Unleashing International Trade through Financial Integration: Evidence from a Cross-Border Payment System

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Unleashing International Trade through Financial Integration: Evidence from a Cross-Border Payment System*

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Abstract

Leveraging administrative firm-level data on the universe of South African exporters between 2010–2019, we document that cross-border payment integration catalyzes international trade by as much as standard tariff reductions. Using the staggered implementation of a Real-Time Gross Settlement (RTGS) system across 14 Southern African Development Community countries that facilitated cross-border payments among participating countries, we document that payment integration increases bilateral trade by about 34% within member countries. This economically significant effect is comparable to a reduction of 8.3 to 12.1 percentage points in tariffs. Crucially, we find no negative spillovers to non-participant trade partners after the system's implementation. Effects on bilateral trade are only present for partners with low financial connections to South Africa through their bank branch network, destinations with domestic RTGS systems, and firms with high levels of financial dependence. Aggregate country-partner data further suggests the system leads to higher bilateral country trade volumes.

KEYWORDS: Financial Integration, International Trade, Cross-border Payments
JEL CLASSIFICATION: F15, F36, G15

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1 Introduction

Financial development is crucial for firms to circumvent the high costs and information asymmetries of international trade (Manova, 2013; Schmidt-Eisenlohr, 2013). The literature has documented how access to finance shapes international commerce in several ways. For example, increased domestic financial development boosts trade flows (Beck, 2002; Contessi and De Nicola, 2012; Paravisini, Rappoport and Schnabl, 2023), and disruptions to credit and financial markets hinder both exports and imports (Amiti and Weinstein, 2011; Chor and Manova, 2012; Manova, Wei and Zhang, 2015; Paravisini, Rappoport, Schnabl and Wolfenzon, 2015; Chaney, 2016; Xu, 2022). Yet, the literature has been silent on the last decade's revolution in the global integration of electronic payments. Hence, our understanding of how this new frontier of financial globalization and banking integration affects exporters and importers remains limited, particularly in identifying the underlying channels.

International electronic payment integration should cut the costs of cross-border banking communication to nearly zero. However, the costs of conducting cross-border payments have not experienced a remarkable decline (Bindseil and Pantelopoulos, 2022). We shed light on the effects of payment integration on international trade, exploiting one notable case of modernization in cross-border payments: the Southern African Development Community Real Time Gross Settlement (SADC–RTGS).

We examine the firm-level consequences of the staggered SADC–RTGS implementation across countries.[1] The SADC–RTGS system is a regional payment platform facilitating cross-border transactions among participating countries. Since all the member countries at the time of the beginning of the implementation eventually joined the system and there were no significant changes in regional trade agreements during the implementation time, we can address the challenge of potential endogeneity between trade and financial international integration. Moreover, we provide evidence that a country's entry into the SADC–RTGS is not predicted by origin, destination, or country-pair characteristics, including past volume of trade between the countries. These results, together with the nature of the system's adoption, alleviate common concerns of endogeneity in the literature. Therefore, our paper is the first to provide causal evidence of the relationship between financial and economic integration by quantifying the impact of promoting payment integration on a firm's engagement in international trade.

[1] A more detailed timeline of the SADC–RTGS implementation is in Table 1.

By using administrative information from South African exporters covering all export transactions from 2010 to 2019, we estimate the effect of payment integration on firms' exports. Figure 1 illustrates the staggered implementation of the payment system and its impact on exports to participant and non-participant countries. This figure provides evidence that once a new country is included in the system, exports from South African firms to the group of countries that eventually participate in SADC–RTGS grow faster than those that never joined it. We, therefore, exploit the staggered implementation of the payment system across participants along with a stacked difference-in-differences approach to analyze its impact on international trade and highlight the mechanisms of such effects. Leveraging the richness of the administrative data, we show that our results are not driven by export demand or other unobserved firm-pair-specific confounders.

[INSERT FIGURE 1 ABOUT HERE]

The rich firm-level data allows us to make a series of empirical contributions. First, the results indicate that firms disproportionately increase their export volume (36%) to participant countries once they join the payment system compared to similar firms that export to other trade partners that do not participate in the payment system. Our results show complementarities between cross-border payment and domestic payment infrastructure. We show that export increases happen only in destinations with domestic RTGSs, where firms can enjoy real-time settlements. These results provide evidence that the effects we find are directly linked to the increase in cross-border payments speed. A back-of-the-envelop calculation reveals that the positive impact of payment integration on international trade is comparable to a reduction in tariffs by 8.3 to 12.1 percentage points. The results also indicate that the number of export transactions increased, suggesting that firms started to make transactions more frequently once payments were cleared more quickly. These results add to the previous literature by focusing on the effects of real-time settlement systems above and beyond their impact on the credit market (D'Andrea and Limodio, 2023). Moreover, we add to the recent literature on the effects of new payment instruments on firms by shedding some light on the impact of cross-border payments modernization (Beck et al., 2018; Barrot and Nanda, 2020; Higgins, 2022).

Second, the results also show that firms that export to participant countries do not reduce their export volume or number of transactions to other trade partners that do not participate in the system. These spillover effects suggest that facilitating cross-border payments might benefit the participating

countries since our evidence is consistent with trade creation and not trade diversion (Panagariya, 2000). Moreover, using firm-level data, our results also show that only firms with higher levels of external financial dependence increase their export volume in the years following the system launch. These results add to the literature showing that faster payments can alleviate financing constraints by shedding some light on these effects in international trade (Barrot and Nanda, 2020).

Third, we shed some light on the mechanisms behind the increase in bilateral trade. The first mechanism we propose deals with trade partners that were already financially connected to South Africa through their bank's branch network. These partners experience a smaller increase in export volume or number of transactions after they joined the payment system. These effects contribute to the literature on the impacts of multinational banks on trade (Michalski and Ors, 2012; Paravisini et al., 2015; Caballero et al., 2018; Claessens and Van Horen, 2021). Our contribution regarding such a strand of the literature is to pin down the effects of cross-border payments from other channels through which multinational banks can affect trade, such as local expertise or market-specific risk assessment. Moreover, our results also suggest that the mechanism through which the system boosts exports seems to be through the transaction costs (risk) and not through exchange risk since exchange rate volatility has only very modest effects in mediating the effect of SADC–RTGS on exports. These results add to recent literature on the impact of exchange rate risk on international trade by documenting its effects on payments (Hassan et al., 2023; Salomao and Varela, 2022).

Fourth, using bank-level data, we show that banks with HQ or other foreign subsidiaries in a country participating in the SADC-RTGS are much more likely to adopt the system. These banks that are more likely to adopt the system experience a significant increase in their inter-bank assets once the country they are located joins the SADC-RTGS. This result suggests that participant banks increase their correspondent banking activity in order to settle cross-border payment system transactions for other banks. Overall, these results provide further evidence that the SADC-RTGS drives the effects that we observe on exports.

Finally, using country-level aggregate trade flows and a gravity equation, we also provide evidence of the aggregate consequences of countries participating in the SADC–RTGS. Consistent with the firm-level results, we find substantial trade responses to participation in the payment system. Our results suggest that trade between participant countries increases between 40 and 45.7% on average. These results are robust for controlling for bilateral variables commonly used in gravity equation estimations,

and fixed effects accounting for the multilateral resistance components. Implementing a back-of-the-envelope calculation, we find that these effects are equivalent to an 8-12% reduction in tariffs.

These findings highlight the significance of financial integration in promoting international trade and emphasize the role of regional payment platforms, such as the SADC–RTGS system, in facilitating cross-border transactions. The paper contributes to the existing literature by disentangling the causal relationship between cross-border payment integration on trade and other aspects of financial development.

2 Institutional Background

2.1 The SADC and its Real-Time Gross Settlement System

Established in 1992, the Southern African Development Community (SADC) region comprises 16 member countries.[2] It has a comprehensive framework for financial cooperation and cross-border transactions through the SADC Finance and Investment Protocol (FIP). Formulated under Articles 21 and 22 of the SADC Treaty, the FIP is a binding agreement ratified by all original member countries' Heads of State and approved at the SADC Summit in 2006. The treaty emphasizes cooperation among central banks for payment, clearing, and settlement systems. Seychelles and the Union of the Comoros joined in 2008 and 2018, respectively.[3]

A key advancement in the SADC region is its Real-Time Gross Settlement (RTGS) Integrated Regional Electronic Settlement System. The implementation started in October 2010, when the SADC Committee of Central Bank Governors approved undertaking the proof of concept in the Common Monetary Area (CMA), which was finally launched in July 2013.[4] Following this pilot phase, the implementation in the other countries was staggered, and the timing of such implementation in each one of the countries is provided in Table 1. This automated interbank settlement system is vital in facilitating real-time or delayed settlement of payment obligations between participating banks. The system, which currently settles payments in South African rand (ZAR) at business hours from 8 AM to

[2] Angola, Botswana, Comoros, Democratic Republic of Congo, Eswatini (formerly Swaziland), Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Tanzania, Zambia, and Zimbabwe.

[3] In our analyses, we only consider the SADC members as of 2013, when the RTGS implementation started, so we exclude Comoros (a late member) and Madagascar (suspended from the community between 2009–2014 due to a *coup d'état*).

[4] The CMA region comprises Lesotho, Namibia, South Africa, and Swaziland.

5 PM South African Standard Time (SAST), operates under the auspices of the South African Reserve Bank (SARB), which was appointed by participating SADC central banks.

