# Trade and Shocks Transmission in a Regional Trade Agreement

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**Abstract**

Using an IV strategy, we document that productivity shocks namely climatic and political shocks in an origin country (or exporting country) affect inflation in the destination country (its importing partner) through trade among African countries. Second, we develop an international trade model à la Eaton and Kortum (2002) extended to include money to discuss how Regional Trade Agreements (RTA) can amplify shocks transmission across countries. We use the model to explore how the African Continental Free Trade Agreement (AfCFTA), adopted in 2021, could affect countries' inflation and its implications for their monetary policy.

**JEL Classification:** E52, E31, F14, F15,O55

**Keywords:** Trade Economics, Climatic Shocks, RTA, AfCFTA

## 1 Introduction

Trade by transmitting shocks across countries can alter a country's monetary policy's ability to reach its goals (Cwik et al., 2011). However, transmission of shocks through trade is less documented among African countries, this might be due to the fact that intra-African trade is low compared to other regions in the world: 18% in 2020, against 68% in Europe and 58% in Asia (United-Nations, 2022). However, with the increase in the number of regional trade agreements (RTA) in Africa, especially with the recent African Continental Free Trade Area (AfCFTA) in 2021, the largest RTA covering all African countries, intra-trade in Africa is projected to increase significantly (Maliszewska et al., 2020; ElGanainy et al., 2023; World Trade Organization, 2023) [1].

In addition, given that African countries are subjected and more vulnerable to many shocks, namely political and climatic shocks compared to other regions in the world

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

(Hassler and Krusell, 2012; IPCC, 2022, 2023), understanding the effect of trade in shock transmission across African countries is detrimental for policymakers, especially for Central Banks monetary policy since the role of monetary policy, in general, is about achieving price stability and managing economic fluctuations. Indeed, one main characteristic of African countries is that they are less industrialized and produce mainly raw materials, therefore climate change by affecting their production could affect their exports and therefore prices with their African trading partners.

In this paper, we first document that climatic or political shocks in an origin country( or exporting country) affect inflation in the destination country (its importing partner) among African nations. Specifically, a 1% decrease in imports due to temperature increases or violent conflict in the origin country raises inflation in the destination country by 0.4 to 0.58%. To do so, we used an instrumental variable (IV) strategy, focusing on how shocks in the origin country affect inflation in the destination country through trade. Imports from the origin country are endogenous when directly regressed on inflation in the destination country. For example, increasing domestic demand (e.g., increased public spending) or a reduction in domestic production in the destination country can simultaneously affect both inflation in the destination country and imports from the origin country. Therefore, we used temperature and conflict-related deaths in the origin country as instruments to isolate the trade-induced inflation effect. The validity of these instruments is discussed in Section 2.3.

Second, we demonstrate that existing Regional Trade Agreements (RTAs) in Africa have significantly increased trade by 62 to 77 percent from 1995 to 2019. These results are robust across various estimation strategies addressing common issues such as selection bias due to zero trade data, heterogeneous effects across time and space, and the staggered adoption of RTAs. Previous estimates of the RTA impact on trade in Africa vary widely across studies, likely due to differences in estimation strategies and the specific RTAs considered. Our focus is on the average overall effect of RTAs on trade in Africa, which could be important in anticipating the potential impact of the recent African Continental Free Trade Area (AfCFTA) covering all African countries. To obtain our results, we employ three estimation techniques. We start with the standard structural gravity model by Anderson and Van Wincoop (2003), which, by excluding zero trade data, may be biased due to selection issues arising from this exclusion. To address this, we complement our analysis with Pseudo Poisson Maximum Likelihood (PPML) estimation, which incorporates all sample values, including zeros. Although widely used in the literature, these two previous methods have limitations in estimating the effects of staggered policies such as RTAs. Additionally, they may be biased if the effects of RTAs are heterogeneous over time and space, which is very likely to be the case. To overcome these limitations, we finally use an event study methodology robust to heterogeneous treatment effects, as proposed by Callaway and Sant'Anna (2021). Importantly, the estimates from these three methods are very close to each other: 77 percent for the structural gravity method, 63 percent for the PPML, and 62 percent for the event study. Furthermore, to our knowledge, this study is the first to estimate the timing of the RTA effect in Africa, finding that it takes, on average, up to eight years for an RTA to significantly impact trade after its implementation.

Thirdly, after showing evidence of the fact that trade transmits shocks across African countries and that RTAs increase trade significantly, we take a step back and develop a theoretical model to discuss more generally the implications of regional trade agreements for monetary policy. In doing so, we build an international trade model a la Eaton and Kortum (2002) augmented with a central bank to quantify the effect of some simulated increase in trade on shocks transmission across countries.

## Related Literature

The current paper is related to three 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) investigate 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.

Despite this rich literature, studies on shock transmission through intra-trade in Africa are scarce, with some exceptions including Ncube et al. (2014). This scarcity might be due to two reasons. First, the low level of intra-trade in Africa, around 18% in 2020, which may have a negligible effect on shock transmission. Second, the lack of data to identify shocks that could be transmitted through trade. However, with the recent African Continental Free Trade Agreement (AfCFTA), intra-trade in Africa is likely to increase, making the question of how trade transmits shocks in Africa a timely topic. This paper is unique because it is the first to use data on temperature and political conflict to provide evidence of shock transmission through trade among African countries.

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 climatic shocks in one country can significantly affect its trade partners through changes in productivity and export capacities. In addition to climatic shocks, we study the effect of political shocks in an origin country on inflation in the destination country through trade.

