80,81] For each of these five economies, refined petroleum was the top import, consisting of 6.5% of Uganda's imports and 14%-17% of the other four countries' imports.[82]

Figure 1 presents the development of the annual inflation rates over the period 1996-2018 for the five EAC countries. What we observe from the figure is a general comovement of the inflation rates between these five countries over the period 1996-2018. Nevertheless, these inflation rates were often above the ceiling of the convergence criterion (8%), the exception being over 2013-2018, the period in which some convergence in inflation levels seemed to be apparent. However, around 2017, there was a notable inflation increase in Burundi to above the ceiling, and Kenya and Rwanda nearly hit the ceiling during that time.

[79] World Development Indicators (World Bank, 2019a).

[80] The ranking of coffee in exports was 3rd for Kenya, 4th for Tanzania, and 1st for Uganda, Rwanda, and Burundi. Tea was the most important export for Kenya and the 2nd most important export for Burundi and Rwanda. Gold was the most important export for Tanzania, the 2nd most important export for Uganda, and the 3rd most important export for Burundi.

[81] All of the 2017 trade data noted in this paragraph are from the OEC (the Observatory of Economic Complexity) website (https://oec.world/en), which in turn based its data on those from the United Nations Statistical Division (Comtrade), with harmonization provided in the BACI International Trade Database.

[82] Packaged medicaments ranked 2nd to 4th in imports for all five countries. Palm oil was the 2nd or 3rd most important import for the largest three countries, and raw sugar ranked within the top 5 imports for all of the countries except Uganda.

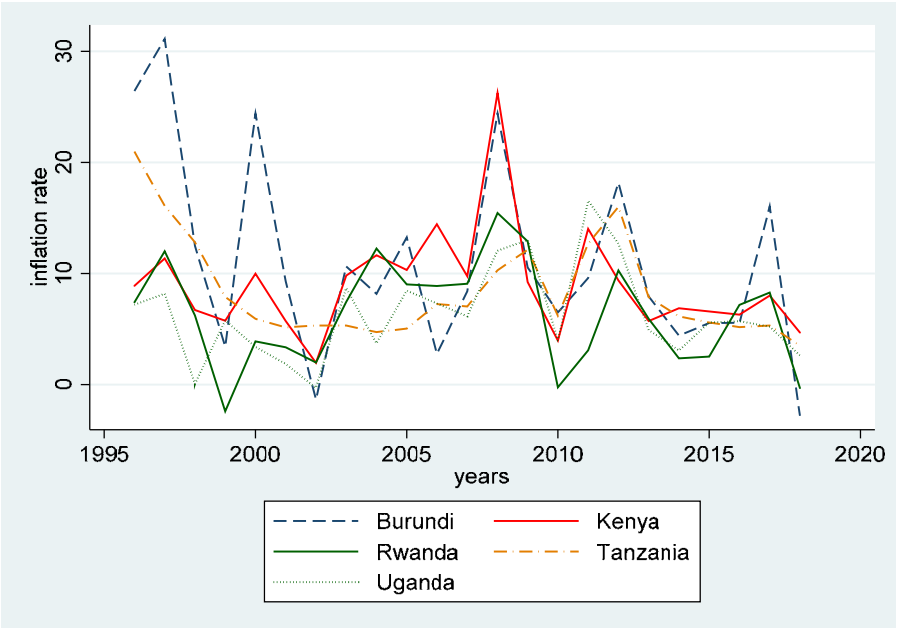


Figure 1: Annual inflation rates for the EAC countries (1996-2018).

Note: Inflation rates are measured as the annual percentage change of the consumer price index. Stata version 15.1 was used to generate this figure. *Source:* World Development Indicators (World Bank, 2019b).

Importantly, there was a substantial drop in inflation from the beginning of 2008 until 2010 in all five countries. This drop was likely connected to the financial global crisis in 2008-2009. Indeed, due to the global recession, one would expect a large drop in demand, which would in turn bring all prices to a low level. In 2011, the inflation rate in all the EAC countries started to rise again, with a dramatic increase in 2012 that lasted until the following year. As highlighted in the AfDB (2012) report, the July 2010–July 2011 higher inflation episode for Kenya, Tanzania and Uganda was driven by higher oil prices (which contributed 20%, 26%, and 21%, respectively, to these countries' inflation in the short run), although for Uganda, monetary expansion contributed even more (32%). The report also found that the short-run contribution to inflation from world food prices during this period was 9% in Tanzania, 11% in Kenya, and 13% in Uganda (for details, see AfDB, 2012).

As mentioned earlier, refined petroleum was the top import in all five countries. Higher oil prices were transmitted to higher domestic food prices due to the higher transportation costs embedded in food prices. Given that refined petroleum was the top import commodity of Burundi and Rwanda, and their dependence on food imports was similar to that of Kenya, Tanzania and Uganda, the presence of higher oil prices was likely a main driver of the higher inflation in July 2010–July 2011 for Burundi and Rwanda as well.

4. Data

All the inflation data used in this study are based on monthly CPI data collected in May–June 2019 from the IMF's International Financial Statistics (IFS) database. The study focuses primarily on month-to-month inflation data in the EAC countries 1995M04-2018M12 (thereby requiring 1995M04-2018M12 CPI data), both without and with seasonal adjustment.[83] Seasonal adjustments are performed on the monthly inflation data through the Census X-12 procedure in EViews version 11 using additive X-11 seasonal adjustment along with the automatic (X-12 default) trend filter by Henderson (1916) and no ARIMA specification.

Monthly inflation data for 12 European and 8 West African nations (for comparison) are also used. The months covered in these cases are discussed in Section 7. Annual data on real GDP (output-side at chained purchasing power parities)[84] were collected from the St. Louis FRED database. These are averaged over years (1995-2018 for EAC countries, 1990-2018 for European countries, and 1990-2017 for WAEMU countries) to provide weights to calculate average inflation rates for other countries in a monetary zone.

The results in the next three sections are presented for both monthly data that have been seasonally adjusted through the previously noted procedure and data that have not. The argument for considering seasonally adjusted data is that since seasonal inflation shocks are recognized as temporary, they are not relevant for monetary policy adjustments. On the other hand, common seasonal variations in inflation may reveal commonalities in economic structures that are relevant for monetary union considerations, and imperfections in the seasonal adjustment process may create patterns in inflation movements that are not actually present. Maravall (1995) stressed that seasonal adjustment along with detrending, as in the X-11 filter, generates a spectral peak that is non-negligible for a cyclical frequency, and Wright (2013) was concerned that the bandwidth typically used in the X-12 filter is too low. For these reasons, the results are presented for both data that are not seasonally adjusted data and data that are. Beyond seasonal adjustment, EViews version 11 was used to generate the results in Sections 5 and 7, and Stata version 15.1 was used to generate the Section 6 results.

[83] The monthly inflation data for the EAC countries are from 1995M05 to 2018M12, although three months for Rwanda, 1997M06-1997M08, are imputed due to missing CPI data for two months. Inflation data prior to 1995M05 are not used since Rwanda has a year of missing CPI data prior to that. The imputations for the missing Rwanda months are simply a straight average of the inflation rates for 1997M05 and 1997M09.

