Trade and Shocks Transmission in Africa: The role of AfCFTA

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Abstract

Using an instrumental variable (IV) strategy, we show that climatic and political shocks in an origin country affect inflation in the destination country through trade in Africa. Specifically, a 1% decrease in imports resulting from such shocks leads to an increase in inflation in the destination country ranging from 0.26% to 0.4%. We then extend an international trade model based on Naito (2017) by incorporating money and productivity shocks to examine how the African Continental Free Trade Area (AfCFTA), adopted in 2021, could amplify the transmission of shocks across African countries. The model is calibrated to Nigeria and South Africa, the two largest economies on the continent. Our findings indicate that the more African countries trade, the more they are exposed to shocks of their trading partners. For instance, if intra-African trade increases by 15% from it current level—the inflationary impact of a productivity shock in an origin country increases from it effect of 0.3% to as much as 0.68%. Moreover, the persistence of inflationary effects also becomes more important with deeper trade integration.

JEL Classification: E52, E31, F14, F15,O55
Keywords: Trade Economics, Climatic Shocks, RTA, AfCFTA

1 Introduction

Despite an increasing number of Regional Trade Agreements (RTA), Africa's intra-regional trade was 18% in 2020, compared to 68% in Europe and 58% in Asia (United-Nations, 2022)[1]. To increase Regional trade, African countries adopted the African Continental Free Trade Area (AfCFTA) in 2021, the largest African RTA covering 54 out of 55 countries [2]. With the implementation of AfCFTA, regional trade is projected

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[1]See the cumulative number of RTAs among African countries in figure 4.
[2]Only Eritrea has not signed yet the AfCFTA to date (ElGanainy et al., 2023)

to increase significantly (Maliszewska et al., 2020; ElGanainy et al., 2023; World Trade Organization, 2023). Most studies project a 15 to 25% increase in trade over a decade following its full implementation (AfBD, 2019; IMF, 2019; UN, 2022) [3]. The recent trade war, which is disrupting traditional global supply chains and increasing protectionism in developed markets, presents a potential opportunity for African countries to strengthen intra-African trade and reposition themselves as alternative trade partners.

However African countries are more exposed to many productivity shocks, namely political and climatic shocks compared to other regions in the world (Hassler and Krusell, 2012; IPCC, 2022, 2023). In addition, Herrendorf et al. (2022) documents that low-income countries have a huge agricultural sector with low productivity. Indeed, one characteristic of African countries is that they are less industrialized and produce mainly raw materials. Consequently, by affecting their production, climate change could affect their exports and therefore prices with their African trading partners. Given the anticipated surge in trade and the region's exposure to the shocks mentioned above, our research focuses on two main questions: to what extent do imports transmit shocks to inflation in the destination countries among African countries? And to what extent will AfCFTA amplify the transmission of shocks to inflation across countries?

To address these questions, we employ an instrumental variable (IV) strategy to show that trade transmits climatic and political shocks from exporting countries to domestic prices within African countries. We rely on two primary data sources for this analysis. To capture climatic shocks, we use the PRIO-GRID framework, which provides global temperature data (Tollefsen et al., 2012), focusing on agricultural land in African countries. For socio-political shocks, we use the Social Conflict Analysis Database (SCAD) from Idean et al. (2012), using the number of fatalities from protests, riots, strikes, political and military conflicts, and other social disturbances. Following Jones and Olken (2010), we justify the exclusion restriction of these instruments by arguing that the temperature in the origin country does not directly affect inflation in the destination country, except in cases where the two countries are contiguous. However, we propose that trade acts as an indirect channel of transmission, which is the focal point of our analysis. Similarly, we argue that there is no direct link between the number of deaths due to sociopolitical conflicts in the origin country and inflation in the destination country. Nevertheless, violent conflicts may reduce exports, representing a productivity (or supply) shock likely to affect prices in the destination country. The validity of these instruments is discussed in Section 2.3.

We begin by assessing the relevance of our instruments, examining whether they induce variation in trade flows across African countries. We find a significant negative association between higher temperatures on agricultural land in the origin country and its export flows. We observe similar results for the number of deaths resulting from social conflicts. We then investigate the inflationary effects of trade variations driven by these negative productivity shocks in the origin country on imports to the destination country. The results indicate that a 1% decrease in imports, caused by either higher temperatures or violent social conflicts in the origin country, leads to a 0.26 to 0.58 percentage point increase in inflation in the destination country, depending on the

[3](Maliszewska et al., 2020) states that trade could increase by 52% in 2035 and more than double after full implementation of AfCFTA.

specification and sample used.

To address the second question, we develop a dynamic stochastic model of international trade based on Naito (2017), incorporating Money-in-the-Utility (MIU) preferences and productivity shocks. This model is used to examine how the African Continental Free Trade Area (AfCFTA) might amplify the transmission of productivity shocks to inflation. We estimate the model using African economic data and simulate the potential impact of AfCFTA on the cross-country propagation of such shocks. Our analysis yields two key findings. First, increased intra-African trade intensifies the transmission of productivity shocks to inflation among trade partners. For instance, if intra-African trade rises by 15% due to AfCFTA, the inflationary impact of a productivity shock originating in one country increases in the destination country from 0.3% (its current effect) to 0.68%. Second, this amplification effect is nonlinear. When intra-African trade increases by 40%, the inflation transmission effect rises only to 0.5%, which is lower than the 0.68% observed at a 15% increase. However, the persistence of the effect increases with greater trade integration.

Related Literature

This paper is related to two strands of literature. First, it is related to the literature on the transmission of shocks through trade across countries (Corsetti et al., 2008; di Giovanni and Levchenko, 2009; Enders and Müller, 2009; Caselli et al., 2020; Kejžar et al., 2022; Baqaee and Farhi, 2024; Benguria et al., 2024; Camara et al., 2024). Enders and Müller (2009) and Corsetti et al. (2008) provide empirical evidence on how international trade can act as a conduit for transmitting economic disturbances across borders. More recently, Baqaee and Farhi (2024), Benguria et al. (2024), and Camara et al. (2024) have explored the network effects and sectoral spillovers that amplify shock transmissions in global trade networks. Further, Kpodar and Imam (2016) investigates the effects of Regional Trade Agreements (RTAs) on growth volatility. Analyzing data from 172 countries over the period 1978-2012, they find that RTAs significantly reduce growth volatility. Their study suggests that countries are more likely to join RTAs when they are exposed to higher growth shocks and have potential partners with stable economic growth. We focus in this study on prices stability.

Somanathan et al. (2021) and Burke et al. (2015) explore the impact of temperature variations on productivity and labor supply, demonstrating a non-linear relationship between temperatures and macroeconomic productivity. These studies suggest that climate shocks in one country can significantly affect its trade partners through changes in productivity and export capacities. We explore empirically that question among African countries. In addition to climate shocks, we study the effect of political shocks in an origin country on inflation in the destination country through trade. Despite this rich literature, studies on shock transmission through intra-trade in Africa are scarce, with some exceptions including Ncube et al. (2014), which focuses on output co-movement in Africa. This scarcity might be due to two reasons. First, the low level of intra-trade in Africa, around 18% in 2020, may have a negligible effect on shock transmission. However, with the recent African Continental Free Trade Area (AfCFTA), intra-trade in Africa is likely to increase, making the question of how trade transmits shocks in Africa a timely topic. Second, there is a lack of data to identify shocks that could be transmitted through trade. In this paper we use PRIO-GRID data on temperature and the Social Conflict Analysis Database (SCAD) from Idean et al. (2012) to provide evidence of shock transmission through trade among African countries.

The paper is also related to how RTAs transmit shocks across countries and their implications for monetary policy (Silveira, 2015; Corsetti et al., 2007, 2005). Eaton and Kortum (2012) discusses how the popular Ricardian model can be used to address many economic issues, including the welfare effects of trade deficits, wage responses to decreases in trade barriers, and responses to technological changes. Eaton and Kortum (2002) develops a Ricardian model that incorporates technology and geography in trade among countries. This model is used to quantify gains from trade and from tariff reductions. They find that all countries gain from free trade, with smaller countries gaining more than larger ones. They also calculate the role of trade in spreading technology across countries. Caliendo and Parro (2015) estimate the trade and welfare effects of NAFTA from tariff changes using a Ricardian model similar to Eaton and Kortum (2002). Importantly, they study how gains from tariff reduction spread across sectors and find that tariff reduction leads to more specialization, especially for Mexico. They also find that, unlike Mexico and the US, Canada suffers a welfare loss. Shikher (2012) Build an Eaton and Kortum Model to study the effect of US-EU trade wars and the effect of trade barriers reduction between high-income and middle-income countries. Lind and Ramondo (2024) Study how international trade can transmit ideas across countries and influence countries' growth. Our model is closer to Naito (2017), which combines an Eaton and Kortum (2002) model of trade with an Acemoglu and Ventura (2002) AK model to explain the implications of trade on economic growth. Since we are primarily interested in the effects of productivity shocks from an exporting partner on inflation in the destination country, we augment the model with a Central Bank.

The remainder of this paper is structured as follows. In Section 2, we provide empirical evidence of the transmission of climatic and political shocks across African countries through trade. Section 3 presents the theoretical model. Section 4 discusses the results of the theoretical model. Finally, Section 5 concludes the paper.

2 Empirical investigation

This section aims to provide empirical evidence of shock transmission through trade. We begin by presenting the data and analyzing how climatic and political shocks in an origin country affect inflation in its trading partner, the destination country.

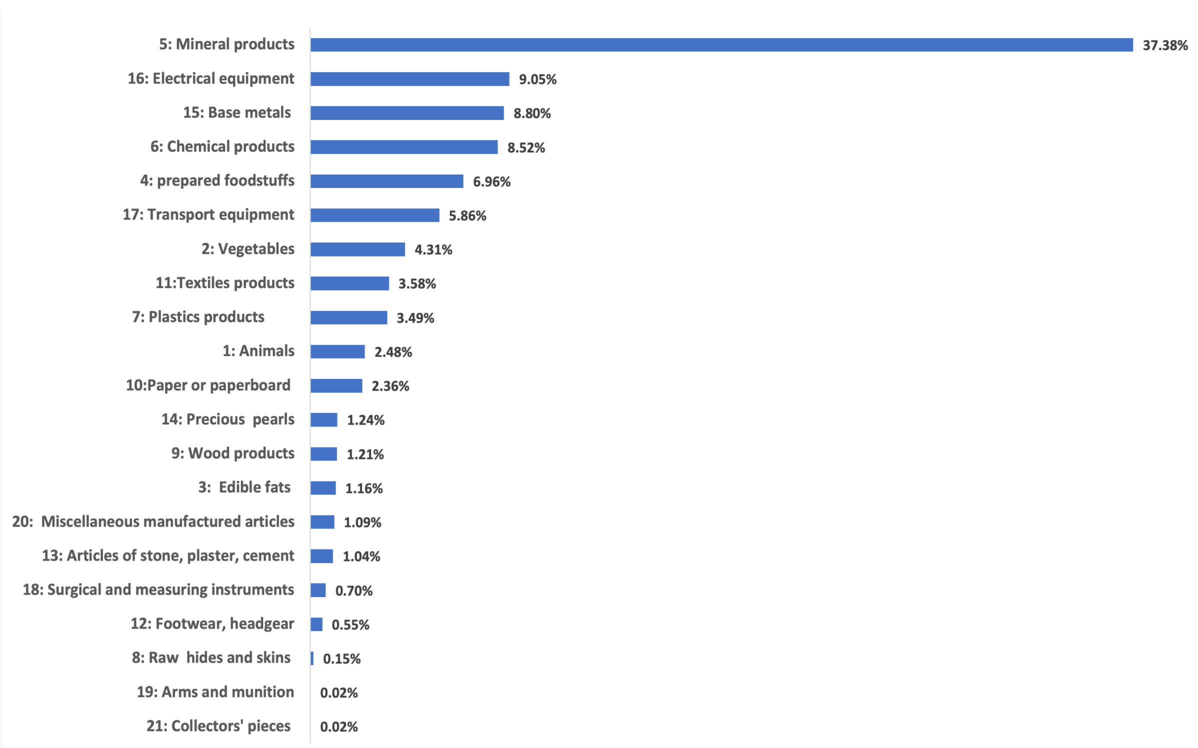
2.1 Data presentation

The data for the analysis of shocks transmission through trade comes from two principal sources. On the one hand, to capture climatic shocks we rely on the *PRIO-GRID* framework, a standardized grid of 0.5 x 0.5 decimal degrees covering the globe Tollefsen et al. (2012). We consider the grid-level average annual temperature and grid-level population. Temperatures are aggregated at the country level by considering the weighted mean across all grid cells falling inside its boundaries. Each grid is weighted by the share of national population falling inside its area. On the other hand, to capture socio-political shocks, we rely on the Social Conflict Analysis Database (SCAD) from Idean et al. (2012). We use the number of fatalities from protests, riots, strikes, political and military conflicts, and other social disturbances. We aggregate this event-level information by computing the total number of fatalities at the country-year level. We exclude events that span multiple years as their occurrence in one year might be endogenized by agents in the following years.