Second, this paper is related to the extensive literature on the effectiveness of RTAs in increasing trade (Carrere, 2006; Baldwin and Taglioni, 2007; Glick and Rose, 2016; de Soyres et al., 2021), with a focus on Africa. Previous estimates of the effect of RTAs in Africa vary widely (Geda and Yimer, 2023; Ngepah and Udeagha, 2018; MacPhee and Sattayanuwat, 2014). This variability can be attributed to differences in methodologies and the specific RTAs or samples used. In our study, we focus on the overall effect of RTAs in Africa and address several methodological issues inherent in estimating their effects.

We begin by estimating a structural gravity model as developed by Anderson and Van Wincoop (2003). This model accounts for the inward and outward multilateral resistance (MTR), taking into consideration that trade between two countries is influenced by the relative trade costs of all other trading partners. To capture this, we include importer and exporter fixed effects, which correct for the bias of omitted variables and reflect that changes in trade costs on one bilateral route can affect trade flows on other routes due to relative prices effects. Additionally, we include pair dummies to eliminate unobserved time-invariant factors between countries (such as deep-seated historical trust or distrust, informal trade networks that are not documented, and unofficial influence of diaspora communities on trade patterns), following Baldwin and Taglioni (2007). This methodology allows us to isolate the variation in the effects of RTAs over time. Using this empirical specification, we find that the effect of RTAs in Africa, while significant, is lower than most previous estimates. For instance, Ngepah and Udeagha (2018) report effects generally exceeding 100%, whereas our estimates range between 62% and 77%. Unlike Ngepah and Udeagha (2018), who focused on the specific effect of each RTA individually in Africa, we estimate the overall effects of RTAs on trade. Additionally, to account for selection bias due to zeros in trade data, we use a PPML estimation. Our OLS estimate is 77%, but accounting for selection bias with PPML reduces this estimate to 63%.

Furthermore, MacPhee and Sattayanuwat (2014) found that the intra-RTA effect for ECOWAS is 128%, while the effect for SADC is 208%. Conversely, the effect for CEMAC was not significant, highlighting the heterogeneity among different RTAs in Africa. Given this evident heterogeneity, to the best of our knowledge, our study is the first to document the overall effect of RTAs on African trade, considering their heterogeneous effects by applying the event study methodology developed by Callaway and Sant'Anna (2021). Using this approach, we find an estimated effect of 62%, which is 1% lower than the PPML estimate.

Third, it is 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.

Our model is closer to Naito (2017), who 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 on inflation and monetary policy transmission, we augment the model with a Central Bank. We are also interested in quantifying how AfCFTA could affect shocks transmission across African countries.

**Additional litterature:** Shikher (2012) Build an Eaton and Kortum Model to study the effect of US-EU trade wars and the effect of trade bariiers reduction between high-income and middle-income countries. Lind and Ramondo (2024) Study how international trade can transmits ideas across countries and influence countries growth. Herrendorf et al. (2022) Documents that low-income countries have a huge agricultural sector with low productivity

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, along with evidence of the effectiveness of RTAs in increasing trade in Africa. 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 and to assess the effectiveness of Regional Trade Agreements (RTAs) in Africa. We begin by presenting the data, followed by an analysis of how climatic and political shocks in an origin country affect inflation in its trading partner, the destination country. Subsequently, we examine the effectiveness of RTAs in enhancing trade within Africa.

## 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, precipitation level and grid-level population (cite individual sources). Temperature and precipitation 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.

The data for the gravity regression come from the data set **Gravity** of `Centre d'études prospectives et d'informations internationales` CEPII (Conte et al., 2022). The main variable of interest is the Regional Trade Agreement (RTA). The World Trade Organization (WTO) recognizes four distinct categories of Regional Trade Agreements (RTAs): Partial Scope Agreements (PSA), Free Trade Agreements (FTA), Customs Unions (CU), and Economic Integration Agreements (EIA). PSAs usually entail the removal of import tariffs in a limited number of sectors, while FTAs generally involve the elimination of import tariffs across most sectors, with each member retaining the ability to enact their own trade policies. Customs Unions, which build upon FTAs, require member states to synchronize their external trade policies and implement a common external tariff. Economic Integration Agreements focus on the liberalization of trade in services. Some examples are Economic Community of West African States (ECOWAS) [2] (wich include West African Economic and Monetray Union (WAEMU, a CU)), Common Market for Eastern and Southern Africa (COMESA) [3], Economic and Monetary Community of Central Africa (CEMAC) [4], etc.

Table 1: Variables and their sources

| Variable | description | Source |
|---|---|---|
| Bilateral trade data | Detailed at 2 digits classification level | WTO Stats |
| RTA | Dummy equal to 1 if origin and destination countries are engaged in a regional trade agreement of any type within the given year | CEPII(from WTO) |
| distcap | bilateral distance between capitals, measured in km | CEPII |
| contiguty | Dummy equal to 1 if countries are contiguous, bilateral | CEPII |
| comlang_off | Dummy equal to 1 if countries share common official or primary language, bilateral | CEPII |
| GDP_o | GDP of the origin country, in current thousands US | CEPII (from WDI) |
| GDP_d | GDP of the destination country, in current thousands US | CEPII (from WDI) |
| Temperature | Average annual temperature in degrees | PRIO-GRID |
| Precipitation | Total annual precipitation in millimeter | PRIO-GRID |
| NDeaths | Total annual deaths in social conflicts | SCAD |

## 2.2 Descriptive statistics

Our study, illustrated in Figure 1, examines 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 of 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