[INSERT TABLE 1 ABOUT HERE]

The SADC–RTGS functions as an electronic central payment system, exclusively dealing in ZAR payments to facilitate cross-border trade within the SADC region. This platform allows for SADC–RTGS participating banks to facilitate financial flows and settle regional transactions within SADC countries on a gross basis and in real-time. The settlement system translates into lower bank expenses by eliminating the need for a correspondent bank as an intermediary. Banks in all participating countries can directly send and receive payments among each other through the SADC–RTGS. This allows banks in the region to optimize liquidity by consolidating funds in a single account, as opposed to maintaining separate nostro accounts across different banks. Additionally, the system accelerates the access of funds for firms and other banks' clients, reducing the processing time.

Commercial and central bank participants in the SADC–RTGS, pre-fund their accounts, mitigating settlement risks for intra-SADC transfers. This pre-funding mechanism offers heightened security and reach for the 82 participating banks connected to the SADC–RTGS. The system has progressed from real-time line (RTL) and continuous processing line (CPL) accounts to the forthcoming continuous batch processing line (CBPL) accounts for low-value payments. Guided by principles such as a focus on cross-border and intra-SADC transactions, utilization of existing infrastructure, adherence to international standards, and investment in straight-through processing, the SADC–RTGS aligns with the broader economic objectives of the SADC region.

The regional interbank settlement system owned by SADC and operated by an appointed central bank is a regional clearing capability for electronic funds transfer (EFT) credits and debits, a clearing capability for card automated teller machine (ATM) transactions, and a clearing and settlement capability for cross-border securities transactions. Benefits extend to participants who enjoy the SADC–RTGS' processing of real-time, immediate, final, and irrevocable transactions, reduced costs through harmonized processes and international standards, and real-time notifications for errors or unfunded accounts. The system's web dashboard provides a running monitor of participants' balances in real-time.

For businesses and individuals in the SADC region, the SADC–RTGS brings many benefits. It offers faster payment services, simplifies cross-border transactions, reduces reliance on cash, and improves safety and security. It also enhances pricing transparency and provides uniform ways of making payments. The ability to compare services and the option to cash out immediately or wait for favorable exchange rates add further flexibility and efficiency to financial transactions within the SADC region. In essence, the SADC–RTGS stands as a testament to regional collaboration, fostering economic integration and providing tangible benefits for the participating countries and their financial institutions.

2.2 The SADC and International Trade Promotion

One of the main concerns when examining the impact of the SADC–RTGS on international trade flows is whether there were other concurrent protocols within the SADC that were designed to promote international trade liberalization.

The SADC encompasses a broad set of protocols to improve cooperation and integration between its member countries. Notably, in 2008, the SADC also established a Free Trade Area (FTA) to promote international trade in the region. The SADC-FTA was only fully established in 2012 and includes 13 members.[5] Also in 2008, the Tripartite Free Trade Area (TFTA), also named the African Free Trade Zone, was agreed upon by the Southern African Development Community (SADC), the Common Market for Eastern and Southern Africa (COMESA), and the East African Community (EAC), encompassing all the member countries of these three organizations. More recently, in 2015, the member countries signed the agreement to move forward with the establishment of the TFTA, but it still has not been fully implemented.

While establishing the SADC-FTA and signing the TFTA marked significant strides in the region's trade liberalization, these developments are not concurrent to the roll-out of the SADC–RTGS. This implies that these advancements in trade liberalizations do not present an identification threat to our current analysis.

[5]The SADC-FTA includes all members except Angola, Comoros, and the Democratic Republic of Congo.

3 Data and Empirical Strategy

3.1 Data Sources

One of the major challenges in estimating the effects of financial integration on international trade is access to detailed firm-level information. We address this by using administrative tax data at the firm level obtained from the South African Revenue Services (SARS) for the 2010–2019 period. Its primary data source is the South African Corporate Income Tax (CIT) data. CIT data are collected by SARS annually and concern the tax year ending in February each year. Firms must submit a corporate income tax return in which they self-report information concerning their income, expenditures, equity and liabilities, capital items, and tax credits. Almost all reporting items are compulsory, and compliance is high, given that SARS may audit firms in a given year.

We complement this information with firm's employment data from the employee income tax certificates (IRP5 forms). IRP5 data are aggregated for each Pay-As-You-Earn (PAYE) reference number. A table linking the PAYE reference numbers to the tax reference number of the firm in the CIT dataset is used to match employees to firms. Companies identified by a unique tax reference number may have multiple PAYE numbers. We match all employees with a matching PAYE reference number to their corresponding tax reference number.[6]

One important feature of the South African Revenue Service and National Treasury Firm-Level Panel (SARS-NT) in our paper is the detailed firm-level customs records. The data covers the years between 2010 and 2019 and contains transaction-level data providing detailed information on export value and quantity by unit (kilo, liter, number, etc.), destination, product, and date of the transaction. This allows us to build a firm panel dataset with the total value of exports as well as the number of transactions performed with each destination country in any given year. In Table 2, we provide summary statistics on the firms in our sample. We show that firms that export to SADC participant countries are very similar to other firms that export solely to other non-SADC trade partners in terms of a large set of characteristics.

Our second source of data comes from the gravity database compiled by the *Centre D'Estudes Prospectives et d'Informations Internationales* - CEPII (Conte et al., 2021). This dataset contains international trade information from more than 200 countries and 5,000 products, between 1994 and 2022, and

[6]For more information on the firm-level data used here, see Pieterse et al. (2018).

comes from reconciled data reported by almost 150 countries to the United Nations Statistics Division, collated via UNCOMTRADE (United Nations, 2023). Moreover, the dataset also contains additional information at the "origin-destination-year" level, including geographic, cultural, trade facilitation, and macroeconomic variables for each country pair over time.

Finally, the last source of data is BankFocus, which we use for two different exercises. First, we focus on the international network of South African banks, extracting information on all the South African banks as well as all their subsidiaries and parents. We ended up with 75 South African banks, which have more than 4 thousand subsidiaries/parents present in 128 countries. We complement this information with the total assets of each bank before the SADC–RTGS implementation in 2012. Such information comes from the BA900 regulatory form, a mandatory form that the South African Reserve Bank (SARB) requires all commercial banks and mutual banks to complete monthly.[7] Second, we exploit information from all international bank conglomerates that have at least one subsidiary in Africa from BankFocus, to highlight the determinants of SADC-RTGS adoption and the implications for interbank activity (correspondent banking).

[INSERT TABLE 2 ABOUT HERE]

3.2 Empirical Strategy

The major challenge in the literature studying the causal effect of increased financial integration on international trade is the concern about endogeneity. In many countries, international financial and trade integration happens simultaneously, making it difficult to isolate the causal average effect of the former on the latter. To address this challenge, our empirical strategy exploits the staggered implementation of the SADC–RTGS to understand the effects of an increase in financial integration caused by the cross-border payment system on international trade. As highlighted by recent articles, researchers should be cautious about interpreting the results of two-way fixed effects models (Goodman-Bacon, 2021; Callaway and Sant'Anna, 2021; de Chaisemartin and d'Haultfœuille, 2020). Goodman-Bacon (2021) shows that the treatment effects using this specification are a combination of the weighted average of the unit-time treatment effects. These treatment effect coefficients in the context of two-way fixed effects can be potentially weighted by negative weights (de Chaisemartin

[7] This database is available publicly via the South African Reserve Bank website, which has been registered from January 1993 to the present, containing information on bank liabilities and assets.

and d'Haultfœuille, 2020). Therefore, the linear regression coefficient may, for instance, be negative while all the individual treatment effects are positive.

Given the staggered implementation of the payment system, we stack implementation cohort-specific data to calculate an average effect across all participants to overcome the problems highlighted above (Gormley and Matsa, 2011; Cengiz et al., 2019; Baker et al., 2022).[8] Although our empirical strategy does not require that the treated and control groups be similar, we use a matching procedure to find a control group similar to the treated units.[9] We construct cohorts by implementation year of SADC–RTGS in each country and stack the cohorts to estimate the average treatment effect. We use an estimation window of 3 years around each cohort year. This choice is made due to the availability of export data, which starts in 2010 (3 years before the 2013 cohort was treated) and to exclude the period of time after the COVID-19 pandemic started. Since all SADC participant countries eventually join the payment system, this choice is not endogenously determined in our setting. Moreover, we provide evidence in Table A.5 of the Appendix that pair-specific and country-specific characteristics do not predict the time of entry in the SADC–RTGS. Furthermore, in analyzing the export volume and number of transactions, we use a Poisson Pseudo-Maximum Likelihood Estimator to account for heteroskedasticity in trade data and the presence of zeros in the dependent variables (Santos Silva and Tenreyro, 2006). In the next few sessions, we provide more details on how we build our control groups and the specifications that we use for different levels of aggregation that we will exploit in our paper.

3.2.1 Firm-Destination Level Evidence

Our empirical strategy consists of difference-in-differences event-study analyses. We exploit quasi-experimental variation arising from the staggered implementation of the payment system. Although ex-ante heterogeneity does not necessarily invalidate the method, we implement a Coarsened Exact Matching technique in our setting to obtain a more balanced sample (Iacus et al., 2012). We use as the control group a sample of matched exporting firms with similar size, levels of productivity and sector that exported only to countries SADC–RTGS non-participant countries in 2012.[10] This choice allows us to estimate the treatment effects cleanly without the issues of not-yet treated units (Callaway

[8] This specification uses stricter criteria for the choice of the control groups. By aligning events by the event time, we prevent the negative weighting of some events that may occur with a staggered design.

[9] Results for the non-matched sample are quantitatively similar to our baseline results and available in Table A.2.