2.2 Descriptive statistics

Figure 1 presents the average trade share of product categories among African countries between 1996 and 2016. We employed a detailed product classification at the two-digit level Word Custom Organization's website. To compute the share, we aggregated the total trade volume for each year across all products and calculated the proportion of each product's trade volume to the total. Our findings show that *mineral products*, comprising oil, gas, cement, cobalt, aluminum, uranium, and other materials, were the most commonly exchanged products among African countries, followed by *electrical equipment, base metals, and chemical products*, each accounting for approximately 9% of total trade. In contrast, the least traded products were collector's pieces, arms and munitions, and raw hides and skins, which accounted for less than 0.5% of total trade.

Figure 1: Intra African trade share by product category



Notes: Average trade among African countries by product over the period 1996-2016

However, it is essential to note that there was a substantial variance in trade volume across different products. For example, animals had the least variation with a standard deviation of 279,816, while the standard deviation of transport equipment was 554 times higher. The most commonly traded products, *mineral products*, had a standard deviation approximately 94 times higher than animals. This heteroskedasticity in the data implies that some products are significantly more volatile in terms of trade volume than others. Moreover, this heteroskedasticity is still apparent at the country pairs level, as illustrated in Figure 5.

Table 6 in the Appendix presents descriptive statistics of variables used in the estimations. Sample 1 and 2 contain respectively 1712 and 1160 pairs of countries. Sample have 51 origin countries and 38 destination countries while in sample 2 have the same set of origin countries but with 3 less destination countries (Gambia, Guinea-Bissau and Sierra Leone).[4]

2.3 Trade and shock transmission across African countries

2.3.1 Empirical specification

To what extent do trade flows transmit shocks across African countries? To answer this question, we focus on one type of climatic shock, namely temperature shocks in the origin country, and ask whether inflation in the destination country is affected. We rely on the local average treatment effect (LATE) interpretation of the instrumental variable estimand put forward in Angrist and Imbens (1994); Angrist et al. (1996). Indeed, for a given instrument Z, a treatment X, and an outcome variable Y, the IV-estimator identifies under suitable conditions the change in the outcome variable due to changes in the treatment X for those units who respond to the instrument Z. In our setup, a unit of observation is a pair of origin-destination countries (o, d), the instrument is the temperature in the origin country (z_{ot}) and the treatment variable is the trade flow from country o to country d (x_{dot}). One of the conditions underlying the IV-regression LATE interpretation is for the instrument to actually induce changes in the treatment variable. [5] Jones and Olken (2010) show that higher temperatures in poor countries have a negative effect on the growth of their exports to the US and to the world. Moreover, the decrease is experienced not only in agricultural goods but also in light manufacturing. For temperature shocks to be a valid instrument in our setup, they might first induce changes in trade flows across African countries.

We show below, by estimating equation 2, that for a given pair of trading countries (o, d), an increase in temperature in the origin country o reduces trade flow from o to d. The second condition, which is referred to as the exclusion restriction, states that the

[4]Sample 1
Origins: AGO BDI BEN BFA BWA CAF CIV CMR COD COG COM CPV DJI DZA EGY ETH GAB GHA GIN GMB GNB GNQ KEN LBR LBY LSO MAR MDG MLI MOZ MRT MUS MWI NAM NER NGA RWA SDN SEN SLE STP SWZ SYC TCD TGO TUN TZA UGA ZAF ZMB ZWE
Destinations: BDI BEN BFA BWA CAF CIV CMR CPV EGY GAB GHA GIN GMB GNB KEN LSO MAR MDG MLI MOZ MRT MUS MWI NAM NER NGA RWA SEN SLE SWZ TCD TGO TUN TZA UGA ZAF ZMB ZWE
Sample 2
Origins: AGO BDI BEN BFA BWA CAF CIV CMR COD COG COM CPV DJI DZA EGY ETH GAB GHA GIN GMB GNB GNQ KEN LBR LBY LSO MAR MDG MLI MOZ MRT MUS MWI NAM NER NGA RWA SDN SEN SLE STP SWZ SYC TCD TGO TUN TZA UGA ZAF ZMB ZWE
Destinations: BDI BEN BFA BWA CAF CIV CMR CPV EGY GAB GHA GIN KEN LSO MAR MDG MLI MOZ MRT MUS MWI NAM NER NGA RWA SEN SWZ TCD TGO TUN TZA UGA ZAF ZMB ZWE

[5]also called endogenous variable

instrument should only influence the outcome variable through the treatment variable. Thus in our case, a temperature shock in the origin country should only affect inflation in the destination country through its effect on the supply of goods to the destination country. This would be violated for example, if temperature increases systematically simultaneously in the origin and destination country. In this case, both partners would experience a negative supply shock and the estimated IV-effect would conflate inflationary pressures originating both inside and outside the destination country. We control for this possibility by also adding the temperature in the destination country in equation 1 which links inflation in the destination country to the trade flow between origin and destination countries. We implement the IV procedure described above by estimating the following equations:

$$y^d_{dt} = a_{do} + \lambda_t + \alpha x_{dot} + \varepsilon_{dot} \quad (1)$$

$$x_{dot} = b_{do} + \gamma_t + \beta z_{ot} + u_{dot} \quad (2)$$

Where for each period t, y^d_{dt} denotes inflation in the destination country d, x_{dot} imports of country d from country o , a_{do} a pair destination $\times$ origin fixed effect , λ_t a time fixed effect, and ε_{dot} an error term capturing other factors influencing inflation aside from international trade. We assume that trade flows are potentially correlated with these latter factors: $cov(x_{dot}, \varepsilon_{dot}) \neq 0$. For example, an increase in public spending in country d might simultaneously increase inflation and imports in machinery. To deal with this endogeneity issue, we use alternatively climatic and socio-political shocks in exporter country o (denoted by z_{ot}) as an instrument to import of d from o.

On the one hand to control for the unbalanced panel nature of the available data on trade, we estimate the above regressions using two samples as described in table 6. In sample 1, we consider all the pairs of origin-destinations for which some data on trade is available between 2001 and 2015, while in Sample 2, we consider only pairs that have trade observations for more than half the period 2001-2015. Although trade flows data are available up to 2019, information on temperature from the PRIO-GRID is only available up to 2014. On the other hand to control for the heteroskedasticity of trade flows across different pairs of countries (see Figure 5), we estimate the regressions using both OLS and Feasible Generalized Least Squares as in Jones and Olken (2010) [6].

In a given year, for each pair, we use as a measure of climatic shocks for trade flows the temperature in the previous year in the origin country. Socio-political shocks in the origin country are captured by a dummy variable equal to 1 if the number of deaths in socio-political conflicts is in the last quartile of the sample.

2.3.2 Results

We begin by answering the question of whether the instrumental variables we consider do induce variations in trade flows across African countries. Results for the first-step regression are given in table 1.

[6] Residuals from the OLS regressions are used to estimate pair-specific variances which are used as

Table 1: First-step regression: shock-induced variations in trade flows (Two-digits data)

	$log(Import_{dot})$							
	Sample 1				Sample 2			
	OLS		FGLS		OLS		FGLS	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Temperature_{ot-1}$	-0.125***	-0.124***	-0.0842***	-0.0861***	-0.185***	-0.184***	-0.107***	-0.109***
	(0.0435)	(0.0435)	(0.0212)	(0.0215)	(0.0475)	(0.0475)	(0.0238)	(0.0240)
$NDeaths - AboveQ3_{ot}$	-0.181***	-0.180***	-0.0909***	-0.0924***	-0.125*	-0.124*	-0.0663**	-0.0694**
	(0.0636)	(0.0636)	(0.0256)	(0.0257)	(0.0667)	(0.0669)	(0.0277)	(0.0280)
$Temperature_{dt-1}$		0.0273		0.0111		0.0399		0.0216
		(0.0492)		(0.0187)		(0.0534)		(0.0203)
$NDeaths - AboveQ3_{dt}$		0.0364		-0.0202		0.0659		-0.0156
		(0.0582)		(0.0224)		(0.0608)		(0.0238)
Constant	12.69***	12.69***	11.78***	12.58***	13.17***	13.16***	16.55***	16.57***
	(0.0104)	(0.0139)	(0.00976)	(0.00780)	(0.0110)	(0.0146)	(0.00504)	(0.00585)
Origin * destination FE	T	T	T	T	T	T	T	T
Year FE	T	T	T	T	T	T	T	T
R2	0.783	0.783	0.988	0.987	0.776	0.776	0.947	0.948
F-stat	8.318	4.406	13.87	7.398	9.507	5.407	12.62	6.748
Observations	15941	15941	15941	15941	13716	13716	13716	13716

Notes: Results based on data from 2001 to 2015. Bilateral import flows are aggregated from the product-level bilateral import data set of the WTO Standards errors are clustered at the Origin * destination level.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Standards errors are clustered at the Origin * destination level.
Instruments: L_temp_agr_c_o Id0_ndeath_c_o

Overall, we find a significant negative impact of higher temperatures and deaths in social conflicts in the origin country on import flows to the destination country. The effect of temperature appears to be more robust both across specifications and to sample selection than the effect of deaths in social conflict. Columns 1 to 4 presents estimation realized on sample 1 while columns 5 to 8 presents the same estimation run on sample 2.
Focusing on OLS regressions, one degree increase on the temperature of the origin country induce a 12% to 18% reduction of imports to destination countries depending on whether one uses sample 1 or sample 2. A correction for heteroskedasticity using FGLS brings the estimates across both sample more in line, with one degree increase in origin country temperature leading to a 9 to 11% decrease in trade flows. These estimated effects are robust to the inclusion of temperatures in the destination country, supporting the fact that they are not driven by a spatial correlation in temperatures. Regarding the effect of deaths in social conflicts in the origin country, the results point to a decrease in imports as social conflicts grow more violent. At the bottom of Table 1, F-statistics across all regressions range from 7 to 14. This may suggest that our instruments are weakly correlated with trade flows as they are not likely to be the main determinants of trade flow variations across African countries.

However, due to the presence of heteroscedasticity in the trade data, the Kleibergen-Paap (KP) test provides a more robust measure of instrument strength than the Cragg-Donald (CD) test. The p-values associated with the KP statistic (*see KP pval in*

weights in a second OLS regression

the table) indicate that the instruments are sufficiently strong to limit bias in the IV estimates to within a tolerable threshold of 5% relative to OLS, as suggested by Baum et al. (2007).[7]

We next turn to the analysis of possible inflationary effects of trade variations due to negative supply shocks in origin countries. Table 2 gives the results of the OLS and IV estimations of the effects of trade variations on domestic inflation. OLS estimates (column 1 and 7) are small in magnitude, non significant, and with opposite signs from sample 1 to sample 2. A correction for heteroskedasticity using FGLS lead to comparable small coefficients with the same sign across samples. This suggests that OLS estimates might be biased.

Table 2: Inflationary effect of shock-induced trade variations

	$Inflation_{dt}$											
	Sample 1						Sample 2					
	OLS	IV-OLS		FGLS	IV-FGLS		OLS	IV-OLS		FGLS	IV-FGLS	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$log(import_{dot})$	0.000326	-0.275	-0.416	0.00521	-0.259***	-0.397*	-0.0144	-0.428	-0.524	0.00751	-0.448*	-0.587*
	(0.0170)	(0.434)	(0.430)	(0.00460)	(0.0720)	(0.225)	(0.0191)	(0.429)	(0.422)	(0.00903)	(0.245)	(0.314)
$Temperature_{dt-1}$			0.802***			0.463***			0.853***			0.348***
			(0.0767)			(0.163)			(0.0846)			(0.0585)
$NDeaths-AboveQ3_{dt}$			1.016***			0.843***			1.158***			0.827***
			(0.123)			(0.0859)			(0.133)			(0.0710)
Constant	5.917***			7.086***			6.080***			3.504***		
	(0.214)			(0.0482)			(0.251)			(0.117)		
Origin * destination FE	T	T	T	T	T	T	T	T	T	T	T	T
Year FE	T	T	T	T	T	T	T	T	T	T	T	T
Observations	16072	15666	15666	16072	15666	15666	13746	13491	13491	13746	13491	13491
CD Fstat		8.361	8.256		6.407	4.040		8.961	8.854		6.238	4.403
KP Fstat		16.31	16.11		7.110	7.881		17.10	16.91		11.73	8.346
KP pval		0.000287	0.000317		0.0286	0.0194		0.000193	0.000212		0.00283	0.0154

*Notes: Results based on data from 2001 to 2015. Inflation is annually winsorized at 5%. Bilateral import flows are aggregated from the 2-digit product-level bilateral import data set of the WTO. In all IV estimations, both lagged temperature and a dummy indicating large casualties in social conflicts in the origin country are used as instruments. Standards errors are clustered at the Origin * destination level.*
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Indeed, the relationship between inflation and importation is not unambiguous as both variables are simultaneously determined. A strong domestic demand could lead to inflationary pressures and also increase import levels. In this case both variables will be positively correlated. Conversely, a negative foreign supply shock could reduce imports and create inflationary pressure in the domestic country if demand stays at its prior level. This latter channel is the one we are interested in estimating in this work.