[2] It's a FTA composed of Cabo Verde; Benin; The Gambia; Ghana; Guinea; Côte d'Ivoire; Liberia; Mali; Niger; Nigeria; Guinea-Bissau; Senegal; Sierra Leone; Togo; Burkina Faso

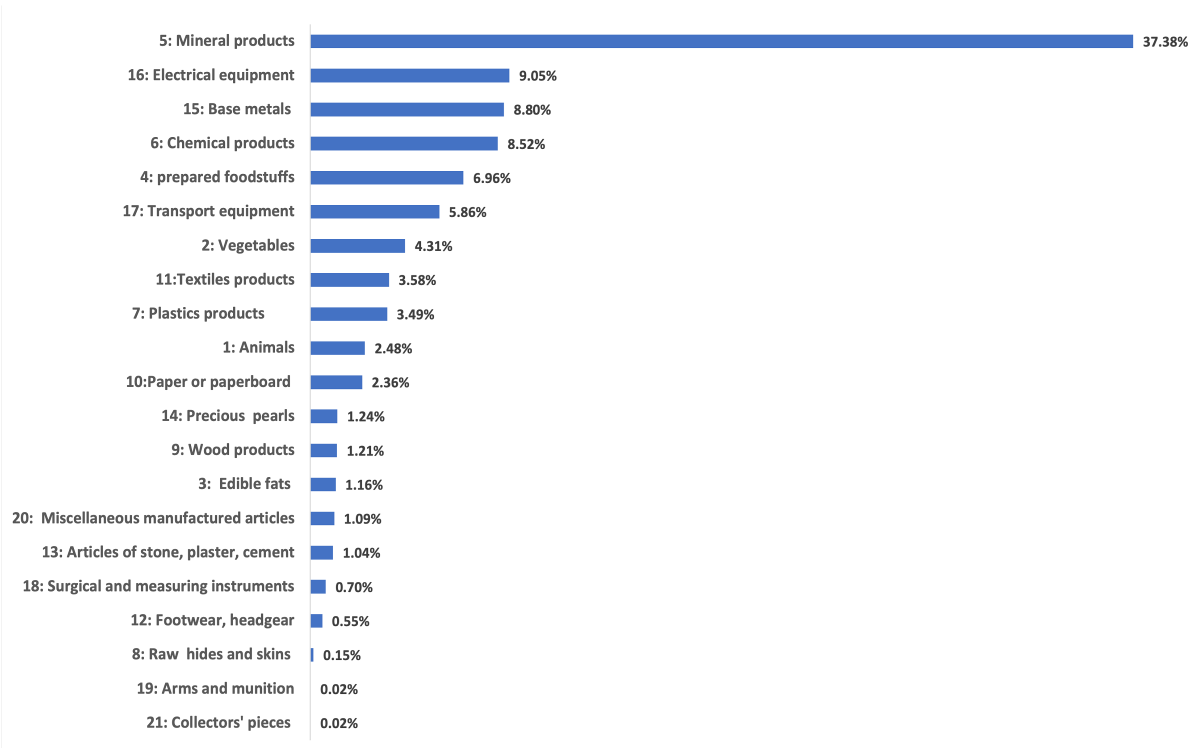
[3] the signatories are: Angola; Burundi; Comoros; Democratic Republic of the Congo; Ethiopia; Eritrea; Kenya; Lesotho; Malawi; Mauritius; Rwanda; Seychelles; Zimbabwe; Sudan; Eswatini; Uganda; Egypt; Tanzania; Zambia

[4] Cameroon; Central African Republic; Chad; Congo; Equatorial Guinea; Gabon

than 0.5% of total trade.

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 4.

Figure 1: Intra African trade share by product category




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

## 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 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:

$$y_{dt}^{d} = a_{do} + \lambda_t + \alpha x_{dot} + \varepsilon_{dot} \tag{1}$$

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

Where for each period $t$, $y_{dt}^{d}$ 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 , $\lambda_t$ a time fixed effect, and $\varepsilon_{dot}$ 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 2. 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 ( *Give evidence of heteroskedasticity and justify*

[5] also called endogenous variable

*the need for a GLS regression as in Jones and Olken*), 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 (precise the threshold absolute value of deaths).
Table 2 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).[7]

Table 2: 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:*

[6] Residuals from the OLS regressions are used to estimate pair-specific variances which are used as weights in a second OLS regression

[7] 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

### 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 3. 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 gives 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 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 3, 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.

Given the evidence of heteroscedasticity in the trade data, the Kleibergen-Paap (KP) test is the more reliable indicator of instrument strength than the Cragg-Donald (CD) test. For a 10% maximal bias, the critical value of 8.96 is a commonly accepted threshold. Since the KP F-statistics exceed this critical value, it indicates that our instruments are strong enough to limit bias in the IV estimates to within a tolerable 10% relative to OLS (Baum et al., 2007) (provide additional sources) .

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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

Table 3: 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
Dummies Cuttoffs: 75

We next turn to the analysis of possible inflationary effects of trade variations due to negative supply shocks in the origin country. Table 4 gives the results the OLS and IV estimations of the effects of trade variations on domestic inflation. OLS estimates (column 1 and 7) are of the expected negative sign but small in magnitude and non significant. A correction for heteroskecasticity using FGLS lead comparably small coefficients with the opposite sign which suggests that OLS estimates might be biased. 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 import 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 (column 2, 3, 8 and 9) ,with temperature and violent social conflict as instrument, yield larger and negative coefficients. A correction for heteroskedasticity using FGLS (column 5, 6, 11 and 12), gives coefficient similar in magnitude statistically significant in most cases. 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 temperatures increases or violent social conflicts in the origin country will lead to a 0.26 to 0.58 % points increase on inflation in the destination country depending on the specification and the used sample. The preferred regression is the one controlling for the temperature and number of Deaths above the third quarter in the destination country. When using the whole sample (sample 1) between 2001 to 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 is available for at least half of the period 2001-2015.