[10] In robustness checks, we also consider the non-matched sample and only the firm pairs in Africa as a control group. Results are quantitatively similar and provided in Table A.2 and Table A.3.

and Sant'Anna, 2021; de Chaisemartin and d'Haultfœuille, 2020). Our matching approach enhances efficiency and the plausibility of our identifying assumptions (Blackwell et al., 2009). Specifically, we estimate the following baseline specification:

$$T_{i,j,c,t} = \exp\{\alpha_{i,j,c} + \alpha_{c,t} + \beta_{RTGS} \cdot Post\ RTGS_{j,t} + \beta_d \cdot Export\ Demand_{j,t}\} \cdot \epsilon_{i,j,c,t} \quad (1)$$

in which i represents the firm, j the destination country, c cohort and t year. $T_{i,j,c,t}$ is our firm-level outcomes for international trade, being the total volume exported to the country j in period t or the total number of export transactions that firm i had with country j in year t. $\alpha_{i,j,c}$ are firm-destination-cohort fixed effects, $\alpha_{c,t}$ are time-cohort fixed effects. The firm-destination-cohort fixed effects control for any confounders specific to each firm and trade partner, which does not vary in our sample period, for example, any geographical or cultural connection between the firm and the destination country. Moreover, we control for the destination-country specific export demand ($Export\ Demand_{j,t}$).[11] Our coefficient of interest is β_{RTGS}, representing the effect of the trade partner j's inclusion in the payment system on firm i exports.

3.2.2 Firm-Level Evidence

After analyzing the effects of SADC–RTGS on firms' exports to cross-border payment system participants, we evaluate the impact of the payment system on firms' total exports and other real outcomes. To do that, we exploit the exposure of such firms to the payment system inclusion of trade partners, using the following measure:

$$RTGS\ Exp_{i,t} = \sum_{j=1}^{n} Post\ RTGS_{j,t} \times \frac{Exports_{i,j}^{2012}}{Total\ Exports_{i}^{2012}} \quad (2)$$

where i denotes the firm, j the destination country, and t time. Therefore, $\frac{Exports_{i,j}^{2012}}{Total\ Exports_{i}^{2012}}$ is the share of exports from firm i to trade partner j in 2012, before the RTGS implementation. Thus, $RTGS\_Exp_{i,t}$ represents the percentage of exports of firm i in 2012 to countries that participated in the payment system in year t. We also use the same weighting to estimate the average export demand ($Export\ Demand_{i,t}$) firm i faces over time.

[11] For more details, see Appendix B.

Virtually all treated firms were exposed to the payment system inclusions in 2013 (the first year of the cross-border payment system). Therefore, we do not use the stacked difference-in-differences approach to analyze the effects on firms' total exports and other real outcomes. Alternatively, we use a fixed effects specification with a control group composed of firms with similar sizes and in similar sectors that did not export to the SADC–RTGS participant countries in 2012. This exercise employs the following specification to analyze such effects on firm outcomes:

$$y_{i,t} = \exp\{\beta_{RTGS} \cdot RTGS\ Exp_{i,t} + \beta_{RTGS} \cdot RTGS\ Exp_{i,t} \times High\ EFD_{s,2012} + \alpha_i + \alpha_{s,t} + \sum_{\tau=2010}^{2019} \alpha_{TFP,t} \times TFP_{i,2012} \times I(t=\tau) + \beta_d \cdot Export\ Demand_{i,t}\} \cdot \epsilon_{i,t} \quad (3)$$

$y_{i,t}$ is the total volume of exports of firm i in year t to any country. In the Online appendix, we also estimate the equation above using the number of destination countries and the total number of products exported as additional dependent variables. α_i are firm fixed effects and $\alpha_{s,t}$ are sector-time fixed effects and $TFP_{i,2012} \times \sum_{\tau=2010}^{2019} I(t=\tau)$ represents an interaction between a dummy variable indicating if the firms' had above or below the median levels of TFP in 2012 and a dummy indicating the time periods. Our fixed effects deal with any possible fixed confounders at the firm level, such as previous export activity or other determinants of export activity that do not change over time, and any time-varying shock at the sector level. Moreover, $High\ EFD_{s,2012}$ represents if the firm had an above-the-median external financial dependence measured by the ratio between the firm trade credit (payables) to the firm sales in 2012. We add an interaction term to analyze if the effects on total firms' exports (and other outcomes) are heterogeneous depending on their levels of financing constraints, building on previous findings on the impact of payment speed on firms' outcomes (Barrot and Nanda, 2020).

3.2.3 Bank-Level Evidence

Following the results of firms' exports to cross-border payment system participants, we evaluate the impact of the payment system on banks' interbank markets. We focus on this market for two specific reasons. First, those markets are typically linked to correspondent banking activity. As banks can use the payment system by directly joining it or by using a correspondent bank, we expect that participant banks will experience an increase in loans to other banks (interbank assets) following the introduction of the country in which the bank is located. Second, this variable is available before and after the

country's introduction so we can check the dynamics of such variables in countries that are more and less likely to participate in the SADC-RTGS to measure the direct usage of the system.

We do that by using information from all conglomerates present at BankFocus with at least one subsidiary in Africa. We start by analyzing which banks are more likely to adopt SADC-RTGS in 2019.[12] We expect that banks that have another subsidiary in countries that adopt the cross-border payment system will be more likely to also adopt it. To test this hypothesis, we use the following cross-section regression using all banks located in countries that adopt the system:

$$SADC\text{-}RTGS\ Participant_{2019} = \delta_{exp} \cdot RTGS\ Exposure_b + \beta \cdot X_b + \gamma_i + \varepsilon_b \tag{4}$$

where b denotes the bank, and i is the country in which the bank is located. $RTGS\ Exposure_b$ is the bank exposure to RTGS, and it is a binary variable that assumes value one if the bank has another subsidiary or the HQ in a country that adopts the SADC-RTGS, X_b are control variables, including a multinational conglomerate dummy, total assets and operating revenues to assets ratio. γ_c represent country fixed effects. Our coefficient of interest is δ_{exp} and represents the likelihood of adopting the RTGS, given that other subsidiaries are located in the country also adopting it. We expect that those banks are more likely to adopt since they can benefit more from doing so.

In a second approach, we exploit the fact that these banks are more likely to adopt the payment system in order to estimate its effects on banks' interbank markets, using the following stacked difference-in-differences specification:

$$y_{b,c,t} = \delta_{RTGS} \cdot Post_{RTGS} \times RTGS\ Exposure_{b,c} + \gamma_{b,c} + \gamma_{h,c,t} + \gamma_{i,c,t} + \varepsilon_{b,c,t} \tag{5}$$

where b denotes the bank, i is the country in which the bank is located, h is the conglomerate, and c is the treatment cohort. $Post_{RTGS}$ is an indicator variable that takes value one after the country where the bank is located joins the system. $\gamma_{b,c}$ represent bank-cohort fixed effects, $\gamma_{i,c,t}$ bank country-year-cohort fixed effects, and $\gamma_{h,c,t}$ represent conglomerate-year-cohort fixed effects, these fixed effects account for unobserved heterogeneity at bank level as well as for time-varying unobserved heterogeneity at the country and conglomerate levels. δ_{RTGS} is our coefficient of interest and represents

[12] This information is available at https://www.resbank.co.za/content/dam/sarb/what-we-do/payments-and-settlements/settlement-services/SADC-RTGS%20Newsletter_Issue%201.pdf.

changes in the interbank markets for banks more likely to adopt the SADC-RTGS compared to other banks in the same country less likely to adopt it.

3.2.4 Aggregate Effects

In addition to investigating the firm-level consequences of joining the SADC–RTGS, we also assess its impacts to bilateral international trade flows using a standard gravity model. Gravity models have been extensively used in studying the determinants of international trade flows and the effects of various types of trade barriers, mostly due to their strong theoretical foundations and intuitive equations (Head and Mayer, 2014). To incorporate the payment system participation into the standard gravity equation, we assume it affects international trade flows via the bilateral *'iceberg'* trade costs component. Therefore, we estimate the following gravity equation:

$$X_{i,j,t} = \exp\{\alpha + \beta_{RTGS} \cdot RTGS_{i,j,t} + \beta \cdot D_{i,j,t} + \gamma_{i,t} + \gamma_{j,t} + \varepsilon_{i,j,t}\} \tag{6}$$

$RTGS_{i,j,t}$ is a binary variable that assumes value 1 when the two countries i and j participate in the RTGS in year t. $\gamma_{i,t}$ represent exporter-by-year fixed effects, and $\gamma_{j,t}$ represent importer-by-year fixed effects, which are commonly used in the gravity literature to account for the multilateral resistance terms (Anderson and Van Wincoop, 2003). $D_{i,j,t}$ represent a set of bilateral control variables, which include geographical distance and contiguity, commonly used in gravity estimations and other variables that capture different dimensions of economic integration between countries, such as whether countries have a free trade agreement, or belong to a same customs union. We estimate Equation (6) using the Poisson Pseudo-Maximum Likelihood - PPML estimator (Santos Silva and Tenreyro, 2006).

4 Results

4.1 Faster Cross-Border Payments and Firm Exports

We start by analyzing the effects of the payment system on firms' exports to different destinations by presenting the estimates of Equation (1) in Table 3. Columns (1) and (2) show the results when using the firm's export volume as the dependent variable, while Columns (3) and (4) use the number of transactions as the dependent variable. Our results show that firms participating in the SADC–

RTGS increase their export volume (30–32%) and their number of export transactions (37–39%) on average. These results are robust for controlling for firm-pair fixed effects, which suggests these effects are not driven by firms' characteristics that might affect exports to a specific destination. Furthermore, these results are not driven by destination country demand or other time-varying shocks that might affect export activity, such as an increase in credit supply caused by the payment system, for example, in D'Andrea and Limodio (2023).