[84] See Feenstra, Robert C., Robert Inklaar and Marcel P. Timmer (2015), "The Next Generation of the Penn World Table" *American Economic Review,* 105(10), 3150-3182, available for download at www.ggdc.net/pwt.

5. Convergence in inflation based on stationarity of inflation differentials

In this section, we investigate whether the inflation-rate levels of the EAC countries show a tendency to converge. We focus on a country's inflation differential, which we define in this paper as the monthly inflation rate minus the weighted average monthly inflation rate for the other four EAC members, with the weights based on real GDP, as noted in the previous section. We investigate whether that inflation-differential variable demonstrates stationarity in the recent era of the EAC in which the five EAC members have been in agreement to form a monetary union in the future. Such stationarity is treated as evidence of a convergence process between the inflation of the country in focus in the inflation differential variable and the inflation of the other EAC countries. The methodology is similar to that used for many of the investigations of inflation-differential stationarity discussed in Section 2, in which the inflation differential was either between the inflation rates for pairs of countries (Busetti et al., 2007; Dridi and Nguyen, 2019; Kishor and Ssozi, 2010) or between a country's inflation rate and the average inflation rate of other countries (Kishor and Ssozi, 2010; Lopez and Papell, 2012). We apply unit-root tests to individual time series, as in Busetti et al. (2007) and Kishor and Ssozi (2010).

For each EAC country's inflation-differential variable, we perform six types of unit-root and stationarity tests to determine whether the inflation rates demonstrate convergence. The unit-root tests formally test whether the inflation rates are in the process of converging, whereas the stationarity tests test whether the inflation rates have converged, with a stable difference between them (Busetti et al., 2007). Four of the tests have the unit root as the null hypothesis: the ADF test (Dickey and Fuller, 1979), the DF-GLS test (Elliot, Rothenburg, and Stock, 1996), the Phillips-Perron test (Phillips and Perron, 1988), and the HEGY test (Hylleberg, et al., 1990).[85] The other two tests have stationarity as the null hypothesis: the KPSS test (Kwiatkowski et al., 1992) and the Canova-Hansen test (Canova and Hansen, 1995).[86] The HEGY test and the Canova-Hansen test are seasonal tests. None of the tests include a trend term in the autoregressive specification, and an estimated intercept is excluded when possible since we are interested in whether there is a tendency for inflation rates to converge to a zero difference.[87]

[85] The significance tests for ADF, DF-GLS, Phillips-Perron and HEGY are sample-size adjusted, with the adjustments for the first three of these tests based on MacKinnon (1996). The HEGY test used is the one that has a unit root for all seasonal frequencies in the null hypothesis. The Canova-Hansen test uses seasonal dummies and includes a lag of the dependent variable to reduce autocorrelation.
[86] The significance tests for KPSS and Canova-Hansen are based on asymptotic critical values.
[87] All the tests exclude the intercept except the DF-GLS and KPSS tests, for which a nonintercept option was not possible.

Table 1 presents the results of the various unit-root and stationarity tests on the EAC country's inflation-differential variables for 2013M11-2018M12, with the starting month being the one when the five EAC members agreed to create a monetary union within ten years.[88] We focus on this recent period since EAC inflation convergence has been investigated in previous studies (Carcel et al., 2015; Dridi and Nguyen, 2019; Kishor and Ssozi, 2010), and we wish to determine whether similar convergence results have been discernable more recently.

Table 1: Unit-root tests on the difference of a given country's inflation rate and that of the other four given EAC countries for 2013M11-2018M12 (62 observations)

	Burundi	Kenya	Rwanda	Tanzania	Uganda
No seasonal adjustment					
ADF	-5.67***	-5.93***	-7.06***	-5.34***	-4.44***
DF-GLS	-5.35***	-4.70***	-3.15***	-4.96***	-4.42***
Phillips-Perron	-5.67***	-5.27***	-4.68***	-5.24***	-4.52***
HEGY	11.39**	3.55*	4.57*	2.78	3.41*
KPSS	0.14	0.04	0.18	0.12	0.10
Canova-Hansen	1.46	2.06	1.69	1.73	1.89
With seasonal adjustment					
ADF	-5.56***	-5.65***	-5.60***	-5.84***	-5.20***
DF-GLS	-5.34***	-4.58***	-5.33***	-3.20***	-4.80***
Phillips-Perron	-5.56***	-5.60***	-5.60***	-6.01***	-5.10***
HEGY	11.35**	6.09*	10.59**	6.52*	6.20*
KPSS	0.15	0.07	0.20	0.12	0.10
Canova-Hansen	1.35	1.70	1.67	1.59	1.83

Notes: The *, **, and *** superscripts indicate significance at the 10%, 5% and 1% levels, respectively.

The ADF, DF-GLS, and Phillips-Perron unit-root tests indicate that the unit root can be rejected for every EAC country at the 5% significance level or lower. The KPSS and Canova-Hansen tests indicate that stationarity cannot be rejected at the 10% significance level for each of the countries. The HEGY seasonal unit-root

[88] These are based on results from calculations in EViews.

test rejects the unit root at the 5% level only for Burundi, with data both seasonally adjusted and not, and Rwanda, with seasonally adjusted data. Otherwise, the HEGY test rejects the unit root at the 10% significance level, except for Tanzania, with data that are not seasonally adjusted. We attribute the generally lower level of significance at which HEGY rejects the unit root to low statistical power with 62 observations.

In general, the results in Table 1 are supportive of stationarity in the inflation-differential variables over the given period, indicating a convergence process in the inflation levels in the recent era of the EAC, in which the five EAC members have been in an agreement to form a monetary union in the future. Table A.1 in Appendix A presents results analogous to those in Table 1 for the period 2000M07-2013M10, with the starting month being the one when the new EAC between Kenya, Tanzania, and Uganda was established and the last month being the one before the first month in Table 1. The results in Table A.1 are similar to those shown in Table 1, although the test statistics for the four unit-root tests are higher in magnitude than those in Table 1, and notably, the HEGY seasonal unit-root test rejects the unit root at the 5% significance level or lower in all cases.[89] The results of Tables 1 and A.1 are consistent with the findings of Dridi and Nguyen (2019), who found support for convergence in the inflation rates among these countries based on panel unit-root tests using 2000M1-2015M12 inflation data on the five EAC countries.

[89] The greater strength in the unit-root test statistics in Table A.1 could be attributed to there being more observations than in Table 1 (160 rather than 60) and perhaps to there being more room for inflation to decrease during this period. We have also produced results (not presented in this paper) analogous to those presented in Tables 1 and A.1 for the period in our data prior to the establishment of the new EAC between Kenya, Tanzania, and Uganda, i.e., the 1995M05–2000M06 period, and the data are again generally supportive of the stationarity of the inflation differential for each of the five countries. Thus, the existence of a convergence process in the inflation in these countries does not appear to be a new phenomenon.