Table 4: 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.*

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

After demonstrating the transmission of shocks through trade, we examine whether existing Regional Trade Agreements (RTAs) have increased trade in Africa. We then explore their role in shock transmission.

In this section, we present two important results separately. First, trade transmits political and climatic shocks to inflation across African countries. Second, existing RTAs are effective in increasing trade by more than 60%. These two results raise many other questions. For instance, what are the implications of RTAs for countries' monetary policies? What should Central Banks in Africa do to better manage the potential effects of shocks from their trading partners following the implementation of the AfCFTA? In the next section, we build a model to provide some answers to these questions.

# 3 The model

In the model, we consider three countries, each with different levels of risk (productivity)[8]. Agents in the model include representative consumers and firms (both final and intermediate) and a Central Bank. Countries import and export intermediate goods to produce their non-tradable final good. *Intermediate Goods Market*: each firm produces

[8]The model is still in its early stages, but we have laid out some foundational concepts to help frame our research questions, particularly focusing on how Regional Trade Agreements (RTA) transmit inflation across trading partners. Here, we present the basis of the model along with some preliminary

a unique variety with its own price, which varies between countries. Countries trade in intermediate goods. *Final Goods Market*: Final goods are aggregated from intermediate goods. These goods can be used to consume and also to invest in the production of the intermediate good. Every period, each country experiences a shock drawn from an independent and identically distributed (iid) Fréchet distribution in the intermediate tradable good sector. Following Eaton and Kortum (2002), we assume that the shape parameter of the Fréchet distribution, which governs the relative comparative advantage ($\theta$), is constant but can vary between countries. Home bias is implicitly considered through bilateral trade costs, such as distance and tariffs.

## 3.1 Households

We introduce money into the utility function to generate a demand for money. Utility is derived from real money balances, represented as $m_{jt} = \frac{M_{jt}}{P^Y_{jt}}$, where $M_{jt}$ denotes nominal money holdings and $P^Y_{jt}$ is the price level in country $j$ at time $t$. Additionally, we incorporate public bonds $D_t$ as an asset in the model, with their interest rate $i_{jt}$ determined by the central bank's monetary policy in country $j$. The interest rate on public bonds influences household decisions through its effect on wealth and consumption over time.

The household's optimization problem is defined as:

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

$$\text{s.t: } C_{jt} + K_{jt+1} - (1-\delta_j)K_{jt} + \frac{D_{jt}}{P^Y_{jt}} + \frac{M_{jt}}{P^Y_{jt}} = \frac{r_{jt}}{P^Y_{jt}} K_{jt} + \frac{(1+i_{jt-1})D_{jt-1}}{P^Y_{jt}} + \frac{M_{jt-1}}{P^Y_{jt}} \quad (3)$$

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

$$C_{jt} + K_{jt+1} - (1-\delta_j)K_{jt} + \frac{D_{jt}}{P^Y_{jt}} + m_{jt} = \frac{r_{jt}}{P^Y_{jt}} K_{jt} + \frac{(1+i_{jt-1})D_{jt-1}}{P^Y_{jt}} + m_{jt-1} \cdot \frac{1}{1+\pi_{jt}},$$

where $\pi_{jt}$ is the inflation rate in country $j$ at time $t$.

## Euler Equations

The first-order conditions give the Euler Equations.
Euler Equation for Capital:

$$U_C(C_{jt}, m_{jt}) = \beta E_t \left[ U_C(C_{j,t+1}, m_{j,t+1}) \left( \frac{r_{jt+1}}{P^Y_{jt+1}} + 1 - \delta_j \right) \right] \quad (4)$$

Euler Equation for Debt:

$$U_C(C_{jt}, m_{jt}) = \beta E_t \left[ U_C(C_{j,t+1}, m_{j,t+1}) \left( \frac{1+i_{jt}}{1+\pi_{jt+1}} \right) \right] \quad (5)$$

Euler Equation for Money:

$$U_m(C_{jt}, m_{jt}) = U_C(C_{jt}, m_{jt}) - \beta E_t \left[ U_C(C_{j,t+1}, m_{j,t+1}) \left( \frac{1}{1+\pi_{jt+1}} \right) \right] \tag{6}$$

These Euler equations describe the intertemporal optimization conditions for consumption, capital, money, and debt. Combined with the budget constraint, they describe citizens' optimization solutions.

$$C_{jt} + K_{jt+1} + \frac{D_{jt}}{P_{jt}^Y} + m_{jt} = \left( \frac{r_{jt}}{P_{jt}^Y} + 1 - \delta_j \right) K_{jt} + \frac{(1+i_{jt-1})D_{jt-1}}{P_{jt}^Y} + \frac{m_{jt-1}}{1+\pi_{jt}} \tag{7}$$

Now how does the Central Bank set its interest rate?