[INSERT TABLE 3 ABOUT HERE]

One potential concern with our empirical approach is whether our control units are an appropriate comparison group to the firms that were exposed to the payment system. In Figure 2, we provide evidence suggesting that, before the implementation of the payment system, the treated and non-treated firms behaved similarly in terms of their export volume and transaction number. In other words, firms that did not export to countries that participated in the SADC-RTGS behaved similarly to exporters that were exposed to the system in the years before the implementation. The figure also shows evidence of a divergence in the volume and transactions in the years following the implementation of SADC–RTGS, which offers reassuring evidence for our empirical strategy.

[INSERT FIGURE 2 ABOUT HERE]

In sum, we find that participating in the international payment system increases a firm's exports (volume and number of transactions). One natural question is whether this increase in trade is due to trade flows being diverted from other countries outside the SADC–RTGS to the participant ones. If firms are just switching the destination of their exports and not generating new trade flows, this could raise concerns about the global welfare implications of the establishment of these payment systems. This problem, often referred to in the trade literature as *trade diversion*, has been extensively examined in the case of trade liberalization policies (Viner, 1950; Dai et al., 2014).

In Table 4, we test if the cross-border payment system is able to influence trade creation or if it just shifts trade away from one country towards the payment system participant countries. We test the hypothesis of trade diversion by including in Equation (1) one additional variable that captures the effect that the adoption of the RTGS may have caused on the exports to countries outside the payment system, which we refer to *RTGS Firms Spillover*. This consists of a binary variable that assumes value

1 when the destination country is not a member of the RTGS, but the firm is directly affected by the adoption of the RTGS by exporting to at least one participating country after the system adoption. In other words, this variable captures the marginal effect of a firm that is affected by the RTGS on their trade volume and transactions with countries outside the payment system.

Our results point out that the volume of exports or the number of transactions from firms that export to SADC–RTGS participant countries to other trade partners that do not participate in the system do not change after the system launch.[13] These results suggest that facilitating cross-border payments contributes to trade creation and not to trade diversion (Panagariya, 2000).

[INSERT TABLE 4 ABOUT HERE]

In order to pin down the effects of the faster payments from other possible confounders that may coincide with the SADC-RTGS implementation, we exploit the fact that only some destinations enjoyed real-time settlement of the cross-border settlements. To do that, we exploit the fact that some destinations had the necessary domestic infrastructure to settle payments instantaneously while others did not (D'Andrea and Limodio, 2023). Therefore, we use a triple interaction between the existence of a domestic RTGS indicator variable and the indicator variable after the destination adopts the SADC-RTGS. Table 5 display the results of such exercise. Our results show that exports only increase for destinations with domestic real-time payment settlement. As expected, places with no domestic RTGS do not experience significant increases in exports in our preferred specification. These null results suggest that the speed of the transactions to those destinations does not change much, especially considering that it may take some time to develop the domestic infrastructure required for the instantaneous payment settlements. Our results are also in line with the hypotheses that firms might experience delays during the payment settlement at the destination caused by the absence of a domestic real-time settlement system.

[INSERT TABLE 5 ABOUT HERE]

[13] This finding diminishes concerns that the effects that we observe here are driven by improvements in firms' productivity, for example.

4.2 Inspecting the Mechanisms

4.2.1 Financial Dependence, Cross-border Payments and Exports

We complement the previous analysis by evaluating the effects of the payment system on firms' total exports by estimating Equation (3). In doing so, we assess the role of financial dependence in explaining our results. In Table 6, we show that there is an increase in the export for firms affected by the system implementation and that such increases in exports are concentrated in sectors with high external financial dependence, as measured by the sector-level payables (trade credit) to total sales ratio in 2012. Table 6 also provides further evidence that these effects are driven by external financial dependence and not other possible mechanisms such as firm size, age, sector or total factor productivity (TFP).[14] This result is in line with the findings in Barrot and Nanda (2020) analyzing the effects of faster procurement payments in the US and their effects in alleviating firms' financial constraints. More broadly, this result also aligns with many studies that show the important role of financial constraints in hindering international trade activity (Feenstra et al., 2014; Muûls, 2015; Niepmann and Schmidt-Eisenlohr, 2017).

[INSERT TABLE 6 ABOUT HERE]

4.2.2 Multinational Banks, Exchange Rate Risk, and Exports

In this section, we test for two possible mechanisms driving our baseline results. The first is the presence of South African banks in destination countries. Banks could shorten delays in payments before the launch of the SADC–RTGS by using their internal capital markets to transfer resources to other destinations and clear the transactions. Another way to avoid such delays is by using correspondent banks to perform the transaction, so one South African bank can transfer the money domestically to another South African bank that uses its subsidiary abroad to settle the transaction. This is the case for some destinations, given the cross-border presence of South African banks throughout the continent (Beck, 2015). Another compelling mechanism could be diminishing the exchange rate risk involved in the transactions. Although the payment system might help with this second problem, this risk is not entirely mitigated since all transactions are still settled in South African Rands.

[14] We obtain the firm's total factor productivity (TFP) by estimating an aggregate production function which we assume to follow a Cobb-Douglas functional form. This is an important factor to consider, especially since previous studies have found that international capital flows can impact aggregate TFP growth (Cingano and Hassan, 2022).

In Table 7, we augment our approach in Table 5 by allowing for heterogeneous effects to check the mechanisms highlighted in our previous paragraph. The first exercise uses measures of South African bank's presence at the destination; this variable is an asset-weighed average of banks' presence in each trade partner. In the second, we exploit a measure is the pair-specific exchange standard deviation in 10 years preceding the SADC–RTGS implementation. As the only change during this period is in the payment speed, while banks' expertise about the destinations should remain relatively fixed, our results provide novel evidence that international banks also affect trade by the payment channel (Michalski and Ors, 2012; Paravisini et al., 2015; Caballero et al., 2018; Claessens and Van Horen, 2021).

[INSERT TABLE 7 ABOUT HERE]

Our results also show that banks' internationalization explains part of the results observed in our baseline specification, although to a lower extent than the presence of domestic RTGS at the destination. Furthermore, our results also provide evidence that the payment system and the increased speed at which transactions are cleared have limited effects on exchange rate risk. Interestingly, we also observe some spillover effects on the number of export transactions for destinations connected to South Africa, suggesting that these destinations experience some preferential effects once the financial constraints are reduced.

4.2.3 SADC-RTGS and Interbank Markets

In this section, we provide direct evidence of the SADC-RTGS usage. Banks can use the cross-border payment system in two ways: by joining the system or using a domestic participant bank as a correspondent to settle transactions with another participating country. Given such a feature, we provide corroborating evidence of SADC-RTGS usage exploiting bank-level information. First, we analyze the determinants of adoption by banks. Second, we investigate whether banks that are more likely to adopt the system increase their interbank market assets after the country in which they are located joins the payment system.

In Table 8, we focus on the fourteen countries adopting the SADC-RTGS, ending up with 119 banks. The table shows that the primary determinant of the system adoption is whether their conglomerate has the HQ or another subsidiary in a participant country. Moreover, we show that being a multinational conglomerate without a connection to another participant country does not affect the

probability of adoption. Although the size of the bank significantly affects the adoption, having a foreign subsidiary in a participant country is much more relevant, representing an effect similar to an increase of 10 standard deviations in assets. Finally, we show that these effects are not driven by countries' unobservables, such as different levels of domestic financial development.

[INSERT TABLE 8 ABOUT HERE]

We exploit the fact that having a foreign subsidiary located in a participant country makes banks more likely to participate in the cross-border payment system to provide evidence of usage by focusing on the interbank markets. We focus on the interbank markets because the information is available before and after the implementation of the system and are directly linked to non-participant banks using participant banks as correspondents, making this information the perfect candidate to analyze bank's usage. In Table 9, we employ a staggered difference-in-differences strategy focusing on the heterogeneous effects on banks that are likely to be SADC-RTGS participants. We show that banks that are less likely to participate do not experience any change in their interbank market behavior. In contrast, we show that banks more likely to be participant experience a significant increase in their interbank market assets after the country they are located starts participating in the system. Importantly, these effects are not driven by conglomerate and country unobserved heterogeneity. These results provide evidence that those banks are likely acting as correspondent banks for non-participant counterparts.

[INSERT TABLE 9 ABOUT HERE]

Figure 3 displays the dynamic effects of the cross-border payments system on banks more likely to participate in the system. This figure provides reassuring evidence that the effects we observe are driven by the system's adoption and not by different growth rates in the interbank markets that are not linked to the country's participation in the system. Overall, the effects in this section provide suggestive evidence of correspondent bank activity of SADC-RTGS participant banks and evidence of system usage.

[INSERT FIGURE 3 ABOUT HERE]

4.3 Aggregate Effects and Gravity Estimations

Finally, we investigate the effects of the RTGS on participant countries using data on aggregate bilateral trade flows. Table 10 presents the estimates of Equation (6) using PPML. Trade information come from the CEPII's BACI database. In columns (2), (4), and (6) we include internal trade flows by inputting them based on the difference between GDP and a country's total exports. Consistent with the firm-level results, Table 10 show that the trade flows between participants of the payment system increase once countries join the system. Our preferred specifications on columns (5) and (6) suggest an increase in such exports between 49% and 58%, on average.