Simple IV estimates (see columns 2, 3, 8, and 9), with temperature and violent social conflict as instruments, yield larger and negative coefficients but not statistically significant. A correction for heteroskedasticity using FGLS (see columns 5, 6, 11, and 12), gives coefficients similar in magnitude and statistically significant at least at 10% level. We regard this similarity in terms of magnitude between the unweighted and weighted IV regressions as suggestive of possible bias being of small magnitude. These latter results imply that a 1% decrease in imports due to increased temperatures or violent social conflicts in the origin country leads to an increase in inflation of 0.26 to 0.58 percentage points in the destination country, depending on the specification and

[7]See also (Stock and Yogo, 2002) for a discussion on instrument strength under heteroscedasticity.

the sample used. The preferred regression is the one controlling for the temperature and number of Deaths above the third quarter in the destination country (columns 6 and 12). When using the whole sample (sample 1) between 2001 and 2015, the effect is 0.4 percent, while it increases up to 0.58 percent when considering a more balanced sample (sample 2), which keeps only countries for which the data are available for at least half of the period 2001-2015.

We can notice that the effect of imports on inflation increases in magnitude (becomes more negative or more pronounced) when we control for temperature in the destination country. This can be explained by the fact that temperature is correlated with import levels (e.g., countries import more during climate stress). Temperature was upwardly biasing the import effect estimate. Once controlled, the negative effect of imports on inflation becomes more evident.

In this section we have shown that trade transmits political and climatic shocks to inflation across African countries. The scond question is : to what extent will AfCFTA amplify the transmission of shocks to inflation across countries?

While instrumental variable (IV) methods can identify a local average treatment effect (LATE) and are useful for estimating the causal impact of observable shocks, they are limited in their ability to study policy counterfactuals—such as the effects of the African Continental Free Trade Area (AfCFTA). In particular, trade liberalization under AfCFTA may modify firms' and consumers' behavior, rendering IV estimates based on pre-reform data unreliable [8]. Structural models, which embed economic behavior explicitly, are better suited to account for such changes [9]. Therefore to answer the above mentionned question, we adopt a structural approach in the following section.

3 The Model

3.1 Model Environment

The model features a multi-country general equilibrium framework in which each country is populated by representative consumers, firms (both intermediate and final goods producers), and a central bank. Each country produces a non-tradable final good by aggregating a continuum of differentiated intermediate goods, which are tradable across countries subject to iceberg trade costs. Intermediate goods are produced by perfectly competitive firms, each of which produces a unique variety using capital as the sole input. The final good is produced under perfect competition using a Constant Elasticity of Substitution (CES) aggregator of intermediate goods. The final good is then used for both consumption and investment in capital.

The consumer's utility function includes real money balances—capturing Money-in-the-Utility (MIU) preferences—which generates a demand for money. The central bank in each country sets the nominal money supply according to an exogenous process. Each country experiences a country-specific productivity shock in the final goods sector,

[8] AfCFTA alters trade and production incentives across all markets. It could also change countries' exposure to external shocks. A structural model endogenizes these amplification mechanisms, allowing us to examine how and why AfCFTA may amplify or dampen inflation spillovers.

[9] An insight aligned with the Lucas critique (Lucas, 1976).

which affects the efficiency with which output is produced. This shock follows an autoregressive process of order one (AR(1)), capturing persistence over time.

Trade between countries is subject to bilateral iceberg costs, τ_{nj}, where shipping τ_{nj} units from country j delivers one unit to country n. These costs introduce home bias and allow the model to capture the frictions and asymmetries commonly observed in trade data.

3.2 Households

We introduce money into the utility function (MIU) to generate a demand for money. Utility is derived from real money balances, represented as $m_{jt} = \frac{M_{jt}}{P_{jt}^Y}$, where M_{jt} denotes nominal money holdings and P_{jt}^Y is the price level in country j at time t.

The household's optimization problem is defined as:

$$\max_{K_{jt+1}, m_{jt}, C_{jt}} \sum_{t=0}^{\infty} \beta^t U(C_{jt}, m_{jt})$$

$$\text{s.t: } C_{jt} + K_{jt+1} - (1-\delta_j)K_{jt} + \frac{M_{jt}}{P_{jt}^Y} = \frac{r_{jt}}{P_{jt}^Y} K_{jt} + \frac{M_{jt-1}}{P_{jt}^Y} \tag{3}$$

By substituting the real money balance expression, the budget constraint can be rewritten as:

$$C_{jt} + K_{jt+1} - (1-\delta_j)K_{jt} + m_{jt} = \frac{r_{jt}}{P_{jt}^Y} K_{jt} + m_{jt-1} \cdot \frac{1}{1+\pi_{jt}},$$

where π_{jt} is the inflation rate in country j at time t. The first-order condition with respect to real balances m_{jt} yields the demand for money. The supply of money is exogenously determined by the Central Bank.

3.3 Central Bank

The role of the Central Bank is to only supply money [10]. It follows this equation: $M_{jt} = (1+\mu_{jt})M_{jt-1}$. Expressed in terms of real balances (to be consistent with the consumer's formulation), it gives:

$$m_{jt} = (1+\mu_{jt}) \frac{m_{jt-1}}{(1+\pi_{jt})}. \tag{4}$$

where μ_{jt} is an exogenous (stochastic) growth rate of the nominal stock of money set by the Central Bank and π_{jt} domestic inflation.

Denote $\bar{\mu}_j$ the average growth rate of money supply. Define $u_t = \mu_{jt} - \bar{\mu}_j$ be the deviation in period t of the growth rate from its unconditional average value. Following Walsh (2003), this deviation is assumed to follow the stochastic process given by:

$$u_{jt} = \rho_j^u u_{jt-1} + \phi z_{jt-1} + \varphi_{jt} \tag{5}$$

[10] We are not studying monetary policy in this paper

with φ_{jt} is a white noise process and $|\rho_j^u| < 1$. One could note that the growth rate of the money stock displays persistence (if $\rho_j^u > 0$), responds to the real productivity shock z in the final good sector, and is subject to random disturbances through the realizations of φ_{jt}.

z_j is the productivity and follows:

$$log(z_{jt}) = \rho_j^z log(z_{jt-1}) + e_{jt} \tag{6}$$

e_{jt} is an iid process following a normal distribution according to: $e_{jt} \sim \mathcal{N}(0, \sigma_j^z)$.

3.4 Intermediate goods-producing firms

Each country j produces a variety $s_j \in S_j \subseteq [0, 1]$. Firms produce under perfect competition. The profit maximization problem for an intermediate goods-producing firm is:

$$\max_{K^x(s_j)} \Pi^x(s_j) = p(s_j)x(s_j) - r_j K^x(s_j)$$

subject to:

$$s.t : x(s_j) = \frac{K^x(s_j)}{a_j(s_j)} \tag{7}$$

where $a_j(s_j)$ and $p(s_j)$ represent the unit capital requirements and the supply price, respectively. The zero-profit condition implies:

$$p(s_j) = a_j(s_j) r_j$$

Let A_j be an iid random variable for $a_j(s_j)$. As in Eaton and Kortum (2002), A_j^{-1} follows a Fréchet distribution:

$$F_j(h) = Pr(1/A_j \leq h) = \exp(-b_j h^{-\theta})$$

where $b_j > 0$ and $\theta > 1$.

We consider iceberg trade costs: shipping τ_{nj} units from country j delivers one unit to country n ($\tau_{nj} \geq 1$). Producing variety s_j in country j and delivering it to country n costs:

$$p_{nj}(s_j) = \tau_{nj} p(s_j) = \tau_{nj} a_j(s_j) r_j \tag{8}$$

The demand price of variety s in country n is:

$$P_n(s) = \min(\{p_{nj}(s)\}_{j=1}^N)$$

3.5 Final Goods-Producing Firms

Firms in the final good sector also operate under perfect competition. Shocks z_n in the final goods sector follow an AR(1) process as shown in equation 6. The profit maximization problem for final goods-producing firms is:

$$\max_{x_n(s)} \Pi_n^Y = P_n^Y Y_n - \int_0^1 P_n(s) x_n(s)\, ds \tag{9}$$

subject to:

$$Y_n = z_n \left(\int_0^1 x_n(s)^{\frac{\sigma_n - 1}{\sigma_n}} ds \right)^{\frac{\sigma_n}{\sigma_n - 1}}$$

where P_n^Y is the price of the final good in country n. As Lemma 1 in Naito (2017), we have:

$$P_n^Y(\{\tau_{nj} r_j\}_{j=1}^N) = c_n \left[\sum_{j=1}^{N} b_j (\tau_{nj} r_j)^{-\theta} \right]^{-1/\theta} \tag{10}$$

where $c_n = z_n^{-1} \Gamma \left(1 + \frac{1-\sigma_n}{\theta}\right)^{\frac{1}{1-\sigma_n}}$ and Γ is the gamma function.

As shown in Appendix B.1, the price of the final good is an index of intermediate goods prices denoted by Q_n. The probability that country n imports goods from country j is the share of import from j in country n's total imports and is given by:

$$\Pi_{nj} = \int_{s_j \in S_{nj}} p_{nj}(s_j) x_n(s_j)\ ds_j / Q_n Y_n \tag{11}$$

3.6 Equilibrium

3.6.1 Definition of the Equilibrium

An equilibrium in a given country j is a set of quantities and prices such that:

- $C_{j,t}, K_{j,t+1}, m_{j,t}$ solve consumer's problem defined in (3) given prices $r_{j,t}, P_{j,t}^Y, \pi_{j,t}$
- $K^x(s_j)$ solve intermediate firms problem in (7) given $r_{j,t}, p(s_j)$
- The intermediate good $x_j(s)$ solve final good firm problem in (9) given $P_{jt}^Y, P_{j,t}(s)$
- Central Bank supplies the quantity of money following (4).
- Market clearing conditions:
  - Intermediate goods market [11] :

$$x(s_j) = \sum_{n=1}^{N} \tau_{nj} x_n(s_j),\ s_j \in S_j \tag{12}$$

  - Capital market (at any period t):

$$K_j = \int_{s_j \in S_j} K^x(s_j)\ ds_j \tag{13}$$

[11] Since firms' problems are static, we omit time subscripts for simplicity. Otherwise, equations 12

– The final goods market clearing:

$$Y_{j,t} = C_{j,t} + K_{j,t+1} + (1 - \delta_j)K_{j,t} \tag{14}$$

– Money market clears, supply by the Central Bank is equal to the demand by consumers

3.6.2 Charactization of the equilibrium

The equilibrium is characterized by a system of equations that solve for the endogenous variables: $C_{j,t}, K_{j,t}, m_{j,t}, P^Y_{jt}, \pi_{jt}, r_{jt}$. For that, let first derive the Euler equations, obtained by the first-order conditions.

Euler Equation for Capital:

$$U_C(C_{jt}, m_{jt}) = \beta E_t \left[U_C(C_{j,t+1}, m_{j,t+1}) \left(\frac{r_{jt+1}}{P^Y_{jt+1}} + 1 - \delta_j \right) \right] \tag{15}$$

Euler Equation for Money:

$$U_m(C_{jt}, m_{jt}) = U_C(C_{jt}, m_{jt}) - \beta E_t \left[U_C(C_{j,t+1}, m_{j,t+1}) \left(\frac{1}{1 + \pi_{jt+1}} \right) \right] \tag{16}$$

These Euler equations characterize the intertemporal optimization conditions for consumption and money holdings [12]. Combined with the budget constraint below, they describe citizens' optimization solutions.

$$C_{jt} + K_{jt+1} + m_{jt} = \left(\frac{r_{jt}}{P^Y_{jt}} + 1 - \delta_j \right) K_{jt} + \frac{m_{jt-1}}{1 + \pi_{jt}} \tag{17}$$

The interpretation of these Euler equations follows standard intertemporal optimization logic.