## 3.2 Central Bank

To employ the previous MIU framework to analyze monetary issues, one should specify how the Central Bank conducts its monetary policy. The Central Bank supply money following this equation:

$$M_{jt} = (1+\mu_{jt})M_{jt-1}$$

$$m_{jt} = (1+\mu_{jt})\frac{m_{jt-1}}{(1+\pi_{jt})}. \tag{8}$$

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

Denote $\bar{\mu}_j$ the average growth rate of money supply. Let 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:

$$u_{jt} = \rho_j^u u_{jt-1} + \phi z_{jt-1} + \varphi_{jt} \tag{9}$$

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

$z_j$ is the productivity and follows:

$$log(z_{jt}) = \rho_j^z log(z_{jt-1}) + e_{jt} \tag{10}$$

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

## 3.3 Intermediate goods-producing firms

Each country $j$ produces a variety $i_j \in I_j \subseteq [0,1]$. The profit maximization problem for an intermediate goods-producing firm is:

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

subject to:

$$x(i_j) = \frac{K^x(i_j)}{a_j(i_j)}$$

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

$$p(i_j) = a_j(i_j) r_j$$

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

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

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

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

$$p_{jn}(i_j) = \tau_{nj} p(i_j)$$

The demand price of variety $i$ in country $n$ is:

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

### 3.4 Final Goods-Producing Firms

Shocks $z_n$ in the final good sector in country $n$, represented as labor productivity shock, are drawn from an iid AR(1) distribution for each country. The profit maximization problem for final goods-producing firms is:

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

subject to:

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

where $z_n$ is the productivity and $P_n^Y$ is the price of the final good in country $n$. From Lemma 1 in Naito, we have:

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

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

simulations to build intuition.

# 4 Results

(I should add something here by the end of the week)

Proposition:

Simple simulation:

# 5 Conclusion

In this paper, we document the transmission of climatic and political shocks through trade. Using an instrumental variable strategy, we show that a 1% decrease in imports due to these shocks raises inflation in the importing country by 0.4 to 0.58%. This highlights trade's critical role as a conduit for external shocks, with significant implications for inflation dynamics in Africa.

We developed a theoretical model to rationalize the aforementioned empirical evidence. Our simulations suggest that RTAs could significantly impact participating countries' inflation and necessitate adjustments in monetary policy to maintain economic stability. Our findings underscore the complex role of regional trade agreements (RTAs) in promoting economic stability, especially when trading with partners more exposed to economic shocks.

Policymakers should consider these issues when implementing trade policies to fully harness the benefits of economic integration.

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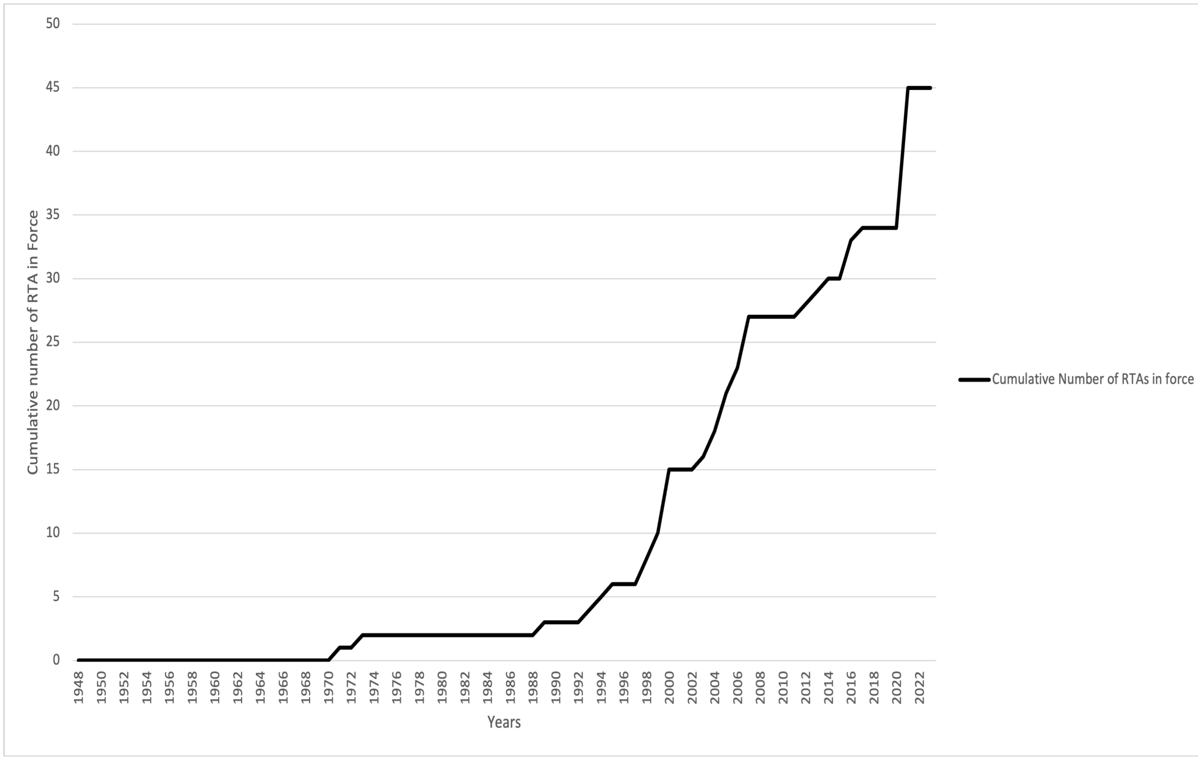
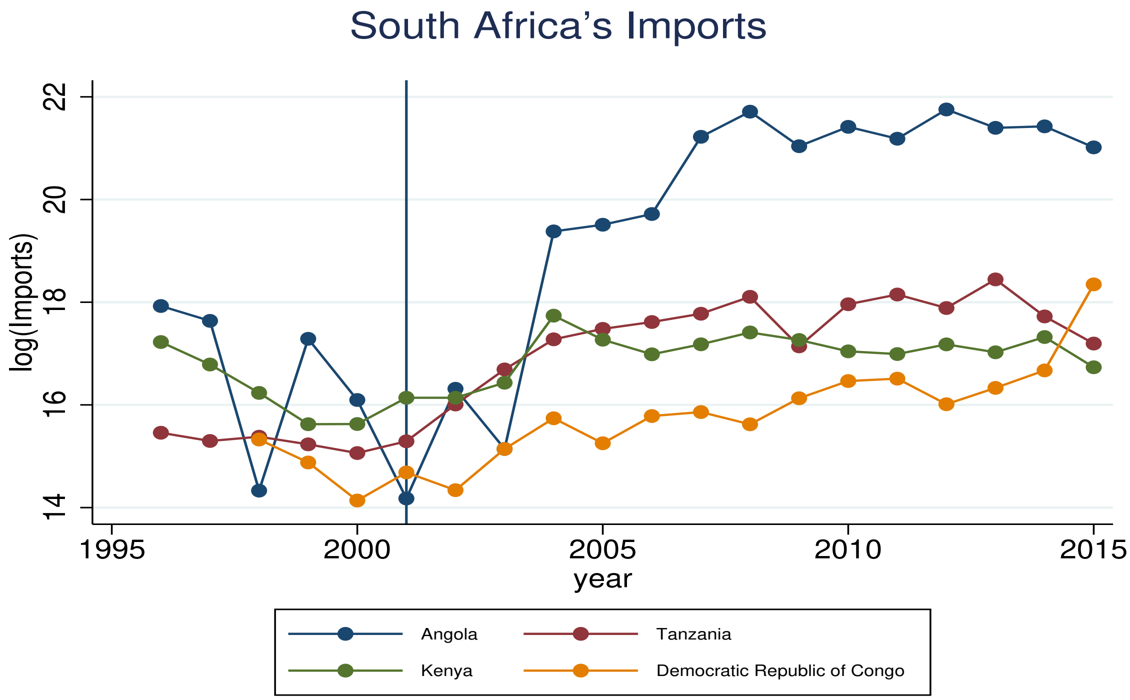
# Appendix