To better illustrate the economic implications of this results, we can compute the *tariff equivalent* effect implied by these estimates, i.e., the equivalent *ad-valorem* tariff rate that, if removed, would have had the same effect on trade as the participation on the RTGS. Despite not including tariffs in our specification, we can compute the *tariff equivalent* effect of the RTGS by relying on (i) the structural gravity model properties and (ii) trade elasticity estimations from the literature (Yotov et al., 2016).[15] In the last three rows of Table 10, we compute the RTGS tariff equivalent effects using different estimates of the trade elasticity from the literature. Using the aggregate elasticity estimate from Caliendo and Parro (2015), we find that participating in the RTGS has an equivalent effect on trade as eliminating a tariff rate of 9.2%–10.6%. Alternatively, using the trade elasticity estimate from Simonovska and Waugh (2014), the tariff equivalent effect is 10.5%–12.1%, while when using the elasticity estimate from Baier and Bergstrand (2007), we obtain rates between 8.3% and 9.6%.

[INSERT TABLE 10 ABOUT HERE]

In sum, the estimates presented in Table 10 confirm the substantial effect of participating in the RTGS on trade flows. The estimates from the gravity equations are very close but slightly larger than the coefficients obtained from the firm level analysis in Table 3. To further gauge the dynamic aggregate effects of the RTGS, we also run an aggregate event-study specification. Figure 4 shows that exports from participating countries had a similar trend in the years preceding the payment system implementation, but they started to diverge after the countries joined the system. It is important to highlight, we find that the dynamic effects are very similar to the firm-level results in Figure 2. These results provide evidence in favor of our empirical strategy and show that the effects are persistent over time.

[15] The tariff equivalent effect can be calculated by $\left[e^{\hat{\beta}_{RTGS}/(\hat{\sigma})} - 1\right] \times 100$ where $\hat{\sigma}$ is the trade elasticity from the literature.

Overall, the results found in this section provide further evidence of the positive effects of the payment system on export activity from participant countries. The results shed some light on the aggregate effects of the modernization of cross-border payments at the aggregate level and qualitatively align with the results using firm-level data.

[INSERT FIGURE 4 ABOUT HERE]

5 Robustness Checks and Additional Results

5.1 Higher Frequency Specification: Monthly Time Windows

We employ a high-frequency strategy to gauge the effects of the SADC–RTGS on firms' exports to participating countries. In Table A.1, we utilize a temporal regression discontinuity design (RD) that evaluates the short-term impact of the payment system across various time windows surrounding the implementation date for firms' trade partners. This approach takes a within-firm perspective, utilizing time as the forcing variable (e.g., Davis, 2008) to compare export trends immediately before and after the implementation. The advantage of this method lies in its capacity to consider unobserved heterogeneity that remains consistent within months around the implementation date, such as other firm characteristics that do not vary in the short run. Consequently, this approach enables an examination of the immediate impact of the implementation. Using the optimal bandwidths, our results suggest that export volumes increased by 19.7% and the number of export transactions increased by 14.3% in the months following the implementation of the SADC–RTGS at the trade partner.

5.2 Alternative Samples

Our baseline results in Table 3 are robust to different samples. In Table A.2, we replicate our baseline results using the non-matched sample of firms, which are quantitatively in line with those in the baseline. Alternatively, in Table A.3, we also replicate those results just using as a control group only other African destinations that do not participate in the SADC–RTGS in order to obtain a more similar group of trade partners as the participant countries. The results presented in such a table are also quantitatively similar to those in our baseline sample.

5.3 More Exporter Activity

Chan and Manova (2015) shows that financial development affects export activity in terms of a number of destinations, especially for firms with higher levels of financial dependence. Using the specification as in Table 6, we test if the introduction of the SADC–RTGS affected the number of destinations and destination-products to which the firms export in Table A.4 we test such conjecture. We do not find evidence of a significant change in the number of destinations or products, even considering heterogeneous effects for firms with higher external financial dependence.

6 Conclusion

Our study provides evidence of the significant positive impact of faster cross-border systems on international trade. The adoption of a payment integration platform resulted in a substantial increase in export volumes for participating firms, equivalent to a reduction in tariffs by 8.3 to 12.1 percentage points. Importantly, our results are consistent with trade creation and not trade diversion. We provide evidence that the reduction in transaction costs (risk) emerged as a key driver of this trade boost, highlighting the crucial role of efficient payment systems in promoting cross-border commerce.

Firms with higher external financial dependence experienced a more pronounced increase in their exports, suggesting that enhanced financial accessibility plays a crucial role in leveraging the benefits of international financial integration for export activities. Our findings disentangle the importance of cross-border payment from other channels in which multinational banks can influence trade. Moreover, we highlight the determinants of cross-border payment system adoption by banks and provide suggestive evidence that adopting-banks are more likely to increase correspondent banking activity after the country they are located joins the system. Overall, our study contributes to the literature on financial integration and its implications for international trade. We provide evidence of how a new form of financial integration—regional cross-border payment systems—deepens economic integration by spurring international trade.

Future work could explore the long-term impacts of payment integration on global trade dynamics, especially for SMEs. Examining policy implications for trade facilitation and growth can inform inclusive trade strategies. Probing digital currencies' role in cross-border trade, particularly services, may illuminate the increasing influence of financial technologies on international commerce.

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Figures

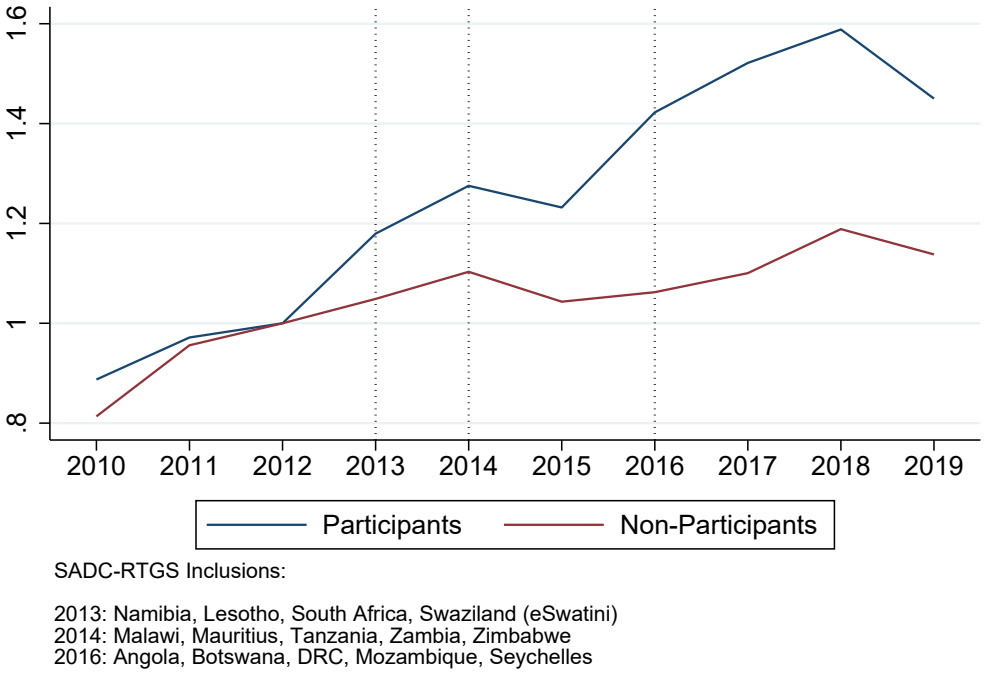

Figure 1. SADC–RTGS Implementation and South African Firms Exports. These series reflect the growth in exports for all the firms in our sample on the South African Revenue Service and National Treasury Firm-Level Panel (Pieterse, Gavin and Kreuser, 2018) normalized by their levels in 2012.

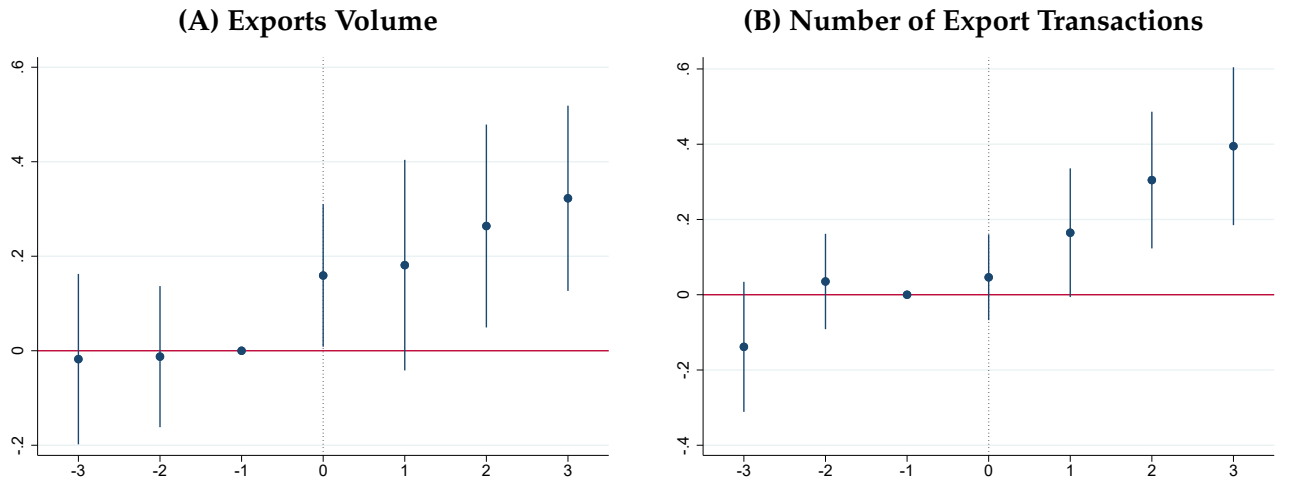

Figure 2. Firm-Destination Exports and the SADC–RTGS. Reported 95% confidence intervals are based on standard errors clustered at the firm × Destination Country × cohort and firm × date × cohort level. All specifications include Firm × Destination Country × Cohort and Year × Continent × Cohort fixed effects as well as time-varying trade partner export demand. Our specification uses Santos Silva and Tenreyro's (2006) Poisson Pseudo-Maximum Likelihood Estimator.