6. Trend in similarity indices of inflation changes for EAC countries

In this section, we investigate the similarity of monthly inflation rate changes between two consecutive time periods for pairs of EAC countries. This approach takes a very short-term perspective by considering only similarity in movement between consecutive periods. The similarity index of inflation-rate movements between countries is measured as follows (see Gianelle et al., 2017; Giannone et al., 2008 and Kalemli-Ozcan et al., 2013, who use an analogous index when measuring the similarity of business cycles between countries):

$$Sim\pi_{ijt} = -\left|\Delta\,\pi_{it} - \Delta\pi_{jt}\right| \qquad (1)$$

where π_{it} and π_{jt} denote the time-t inflation rates in countries i and j, respectively (with $i, j \in \{1,2,\ldots,5\}$, given the five EAC countries), and Δ is the difference operator. Higher values of the index indicate greater similarity in inflation-rate changes, with perfect similarity reflected by the upper bound of zero. We investigate whether inflation-rate changes have been converging, i.e., have tended to become more similar over time by simply regressing the similarity index on a time trend based on the following regression equation:

$$Sim\pi_{ijt} = \beta_0 + \beta_1 t + \varepsilon_{ijt} \qquad (2)$$

where t (time) is the independent variable, measured in number of months since the first month used, based on 1995M05-2018M12 data, and ε_{ijt} is the term (in each regression, the i and j subscripts do not vary since panel regressions are not used). A positive sign for β_1 is indicative of convergence. We applied the Newey-West (1987) method to estimate the standard errors since the Breusch-Godfrey tests show that the error terms are serially correlated in all country pairs.[90]

The regression results of the model in equation (2) for each of the 10 country pairs among the EAC countries are reported in Table 2. Again, we report results for both data that are not seasonally adjusted and data that are. Overall, these results show that the estimated coefficient on the time variable is significantly positive for most of the country pairs. Only the estimates for the Kenya-Rwanda and Tanzania-Rwanda pairs show lower significance (10% significance level) for data without seasonal adjustment, and only the estimates for the Tanzania-Rwanda and Uganda-Rwanda pairs are non-significant for data that are seasonally

[90] According to Newey-West (1987), if the error terms are serially correlated, even the statistical inferences from the usual robust standard errors can still be misleading. Hence, we correct this issue by using the heteroscedasticity- and autocorrelation-consistent (HAC) estimators of the variance-covariance matrix of the coefficient estimates (VCE).

adjusted. In all the pairs, regardless of seasonal adjustment, the estimated coefficient on the time variable is positive.

Table 2: Regression results based on the model in equation (2)

	No seasonal adjustment		With seasonal adjustment	
Country pairs	Time coefficient	Constant coefficient	Time coefficient	Constant coefficient
Kenya-Burundi	0.008*** (0.002)	-3.367*** (0.352)	0.007*** (0.002)	-3.062*** (0.364)
Kenya-Rwanda	0.002* (0.001)	-1.624*** (0.188)	0.002** (0.001)	-1.505*** (0.183)
Kenya-Tanzania	0.005*** (0.001)	-1.945*** (0.150)	0.003*** (0.001)	-1.433*** (0.142)
Kenya-Uganda	0.004*** (0.001)	-1.936*** (0.152)	0.003*** (0.001)	-1.492*** (0.123)
Rwanda-Burundi	0.007*** (0.002)	-3.382*** (0.380)	0.007*** (0.002)	-3.015*** (0.367)
Tanzania-Burundi	0.009*** (0.002)	-3.482*** (0.346)	0.007*** (0.002)	-2.933*** (0.354)
Tanzania-Rwanda	0.002* (0.001)	-1.659*** (0.163)	0.000 (0.001)	-0.981*** (0.150)
Tanzania-Uganda	0.007*** (0.001)	-2.340*** (0.171)	0.003*** (0.001)	-1.334*** (0.125)
Uganda-Burundi	0.008*** (0.002)	-3.380*** (0.345)	0.007*** (0.002)	-2.947*** (0.342)
Uganda-Rwanda	0.002** (0.001)	-1.737*** (0.170)	0.001 (0.001)	-1.378*** (0.175)

Notes: Newey-West (1987) robust standard errors (i.e., heteroscedasticity- and autocorrelation-consistent standard errors) are shown in parentheses. The *, **, and *** superscripts indicate significance at the 10%, 5% and 1% levels, respectively. The results are for country pairs (each pair is shown in the first column). The number of observations is 283 from the period 1995M05-2018M12.

Based on the results in Table 2, we can conclude that the short-term inflation-rate movements between each of the country pairs are converging, albeit Rwanda's. convergence with the three original founders of the EAC is still weak, especially for data that are seasonally adjusted. Nevertheless, given that all the estimated coefficients are positive, it is a good sign for a successful monetary union that the inflation rate changes for the five EAC countries are becoming more similar. For an economic interpretation, although the estimated coefficients are small both for data without and with seasonal adjustments, the highest coefficient, 0.009, between Tanzania and Burundi, using data without seasonal adjustment, indicates that the inflation rate changes are becoming closer by an average of 0.009 percentage points each month, or 0.108 percentage points over a year. Other country pairs showing strong convergence in inflation-rate changes, both for data that are not seasonally adjusted and data that are, are Kenya-Burundi, Uganda-Burundi, and Rwanda-Burundi. Each of these pairs converged at a rate of at least

0.007 percentage points per month for data both with and without seasonal adjustment.

One can argue that the recent convergence in inflation-rate changes and inflation-rate levels is the result of the efforts these countries are making to achieve monetary policy harmonization to deal with inflation. For instance, according to the latest governors' report (EAC, 2018), the countries in the EAC have made substantial progress in implementing some of the key priorities, such as putting in place requirements for an adoption of a price-based/inflation-targeting monetary policy framework, including liquidity forecasting and reserve requirements (both national and international). Moreover, they have harmonized monetary policy implementation processes through the development of interbank markets and monetary policy communication strategies, among other developments (EAC, 2018). However, the report also highlights that the partner states' central banks are at different stages regarding the harmonized policies meant for the transition period to a monetary union.[91]

7. Correlation in inflation

This section investigates the degree to which monthly inflation rates are correlated between each EAC member and the other countries in the EAC. It considers both the most recent correlations and those in the recent past. We present the correlation results for four different periods between 1995M05 and 2018M12, based on three historically relevant break points: 2000M07, when the new EAC between Kenya, Tanzania, and Uganda was established; 2009M07, when Burundi and Rwanda joined the EAC Customs Union (they joined the EAC two years earlier); and 2013M11, when the five EAC members agreed to create a monetary union within ten years. The four periods considered are therefore 1995M05-2000M06, 2000M07-2009M06, 2009M07-2013M10, and 2013M11-2018M12. The last period is the same as that investigated in Section 5. For comparison, similar correlations are calculated for countries in the EMU and for countries in the WAEMU.

Before presenting the correlation results, it is relevant to consider the stationarity properties of the data, as correlation findings between nonstationary variables could simply be spurious. The results from the same unit-root and stationarity tests used in Section 5 for inflation disparities (except that an estimated intercept is allowed in all of the tests) are presented for each country's inflation rate in the four historical periods in Table B.1 in Appendix B. That table indicates that stationarity is supported in the vast majority of country-period

[91] The transition period is three years before the partner states adopt the common monetary policy framework, and according to the current agenda, this is the period between 2018 and 2021.

cases,[92] so it appears reasonable to investigate correlations between each country's inflation series and the weighted averages of other EAC-country inflation series.