Figure 2: cumulative numbers of RTA among African countries




*source :WTO*

Figure 3




*source :WTO*

# A Trade and shock transmission

**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

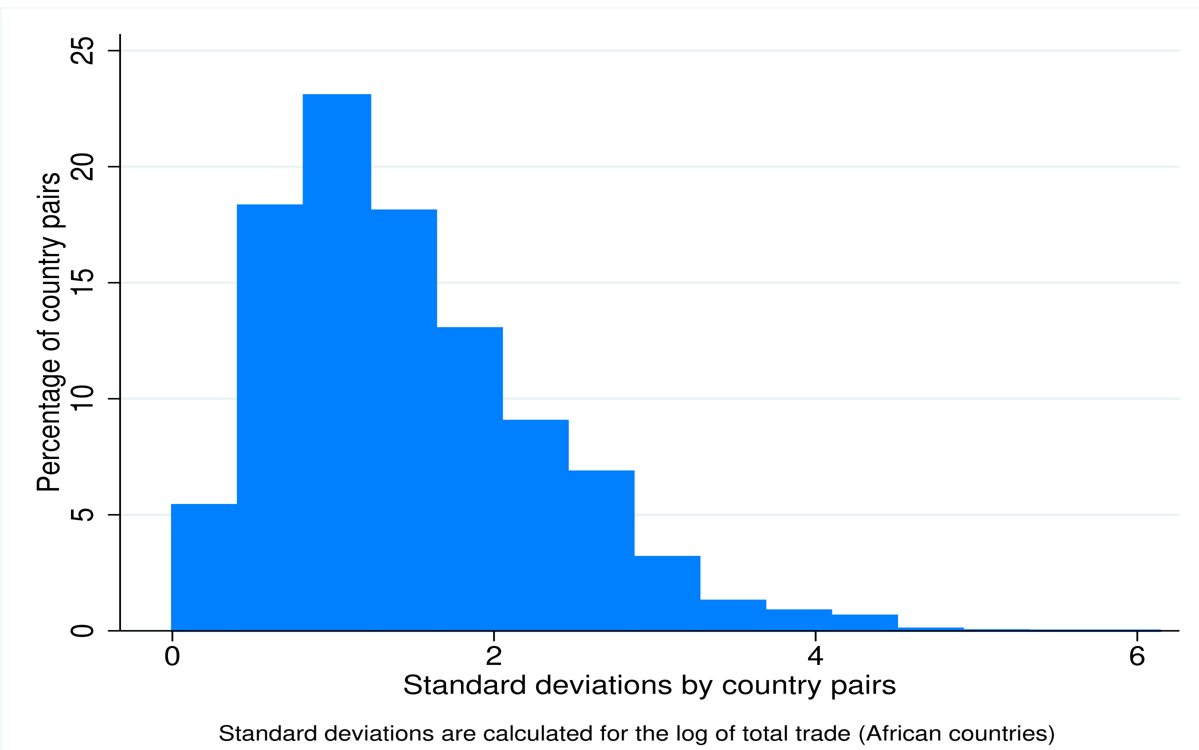
Table 5: IV-regression: inflationary effect of shock-induced trade variations

| | (1) infl_cpi_d | (2) infl_cpi_d | (3) infl_cpi_d | (4) infl_cpi_d | (5) infl_cpi_d | (6) infl_cpi_d | (7) infl_cpi_d | (8) 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.