Next, we derive the equation determining the nominal return on capital r_{jt}, which influences final good prices as shown in equation 10. The following lemma formalizes this relationship.

Lemma

The return on capital solves the following equation:

$$r_{jt}K_{jt} = \sum_{n=1}^{N} \Pi_{nj}(r_{nt}K_{nt} - M_{n,t-1}\mu_{nt}), j = 1, ..., N - 1 \tag{18}$$

A detailed proof of this lemma can be seen in appendix B.3.

Interpretation: This equation can be broken down and interpreted as follows [13]:

and 13 would include time indices (e.g. $K_{j,t}$.

[12] Throughout the text, the terms 'money' and 'real balances' are used interchangeably to denote mj, t.

[13] Note that it's redundant to add the N-th equation, for more details see appendix B.4. In other

- Π_{nj}: represents the probability or fraction of the total value from country n that influences country j. It acts as a weighting factor that indicates the interaction between country n and country j.

- $(r_n K_n - M_{n,t-1}\mu_n)$: This term inside the summation can be broken down further:

  - $r_n K_n$: The total returns to capital in country n.
  - $M_{n,t-1}\mu_n$: represents the additional money supply in country n at time t relative to time $t-1$. This term is subtracted from the total returns to capital, indicating the impact of money supply on the returns.

The equation states that the total returns to capital in country j ($r_j K_j$) are determined by summing up the weighted and adjusted returns to capital from all other countries. Each term in the summation adjusts the returns to capital from country n by subtracting the impact of the money supply. It illustrates the interdependencies and the role of trade in determining the distribution of capital returns among countries. Although we do not have a closed-form solution, we can describe the mechanism through which a productivity shock in one country affects inflation in its trading partners.

Mechanism (channel) of productivity shocks transmission to inflation. How does a productivity shock in a given country affect inflation in its trading partners? Consider a negative productivity shock in the final good sector of the origin country. This shock leads to a contraction in domestic output and a reduction in capital accumulation, since the final good is used for both consumption and investment in capital. The resulting decline in capital supply increases the marginal product of capital, thereby raising the domestic interest rate. Higher interest rates, in turn, elevate the production costs of intermediate goods, pushing up their prices. Because these intermediate goods are traded and used as essential inputs in final good production abroad, the price increase is transmitted across borders through trade linkages (see equation 8). In the destination country, higher imported input prices raise domestic production costs, ultimately leading to an increase in the final good's price level. This trade-based transmission mechanism—formally captured in equation 10—demonstrates how a domestic productivity shock can generate inflationary pressures in trading partner economies.

The next section estimates the model with African data to investigate the extent to which AfCFTA amplifies shock transmission across countries.

4 The effect of AfCFTA on shock transmission

To what extent will AfCFTA amplify the transmission of shocks to inflation across countries? In this part, we consider a three country version of the model. We choose Nigeria and South Africa to represents intra-African regional trade as they are the two largest economies in Africa. We also used China to represent the rest of the world [14]. They are mainly used to estimate the productivity shocks persistence and their standard errors as well as the trade cost.

words, this means that r_N can't be identified; we therefore normalized it to 1.

[14] Note that China has been Africa's largest trading partner during the last 15 years (The State

4.1 Data for the estimation of parameters

It is well-documented that intra-African trade faces higher costs compared to other regions. Factors contributing to these elevated costs include infrastructural deficits, complex customs procedures, input delays and regulatory barriers (Adom and Schott, 2024; Portugal-Perez and Wilson, 2008). As a measure of trade cost, we use the bilateral trade cost based on Novy (2013) from **ESCAP-WB** Trade Cost Database. It captures trade costs in its wider sense, including not only international transport costs and tariffs but also other trade cost components such as direct and indirect costs associated with differences in languages, and currencies as well as cumbersome import or export procedures. The data is from 1995 to 2021 and covers over 180 countries. These trade cost data are generally higher than the value of the goods, making the add-valorem trade cost higher than 1.

We used data on Total Factor Productivity (TFP) measures , which captures the efficiency with which inputs are transformed into outputs over time [15]. These measures are calculated using a Cobb-Douglas production function framework and adjusted for differences in capital and labor input quality. The current version (PWT 10.0) is described in detail by Feenstra et al. (2015).

4.2 Estimation of parameters and validation of the model

Table 3 displays the estimated trade cost between countries, the persistance of the productivity shocks and their standard errors (std) [16]. Table 9 contains the remaining parameters of the model, which are standard in the litterature.

Table 3: Estimated Parameters and their Descriptions for the three countries.

Parameter	**Description**	**1.Nigeria**	**2.South Africa**	**3.China**
τ_{1j}	Trade cost to 1	1	2	1.6
τ_{2j}	Trade cost to 2	2	1	1.15
τ_{3j}	Trade cost to 3	1.15	1.6	1
ρ^z_j	Persistence of productivity shocks	0.946	0.968	0.887
σ^z_j	std of productivity shocks	0.043	0.036	0.062

Note: Trade cost refers to the average bilateral trade cost over the period 1995–2021. std denotes standard errors. The subscript j indicates country j. Trade cost values are expressed relative to domestic trade costs. For example, the trade cost between Nigeria and South Africa is twice as high as the internal trade cost within either country. Similarly, trade between Nigeria and China incurs a cost 1.6 times higher, while the cost between South Africa and China is 1.15 times higher.

To validate the model, we compare untargeted moments from the model to their conterparts in the data. Table 4 presents the results. First, we look at trade share which is 18% in the data and 16.2% in the model. Second, since the focus is on inflation, we compare the standard errors of inflation in the destination country(represented by South

Council). We alternatively used the US as the rest of the world, and the results were similar.

[15]TFP at constant national prices.

[16]It is worth noting that the trade cost estimates used in our analysis, taken from Novy (2013), are symmetric. We rely on these measures primarily due to the lack of more detailed data on intra-African trade costs. However, trade costs are not necessarily symmetric in reality; for instance, the cost of shipping goods from Nigeria to South Africa may differ from the cost of shipping in the reverse

Africa) to their model conterpart. These standard errors are obteined using the inflation generated in the destination country after a standard error productivity shock in the origin country (represented by Nigeria). Lastly, we look at the inflation correlation between the destination country and the origin country.

Table 4: Untargeted Moments

	Trade Share	Inflation Std	Inflation Correlation
Model	16.2%	3.98%	15.4%
Data	18%	4.39%	13.8%

Note: The table reports intra-African untargeted moments, calculated using data from 1975 to 2021. South Africa and Nigeria are used as representative countries for intra-African trade. The reported inflation correlation is measured between these two countries, using GDP deflator data from the World Development Indicators (retrieved on 25/04/2025). As a robustness check, we also used the consumer price index (CPI); the results were similar.

Overall, these three moments are close to each other when one compares the data to their model-generated conterparts.

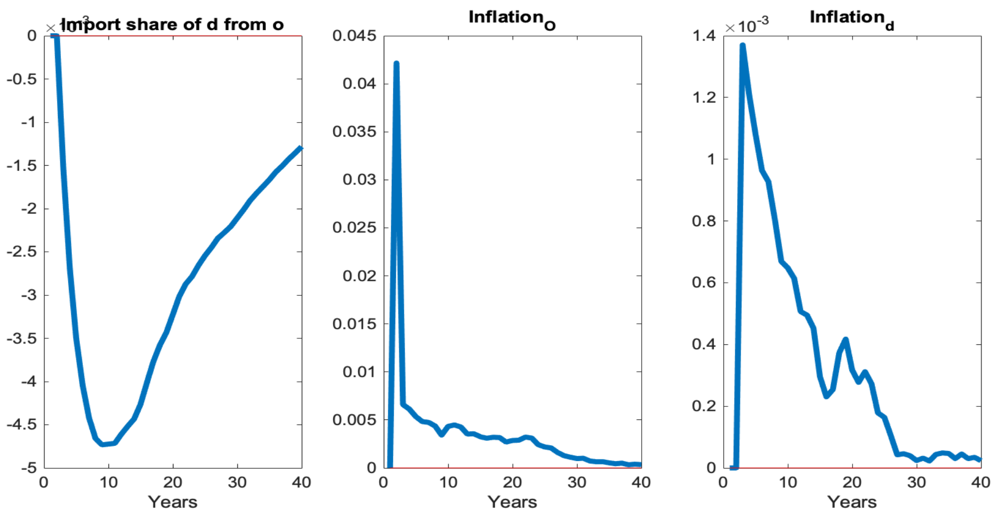
4.3 Results

Figure 2 illustrates the impact of a standard deviation negative productivity shock originating in the exporting (origin) country.[17] The first column displays the share of imports in the destination country sourced from the origin country; the second column shows inflation in the origin country; and the third depicts inflation in the destination country. The scenario corresponds to the Business As Usual (BAU) case, which uses parameters estimated from the previously described data. The results show that a negative standard deviation productivity shock reduces the import share from the origin country up to approximately 0.5%. In the origin country, inflation rises significantly, reaching up to 4.2% after two years (captured by the variable $inflation_o$). In the destination country, inflation increases more moderately, peaking at 0.14% in the third year. Although the magnitude of the inflationary effect is smaller in the destination country, it dissipates more gradually and takes longer to return to its initial level compared to the origin country.

direction, as thoroughly documented in Brancaccio et al. (2020).

[17] As shown in Table 3, the standard deviation of productivity in the origin country—represented by Nigeria—is 4.3%. A negative one standard deviation productivity shock therefore corresponds to a 4.3% decline in productivity.

Figure 2: Supply Shocks in the origin country before AfCFTA



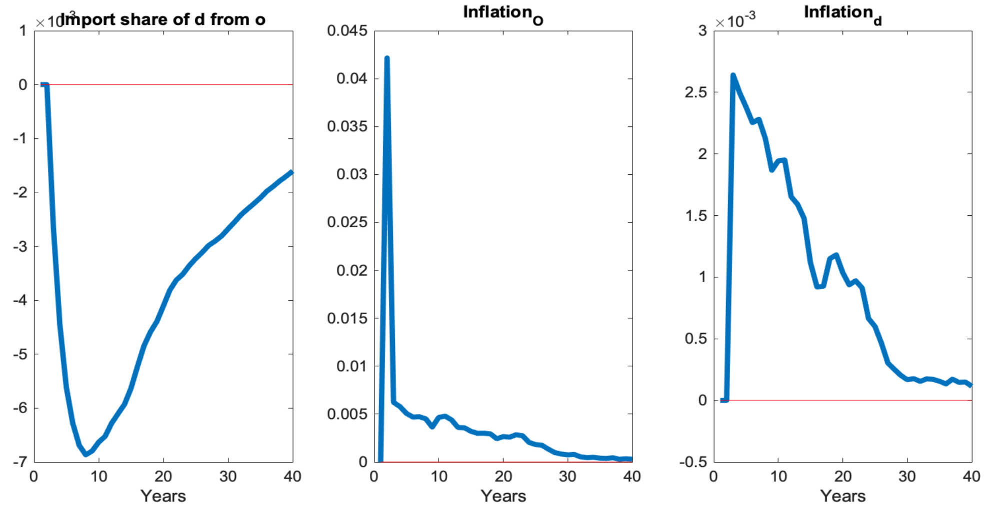
Notes: *This figure displays the impact of a Standard Deviation Productivity Shock in the Origin Country under the Business As Usual (BAU) Scenario. BAU is the model with parameters estimated with the data before AfCFTA (up to 20221). All the variables are expressed as a percentage deviation from the steady states.*

Channel of the Effect of a Productivity Shock: A negative productivity shock in any given country reduces both the country's output and its capital stock, as the final good is used for both consumption and investment in capital. This decline in capital supply leads to an increase in its price—reflected in a rise in the interest rate. Higher capital costs, in turn, raise the prices of both intermediate and final goods. Because intermediate goods are traded, these price increases are transmitted internationally, thereby raising prices in destination (importing) countries as well. Equation (10) formally captures the relationship between a country's price level and the interest rates of its trading partners. Additionally, Figure 6 in the Appendix illustrates the response of capital and interest rates to a productivity shock.

AfCFTA Scenario: Figure 3 presents the scenario under the African Continental Free Trade Area (AfCFTA). This scenario assumes an increase in intra-African trade from 16% to 30%, in line with most projections, which estimate trade growth between 15% and 25% following AfCFTA implementation. To simulate this, intra-African trade costs are reduced by 42.5%, from a value of 2 to 1.15.