Table C.1 in Appendix C presents the results from Shapiro-Wilk tests for normality regarding the inflation rates of each EAC country in the four historical periods. The tables indicate the frequent appearance of non-normality in the data series, both without and with seasonal adjustment. To avoid problems arising from non-normality and the existence of outliers, a nonparametric measure of correlation is used. Specifically, the correlation measure used is the Kendall rank correlation (tau) coefficient, which captures the ordinal association between a couple of variables.

If observations of data for the same period from the two series are both ranked higher or both ranked lower than another set of observations from another period, then that pair of observations (from both series for the two time periods) is in agreement on the ranking and is said to be concordant. If the observations instead disagree on the ranking, they are said to be discordant. With n representing the length of each data series, nc representing the number of concordant pairs, and nd representing the number of discordant pairs, the basic definition of Kendall's tau (Kendall, 1938), without ties (repeated values in one or both data series), is given by

$$\tau = \frac{n_c - n_d}{n(n-1)/2} \qquad (3)$$

Kendall's tau can range from -1 (perfect disagreement in rankings) to 1 (perfect agreement in rankings), and independent random series tend to have a Kendall's tau value of approximately 0. The specific form of Kendall's tau used in this paper is tau-b (Kendall, 1945), which accounts for ties through a slightly more complex formula than the basic Kendall's tau formula, with some variation across software due to computational efficiency issues.

Table 3 presents the results for the Kendall's tau-b correlations between each country's inflation rate and the weighted average of the inflation rates of the other EAC members for the four historical periods on which we focus. For each country, this correlation appears to have strengthened over the whole sample range of 1995M05-2018M12, since the correlation for each country is strongest in the last two periods, 2009M07-2013M10 and 2013M11-2018M12. The increase in these correlations is useful for achieving success in the intended monetary union agreed upon at the beginning of the last period. Between the last two periods, the correlation of Rwanda's inflation rate with that of the rest of the EAC strengthened substantially, from 0.035 to 0.234, without seasonal adjustment, and from 0.103 to 0.274, with seasonal adjustment. However, for each of the largest three economies – Kenya, Tanzania, and Uganda – the correlation of the inflation

[92] These results contrast with the ADF and PP test results for these countries' monthly inflation rates (without seasonal adjustment) presented in Carcel et al. (2015), who, when using a shorter time-span of 2004M01 to 2013M12, could not reject the unit root for these countries (without seasonal adjustment). They also found evidence of structural breaks. One reason for the difference between their results and ours could be that our time series consists of month-to-month inflation rates, whereas they apparently used monthly year-over-year inflation rates.

rate with that of the rest of the EAC fell in magnitude between the last two periods. The correlation of Burundi's inflation with that of the rest of the EAC was nearly unchanged between the last two periods based on seasonally adjusted data (it dropped slightly between these periods only when using data without seasonal adjustment and rose slightly when using seasonally adjusted data).

The fact that the correlation of the inflation rates with those of the rest of the EAC peaked in the 2009M07-2013M10 period for each of the three largest economies may be connected to world oil prices, which were notably higher in this period than in the other periods. As noted previously, refined petroleum was the top import in each of these countries. All else being equal, when oil prices are high, a 1% change in the oil price is expected to have a larger effect on each economy, with a similar sign of that effect for each economy. However, the two smallest economies, Burundi and Rwanda, did not experience a strong diminution of the correlations of their inflation rates with those of the rest of the EAC (indeed, that correlation increased for Rwanda), and these two countries also had refined petroleum as their top import.

To consider the robustness of our results, we calculated Pearson correlation coefficients for the same data used in Table 3, and the results are presented in Table D.1 in Appendix D. Qualitatively, the results are quite similar to those shown in Table 3 in that the highest correlation occurs in one of the last two periods for each of the countries.[93,94]

[93] Some notable differences are that Table D.1 indicates that when using the data without seasonal adjustment, the correlation of Burundi's inflation rate and Kenya's inflation rate with the inflation rate of the other EAC members increases between the last two periods.

[94] Kishor and Ssozi (2010) presented Pearson correlations between each EAC country's inflation rate and the average EAC inflation rate based on quarterly data for 1981:3-2000:2 and 2000:3-2009:1. They similarly find that the correlations are higher in the latter period (that under the new EAC treaty) than in the earlier period.

Table 3: Kendall's tau-b correlation measures between a given country and the other four EAC countries (weighted by GDP)

	Burundi	Kenya	Rwanda	Tanzania	Uganda
1995M05-2000M06					
No seasonal adjustment	0.174** (0.046)	0.174** (0.047)	0.008 (0.927)	0.071 (0.416)	0.056 (0.528)
With seasonal adjustment	0.149 (0.089)	0.138 (0.114)	0.205* (0.019)	0.034 (0.698)	0.232*** (0.008)
2000M07-2009M06					
No seasonal adjustment	0.189*** (0.004)	0.168*** (0.010)	0.169*** (0.010)	0.111* (0.088)	0.134** (0.040)
With seasonal adjustment	0.120* (0.066)	0.193*** (0.003)	0.247*** (0.002)	0.117* (0.073)	0.208*** (0.001)
2009M07-2013M10					
No seasonal adjustment	0.261*** (0.007)	0.511*** (0.000)	0.035 (0.723)	0.347*** (0.003)	0.418*** (0.000)
With seasonal adjustment	0.250*** (0.009)	0.454*** (0.000)	0.103 (0.287)	0.362*** (0.002)	0.418*** (0.000)
No seasonal adjustment	0.240*** (0.006)	0.381*** (0.000)	0.234*** (0.007)	0.267*** (0.002)	0.212** (0.015)
With seasonal adjustment	0.287*** (0.001)	0.333*** (0.000)	0.279** (0.001)	0.286*** (0.001)	0.249*** (0.004)

Notes: p-values (two-tailed) are shown in parentheses. The *, **, and *** superscripts indicate significance at the 10%, 5% and 1% levels, respectively. The number of observations for the 1995M05-2000M06, 2000M07-2009M06, 2009M07-2013M10, and 2013M11-2018M12 periods are 62, 108, 52, and 62, respectively.

Figure 3 presents information for the EAC similar to that provided in Table 3, with the difference being that rolling five-year correlations are shown so that we can observe local temporal trends. The year noted for each data point is the midpoint of the five years used to calculate the correlations, or, more precisely, the 31st month in the 60-month window used in that calculation. The figure shows that for all five countries, the correlations rise after 2001 (except for Rwanda when using seasonally adjusted data). However, Burundi shows a small decline after 2013, and Kenya, Tanzania, and Uganda show substantial dips in the correlation

around 2013-2014. Rwanda shows a dramatic rise in its correlation with the rest of the EAC after 2012, but its highest correlation with the rest of the EAC occurred in the around the end of 2003 based on the data without seasonal adjustment and in the early 2000s based on seasonally adjusted data. After 2013, when the goal of creating a common currency for the EAC countries was agreed upon, Rwanda shows an increased correlation of its inflation rate with that of the rest of the EAC, but the same cannot be said of Kenya, Tanzania, and Uganda, which show reduced correlations over this time, and it can be said for Burundi only regarding its seasonally adjusted data. Consistent with Table 3, all countries show significantly positive correlations for the last 5-year period. Burundi, Kenya, and Uganda also show such significance for all 5-year periods back to at least late 2007, whereas Rwanda and Tanzania show more recent episodes of no significance in each of their correlations with the rest of the EAC.

