EUROPEAN CENTRAL BANK

EUROSYSTEM

Working Paper Series

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Interlinking payment systems and trade flows

No 3202

Abstract

This paper provides the first causal estimate of the economic impact of interlinking payment systems across countries. We exploit a new dataset of payment systems interlinking initiatives, which identifies over 2,000 connections, and employ standard gravity methods to estimate their impact on trade flows. Consistent with trade costs theory, we find that inter-connected countries have around 4% higher trade volumes, roughly half the effect of a trade agreement and a quarter of the effect of a common currency area. Our results isolate the average effect on trade, of directly connecting fast payment systems, net of country pairs already accessing the correspondent banking network. The estimated impact is larger for payment systems that allow wholesale transactions, those that link small countries, which, typically, are less connected to the correspondent banking network, and for geographical areas that face high cross-border payment costs. This suggests that the benefits from interlinking are derived from reduced cross-border trade costs. Our findings are causal – proved by parametric and semi-parametric estimators – and robust to numerous additional controls, including exclusion of the largest interlinked country group, the euro area.

Keywords: Trade, interlinking, fast payment systems

JEL Codes: E42, F15, F30

Non-technical summary

Payment systems play a critical role in the global economy by enabling smooth exchanges of money and settlement of transactions. These systems are often considered as the "plumbing" aspect of the financial infrastructure and are the pillars of international trade and financial flows. Payment systems have been central to policy debate following the exclusion of Russian banks from the SWIFT payment system and the announcement that the BRICS+ countries are working on alternatives to western-based payment networks (European Central Bank, June 2025).

However, debate on payment systems is not being driven solely by geopolitical considerations. International payments are notoriously slow and expensive, with fees, in some regions of Africa, that can reach more than 15% of the transacted amount (Committee on Payments and Market Infrastructure, 2024). These limitations hamper trade and economic development in the poorest regions of the world in particular. To try to resolve these issues, in 2020, the G20 countries introduced a roadmap to improve cross-border payments. An important aspect of this roadmap is the development and interlinking of fast payment systems, that is, payment systems that allow settlement of transactions within seconds.[1] Policymakers argue that interlinking payment systems would reduce costs and increase the speed of cross-border payments, which would improve financial inclusion and reduce trade-related and remittances costs.

Despite its increasing relevance in policy debate, the benefits of interlinking remain largely unquantified. This paper aims to fill this gap by offering the first comprehensive evidence on the global impact on international trade flows of interlinking payment systems. It exploits a new dataset provided by Ferrari Minesso et al. (2025), which maps over 2,000 payment system connections, combined with bilateral trade flows, for more than 150 countries, on an annual basis for the period 2021-2024. The paper estimates that trade among countries with interlinked payment systems is approximately 4% higher than for non-linked countries. This is an economically meaningful effect that amounts to roughly half of the trade increase typically associated with a trade agreement and around one-quarter of the effect of being part of a common currency. Importantly, the analysis isolates the impact on trade of interlinking fast payment systems beyond the ability to exchange payments through alternative channels, such as correspondent banking.

In line with the hypothesis that interlinking reduces trade costs, the positive effects of interlinking are particularly pronounced for small countries and regions where, traditionally, cross-border payments are slower and more expensive. Similarly, payment systems that support wholesale transactions yield the highest trade benefits. These findings suggest that interlinking reduces trade costs,

[1] The Eurosystem is fully committed to the development of the G20 roadmap and, in line with its goals, is exploring several interlinking possibilities related to the Eurosystem fast payment system, TIPS.

especially in areas with less developed financial infrastructures.

The gravity model – the standard workhorse model in trade economics – is the baseline model employed in this paper. The results derived from the baseline model are confirmed when using alternative advanced statistical methods such as parametric bias-correction methods and semi-parametric synthetic difference-in-differences. Also, the results remain robust across different scenarios, such as excluding the euro area – the largest interconnected region globally.

This research offers policymakers valuable insights into the economic benefits of interlinking payment systems and its role in promoting trade and financial integration globally. From a policy perspective, the results underline the importance of initiatives aimed at improving cross-border payment systems, such as the Eurosystem's TIPS and other global efforts.