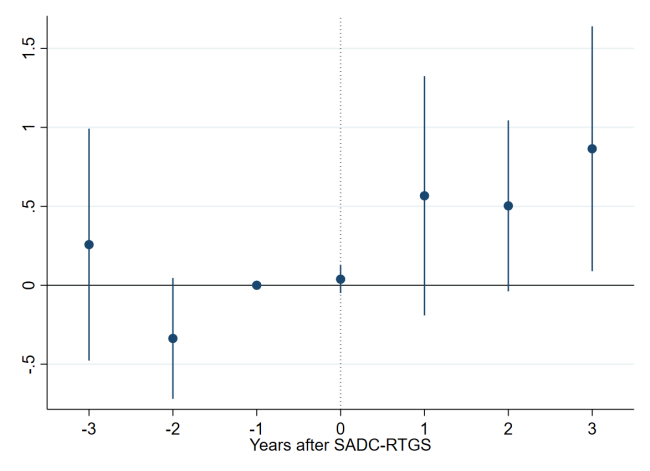

Figure 3. SADC-RTGS and Interbank Assets. Reported 95% confidence intervals are based on standard errors are clustered at the bank-cohort level. The figure displays the dynamic specification of Column 3 from Table 9. The dependent variables are the inverse hyperbolic sine transformation of the original variables. The specification includes origin bank × cohort, country × time × cohort and conglomerate × time × cohort fixed effects.

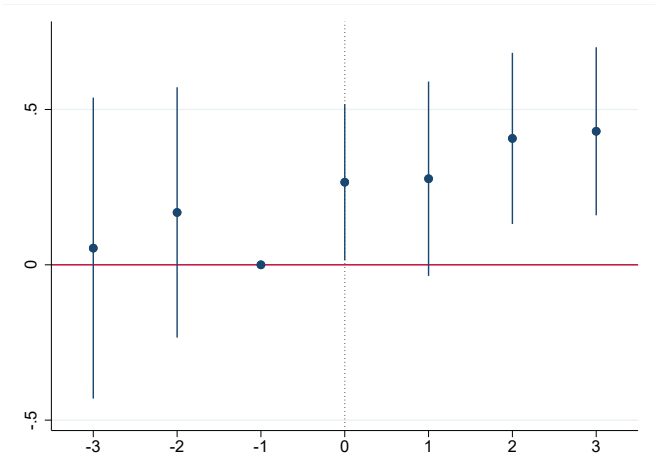

Figure 4. SADC-RTGS at Gravity Estimations. Reported 95% confidence intervals are based on standard errors clustered at the origin country × destination country. All specifications include origin country × cohort and time × cohort fixed effects and pair-specific controls (SACU, SADC-FTA, FTA, Customs Unions, and Contiguous Countries dummies and Log(Distance)). Our specification uses Santos Silva and Tenreyro's (2006) Poisson Pseudo-Maximum Likelihood Estimator.

Tables

Table 1. SADC–RTGS Timeline. This table describes the events that led to the creation of the South African Development Community's Real-Time Gross Settlement payment system.

Date	Event
October 2010	SADC Committee of Central Bank Governors (CCBG) approves undertaking the proof of concept in the CMA region.
April 2013	CCBG approves the legal agreements. CMA Governors sign the agreements.
July 2013	SADC–RTGS goes live in Lesotho, Namibia, South Africa and Swaziland.
April 2014	SADC–RTGS goes live in Malawi, Tanzania, and Zimbabwe.
September 2014	SADC–RTGS goes live in Mauritius and Zambia.
July 2016	SADC–RTGS goes live in Seychelles.
October 2016	SADC–RTGS goes live in Angola, Botswana, and Mozambique.
November 2016	SADC–RTGS goes live in The Democratic Republic of Congo.

Table 2. Summary Statistics. The table reports the mean for each variable for the group in each column in our final stacked sample after the Coarsened Exact Matching procedure using firm sector, size, and TFP. All variables, including information about the control group, are computed at the baseline, i.e., one year before the inclusion in the SADC–RTGS. All variables except for the Exports to Sales Ratio are denoted in millions of ZAR deflated by CPI, with the base year 2012. The *p*-values are adjusted to consider the multiple-hypothesis testing approach as in Clarke, Romano and Wolf (2020) with 5,000 repetitions.

	All Firms (1)	Treated Firms (2)	Control Firms (3)	Mean Difference Test *p*-value (4)
Loans	0.130	0.128	0.135	0.610
Receivables	1.060	0.547	1.936	0.610
Payables	0.598	0.639	0.528	0.341
Capital Stock	0.579	0.486	0.736	0.348
Value Added	1.123	1.174	1.035	0.376
Exports to Sales Ratio	0.040	0.037	0.046	0.230
Exports	0.248	0.193	0.341	0.312
Observations	52,694	33,199	19,495	

Table 3. Firm-Destination Exports and the SADC–RTGS. Standard errors clustered at the firm × destination country × cohort and firm × date × cohort level. Regressions use the matched sample of Coarsened Exact Matching procedure using the firm sector and firm sales. All specifications use Santos Silva and Tenreyro's (2006) Poisson Pseudo-Maximum Likelihood Estimator. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	Exports Volume		Exports Transactions	
	(1)	(2)	(3)	(4)
Post-RTGS	0.326***	0.300***	0.385***	0.374***
	(0.082)	(0.079)	(0.078)	(0.076)
Export Demand	0.643***	0.637***	0.493***	0.483***
	(0.123)	(0.123)	(0.110)	(0.105)
Firm × Cohort FE	✓		✓	
Destination Country × Cohort FE	✓		✓	
Firm × Destination Country × Cohort FE		✓		✓
Year × Continent × Cohort FE	✓	✓	✓	✓
Observations	1,507,450	1,507,389	1,507,552	1,507,491
R^2	0.643	0.873	0.742	0.876

Table 4. Firm-Destination Exports and the SADC–RTGS - Spillover Effects. Standard errors clustered at the firm × destination country × cohort and firm × date × cohort level. Our specification uses Santos Silva and Tenreyro's (2006) Poisson Pseudo-Maximum Likelihood Estimator. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	Exports Volume		Exports Transactions	
	(1)	(2)	(3)	(4)
Post-RTGS	0.363***	0.360***	0.332***	0.360***
	(0.089)	(0.095)	(0.086)	(0.085)
RTGS Firm Spillover	0.077	0.109	–0.061	–0.007
	(0.051)	(0.070)	(0.060)	(0.058)
Export Demand	0.629***	0.628***	0.500***	0.490***
	(0.122)	(0.120)	(0.110)	(0.105)
Firm × Cohort FE	✓		✓	
Destination Country × Cohort FE	✓		✓	
Firm × Destination Country × Cohort FE		✓		✓
Year × Cohort FE	✓	✓	✓	✓
Observations	1,502,029	1,501,968	1,502,131	1,502,070
R^2	0.643	0.873	0.742	0.876

Table 5. Firm-Destination Exports and the SADC–RTGS - The Role of Fast Payments. Standard errors clustered at the firm × destination country × cohort and firm × date × cohort level. Regressions use the matched sample of Coarsened Exact Matching procedure using the firm sector and firm sales. Our specification uses Santos Silva and Tenreyro's (2006) Poisson Pseudo-Maximum Likelihood Estimator. Information from the date of adoption of the Domestic RTGS comes from D'Andrea and Limodio (2023). Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	Exports Volume		Exports Transactions	
	(1)	(2)	(3)	(4)
Post-RTGS	–0.083	0.008	–0.376**	–0.232
	(0.176)	(0.178)	(0.186)	(0.171)
× Domestic RTGS	0.481**	0.383**	0.746***	0.627***
	(0.193)	(0.190)	(0.220)	(0.209)
RTGS Firm Spillover	0.094*	0.122*	–0.039	0.013
	(0.052)	(0.071)	(0.062)	(0.061)
Export Demand	0.657***	0.653***	0.538***	0.521***
	(0.125)	(0.124)	(0.117)	(0.113)
Firm × Cohort FE	✓		✓	
Destination Country × Cohort FE	✓		✓	
Firm × Destination Country × Cohort FE		✓		✓
Year × Continent × Cohort FE	✓	✓	✓	✓
Observations	1,507,389	1,507,389	1,507,491	1,507,491
R^2	0.643	0.873	0.742	0.876