The results exhibit a pattern similar to that observed in Figure 2. Notably, the inflation dynamics in the origin (exporting) country remain largely unchanged. However, the inflation response in the destination (importing) country becomes more pronounced compared to the Business As Usual (BAU) scenario. This heightened sensitivity is driven by greater transmission of price effects from the origin country. As goods become more expensive in the origin country following the productivity shock—and given the increased share of imports from that country under AfCFTA—the destination country experiences stronger inflationary pressure. Specifically, inflation in the destination country rises from 0.14% under the BAU scenario to 0.26% under AfCFTA.

Figure 3: Supply Shocks in the origin country after AfCFTA



Notes: *This figure illustrates the impact of a one standard deviation productivity shock in the origin country under an AfCFTA scenario (Scenario 2), which corresponds to an approximate 15% increase in intra-African trade. All variables are expressed as percentage deviations from their respective steady states.*

Simulated Scenarios. We simulate four scenarios. The *Business-as-Usual (BAU)* scenario uses parameters estimated from the data. Scenarios 1 to 3 correspond to *AfCFTA* (African Continental Free Trade Area) scenarios, incorporating reductions in trade costs intended to generate increases in intra-African trade between 15% and 25%, consistent with projections from studies such as Maliszewska et al. (2020), ElGanainy et al. (2023), and World Trade Organization (2023).

- **Scenario 1** reduces intra-regional trade costs from 2 to 1.5, increasing the trade share from the baseline of 16.2% to 22.6%.
- **Scenario 2** lowers trade costs further to 1.15—a 42.5% reduction—resulting in a 30.46% intra-regional trade share.
- **Scenario 3** applies an almost 50% reduction in trade costs, down to 1.001, leading to a 40% increase in intra-regional trade.

To ensure comparability with the instrumental variable (IV) estimates presented earlier, we scale the productivity shock to induce a 1% decline in imports. Specifically, we examine a negative productivity shock in the origin country that leads to a 1% reduction in imports in the destination country, and assess the resulting impact on inflation in the destination country.[18] Table 5 summarizes the results, reporting trade costs, the resulting trade shares, and the peak inflation observed in the destination country.

In the BAU scenario, a productivity shock in the origin country that leads to a 1% decline in imports results in a gradual rise in inflation, peaking at 0.3% after three

[18]Results for the same scenarios under a one standard deviation productivity shock are reported in Table 10 in the Appendix.

Table 5: Results of the simulation scenarios

Scenarios	Trade Cost	Trade Share	Inflation Peak
BAU	2	16.2%	0.3%
Scenario 1	1.5	22.6%	0.33%
Scenario 2	1.15	30.46%	0.68%
Scenario 3	1.001	40%	0.5%

Note: The table presents the simulated scenarios along with the corresponding results. The second column reports the intra-regional trade costs within Africa, while the third column shows the resulting trade share between African countries. The fourth column displays the peak inflation observed in the destination country following a productivity shock in the origin country. The dynamic pattern of the inflation response remains consistent with that shown in Figure 2; only the magnitude of the effect varies across scenarios.

years. This magnitude aligns with the range estimated in the previous IV analysis, which lies between 0.26% and 0.4%.

The remaining three scenarios correspond to the AfCFTA simulations discussed earlier. In Scenario 1, where intra-African trade increases to 22.6%, the same 1% reduction in imports leads to a slightly higher inflation peak of 0.33%. In Scenario 2, with intra-African trade rising to 30%, the inflationary effect intensifies, reaching a peak of 0.68%. Notably, inflation persistence is also stronger in this case: ten years after the shock, the inflation effect remains around 0.2% (see Figure 3), compared to just 0.05% in the BAU scenario with an intra-trade share of 16.2% (see Figure 2).

In Scenario 3, where intra-African trade reaches 40%, the inflation peak is slightly lower at 0.5%, but the persistence of the shock is even more pronounced. A decade after the shock, inflation remains elevated at approximately 0.3%, relative to 0.05% under the BAU scenario (see Figure 7 in Appendix).[19]

Interpreting the Magnitude of the Inflationary Effect. How important is an estimated inflationary impact of 0.68%? This figure corresponds to a moderate AfCFTA scenario, involving an intra-African trade increase of approximately 15%. While this figure may appear modest at first glance, its significance depends on the inflation-targeting regime of the country in question. For instance, in the West African Economic and Monetary Union (WAEMU), where the central bank targets inflation close to 2%, a 0.68% increase represents more than a third of the target—potentially complicating monetary policy implementation[20].

Moreover, the persistence of the effect is particularly noteworthy. Our simulations show that in more integrated trade scenarios, the inflationary impact can last for a decade or more before dissipating. This long-lasting pressure could pose challenges for central banks attempting to maintain price stability, especially when managing simultaneous external shocks.

[19] The inflationary effect remains around 0.2% even after twenty years; see Figure 7 in the appendix.

[20] The West African Economic and Monetary Union (WAEMU) is a regional organization of eight West African countries that share a common currency—the CFA franc—and a central bank, the BCEAO (Central Bank of West African States). The union aims to promote economic integration and monetary stability among its member states.

5 Conclusion

In this paper, we document how climatic and political shocks are transmitted through trade to inflation among African countries. Using an instrumental variable strategy, we show that a 1% decrease in imports due to such shocks increases inflation in the importing country by between 0.26% and 0.4%. To better anticipate the potential impact of the African Continental Free Trade Area (AfCFTA), we extend a general equilibrium trade model that incorporates Money-in-the-Utility (MIU) preferences and productivity shocks. Estimating this model with African data, we find that if AfCFTA leads to a 15% increase in intra-African trade, the inflationary effect of a productivity shock on trading partners could rise to as much as 0.68%. We also find that while the magnitude of this transmission effect is nonlinear, its persistence increases with deeper trade integration.

Our findings underscore the complex role of regional trade agreements (RTAs) in promoting economic stability—particularly when trade partners are exposed to shocks. In the context of AfCFTA, each African country should seek to better understand the shock exposure of its key partners and diversify its trade relationships. This would enable countries to more effectively manage supply shocks by redirecting trade to less-affected partners within Africa when necessary.

This paper also raises important questions for future research: How will AfCFTA influence the transmission of shocks to economic growth? And how should central banks adjust their monetary policy frameworks to better manage inflation under deeper trade integration?

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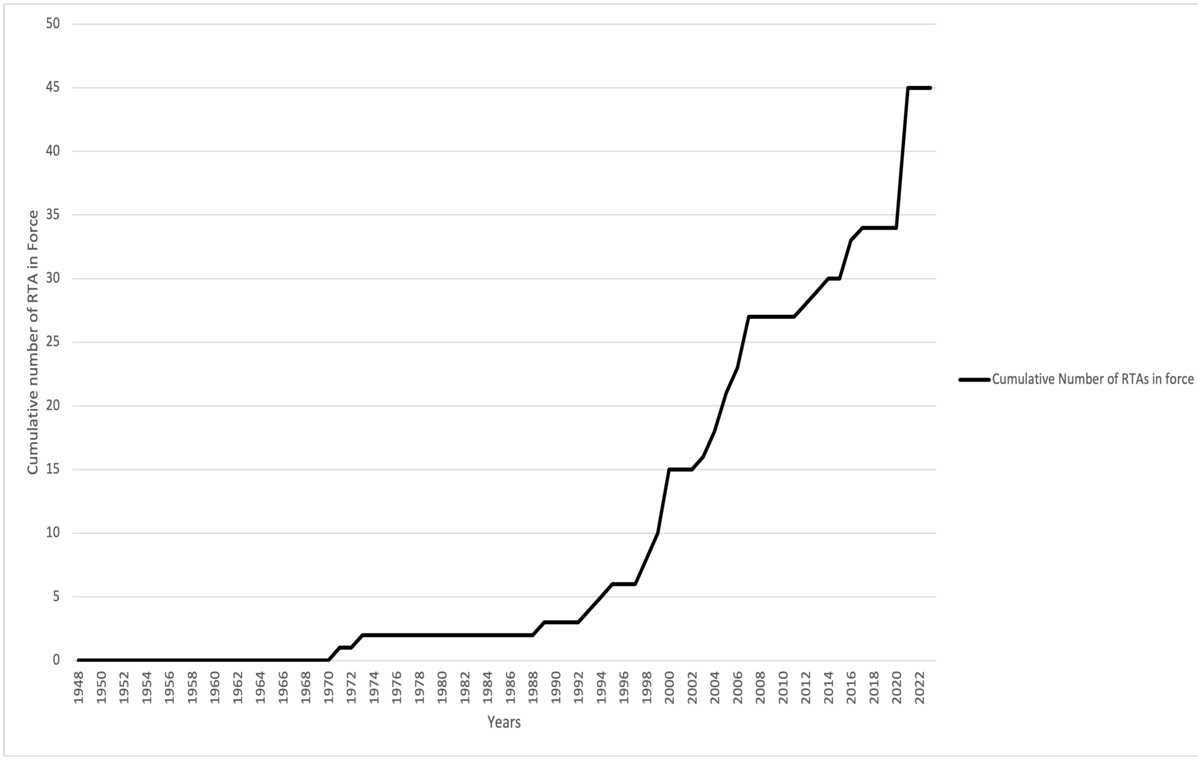
Appendix

Figure 4: cumulative numbers of RTA among African countries



Source :Based on data from the World Trade Organization (WTO)

Brief Presentation of the AfCFTA

The African Continental Free Trade Area (AfCFTA)

The African Continental Free Trade Area (AfCFTA), launched in 2021, is a transformative initiative to unify Africa into a single market for goods and services. As of early 2024, 54 out of 55 African Union member states had signed the agreement, and 47 had ratified it Union (2024). The AfCFTA aims to eliminate tariffs on 90% of goods and reduce non-tariff barriers, facilitating deeper continental trade integration.

The World Bank projects that full implementation could increase Africa's income by approximately \$450 billion by 2035 and lift 30 million people out of extreme poverty Bank (2020). Despite this promise, intra-African trade remains limited—comprising only around 13% of the continent's total trade volume as of 2022 Foundation (2023)—underscoring the need for improved infrastructure and regulatory alignment.

For ongoing updates, consult the African Union portal at au.int.

A Trade and shock transmission

Table 6: Descriptive Statistics

Sample 1

	count	min	p25	p50	mean	p75	max
bilateral imports (million USD)	15941	1.9e-09	0.024	0.34	35.8	5.06	5132.5
temperature deviation in origin	14971	-2.00	-0.12	0.084	0.089	0.31	3.47
#deaths in social conflict in origin	15941	0	0	2	152.6	26	8791
#deaths in social conflict in origin if $\#deaths > 0$	9180	1	4	18	265.1	152	8791
#deaths Above Q3	15249	0	0	0	0.15	0	1
pairwise SD of log(Imports)	15941	0.0011	0.92	1.58	1.68	2.27	6.65
pairwise SD of temperatures in origin	15941	0.0076	0.26	0.33	0.39	0.46	2.68
inflation in destination	15673	-2.20	2.27	4.91	5.92	8.50	32.9
RTA	15941	0	0	0	0.23	0	1
Observations	15941						

Sample 2

	count	min	p25	p50	mean	p75	max
bilateral imports (million USD)	13716	1.9e-09	0.044	0.60	41.0	6.97	5132.5
temperature deviation in origin	12916	-2.00	-0.12	0.084	0.088	0.31	3.47
#deaths in social conflict in origin	13716	0	0	2	156.0	30	8791
#deaths in social conflict in origin if $\#deaths > 0$	8030	1	4	18	266.5	152	8791
#deaths Above Q3	13181	0	0	0	0.15	0	1
pairwise SD of log(Imports)	13716	0.13	0.90	1.51	1.62	2.21	6.18
pairwise SD of temperatures in origin	13716	0.083	0.26	0.33	0.39	0.45	2.06
Inflation in destination	13491	-2.20	2.18	4.77	5.89	8.68	32.9
RTA	13716	0	0	0	0.25	0	1
Observations	13716						

Notes: This table presents some descriptive statistics of the variables used in the IV regression.