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

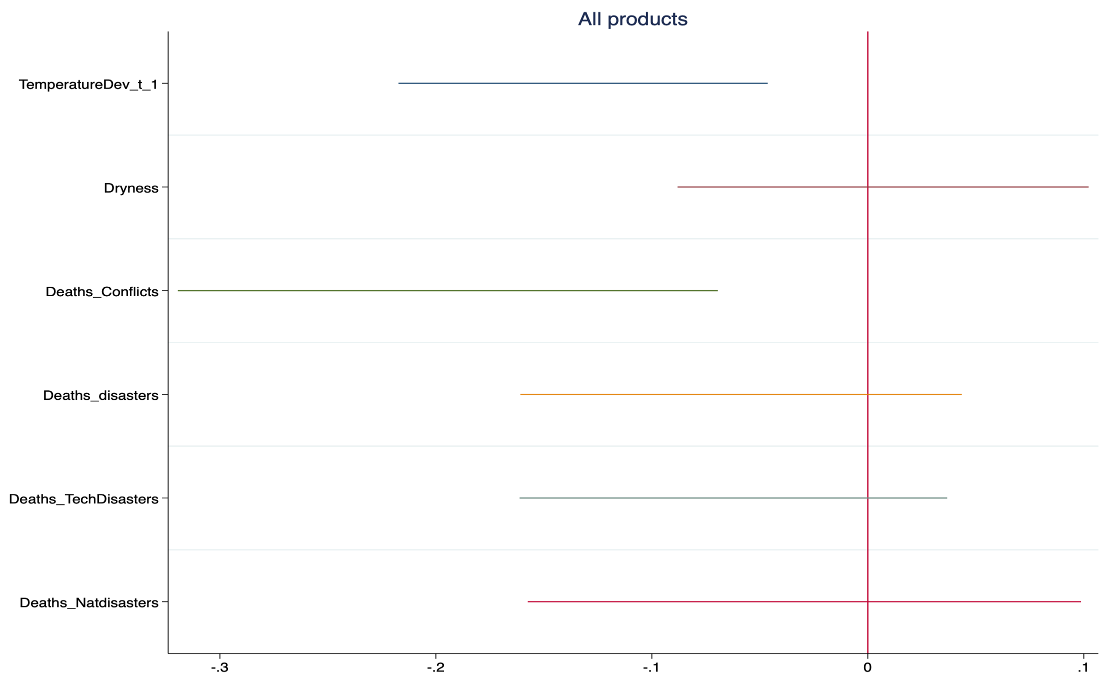
Figure 4: standard deviations of bilateral imports across pair of countries




*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.

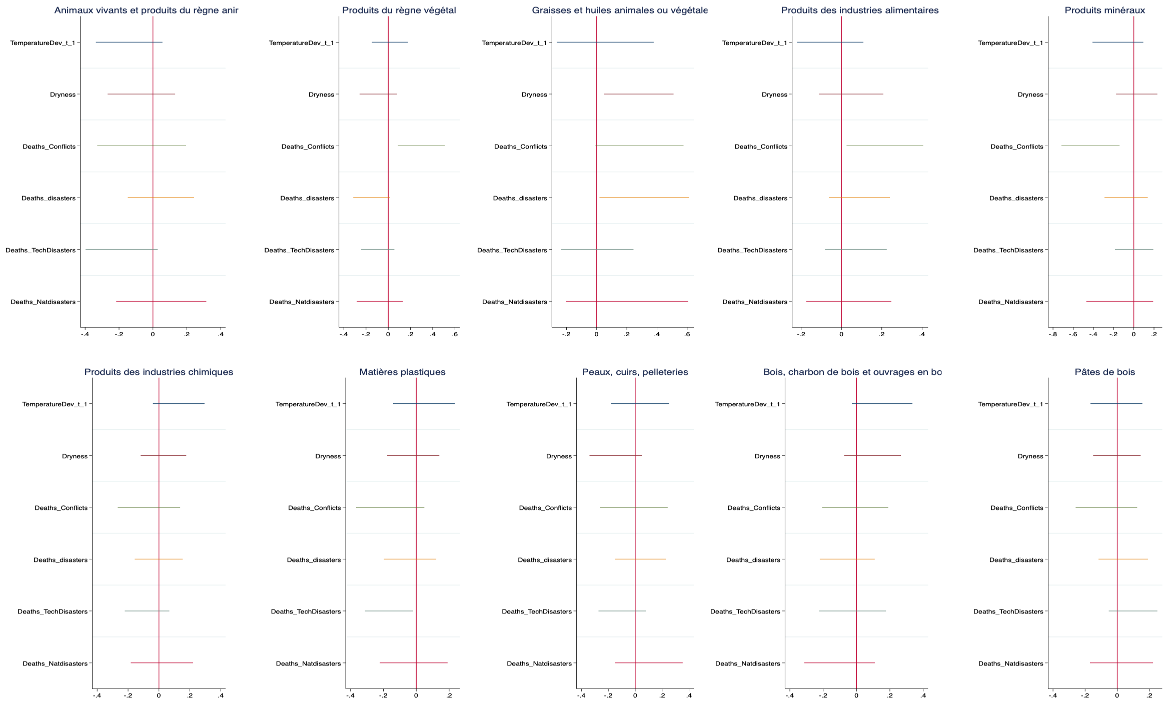
cross African countries.