From Table 3 and Figure 3, we can see the development in the inflation correlations over time, and in the last period presented, the inflation correlations are among the highest over all the periods covered for all the EAC countries. Kendall's tau in Table 3 ranges from 0.212 (Uganda) to 0.381 (Kenya) with the non-seasonally adjusted data and from 0.249 (Uganda) to 0.333 (Kenya) with the seasonally adjusted data. Are these magnitudes high for a set of countries aiming to have a single currency? To help answer this question, we can compare these inflation correlations to similarly calculated inflation correlations for countries in the EMU by 2001 and countries in the WAEMU.[95]

[95] The results regarding DF-GLS unit-root tests for the EMU and WAEMU in the periods we are investigating are presented in Appendix B. Again, rejection of the unit root occurs in the vast majority of cases.

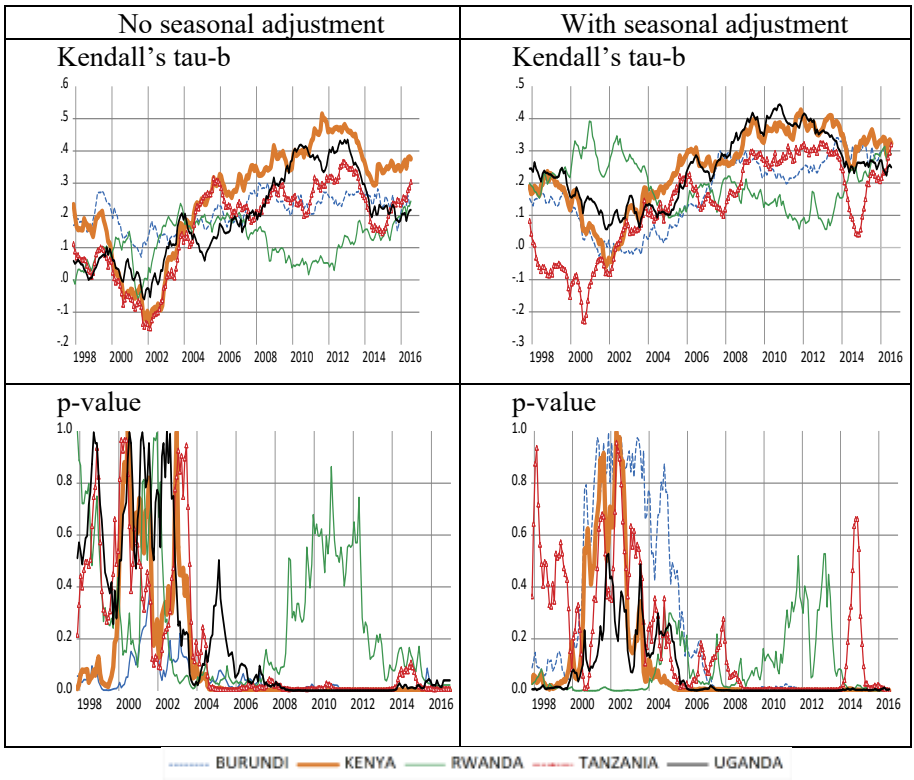


Figure 3: Rolling Kendall's tau among EAC countries

Notes: Rolling 5-year Kendall's tau on monthly inflation between each EAC member and the other EAC members (weighted by GDP) (top) and p-values (bottom) representing significance from having zero correlation. The data used are from 1995:5 to 2018:12. The figure reports the information for the midpoint (31st month of 60 months) of the 5-year spans, with the starting digit of the year placed where the first month of that year stands.

Table 4 presents Kendall's tau information for the twelve European countries that were members of the EMU by 2001 regarding the correlation of those country inflation rates with those of the other 2001 EMU members. All the countries listed joined the EMU in 1999 except Greece, which joined in 2001. The table presents inflation correlation information for the five calendar years prior to the launch of the euro in 1999 (1994-1998) and for 2014-2018 and presents information for data both without seasonal adjustment and with seasonal adjustment.

For the 1994-1998 period, the correlation of each European country's inflation rate with that of the other 2001 EMU members appears weaker than the analogous correlations among EAC members in 2013M11-2018M12: for data without

seasonal adjustment, the correlations range from -0.115 for Greece to 0.260 for the Netherlands, with a median of 0.119, and for the seasonally adjusted data, the correlations range from -0.227 for Italy to 0.389 for Belgium, with a median of 0.161.

Table 4: Kendall's tau for inflation rates between a given country and (a) the other 2001 EMU members

Country	No seasonal adjustment		With seasonal adjustment	
	1994-1998	2014-2018	1994-1998	2014-2018
Austria	0.151 (0.093)	0.457** (0.000)	0.055 (0.532)	0.417** (0.000)
Belgium	0.254** (0.004)	0.263** (0.003)	0.389** (0.000)	0.434** (0.000)
Finland	0.087 (0.326)	0.501** (0.000)	0.051 (0.566)	0.406** (0.000)
France	0.198* (0.026)	0.456** (0.000)	0.297** (0.001)	0.475** (0.000)
Germany	0.066 (0.468)	0.367** (0.000)	0.190* (0.032)	0.433** (0.000)
Greece	-0.115 (0.193)	0.364** (0.000)	0.278** (0.002)	0.310** (0.000)
Ireland	0.044 (0.636)	0.501** (0.000)	0.064 (0.467)	0.256** (0.004)
Italy	-0.089 (0.317)	-0.032 (0.721)	-0.227** (0.010)	0.096 (0.278)
Luxembourg	0.044 (0.619)	0.456** (0.000)	0.156 (0.078)	0.368** (0.000)
Netherlands	0.260** (0.003)	0.406** (0.000)	0.318** (0.000)	0.419** (0.000)
Portugal	0.238** (0.007)	-0.159 (0.072)	0.120 (0.176)	0.120 (0.176)
Spain	0.232** (0.009)	0.367** (0.000)	0.240*** (0.007)	0.462** (0.014)
Mean	0.114	0.329	0.161	0.350
Median	0.119	0.387	0.173	0.412

Notes: p-values (two-tailed) are shown in parentheses. The *, **, and *** superscripts indicate significance at the 10%, 5% and 1% levels, respectively.

Notably, Greece and Italy, two of the countries with economies that provided substantial challenges for the eurozone in later years, show negative (albeit nonsignificant) correlations for the data without seasonal adjustment, and Italy shows a statistically significant negative correlation with the seasonally adjusted data. With the seasonally adjusted data, Greece shows a much different correlation for 1994-1998, a statistically significant positive one, which is indicative of the importance of a different seasonal pattern for Greece than for the other 2001 EMU countries. Nevertheless, if we consider instead the five calendar years prior to Greece's EMU entry, 1996–2000 (not shown in the table), Greece's inflation correlation with the other 2001 EMU members is nonsignificantly positive at 0.08

when using seasonally adjusted data and is again nonsignificantly negative at -0.017 when using the non-seasonally adjusted data.