Construction of shock data Gridded Population of the World (GPWv4) 30 arc-seconds (approximately 1 km at the equator) population count for the years 2000, 2005, 2010, 2015, and 2020, consistent with national censuses and population registers

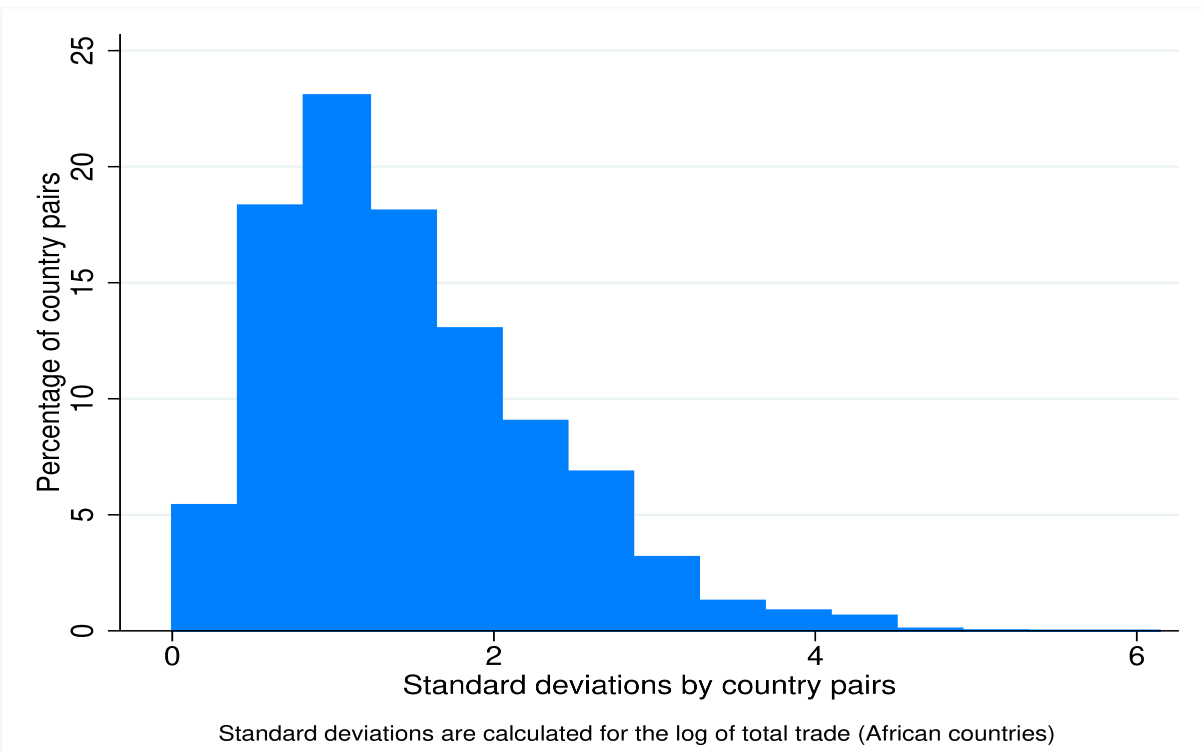
Table 7: IV-regression: inflationary effect of shock-induced trade variations

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	infl_cpi_d	infl_cpi_d	infl_cpi_d	infl_cpi_d	infl_cpi_d	infl_cpi_d	infl_cpi_d	infl_cpi_d
log_import_ij	-0.0218	-0.370	3.718	-0.416	-0.00248	-0.393***	-1.298	-0.425***
	(0.0197)	(0.723)	(12.47)	(0.713)	(0.00767)	(0.122)	(16.55)	(0.109)
above_med_supplier_import			-6.648				-0.201	
			(18.37)				(22.85)	
above_Q3_supplier_import				-0.279				-0.108
				(1.189)				(0.460)
Constant	6.238***	8.567*	-27.86	8.705*	1.776***			
	(0.254)	(5.069)	(108.8)	(5.043)	(0.0634)			
Origin * destination FE	T	T	T	T	T	T	T	T
Year FE	T	T	T	T	T	T	T	T
R2	0.646	0.632	-0.539	0.624	0.900	-0.0232	-0.213	-0.0139
Observations	13266	11816	11816	11816	12532	11815	11815	11815
CD Fstat		5.025	0.0493	2.894		4.287	0.0395	1.006
KP Fstat		5.589	0.113	6.342		3.223	0.0840	2.253
KP pval		0.0181	0.736	0.0118		0.0726	0.772	0.133

Notes: Results based on data from 2001 to 2015. Inflation is annually winsorized at 5%. Bilateral import flows are aggregated from the product-level bilateral import data set of the WTO. Standards errors are clustered at the Origin * destination level.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Figure 5: standard deviations of bilateral imports across pair of countries



Notes: This graph presents standard deviations of bilateral imports by pairs of countries. When we also do the same exercise for the most exchanged products "mineral products", we get similar results.

Table 8: First-step regression: shock-induced variations in trade growth

	(1) D_log_import_ij05	(2) D_log_import_ij05	(3) D_log_import_ij05	(4) D_log_import_ij05	(5) D_log_import_ij05	(6) D_log_import_ij05	(7) D_log_import_ij05	(8) D_log_import_ij05
L.temp_pop_c_o	-0.125***	-0.126***	-0.0376**	-0.0408**	-0.115***	-0.116***	-0.0306*	-0.0315*
	(0.0439)	(0.0440)	(0.0167)	(0.0170)	(0.0434)	(0.0435)	(0.0167)	(0.0168)
Id0_ndeath_c_o	-0.109	-0.109	-0.0279	-0.0210	-0.103	-0.102	-0.0343*	-0.0340*
	(0.0680)	(0.0680)	(0.0203)	(0.0219)	(0.0682)	(0.0682)	(0.0198)	(0.0201)
L.temp_pop_c_d		-0.100**		-0.0375***		-0.0853*		-0.0344***
		(0.0441)		(0.0139)		(0.0447)		(0.0130)
Id0_ndeath_c_d		0.0195		-0.0257		0.0394		-0.0251
		(0.0596)		(0.0206)		(0.0585)		(0.0204)
Constant	0.133***	0.139***	0.0437***	-0.0434***	0.139***	0.141***	0.108***	0.112***
	(0.0113)	(0.0150)	(0.00379)	(0.00490)	(0.0113)	(0.0148)	(0.00367)	(0.00471)
Destination FE	F	F	F	F	F	F	F	F
Origin FE	F	F	F	F	F	F	F	F
Origin * destination FE	T	T	T	T	T	T	T	T
Year FE	T	T	T	T	T	T	T	T
R2	0.0609	0.0612	0.291	0.444	0.0436	0.0439	0.0769	0.0772
F-stat	5.849	4.286	3.698	3.807	5.051	3.572	3.332	3.678
Observations	12731	12731	12731	12731	11887	11887	11887	11887

Notes: Results based on data from 2001 to 2015. Bilateral import flows are aggregated from the product-level bilateral import data set of the WTO. Standards errors are clustered at the Origin * destination level.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
Standards errors are clustered at the Origin * destination level.

B Theorethical appendix

B.1 Index of intermediate goods prices

The price of the final good is an index of intermediate goods prices

Let consider the minimisation problem:

$$\min_{\{x_n(i)\}} C_n = \int_0^1 P_n(i) x_n(i)\, di$$

Subject to:

$$Y_n = z_n\left(\int_0^1 x_n(i)^{\frac{\sigma_n - 1}{\sigma_n}}\, di\right)^{\frac{\sigma_n}{\sigma_n - 1}} \tag{19}$$

Where:

- $x_n(i)$ is the decision variable representing the quantity of the i-th input used (intermediate good).
- $P_n(i)$ is the price of the i-th input.
- Y_n is the output level that needs to be produced.
- z_n is a productivity parameter.
- σ_n is the elasticity of substitution between the inputs.

Lagrangian Function

To solve this optimization problem, we introduce a Lagrange multiplier λ for the constraint and set up the Lagrangian function $\mathcal{L}$:

$$\mathcal{L} = \int_0^1 P_n(i)x_n(i)\,di + \lambda \left[Y_n - z_n \left(\int_0^1 x_n(i)^{\frac{\sigma_n - 1}{\sigma_n}}\,di \right)^{\frac{\sigma_n}{\sigma_n - 1}} \right]$$

First-Order Conditions

To find the optimal $x_n(i)$, we take the derivative of $\mathcal{L}$ with respect to $x_n(i)$ and set it to zero:

$$\frac{\partial \mathcal{L}}{\partial x_n(i)} = P_n(i) - \lambda z_n \frac{\sigma_n}{\sigma_n - 1} \left(\int_0^1 x_n(j)^{\frac{\sigma_n - 1}{\sigma_n}}\,dj \right)^{\frac{1}{\sigma_n - 1}} x_n(i)^{-\frac{1}{\sigma_n}} = 0$$

Simplifying, we get:

$$P_n(i) = \lambda z_n \frac{\sigma_n}{\sigma_n - 1} \left(\int_0^1 x_n(j)^{\frac{\sigma_n - 1}{\sigma_n}}\,dj \right)^{\frac{1}{\sigma_n - 1}} x_n(i)^{-\frac{1}{\sigma_n}}$$

To find the relation between $x_n(i)$ and $x_n(i')$, we start from the first-order conditions derived:

$$P_n(i) = \lambda z_n \frac{\sigma_n}{\sigma_n - 1} \left(\int_0^1 x_n(j)^{\frac{\sigma_n - 1}{\sigma_n}}\,dj \right)^{\frac{1}{\sigma_n - 1}} x_n(i)^{-\frac{1}{\sigma_n}}$$

Similarly, for another input i':

$$P_n(i') = \lambda z_n \frac{\sigma_n}{\sigma_n - 1} \left(\int_0^1 x_n(j)^{\frac{\sigma_n - 1}{\sigma_n}}\,dj \right)^{\frac{1}{\sigma_n - 1}} x_n(i')^{-\frac{1}{\sigma_n}}$$

Now, we compute the ratio $\frac{P_n(i)}{P_n(i')}$:

$$\frac{P_n(i)}{P_n(i')} = \frac{\lambda z_n \frac{\sigma_n}{\sigma_n - 1} \left(\int_0^1 x_n(j)^{\frac{\sigma_n - 1}{\sigma_n}}\,dj \right)^{\frac{1}{\sigma_n - 1}} x_n(i)^{-\frac{1}{\sigma_n}}}{\lambda z_n \frac{\sigma_n}{\sigma_n - 1} \left(\int_0^1 x_n(j)^{\frac{\sigma_n - 1}{\sigma_n}}\,dj \right)^{\frac{1}{\sigma_n - 1}} x_n(i')^{-\frac{1}{\sigma_n}}}$$

Notice that many terms cancel out:

$$\begin{aligned}
\frac{P_n(i)}{P_n(i')} &= \frac{x_n(i)^{-\frac{1}{\sigma_n}}}{x_n(i')^{-\frac{1}{\sigma_n}}} \\
\frac{P_n(i)}{P_n(i')} &= \left(\frac{x_n(i')}{x_n(i)} \right)^{\frac{1}{\sigma_n}} \\
\left(\frac{P_n(i)}{P_n(i')} \right)^{\sigma_n} &= \frac{x_n(i')}{x_n(i)} \\
\frac{x_n(i)}{x_n(i')} &= \left(\frac{P_n(i')}{P_n(i)} \right)^{\sigma_n}
\end{aligned}$$

Thus, the optimal allocation of $x_n(i)$ in terms of $P_n(i)$ and $P_n(i')$ is:

$$x_n(i) = x_n(i') \left(\frac{P_n(i')}{P_n(i)} \right)^{\sigma_n} \tag{20}$$

Now integrate this expression in

$$\begin{aligned}
Y_n =& z_n \left(\int_0^1 x_n(i)^{\frac{\sigma_n - 1}{\sigma_n}} \, di \right)^{\frac{\sigma_n}{\sigma_n - 1}} \\
=& z_n \left(\int_0^1 (x_n(i') \left(\frac{P_n(i')}{P_n(i)} \right)^{\sigma_n})^{\frac{\sigma_n - 1}{\sigma_n}} \, di \right)^{\frac{\sigma_n}{\sigma_n - 1}} \\
=& z_n P_n(i')^{\sigma_n} x_n(i') \left(\int_0^1 P_n(i)^{1-\sigma_n} \, di \right)^{\frac{\sigma_n}{\sigma_n - 1}}
\end{aligned}$$

$$\begin{aligned}
x_n(i') =& Y_n / (z_n P_n(i')^{\sigma_n} \left(\int_0^1 P_n(i)^{1-\sigma_n} \, di \right)^{\frac{\sigma_n}{\sigma_n - 1}}) \\
x_n(i') =& P_n(i')^{-\sigma_n} \left(\int_0^1 P_n(i)^{1-\sigma_n} \, di \right)^{\frac{\sigma_n}{1-\sigma_n}} Y_n / z_n \\
\int_0^1 P_n(i') x_n(i') \, di =& \int_0^1 P_n(i')^{1-\sigma_n} \, di \left(\int_0^1 P_n(i)^{1-\sigma_n} \, di \right)^{\frac{\sigma_n}{1-\sigma_n}} Y_n / z_n \\
=& z_n^{-1} \left(\int_0^1 P_n(i)^{1-\sigma_n} \, di \right)^{\frac{1}{1-\sigma_n}} Y_n \\
=& Q_n Y_n
\end{aligned}$$

Q_n is a price index.