Table 6. Firms' Total Exports and the SADC–RTGS. Standard errors clustered at the firm × sector × date level. *RTGS_Exp* is the exposure variable defined in Equation (3). Regressions use the matched sample of Coarsened Exact Matching procedure using the firm sector and firm sales. Our specification uses Santos Silva and Tenreyro's (2006) Poisson Pseudo-Maximum Likelihood Estimator. High EFD represents sectors with above the median payables (trade credit) to total sales ratio in 2012. High TFP represents firms with above the median TFP in 2012. Big represents firms with above the mean size (sales) in 2012 and Older represents firms with above the median age in 2012. Primary and Services are dummy variables representing firms in the primary and services (including commerce and others) sectors, respectively. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	Total Exports					
	(1)	(2)	(3)	(4)	(5)	(6)
RTGS_Exp	0.096	–0.127	–0.126	–0.163	–0.183*	–0.123
	(0.081)	(0.104)	(0.108)	(0.113)	(0.104)	(0.099)
× High EFD		0.449***	0.449***	0.438***	0.462***	0.459***
		(0.143)	(0.143)	(0.142)	(0.138)	(0.140)
× Big			–0.002			
			(0.077)			
× Older				0.086		
				(0.074)		
× High TFP					0.106	
					(0.142)	
× Primary						–0.006
						(0.131)
× Services						–0.009
						(0.092)
Export Demand	0.072	0.041	0.041	0.046	0.041	0.052
	(0.116)	(0.116)	(0.116)	(0.115)	(0.116)	(0.118)
Firm FE	✓	✓	✓	✓	✓	✓
TFP × Year FE	✓	✓	✓	✓	✓	✓
Sector × Year FE	✓	✓	✓	✓	✓	✓
Observations	40,748	40,748	40,748	40,748	40,748	39,821
R^2	0.926	0.926	0.924	0.924	0.924	0.925

Table 7. Firm-Destination Exports and the SADC–RTGS - Mechanisms. Standard errors clustered at the firm × destination country × cohort and firm × date × cohort level. Regressions use the matched sample of Coarsened Exact Matching procedure using the firm sector and firm sales. Our specification uses Santos Silva and Tenreyro's (2006) Poisson Pseudo-Maximum Likelihood Estimator. Information from the date of adoption of the Domestic RTGS comes from D'Andrea and Limodio (2023). Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	Exports Volume			Exports Transactions		
	(1)	(2)	(3)	(4)		
Post-RTGS	0.021	–0.005	0.020	–0.256	–0.220	–0.241
	(0.178)	(0.179)	(0.178)	(0.174)	(0.174)	(0.175)
× Domestic RTGS	0.419**	0.388**	0.425**	0.693***	0.619***	0.699***
	(0.196)	(0.191)	(0.198)	(0.232)	(0.212)	(0.233)
× Banking Integration	–0.395*		–0.407*	–0.397**		–0.409**
	(0.219)		(0.223)	(0.170)		(0.171)
× Exc. Rates Vol.		–0.001	–0.003		–0.008	–0.010*
		(0.005)	(0.005)		(0.006)	(0.006)
RTGS Firm Spillover	0.118	0.122*	0.119	–0.033	0.005	–0.038
	(0.078)	(0.071)	(0.079)	(0.071)	(0.060)	(0.071)
× Banking Integration	0.033		0.031	0.296*		0.303*
	(0.184)		(0.184)	(0.157)		(0.158)
× Exc. Rates Vol.		–0.000	–0.000		0.001	0.001
		(0.001)	(0.001)		(0.001)	(0.001)
Export Demand	0.676***	0.662***	0.681***	0.599***	0.507***	0.602***
	(0.129)	(0.129)	(0.130)	(0.145)	(0.119)	(0.146)
Firm × Destination Country × Cohort FE	✓	✓	✓	✓	✓	✓
Year × Continent × Cohort FE	✓	✓	✓	✓	✓	✓
Observations	1,457,158	1,457,158	1,457,158	1,457,260	1,457,260	1,457,260
R^2	0.873	0.873	0.873	0.877	0.877	0.877

Table 8. SADC-RTGS Bank Adoption. Standard errors are clustered at the bank and country levels. A multinational conglomerate is a dummy variable that indicates if the conglomerate has at least one subsidiary in a country other than the HQ country. HQ/Foreign Subsidiary RTGS Exposure is a dummy variable indicating that the conglomerate has at least one subsidiary or the HQ in a country that adopts SADC-RTGS at time t. Measures of total assets and operating revenues to asset ratio are standardized. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	SADC-RTGS Participant in 2019			
	(1)	(2)	(3)	(4)
Multinational Conglomerate	–0.131	0.196		
	(0.148)	(0.128)		
HQ/Foreign Subsidiary RTGS Exposure	0.361**	0.361**	0.382**	0.458***
	(0.143)	(0.157)	(0.154)	(0.144)
Total Assets				0.041**
				(0.019)
$\frac{\text{Operating Revenues}}{\text{Total Assets}}$				0.020
				(0.020)
Country FE		✓		
Country × Multinational Cong. FE			✓	✓
Observations	119	119	118	102
R^2	0.111	0.401	0.445	0.519

Table 9. SADC-RTGS Bank Adoption and Interbank Markets. The dependent variables are the inverse hyperbolic sine transformation of the original variables. Standard errors are clustered at the bank-cohort level. A multinational conglomerate is a dummy variable that indicates if the conglomerate has at least one subsidiary in a country other than the HQ country. HQ/Foreign Subsidiary RTGS Exposure is a dummy variable indicating that the conglomerate has at least one subsidiary or the HQ in a country that adopts SADC-RTGS at time t. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	Interbank Assets / T. Assets			Interbank Liabilities / T. Assets		
	(1)	(2)	(3)	(4)	(5)	(6)
Post-RTGS at Country	–0.010			–0.063*		
	(0.042)			(0.037)		
Post-RTGS at Country	0.206***	0.297**	0.503**	0.028	0.005	0.039
× HQ/Foreign Subsidiary RTGS Exposure	(0.079)	(0.137)	(0.248)	(0.068)	(0.094)	(0.160)
Bank × Cohort FE	✓	✓	✓	✓	✓	✓
HQ Country × Year × Cohort FE	✓	✓		✓	✓	
Country × Year × Cohort FE		✓	✓		✓	✓
Conglomerate × Year × Cohort FE			✓			✓
Observations	13,046	12,374	11,174	12,114	11,432	10,306
R^2	0.481	0.544	0.606	0.474	0.541	0.595

Table 10. Gravity Estimations. Standard errors in parenthesis are clustered at the origin country × destination country. Our specification uses Santos Silva and Tenreyro's (2006) Poisson Pseudo-Maximum Likelihood Estimator. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. The last three rows compute the tariff equivalent effect of the SADC–RTGS using different trade elasticities estimates from the literature. The tariff equivalent effects are calculated using $\left[e^{\hat{\beta}_{RTGS}/(\hat{\sigma})} - 1\right] \times 100$.

	Bilateral Trade Flows					
	(1)	(2)	(3)	(4)	(5)	(6)
Post RTGS	0.566**	0.563**	0.469**	0.480**	0.399**	0.457**
	(0.225)	(0.226)	(0.198)	(0.200)	(0.163)	(0.184)
Southern Africa Customs Union	3.216***	3.179***	1.934***	1.852***	1.106***	1.299***
	(0.342)	(0.343)	(0.317)	(0.324)	(0.238)	(0.291)
SADC FTA	0.114	0.112	0.139	0.144	-0.063	0.071
	(0.293)	(0.292)	(0.291)	(0.290)	(0.173)	(0.237)
Customs Union			2.285***	2.282***	0.701***	1.575***
			(0.087)	(0.092)	(0.087)	(0.123)
FTA			0.985***	1.047***	0.287***	0.836***
			(0.101)	(0.109)	(0.050)	(0.095)
Log(Distance)					–0.616***	–0.337***
					(0.029)	(0.040)
Contiguous Countries					0.559***	0.138
					(0.068)	(0.130)
Origin × Time FE	✓	✓	✓	✓	✓	✓
Destination Country × Time FE	✓	✓	✓	✓	✓	✓
Internal Trade		✓		✓		✓
Observations	355,320	357,081	355,320	357,081	355,320	357,081
R^2	0.267	0.264	0.284	0.281	0.296	0.286
Post RTGS Tariff Equivalent						
$\hat{\sigma} = 4$ (Simonovska and Waugh, 2014)	15.2%	15.1%	12.4%	12.7%	10.5%	12.1%
$\hat{\sigma} = 4.55$ (Caliendo and Parro, 2015)	13.2%	13.2%	10.9%	11.1%	9.2%	10.6%
$\hat{\sigma} = 5$ (Baier and Bergstrand, 2007)	12.0%	11.9%	9.8%	10.1%	8.3%	9.6%

Appendix A Additional Results

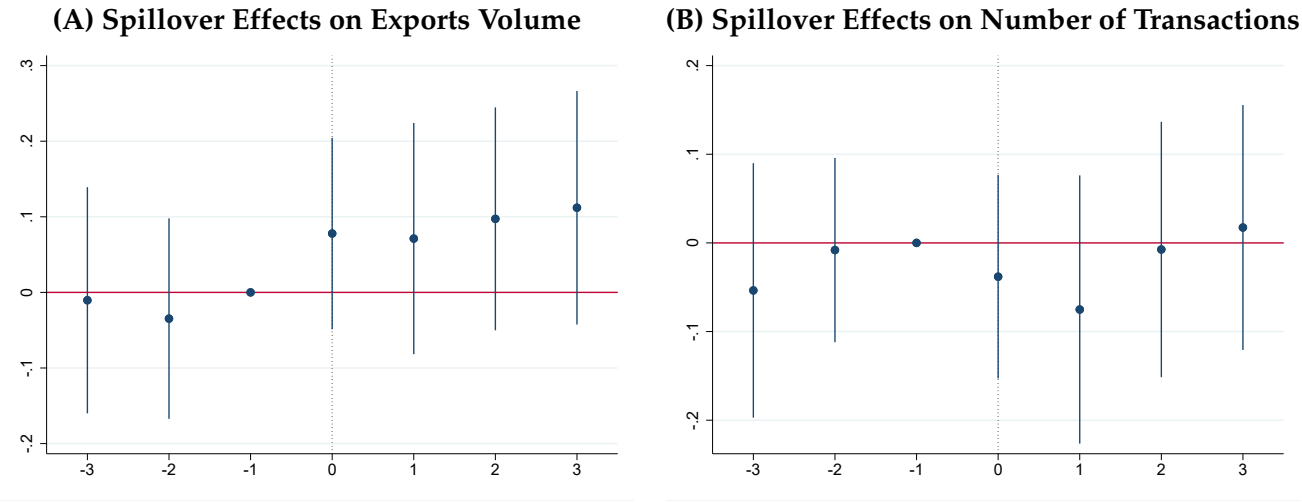

Figure A.1. Firm-Destination Exports and the SADC–RTGS. Reported 90% confidence intervals are based on standard errors clustered at the firm × trade partner × cohort and firm × date × cohort level. All specifications include Firm × Trade Partner × Cohort and Year × Continent × Cohort fixed effects as well as time-varying trade partner export demand. Our specification uses Santos Silva and Tenreyro's (2006) Poisson Pseudo-Maximum Likelihood Estimator.