For the 2014-2018 period, the correlation of each European country's inflation rate with that of the other 2001 EMU members appears in many ways stronger than the analogous correlations among EAC members in 2014-2018: for data without seasonal adjustment, the median correlation is 0.387 and the highest correlation is 0.501 (Ireland), and for seasonally adjusted data, the median correlation is 0.412 and the highest correlation is 0.475 (France). This much stronger set of inflation correlations for the EMU members in comparison to the 1994-1998 period may be attributed to success in integrating the EU economies, a process in which a common currency was instrumental. Nevertheless, even in the 2014-2018 period, Italy and Portugal show low correlations with the rest of the 2001 EMU members: -0.032 and -0.159, respectively, for the data without seasonal adjustment and 0.096 and 0.120, respectively, for the data with seasonal adjustment.

Table 5 presents Kendall's tau information for the eight members of the WAEMU during the period April 2013–March 2018. The WAEMU is one of two common currency areas in Africa using the CFA franc, the other being the Central African Economic and Monetary Community (CEMAC). The former uses the West African CFA franc, and the latter uses the Central African CFA franc. Both CFA francs are pegged to the euro, and therefore, they are pegged to each other.

Table 5: Kendall's tau for the correlation of monthly inflation rates between a given country and other WAEMU members, April 2013–March 2018

Country	No seasonal adjustment	With seasonal adjustment
Benin	0.073 (0.411)	0.104 (0.243)
Burkina Faso	0.218** (0.014)	0.129 (0.148)
Côte d'Ivoire	-0.013 (0.888)	0.047 (0.597)
Guinea-Bissau	0.146* (0.100)	-0.069 (0.440)
Mali	0.306*** (0.001)	0.088 (0.323)
Niger	0.221** (0.013)	-0.037 (0.679)
Senegal	-0.203** (0.022)	-0.059 (0.511)
Togo	0.111 (0.214)	-0.012 (0.894)
Mean	0.057	0.024
Median	0.073	0.018

Notes: p-values (two-tailed) shown in parentheses. The *, **, and *** superscripts indicate significance at the 10%, 5% and 1% levels, respectively.

Overall, the correlations seem much weaker for these countries than the analogous 2014-2018 correlations shown for the EAC countries. For these WAEMU countries, the correlations using the data without seasonal adjustment range from a statistically significant -0.208 for Senegal to a statistically significant 0.299 for Mali, with a median of 0.092, and the correlations using the data with seasonal adjustment are all nonsignificantly different from zero, ranging from -0.067 for Guinea-Bissau to 0.145 for Burkina Faso, with a median of 0.014.

8. Conclusions

In this study, we have explored how inflation-rate levels and inflation-rate movements for EAC countries have developed over time. By investigating whether there is stationarity in the difference between the inflation of each EAC country and that of the other EAC countries, we have found support for the existence of a convergence tendency in the inflation levels within the EAC. Through a similarity index, we have shown that for most country pairs (8 of 10) among the five EAC countries, changes in inflation between consecutive months became more similar between 1995 and 2018.

We also explored inflation-movement similarities through a rank-correlation measure, Kendall's tau, applied to monthly data over historically relevant periods and over rolling 5-year periods. Overall, the correlations between the EAC countries seem favorable to monetary union when these correlations are compared to analogous ones for the 2001 EMU countries prior to the creation of the euro and to analogous ones for the WAEMU countries. These results are supportive of the success of the planned EAC monetary union, but there is some cause for concern regarding the decrease in the correlations of the three largest EAC members with the rest of the EAC (from each of their perspectives) after 2013.

References

AfDB [African Development Bank] (2012). Inflation Dynamics in selected East African countries: Ethiopia, Kenya, Tanzania and Uganda. AfDB Brief.

Busetti, F., Forni, L., Harvey, A., & Venditti, F. (2007). Inflation Convergence and Divergence within the European Monetary Union. *International Journal of Central Banking*, *3*(2), 95–121.

Carcel, H., Gil-Alaña, L. A., & Madigu, G. (2015). Inflation convergence in the East African Community: a fractional integration and cointegration study. *Global Economy Journal*, *15*(4), 507–524.

Canova, F., and Hansen, B. E. (1995). Are seasonal patterns constant over time? A test for seasonal stability. Journal of Business & Economic Statistics, 13(3), 237-252.

Dickey, D.A, and Fuller, W.A. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association*, 74, 427-431.

Dridi, J., & Nguyen, A. D. (2019). Assessing Inflation Convergence in the East African Community. *Journal of International Development*, *31*(2), 119–136.

Drummond, P., Aisen, A., Alper, E., Fuli, E., & Walker, S. (2015). *Toward a monetary union in the East African Community: asymmetric shocks, exchange rates, and risk-sharing mechanisms* (No. 15-16). IMF. African Department

EAC (2013), *Protocol on the Establishment of the East African Monetary Union.* East African Community. Available at https://www.eac.int/documents/category/key-documents

EAC (2018), *The 22nd ordinary meeting of the Monetary Affairs Committee (MAC). Report of the Governors*. 24th August. EAC Secretariat, Arusha, Tanzania.

Elliott, Graham, Thomas J. Rothenberg and James H. Stock (1996). "Efficient Tests for an Autoregressive Unit Root," *Econometrica* 64, 813-836.

Feenstra, R. C., Inklaar, R., & Timmer, M. P. (2015). The next generation of the Penn World Table. *American Economic Review*, *105*(10), 3150–82.

Gianelle, C., Montinari, L., & Salotti, S. (2017). Interregional Trade, Specialization, and the Business Cycle: Policy Implications for the EMU. *Journal of Business Cycle Research*, 13(1), 1-27.

Giannone, D., Lenza, M., & Reichlin, L. (2008). Business cycles in the euro area. Working paper No. 14529. National Bureau of Economic Research. Retrieved from: https://www.nber.org/papers/w14529

Gil-Alaña, L. A. (2003). Testing of fractional cointegration in macroeconomic time series. *Oxford Bulletin of Economics and Statistics*, *65*(4), 517-529.

Canova, F. and Hansen, B. E. (1995). "Are seasonal patterns constant over time? a test for seasonal stability," *Journal of Business & Economic Statistics,* 13, 237–252.

Henderson, R. (1916). Note on graduation by adjusted average. *Transactions of the Actuarial Society of America*, *17*, 43-48.

Hylleberg, S., Engle, R. F., Granger, C. W., and Yoo, B. S. (1990). "Seasonal integration and cointegration," *Journal of Econometrics,* 44, 215–238.

Kalemli-Ozcan, S., Papaioannou, E., & Peydro, J. L. (2013). Financial regulation, financial globalization, and the synchronization of economic activity. *The Journal of Finance*, *68*(3), 1179–1228.

Kendall, M. G. (1938). A new measure of rank correlation. *Biometrika*, *30*(1–2), 81–93.

Kendall, M. G. (1945). The treatment of ties in ranking problems, *Biometrika*, *33*(3), 239-251.

Kenen, P.B. (1969). The optimum currency area: An eclectic view. In R.A. Mundell and A.K. Swoboda (Eds.), *Monetary problems of the International Economy*, (pp. 41-60). Chicago: University of Chicago Press.