Coming back to the profit maximization problem:

$$\begin{aligned}
\max_{x_n} \Pi_n^Y =& P_n^Y Y_n - \int_0^1 P_n(i) x_n(i) \, di \\
=& P_n^Y Y_n - Q_n Y_n
\end{aligned}$$

subject to:

$$Y_n = z_n (\int_0^1 x_n(i)^{\frac{\sigma_n - 1}{\sigma_n}} \, di)^{\frac{\sigma_n}{\sigma_n - 1}}$$

Zero profit maximization yields

$$Q_n = P_n^Y \tag{21}$$

The probability that country n imports goods from country j is given by:

$$\Pi_{nj} = \int_{s_j \in S_{nj}} p_{nj}(s_j) x_n(s_j) \; ds_j / Q_n Y_n \tag{22}$$

B.2 Establishing: $Y_{jt}Q_{jt} = r_{jt}K_{jt} - M_{jt-1}\mu_{jt}$

Equating final goods market clearing to consumers' budget constraints taking into account bonds market clearing gives:

$$
\begin{aligned}
Y_{jt} &= C_{jt} + K_{jt+1} - (1-\delta)K_{jt} \text{ (Goods market clearing)} \\
&= \frac{r_{jt}}{P^Y_{jt}} K_{jt} + \frac{M_{jt-1} - M_{jt}}{P^Y_{jt}} \text{ (Consumer Budget constraint, with } D_{jt} = 0) \\
&= \frac{r_{jt}}{P^Y_{jt}} K_{jt} - \frac{M_{jt-1}\mu_{jt}}{P^Y_{jt}} \quad \text{(Using money supply in 4)} \\
Y_{jt}Q_{jt} &= r_{jt}K_{jt} - M_{jt-1}\mu_{jt} \quad \text{(Using 21)}
\end{aligned}
$$

B.3 Proof of the lemma

Lemma: From Capital market clearing in (13), we have (abstracting time script):

$$
\begin{aligned}
K_j &= \int_{s_j \in S_j} K^x(s_j)\ ds_j \\
&= \int_{s_j \in S_j} x(s_j)a_j(s_j)\ ds_j \text{ (By using intermediate production technology)} \\
&= \int_{s_j \in S_j} \sum_{n=1}^{N} \tau_{nj} x_n(s_j) a_j(s_j)\ ds_j \text{ (By using intermediate goods market clearing)} \\
&= \int_{s_j \in S_j} \sum_{n=1}^{N} \frac{p_{nj}(s_j)}{r_j} x_n(s_j)\ ds_j \text{ (By using (8))} \\
&= \sum_{n=1}^{N} \left(\int_{s_j \in S_j} p_{nj}(s_j) x_n(s_j)\ ds_j \right) / r_j \text{ (Interverting sum and integral)} \\
&= \sum_{n=1}^{N} \Pi_{nj} Q_n Y_n / r_j \text{ (Using (11))} \\
K_j &= \sum_{n=1}^{N} \Pi_{nj} (r_n K_n - M_{n,t-1}\mu_n)/r_j \text{ (using B.2)}
\end{aligned}
$$

$$
r_j K_j = \sum_{n=1}^{N} \Pi_{nj} (r_n K_n - M_{n,t-1}\mu_n), j = 1, ..., N-1 \tag{23}
$$

$$
\Pi_{nj}(\{\tau_{nk} r_k\}_{k=1}^{N}) = \frac{(b_j \tau_{nj} r_j)^{-\theta}}{\sum_{k=1}^{N} (b_k \tau_{nk} r_k)^{-\theta}}
$$

B.4 Redundancy Explanation

Consider the system of equations for $j = 1, \ldots, N-1$:

$$r_jK_j = \sum_{n=1}^{N} \Pi_{nj}(r_nK_n - M_{n,t-1}\mu_n)$$

The equation states that the total returns to capital in country j, r_jK_j are determined by summing up the weighted and adjusted returns to capital from all other countries. Each term in the summation adjusts the returns to capital from country n by subtracting the impact of the money supply.

Now, consider the system of N equations. If we know the equations for $N-1$ countries, the equation for the N-th country is automatically satisfied because the total system must balance.

1. **Equations for $j = 1$ to $j = N - 1$**:

$$r_1K_1 = \sum_{n=1}^{N} \Pi_{n1}(r_nK_n - M_{n,t-1}\mu_n)$$

$$r_2K_2 = \sum_{n=1}^{N} \Pi_{n2}(r_nK_n - M_{n,t-1}\mu_n)$$

$$\vdots$$

$$r_{N-1}K_{N-1} = \sum_{n=1}^{N} \Pi_{n,N-1}(r_nK_n - M_{n,t-1}\mu_n)$$

2. **Summing these $N - 1$ equations**:

$$\sum_{j=1}^{N-1} r_jK_j = \sum_{j=1}^{N-1}\sum_{n=1}^{N} \Pi_{nj}(r_nK_n - M_{n,t-1}\mu_n)$$

3. **Right-Hand Side Simplification**: Using $\sum_{j=1}^{N} \Pi_{nj} = 1$,

$$\begin{aligned}\sum_{j=1}^{N-1}\sum_{n=1}^{N} \Pi_{nj}(r_nK_n - M_{n,t-1}\mu_n) &= \sum_{n=1}^{N}(r_nK_n - M_{n,t-1}\mu_n)\sum_{j=1}^{N-1}\Pi_{nj} \\ &= \sum_{n=1}^{N}(r_nK_n - M_{n,t-1}\mu_n)(1 - \Pi_{nN})\end{aligned}$$

Therefore,

$$\begin{aligned}
\sum_{j=1}^{N-1} r_j K_j &= \sum_{n=1}^{N} (r_n K_n - M_{n,t-1}\mu_n)(1 - \Pi_{nN}) \\
&= \sum_{n=1}^{N} (r_n K_n - M_{n,t-1}\mu_n) - \sum_{n=1}^{N} (r_n K_n - M_{n,t-1}\mu_n)\Pi_{nN} \\
0 &= r_N K_N - \sum_{n=1}^{N} M_{n,t-1}\mu_n - \sum_{n=1}^{N} (r_n K_n - M_{n,t-1}\mu_n)\Pi_{nN} \\
r_N K_N &= \sum_{n=1}^{N} (r_n K_n - M_{n,t-1}\mu_n)\Pi_{nN} + \sum_{n=1}^{N} M_{n,t-1}\mu_n
\end{aligned}$$

This latest equation clearly derives the expression for $r_N K_N$. One important feature of this equation is that its structure differs from the remaining $N-1$ equations. An additional term, $\sum_{n=1}^{N} M_{n,t-1}\mu_n$, is added to the sum. This term represents the total monetary adjustments across all countries. It accounts for the overall effect of the growth in the money supply from each country on the returns to capital in country N.

B.5 The stationary (scaled) model

The original model is not stationary, because it exhibits growth. To make it stationary we scaled it by dividing by capital of country N. The main change in consumers problem will be in their Budget constraint, let look at it in detail. We start by the initial Budget Constraint:

$$\begin{aligned}
&C_{jt} + K_{jt+1} - (1-\delta_j)K_{jt} + \frac{M_t}{P^Y_{jt}} = \frac{r_{jt}}{P^Y_{jt}} K_{jt} + \frac{M_{t-1}}{P^Y_{jt}} \\
&C_{jt} + K_{jt+1} - (1-\delta_j)K_{jt} + m_{jt} = \frac{r_{jt}}{P_{jt}} K_{jt} + \frac{m_{jt-1}}{1+\pi_{jt}} \\
&\frac{C_{jt}}{K_{Nt}} + \frac{K_{jt+1}}{K_{Nt}} \cdot \frac{K_{Nt+1}}{K_{Nt+1}} + \frac{m_{jt}}{K_{Nt}} = (\frac{r_{jt}}{P_{jt}} + 1 - \delta_j)\frac{K_{jt}}{K_{Nt}} + \frac{m_{jt-1}}{K_{Nt-1}} \cdot \frac{K_{Nt-1}}{K_{Nt}} \\
&\tilde{c}_{jt} + (1+\gamma_{Nt+1})\tilde{k}_{j_{t+1}} + \tilde{m}_{jt} = (\frac{r_{jt}}{P_{jt}} + 1 - \delta_j)\tilde{k}_{jt} + \frac{\tilde{m}_{jt-1}}{1+\gamma_{Nt}} \quad \text{(For stationarity)}
\end{aligned}$$

The modified problem to solve is therefore:

$$\max_{\{\tilde{c}_{jt}, \tilde{k}_{jt+1}, \tilde{m}_{jt}\}} E_0 \sum_{t=0}^{\infty} \beta_j^t u(\tilde{c}_{jt}, \tilde{m}_{jt})$$

$$\text{st:} \quad \tilde{c}_{jt} + (1+\gamma_{Nt+1})\tilde{k}_{j_{t+1}} + \tilde{m}_{jt} = (\frac{r_{jt}}{P_{jt}} + 1 - \delta_j)\tilde{k}_{jt} + \frac{\tilde{m}_{jt-1}}{1+\gamma_{Nt}}$$

Lagrangian and Euler Equations

To derive the Euler equations, let write the Lagrangian $\mathcal{L}$, where the Lagrange multiplier for the constraint is λ_t :

$$\mathcal{L} = E_0 \sum_{t=0}^{\infty} \beta_j^t \Big\{ u(\tilde{c}_{jt}, \tilde{m}_{jt}) - \lambda_t \Big[\tilde{c}_{jt} + (1 + \gamma_{Nt+1}) \tilde{k}_{jt+1} + \tilde{m}_{jt} - \left(\left(\frac{r_{jt}}{P_{jt}} + 1 - \delta_j \right) \tilde{k}_{jt} + \frac{\tilde{m}_{jt-1}}{1 + \gamma_{Nt}} \right) \Big] \Big\}$$

First-Order Conditions

1. **With respect to $\tilde{c}_{jt}$:**

$$\frac{\partial \mathcal{L}}{\partial \tilde{c}_{jt}} = \beta_j^t \left(u_c(\tilde{c}_{jt}, \tilde{m}_{jt}) - \lambda_t \right) = 0 \quad \Rightarrow \quad \lambda_t = u_c(\tilde{c}_{jt}, \tilde{m}_{jt})$$

2. **With respect to $\tilde{k}_{jt+1}$:**

$$\frac{\partial \mathcal{L}}{\partial \tilde{k}_{jt+1}} = E_t \left(\beta_j^t \left(-\lambda_t (1 + \gamma_{Nt+1}) \right) + \beta_j^{t+1} \lambda_{t+1} \left(\frac{r_{j,t+1}}{P_{j,t+1}} + 1 - \delta_j \right) \right) = 0$$

$$\Rightarrow u_c(\tilde{c}_{jt}, \tilde{m}_{jt})(1 + \gamma_{Nt+1}) = E_t \left(\beta_j u_c(\tilde{c}_{j,t+1}, \tilde{m}_{j,t+1}) \left(\frac{r_{j,t+1}}{P_{j,t+1}} + 1 - \delta_j \right) \right)$$

3. **With respect to $\tilde{m}_{jt}$:**

$$\frac{\partial \mathcal{L}}{\partial \tilde{m}_{jt}} = \beta_j^t \left(u_m(\tilde{c}_{jt}, \tilde{m}_{jt}) - \lambda_t \right) + \beta_j^{t+1} E_t \left(\lambda_{t+1} \cdot \left(\frac{1}{1 + \gamma_{N,t+1}} \right) \right) = 0$$

$$\Rightarrow u_m(\tilde{c}_{jt}, \tilde{m}_{jt}) = u_c(\tilde{c}_{jt}, \tilde{m}_{jt}) - \beta_j E_t \left(\frac{u_c(\tilde{c}_{j,t+1}, \tilde{m}_{j,t+1})}{1 + \gamma_{N,t+1}} \right)$$

Combining these equations gives the Euler equation for the stationary model.