Table A.1. High-Frequency Identification using Monthly Firm-Destination Exports: Regression Discontinuity Design. Standard errors clustered at the firm × destination country × cohort level. Our specification uses Santos Silva and Tenreyro's (2006) Poisson Pseudo-Maximum Likelihood Estimator. The local linear regression includes a dummy for post-RTGS implementation, time since the cutoff date, squared value of time since the cutoff date, and the interactions between these two variables and the post-SADC–RTGS implementation dummy. Each pair of columns estimates separate regressions for the different windows around the implementation date represented in months, as indicated in their title. The controls include demand export and Firm × destination country fixed effects. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

	Bandwidth (-2,2)		Bandwidth (-3,3)		Bandwidth (-4,4) **Opt. Band. Exp. Vol.**		Bandwidth (-5,5) **Opt. Band. Exp. Trans.**	
	Exp. Volume	Exp. Trans.	Exp. Volume	Exp. Trans.	Exp. Volume	Exp. Trans.	Exp. Volume	Exp. Trans.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Post-RTGS	0.114*	0.173***	0.127	0.279***	0.197**	0.258***	0.115*	0.143***
	(0.066)	(0.041)	(0.144)	(0.100)	(0.094)	(0.041)	(0.066)	(0.030)
Firm × Destination FE	✓	✓	✓	✓	✓	✓	✓	✓
Observations	92,267	92,267	143,030	143,030	192,187	192,187	246,929	246,929
R^2	0.842	0.847	0.825	0.841	0.821	0.838	0.811	0.837

Table A.2. Firm-Destination Exports and the SADC–RTGS: Non-Matched Sample. Standard errors clustered at the firm × destination country × cohort and firm × date × cohort level. Regressions use the matched sample of Coarsened Exact Matching procedure using the firm sector and firm sales. Our specification uses Santos Silva and Tenreyro's (2006) Poisson Pseudo-Maximum Likelihood Estimator. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	Exports Volume		Exports Transactions	
	(1)	(2)	(3)	(4)
Post-RTGS	0.316***	0.332***	0.379***	0.354***
	(0.078)	(0.080)	(0.077)	(0.081)
Export Demand	0.606***	0.600***	0.453***	0.433***
	(0.125)	(0.125)	(0.105)	(0.113)
Firm × Cohort FE	✓		✓	
Destination Country × Cohort FE	✓		✓	
Firm × Destination Country × Cohort FE		✓		✓
Year × Cohort FE	✓	✓	✓	✓
Observations	1,562,916	1,562,978	1,563,020	1,563,082
R^2	0.883	0.672	0.875	0.743

Table A.3. Firm-Destination Exports and the SADC–RTGS: Only African Trade Partners as Controls. Standard errors clustered at the firm × trade partner × cohort and firm × date × cohort level. Regressions use the matched sample of Coarsened Exact Matching procedure using the firm sector and firm sales. Our specification uses Santos Silva and Tenreyro's (2006) Poisson Pseudo-Maximum Likelihood Estimator. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	Exports Volume		Exports Transactions	
	(1)	(2)	(3)	(4)
Post-RTGS	0.223***	0.220***	0.384***	0.381***
	(0.079)	(0.080)	(0.077)	(0.078)
Export Demand	0.176*	0.178*	0.469***	0.477***
	(0.103)	(0.104)	(0.122)	(0.118)
Firm × Cohort FE	✓		✓	
Destination Country × Cohort FE	✓		✓	
Firm × Destination Country × Cohort FE		✓		✓
Year × Cohort FE	✓	✓	✓	✓
Observations	707,374	707,318	707,409	707,353
R^2	0.663	0.813	0.812	0.890

Table A.4. Firms Total Exports' Destinations and Products and the SADC–RTGS. Standard errors clustered at the firm × sector × date level. *RTGS_Exp* is the exposure variable defined in Equation (3). Regressions use the matched sample of Coarsened Exact Matching procedure using the firm sector and firm sales. Our specification uses Santos Silva and Tenreyro's (2006) Poisson Pseudo-Maximum Likelihood Estimator. High EFD represents sectors with above the median payables (trade credit) to total sales ratio in 2012. High TFP represents firms with above the median TFP in 2012. Big represents firms with above the mean size (sales) in 2012 and Older represents firms with above the median age in 2012. Primary and Services are dummy variables representing firms in the primary and services (including commerce and others) sectors, respectively. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

	Destinations		Destination-HS6 Products		Destination-HS4 Products	
	(1)	(2)	(3)	(4)	(5)	(6)
RTGS_Exp	–0.015	–0.014	0.032	0.070*	0.024	0.060
	(0.019)	(0.020)	(0.031)	(0.040)	(0.029)	(0.037)
× High EFD		–0.002		–0.082		–0.077
		(0.036)		(0.056)		(0.051)
Export Demand	–0.006	–0.006	0.121*	0.123*	0.093	0.095
	(0.034)	(0.034)	(0.067)	(0.067)	(0.059)	(0.059)
Firm FE	✓	✓	✓	✓	✓	✓
TFP × Year FE	✓	✓	✓	✓	✓	✓
Sector × Year FE	✓	✓	✓	✓	✓	✓
Observations	40,895	40,895	40,866	40,866	40,866	40,866
R^2	0.308	0.308	0.780	0.780	0.730	0.730

Table A.5. Predictors of SADC–RTGS Timing. Robust Standard Errors. All predictors are the standardized original variable at the entry year. The control group for each regression is comprised of trade pairs treated afterward. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

	SADC-RTGS in 2013	SADC-RTGS in 2014
	(1)	(2)
Pair Specific Characteristics		
Previous Year Bilateral Trade flows (1,000 Current USD)	-0.903	3.364
	(0.918)	(2.230)
Time Difference (hours)	0.048	0.144
	(0.168)	(0.368)
Distance (1,000 km)	-0.264	0.312
	(0.211)	(0.338)
Origin Specific Characteristics		
Origin Time to start a business (days)	0.016	0.054
	(0.028)	(0.047)
Origin GDP, PPP (1,000 Current USD)	0.328	0.744
	(0.416)	(0.461)
Origin Trade flows (1,000 Current USD)	1.372	-4.251*
	(1.243)	(2.560)
Destination FE	✓	✓
Observations	133	121
R^2	0.309	0.519

Table A.6. Predictors of SADC–RTGS timing: South African Trade Partners. Robust Standard errors. All predictors are the standardized original variable at the entry year. The control group for each regression is comprised of trade pairs treated afterward. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

	SADC-RTGS in 2013	SADC-RTGS in 2014
	(1)	(2)
One year lag bilateral trade	-0.415	-2.225
	(0.962)	(1.466)
Time Difference (hours)	0.959	-0.188
	(1.310)	(3.166)
Distance (1,000 km)	-1.665	-1.662
	(1.394)	(3.599)
Destination Time required to start a business (days)	0.109	-0.057
	(0.187)	(0.305)
Observations	13	10
R^2	0.281	0.289

Appendix B Export Demand

Our main goal is to identify the effect of financial integration on international trade in South Africa. Despite the empirical design and the inclusion of the control variables described in Section 3.2, there is still a concern that our estimates can be contaminated by the presence of additional country-specific shocks that are relevant both for our dependent variables and our measure of exposure to the SADC–RTGS system. One potential issue would be the existence of trade-partner-specific demand shocks that are also correlated with the country's participation in the SADC–RTGS.

We address this potential confounding factor and estimate a trade-partner-specific component that captures year-by-year aggregated shocks to the country's demand for global exports. The idea is that this measure can capture the overall changes in the country's demand for global exports, excluding trade with South Africa.

Following a similar strategy as Costa, Garred and Pessoa (2016), we estimate an auxiliary regression, using aggregated bilateral trade data between 2010 and 2019 (cf. the discussion in Section 3.1), and excluding South Africa. Specifically, the estimated model is:

$$X_{ijt} = \alpha + \Sigma\delta_{it} \cdot \mathbb{1}(\text{Importer} = i) \cdot \mathbb{1}(\text{Year} = t) + \gamma_{ij} + \epsilon_{ijt}$$

where X_{ijt} is the volume of trade between importer i, and exporter j in year t. γ_{ij} represents a set of country-pair dummy variables that capture the time-invariant pair-specific determinants of bilateral trade, such as distance, common language, and contiguity. Our coefficient of interest is δ_{it}, obtained from the interaction between an importer-specific dummy and a year-specific dummy variable. This means that the importer-year-specific coefficients represent the average deviations in bilateral trade of that country's imports in any given year, excluding trade with South Africa. We refer to the estimates $\hat{\delta}_{it}$ as the export demand component and include it as a control variable in our specifications to control for the trade-partner-specific demand shocks.