Kishor, N., & Ssozi, J. (2010). Inflation convergence and currency unions: the case of the East African community. *Indian Growth and Development Review*, 3(1), 36–52.

Kwiatkowski, D., Phillips, P.C.B., Shmidt, P., and Shin, Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root. *Journal of Econometrics*. *54*(1-3): 159-178.

Kočenda, E., & Papell, D. H. (1997). Inflation convergence within the European Union: A panel data analysis. *International Journal of Finance & Economics*, 2(3), 189–198.

Lagoa, S. (2017). Determinants of inflation differentials in the euro area: Is the New Keynesian Phillips Curve enough? *Journal of Applied Economics*, *20*(1), 75–103.

Lopez, C., & Papell, D. H. (2012). Convergence of euro area inflation rates. *Journal of International Money and Finance*, *31*(6), 1440–1458.

Marinucci, D., & Robinson, P. M. (2001). Semiparametric fractional cointegration analysis. *Journal of Econometrics*, *105*(1), 225-247.

Maravall, A. (1995). Unobserved Components in Economic Time Series. In M.H. Pesaran and M. Wickens (Eds.) *Handbook of Applied Econometrics*, *Vol 1. Macroeconomics* (pp. 12-72), Oxford: Blackwell.

McKinnon, R.I. (1963). Optimum currency areas. *The American Economic Review, 53*(4), 717-725.

Mundell, R. A. (1961). A theory of optimum currency areas. *The American Economic Review,* 51(4), 657-665.

Newey, W. K., & West, K. D. (1987). A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. *Econometrica*, 55(3), 703-708.

Nkwatoh, L. S. (2018). Does ECOWAS Macroeconomic Convergence Criteria Satisfy an Optimum Currency Area?. *Journal of Economics and Management Sciences*, *1*(2), 61-68.

Phillips, P.C.B., & Perron, P. (1988). Testing for a unit root in time series regression. *Biometrika*, 75(2), 335-346.

Saka, J. O., Onafowokan, I. A., & Adebayo, A. A. (2015). Analysis of convergence criteria in a proposed monetary union: a study of the economic community of West African States. *International Journal of Economics and Financial Issues*, *5*(1), 230–239.

Schwarz, G.E. (1978). Estimating the dimension of a model. *The Annals of Statistics*, *6*(2): 461-464.

Siklos, P. L., & Wohar, M. E. (1997). Convergence in interest rates and inflation rates across countries and over time. *Review of International Economics*, *5*(1), 129–141.

Wright, J. H. (2013) Unseasonal Seasonals? (Including comments and discussion) *Brookings Papers on Economic Activity*, Fall, 65-126.

World Bank (2019a). World Development Indicators. Database downloaded from https://databank.worldbank.org/source/world-development-indicators#, on 19/08/2019

World Bank (2019b). World Development Indicators. Database downloaded from https://databank.worldbank.org/source/world-development-indicators#, on 26/03/2019

Appendix A. Table 1 repeated for data without seasonal adjustment and for seasonal tests

Table A.1: Unit-root tests on the difference of a given country's inflation rate and that of the other four given EAC countries for 2000M07-2013M10 (160 observations)

	Burundi	Kenya	Rwanda	Tanzania	Uganda
No seasonal adjustment					
ADF	-14.78***	-9.51***	-8.84***	-8.35***	-10.22***
DF-GLS	-5.65***	-3.76***	-8.93***	-3.74***	-8.62***
Phillips-Perron	-14.90***	-9.26***	-8.44***	-8.35***	-10.03***
HEGY	21.47**	13.04**	10.17**	13.44**	10.23**
KPSS	0.03	0.15	0.13	0.15	0.14
Canova-Hansen	1.69	1.73	1.95	1.34	1.70
With seasonal adjustment					
ADF	-14.5***	-10.04***	-10.72***	-8.82***	-12.02***
DF-GLS	-6.44**	-6.50***	-7.80***	-7.38***	-4.22***
Phillips-Perron	-14.71***	-10.00***	-10.75***	-9.00***	-12.03***
HEGY	22.23**	18.35**	16.90**	18.56**	21.42**
KPSS	0.04	0.20	0.18	0.13	0.15
Canova-Hansen	1.41	0. 98	1.07	0.97	1.16

Notes: The *, **, and *** superscripts indicate significance at the 10%, 5% and 1% levels, respectively.

Appendix B: Unit-root tests on inflation rates for each country

Table B.1: Unit-root and stationarity test results for EAC countries

	No seasonal adjustment		With seasonal adjustment	
	Proportion of country-period combinations supporting stationarity[a]	Cases where nonstationarity is suggested	Proportion of country-period combinations supporting stationarity[a]	Cases where nonstationarity is suggested
ADF	95%	Tanzania, 2000M07–2009 M06	95%	Uganda, 2009M07-2013M10
Phillips-Perron	100%	-	100%	-
DF-GLS	90%	Rwanda, 1995M07-2000M06 Tanzania, 2000M07-2009M06	85%	Rwanda & Tanzania 1995 M07-2000:6 Tanzania, 2009:7-2013:10
HEGY	80%	Tanzania & Uganda 1997M04-2000M06 Kenya, 2009M07-2013M10 Uganda, 2013M11-2018M12	100%	-
KPSS	100%	-	90%	Tanzania, 1995M07-2000M06 Tanzania, 2000M07-2009M06;
Canova-Hansen	100%	-	100%	-

Notes: [a] For the ADF, Phillips-Perron, and HEGY tests, support of stationarity is indicated by rejecting the null hypothesis of a unit root, and for the KPSS and Canova Hansen tests, support for stationarity is indicated by not rejecting the null hypothesis of stationarity. The significance level for the rejection of the null hypothesis is 5% for the ADF, Phillip-Perron, DF-GLS and KPSS tests and 10% for the two seasonal tests, HEGY and Canova-Hansen. In each cell, the results are summarized for the 20 combinations of the five EAC countries and the four historical periods under consideration (1995M05-2000M06, 2000M07-2009M06, 2009M07-2013M12, and 2013M11-2018M12).[b] Cases where nonstationarity is suggested refer to those cases in which stationarity was not supported in the cell immediately to the left.

Table B.2 Unit-root and stationarity test results for EMU countries. The numbers shown are the test statistics for the DF-GLS test (with intercept, no time trend).

	No seasonal adjustment		With seasonal adjustment	
	1994–1998	2014–2018	1994–1998	2014–2018
Austria	-5.759***	-1.020	-4.847***,a	-3.469***
Belgium	-2.095**	-6.700***	-5.352***	-6.168***,a
Finland	-6.340***	-2.021**	-6.735***	-3.682***
France	-5.657***	-8.45***	-7.052***,a	-7.807***,a
Germany	0.571	-4.664***	-3.008***,a	-7.467***
Greece	-1.043	-0.326	-1.800*,b	-2.066**
Ireland	-3.655***	-4.580***	-7.933***	-7.285***
Italy	-2.432**,a	-5.209***	-3.032***,a	-3.175***
Luxembourg	-1.799*	-2.303**	-1.286	-2.982***a
Netherlands	-0.694	-7.645***	-7.987***	-6.268***
Portugal	-0.6425***	-7.573***	-6.979***	-6.566***
Spain	-4.841***,b	-2.979***	-3.201***a	-5.191***

Notes: The *, **, and *** superscripts indicate significance at the 10%, 5% and 1% levels, respectively. The Schwarz information criterion (Schwarz, 1978) is used to determine lag lengths (maximum 10 months) for the DF-GLS test. The superscript [a] indicates that the KPSS test rejected stationarity at the 5% level but not at the 1% level; the superscript [b] indicates that the KPSS test rejected stationarity at the 1% level; absence of the superscript indicates that the KPSS test did not reject stationarity at the 5% level. Based on output from EViews version 11.