Capital Euler equation:

$$u_c(\tilde{c}_{jt}, \tilde{m}_{jt})(1 + \gamma_{Nt+1}) = \beta_j E_t \left(u_c(\tilde{c}_{j,t+1}, \tilde{m}_{j,t+1}) \left(\frac{r_{j,t+1}}{P_{j,t+1}} + 1 - \delta_j \right) \right)$$

Money Euler equation:

$$u_m(\tilde{c}_{jt}, \tilde{m}_{jt}) = u_c(\tilde{c}_{jt}, \tilde{m}_{jt}) - \beta_j E_t \left(\frac{u_c(\tilde{c}_{j,t+1}, \tilde{m}_{j,t+1})}{1 + \gamma_{N,t+1}} \right)$$

These Euler equations describe the intertemporal optimization conditions for consumption, capital, money, and debt. These equations, combined with the Budget Constraint below in equation 24, they describe citizens' optimization solutions.

$$\tilde{c}_{jt} + (1 + \gamma_{Nt+1}) \tilde{k}_{j_{t+1}} + \tilde{m}_{jt} = (\frac{r_{jt}}{P_{jt}} + 1 - \delta_j) \tilde{k}_{jt} + \frac{\tilde{m}_{jt-1}}{1 + \gamma_{Nt}} \tag{24}$$

Summuray of the equations characterizing the solution

The following system of equations summarizes the stationary solution to sole for: $\tilde{c}_{j,t}, \tilde{k}_{j,t}, \tilde{m}_{j,t}, , P^Y_{jt}, \pi_{jt}, r_{jt}, z_{jt}, u_{jt}, \gamma_{j,t}$:

$$
\begin{aligned}
u_c(\tilde{c}_{jt}, \tilde{m}_{jt})(1+\gamma_{Nt+1}) &= \beta_j E_t \left(u_c(\tilde{c}_{j,t+1}, \tilde{m}_{j,t+1}) \left(\frac{r_{j,t+1}}{P_{j,t+1}} + 1 - \delta_j \right) \right) \\
u_m(\tilde{c}_{jt}, \tilde{m}_{jt}) &= u_c(\tilde{c}_{jt}, \tilde{m}_{jt}) - \beta_j E_t \left(\frac{u_c(\tilde{c}_{j,t+1}, \tilde{m}_{j,t+1})}{1+\gamma_{N,t+1}} \right) \\
\tilde{c}_{jt} + (1+\gamma_{Nt+1})\tilde{k}_{j_{t+1}} + \tilde{m}_{jt} &= (\frac{r_{jt}}{P_{jt}} + 1 - \delta_j)\tilde{k}_{jt} + \frac{\tilde{m}_{jt-1}}{1+\gamma_{Nt}} \\
\tilde{k}_{jt} &= \sum_{n=1}^{N} \Pi_{nj}(\tilde{k}_{nt} r_n / r_j - P_{n,t-1} \frac{\tilde{m}_{n,t-1}}{1+\gamma_N} \mu_n / r_j) \\
P^Y_{jt}(\{\tau_{jn} r_{nt}\}_{n=1}^N) &= c_j [\sum_{n=1}^{N} b_n (\tau_{jn} r_{nt})^{-\theta}]^{-1/\theta} \\
log(z_{jt}) &= \rho^z_j log(z_{jt-1}) + e_{jt} \\
\mu_{jt} - \bar{\mu}_j = u_t &= \rho^u_j u_{jt-1} + \phi_j z_{jt-1} + \varphi_{jt} \\
\tilde{m}_{jt} &= (1+\mu_{jt}) * \frac{\tilde{m}_{jt-1}}{(1+\pi_{jt})(1+\gamma_{Nt})} \\
\gamma_{j,t} &= \frac{k_{jt}}{k_{jt-1}} - 1 = \frac{k_{Nt}\tilde{k}_{jt}}{k_{Nt-1}\tilde{k}_{jt-1}} - 1.
\end{aligned}
$$

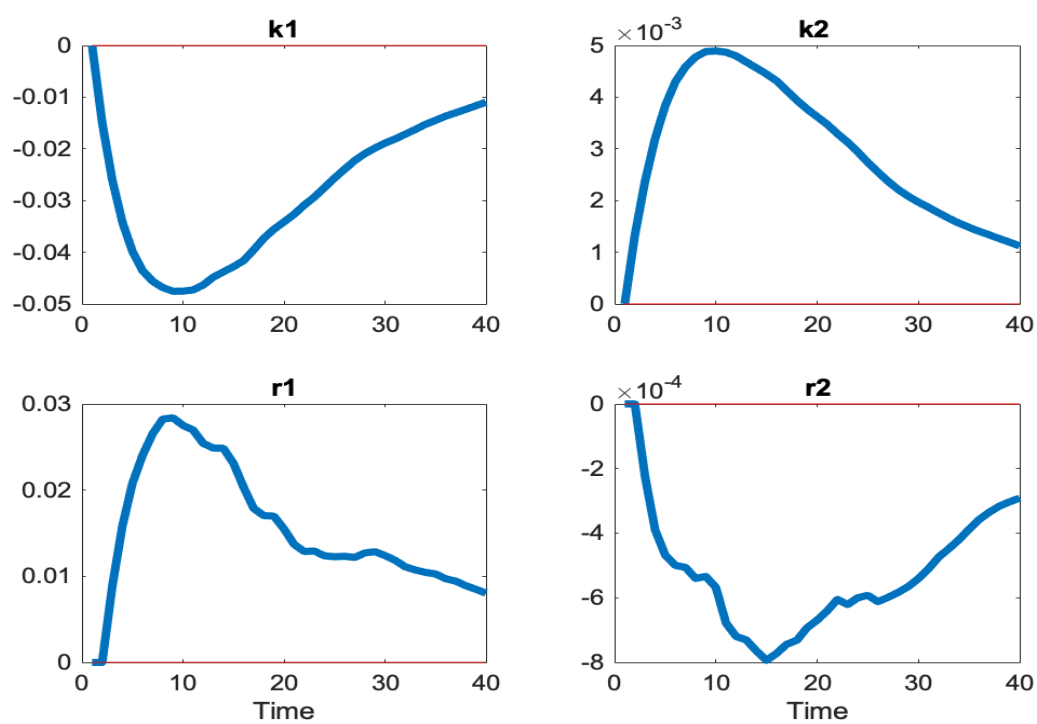
Table 9: Model Parameters and Descriptions for the Three Countries.

Parameter	**Description**	**1.Nigeria**	**2.South Africa**	**3.China**
τ_{1j}	Trade cost to 1*	1	2	1.6
τ_{2j}	Trade cost to 2*	2	1	1.15
τ_{3j}	Trade cost to 3*	1.15	1.6	1
ρ_j^z	Persistence of productivity shocks*	0.946	0.968	0.887
σ_j^z	std of productivity shocks*	0.043	0.036	0.062
β_j	Discount factor	0.96	0.96	0.96
δ_j	Depreciation rate	0.05	0.05	0.05
ρ_j^u	Persistence of money supply shocks	0.5	0.5	0.5
σ_j^u	Volatility of money supply shocks	0.0045	0.0045	0.0045
ϕ_j	Persistence of productivity shocks on money supply shocks	0.5	0.5	0.5
σ_j	Elasticity of substitution between two varieties	1.15	1.15	1.15
$\bar{\mu}_j$	Long term money growth rate	0	0	0
b_j	country state of technology	0.5	0.5	0.5
θ	Inverse of the variability of productivity distribution in intermediate goods	1.2	1.2	1.2

Note: The subscript j denotes country j. An asterisk (*) indicates a parameter estimated using data from the period prior to the implementation of AfCFTA. Trade costs are interpreted relative to domestic trade: for example, trade costs between Nigeria and South Africa are twice as high as within-country trade costs. Similarly, trade costs between Nigeria and China are 1.6 times higher, and between China and South Africa, 1.15 times higher.

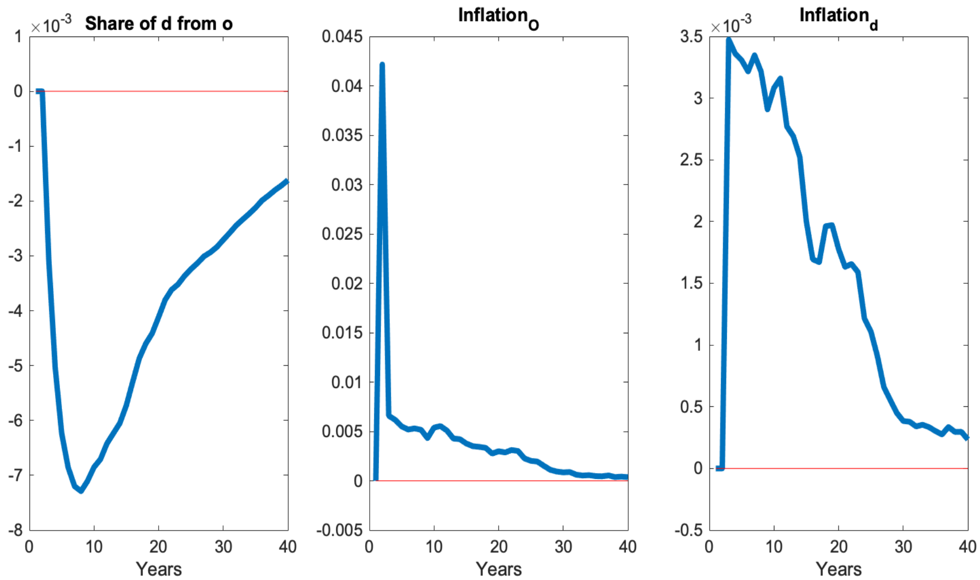
C Model's results appendix

Figure 6: Effect on Capital and interest rates



Notes: *Notes: This figure displays the impact of a Standard Deviation Productivity Shock in the Origin Country under the Business As Usual (BAU) Scenario. BAU is the model with parameters estimated with the data before AfCFTA (up to 20221). All the variables are expressed as a percentage deviation from the steady states.*

Figure 7: Effect of AfCFTA for an increase in intra-trade to 40%



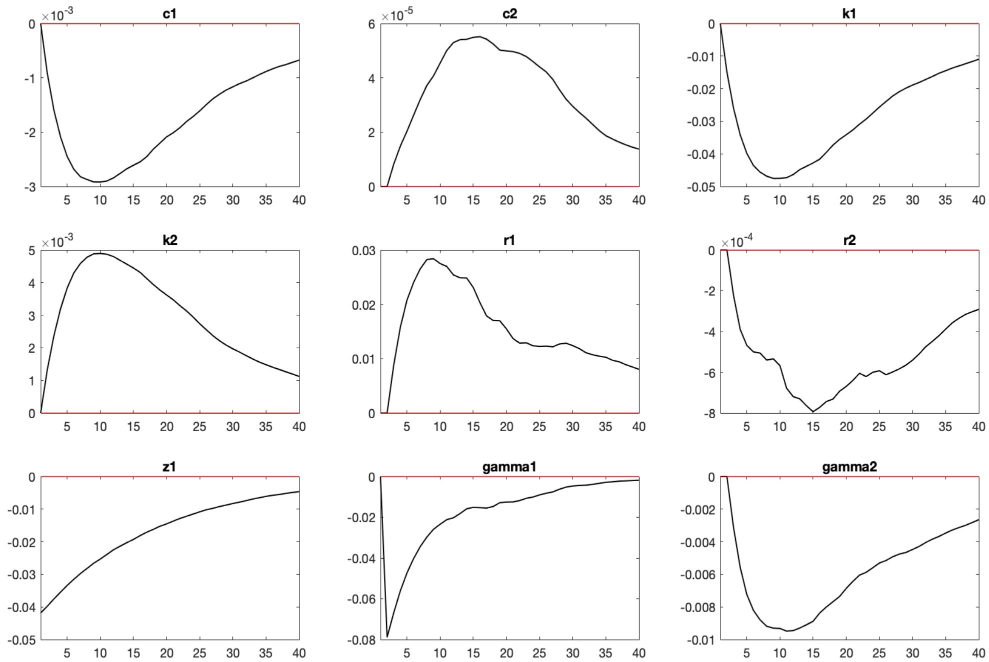
Notes: *This figure illustrates the impact of a standard deviation productivity shock in the origin country under an AfCFTA scenario (Scenario 3), which corresponds to an approximate 40% increase in intra-African trade. All variables are expressed as percentage deviations from their respective steady states.*

Table 10: Results of the simulation scenarios

Scenarios	Trade Cost	Trade Share	Inflation Peak	GDP Trough
BAU	2	16.2%	0.14%	-0.9%
Scenario 1	1.5	22.6%	0.2%	-1.2%
Scenario 2	1.15	30.46%	0.48%	-2.6%
Scenario 3	1.001	40%	0.35%	-2%

Note: The second column represents the intra-regional trade cost in Africa. The second column is the trade share between African countries, and the third column represents the peak in inflation in the destination country. The dynamic is the same as presented in Figure 2, only the magnitude changes. For scenario 3, in addition to lowering the trade cost to 1.001, we increase the relative trade cost between Africa and the rest of the world.

Figure 8: More complete dynamics including consumption and growth



Notes: *This figure displays the impact of a Standard Deviation Productivity Shock in the Origin Country under the Business As Usual (BAU) Scenario. BAU is the model with parameters estimated with the data before AfCFTA (up to 20221). All the variables are expressed as a percentage deviation from the steady states.*