Figure 5



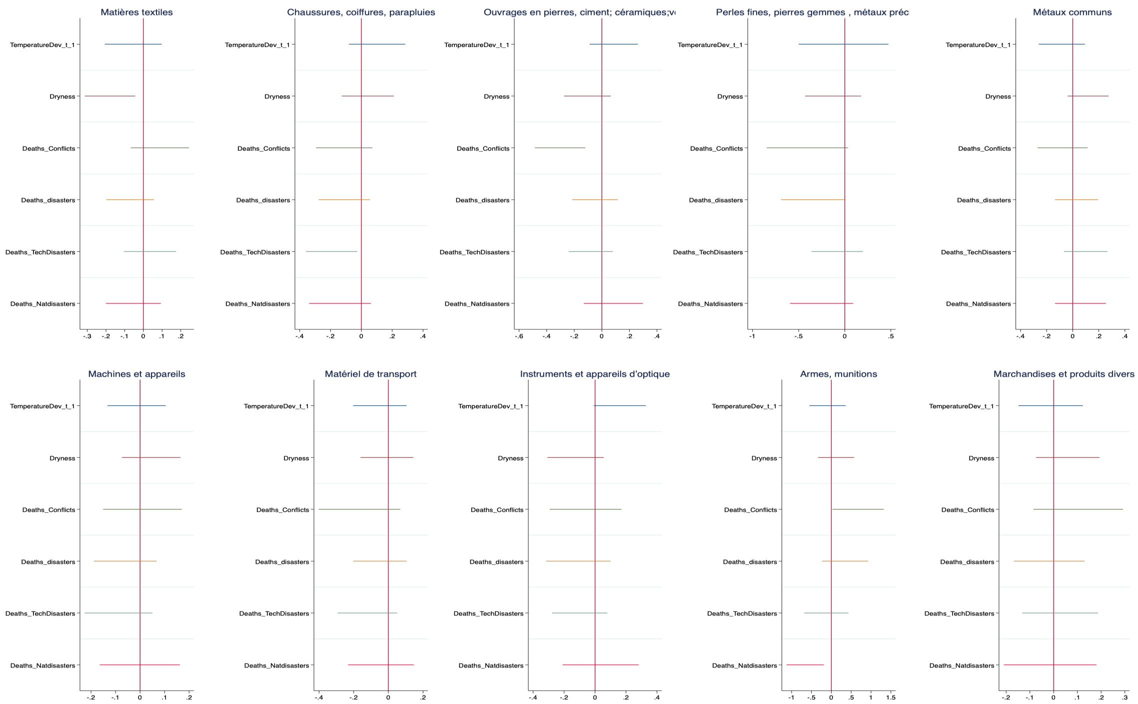

*Notes:*

Figure 6




*Notes:*

Figure 7




*Notes:*

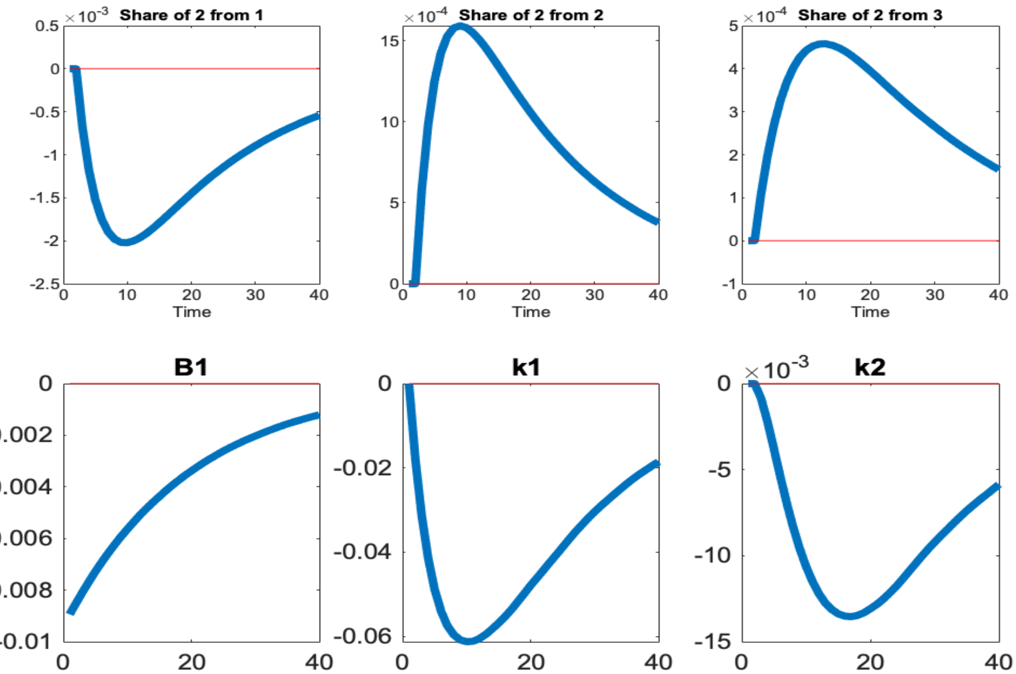
Table 6: First-step regression: shock-induced variations in trade growth

| | (1)<br>D_log_import_ij05 | (2)<br>D_log_import_ij05 | (3)<br>D_log_import_ij05 | (4)<br>D_log_import_ij05 | (5)<br>D_log_import_ij05 | (6)<br>D_log_import_ij05 | (7)<br>D_log_import_ij05 | (8)<br>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 Model's results appendix

Figure 8: Country 2 trade share dynamics




*Notes: This figure presents the The first row shows the trade share of country 2 from the three different countries.*