Table B.3 Unit-root and stationarity test results for WAEMU members, April 2013 – March 2018. The numbers shown are the test statistics for the DF-GLS test (with intercept, no time trend).

Country	No seasonal adjustment	With seasonal adjustment
Benin	-7.410***	-8.263***,[a]
Burkina Faso	-6.898***	-9.609***
Côte d'Ivoire	-6.686***	-8.577***
Guinea-Bissau	-7.969***	-9.765***
Mali	-5.720***	-9.393***
Niger	-4.572***	-10.294***
Senegal	-0.361	-4.022***
Togo	-5.759***	-8.468***

Notes: The *, **, and *** superscripts indicate significance at the 10%, 5% and 1% levels, respectively. The Schwarz information criterion (Schwarz, 1978) is used to determine lag lengths (maximum 10 months) for the DF-GLS test. The superscript [a] indicates that the KPSS test rejected stationarity at the 5% level but not at the 1% level; the superscript [b] indicates that the KPSS test rejected stationarity at the 1% level; absence of the superscript indicates that the KPSS test did not reject stationarity at the 5% level. Based on output from EViews version 11.

Appendix C: Normality Tests

Table C.1: Shapiro-Wilk test for normality of EAC inflation data in four periods

	Burundi	Kenya	Rwanda	Tanzania	Uganda
1995M05-2000M06					
No seasonal adjustment	0.978 (0.322)	0.955** (0.023)	0.831*** (0.000)	0.948** (0.010)	0.981 (0.448)
With seasonal adjustment	0.969 (0.121)	0.950** (0.014)	0.829*** (0.000)	0.924*** (0.001)	0.963* (0.059)
2000M07-2009M06					
No seasonal adjustment	0.980 (0.108)	0.793*** (0.000)	0.984 (0.217)	0.986 (0.340)	0.996 (0.989)
With seasonal adjustment	0.982 (0.142)	0.789*** (0.000)	0.966*** (0.007)	0.932*** (0.000)	0.993 (0.849)
2009M07-2013M10					
No seasonal adjustment	0.917*** (0.002)	0.948** (0.023)	0.985 (0.739)	0.977 (0.421)	0.870*** (0.000)
With seasonal adjustment	0.906*** (0.000)	0.954** (0.043)	0.955** (0.046)	0.969 (0.196)	0.862*** (0.000)
2013M11-2018M12					
No seasonal adjustment	0.895*** (0.000)	0.971 (0.145)	0.980 (0.390)	0.977 (0.296)	0.974 (0.212)
With seasonal adjustment	0.883*** (0.000)	0.990 (0.886)	0.940*** (0.005)	0.940*** (0.004)	0.973 (0.184)

Notes: The null hypothesis is normality. Test statistics further from 1 are more supportive of non-normality. p-values (two-tailed) are shown in parentheses. The *, **, and *** superscripts indicate significance at the 10%, 5% and 1% levels, respectively. These calculations were determined through the uninorm command in the EViews add-in package *Normtest* by IHS EViews.

Appendix D. Table 3 repeated with Pearson correlation coefficients instead of Kendall's tau-b

Table D.1 Pearson correlation coefficients between a given country and the other four EAC countries (weighted by GDP)

	Burundi	Kenya	Rwanda	Tanzania	Uganda
1995M05-2000M06					
No seasonal adjustment	0.231*** (0.070)	0.277** (0.030)	-0.080 (0.554)	0.189 (0.140)	0.061 (0.639)
With seasonal adjustment	0.178 (0.165)	0.217* (0.091)	0.183 (0.154)	0.138 (0.286)	0.386*** (0.002)
2000M07-2009M06					
No seasonal adjustment	0.281*** (0.003)	0.343*** (0.003)	0.286*** (0.003)	0.240** (0.012)	0.198** (0.040)
With seasonal adjustment	0.196** (0.042)	0.365*** (0.000)	0.371*** (0.001)	0.246** (0.010)	0.360*** (0.001)
2009M07-2013M10					
No seasonal adjustment	0.376*** (0.006)	0.556*** (0.000)	0.078 (0.584)	0.458*** (0.006)	0.578*** (0.000)
With seasonal adjustment	0.308** (0.026)	0.581*** (0.000)	0.155 (0.273)	0.532** (0.000)	0.595*** (0.000)
2013M11-2018M12					
No seasonal adjustment	0.452*** (0.002)	0.591*** (0.000)	0.314** (0.013)	0.428*** (0.005)	0.347*** (0.006)
With seasonal adjustment	0.422*** (0.001)	0.494*** (0.000)	0.470*** (0.001)	0.377 *** (0.003)	0.420*** (0.007)

Notes: p-values (two-tailed) are shown in parentheses. The *, **, and *** superscripts indicate significance at the 10%, 5% and 1% levels, respectively. The number of observations for the 1995M05-200M06, 2000M07-2009M06, 2009M07-2013M10, and 2013M11-2018M12 periods are 62, 108, 52, and 62, respectively.

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The Prospects for the East African Monetary Union

An Empirical Analysis

The four papers in this thesis answer the critical question of whether the East African Monetary Union (EAMU) is economically feasible by operationalizing the theory of optimum currency areas (OCA). The first paper uses the fixed effect filter estimator to assess trade integration among EAC countries. It is found that EAC membership has a positive and significant effect on intra-EAC trade. The second paper investigates business cycle synchronization and core-periphery patterns. We use a wavelet decomposition as a powerful tool for analyzing the comovement of business cycles and we found that business cycles of Kenya, Tanzania, and Uganda are more synchronized. These countries also form the core of the EAMU.

The third paper links business cycle synchronization and trade intensity. This analysis is relevant, as it is associated with the hypothesis of the endogeneity of the OCA criteria, whereby a monetary union among member countries is predicted to increase trade among them, which, in turn, may lead to more synchronized business cycles. The results show that trade intensity has led to more synchronized business cycles, suggesting that monetary union among EAC countries may be beneficial. The fourth paper mainly uses a similarity index and a rank correlation measure, Kendall's tau, to investigate the degree to which inflation rates and their movements for countries in the EAC have become more similar. The results show that changes in inflation have become more similar over time and that there are high inflation correlations between EAC countries. These findings are important for EAC policymakers, who decided to participate in a monetary union by 2024.

YVONNE UMULISA is a PhD student in economics at Jönköping International Business School and an assistant lecturer at the University of Rwanda. Inspired by the theory of optimum currency areas, her research focuses on the economics of the East African Community Union (EAMU) to generate empirical evidence to inform key decision-makers about the future development of the EAMU. Parts of her dissertation research has so far been published in the Journal of Economic Integration and African Development Review.

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