1 Introduction

Payment systems have for long been considered the backbone of the financial infrastructure—that is, the critical "plumbing" supporting the functioning of modern economies by enabling transaction clearing and settlement (Kahn and Roberds, 2009; Portes, 2008). While this metaphor highlights the systemic importance of payment systems, it simultaneously obscures their potential as a source of economic transformation and policy leverage. In recent years, the focus on payment systems has increased, and, in particular, their cross-border dimension. Since 2021, several countries and institutions (including the Eurosystem, the Bank for International Settlements, Brazil, India and China) have implemented innovative cross-border payment interlinking initiatives.[2] Also, exclusion from cross-border payment systems has been used as a major tool of geo-economic coercion, for example, against Iran and Russia. Perhaps for these reasons, cross-border payments are once more at the top of the agenda of global leaders, so much so, that, increasingly, payment systems are mentioned in the communiqués of the G7 and BRICS leaders (Chari et al., 2025). Many of these initiatives are motivated by the assumption that improvement to (or exclusion from) cross-border payment systems reduces (increases) the costs of sending money between countries, decreases global transaction costs, and facilitates international trade. However, the literature on the broader implications of improving payment systems remains limited and, to the best of our knowledge, there are no estimates of the global economic impact of payment system interlinking. The existing literature has focused either on case studies (Mariani et al., 2024), exclusions from payment systems like SWIFT as the result of sanctions (Cipriani et al., 2023), or retrenchments of global banking (Rice et al., 2020). The aim of the present paper is to fill that gap and provide a quantification of the trade benefits derived from cross-country interlinking of payment systems.

One of the reasons for wanting to interlink payment systems is that cross-border payments are notoriously slow and expensive and, in most cases, rely on correspondent banking relations. For example, the average global cost of sending remittances is around 6%, while Small and Medium-sized Enterprises (SMEs) in emerging market economies face substantial delays and significant fees when paying suppliers or receiving payments abroad (Cipollone, 2025).[3] The fragmentation of

[2] On 21 October 2024, the Eurosystem announced its plan to implement a cross-currency settlement service in TIPS (the Eurosystem's fast payment system) in Swedish kronor and Danish krone. It announced, also, that it was undertaking exploratory investigation into linking TIPS with other fast payment systems (Nexus and UPI), see Eurosystem launches initiatives to improve cross-border payments by interlinking fast payment systems. In 2022, the Bank for International Settlements initiated Project Nexus, which aims to connect multiple domestic instant payment systems into a single, interoperable cross-border network. Since 2020, Brazil and India have both interlinked their domestic fast payment systems (Pix and UPI) to several countries in their regions (Ferrari Minesso et al., 2025), while China is implementing plans to expand the reach of its domestic payment infrastructure (CIPS) and interlink with other countries, see European Central Bank (June 2025). New payment initiatives are underway also in Africa (Ferrari Minesso et al., 2025).

[3] E.g., the cost to small firms of a €5,000 transfer within Western Balkans is estimated to be approximately 10

payment systems across jurisdictions and the reliance on a limited number of correspondent banks[4] amplify these inefficiencies (Rice et al., 2020). These problems have for long been recognized by the international policy community. The G20 response, in the form of its Roadmap for Enhancing Cross-Border Payments, has made the interlinking domestic payment systems—and particularly Fast Payment Systems (FPS)—a strategic priority to make payments "faster, cheaper, more transparent, and more inclusive" (Committee on Payments and Market Infrastructure, 2024). These interlinking efforts are expected to generate significant welfare gains by reducing the transaction costs for individuals, firms and financial intermediaries and facilitating cross-border trade and investment.

From an economic perspective, the interlinking of payment systems is more than a technical coordination exercise; it entails the reconfiguration of cross-border financial infrastructures, with potentially, far-reaching economic and geopolitical consequences. Some recent studies emphasize that payment networks are not merely operational backbones, they are also strategic assets that shape international monetary and trade relations (Clayton et al., 2023). The ability to clear and settle transactions efficiently affects asset liquidity (Coppola et al., 2023), trade transaction costs (Devereux and Shi, 2013; Rey, 2001), the resilience of global value chains to shocks (Gopinath et al., 2020) and incentives for invoicing currency choices, (Gopinath and Stein, 2018). These factors explain why geopolitical considerations have been shown to be a strong driver of payment systems interlinking initiatives (Ferrari Minesso et al., 2025) and why payment systems have been used as sanction tools (Cipriani et al., 2023).

However, the academic literature sheds little light on whether connecting payment systems actually improves economic outcomes. The costs related to existing payment infrastructures, for example the fees linked to correspondent banking and exchange rate conversions, are well documented (Committee on Payments and Market Infrastructure, 2024). Some argue that these fees stem mostly from inefficiencies in the domestic payment infrastructure or conflicting payer and payee preferences on issues such as speed and settlement finalities (Waller, 2024). In these cases, interlinking payment systems would provide little economic benefit and would not justify the related economic and political efforts. At the same time, there are others who argue that exclusion from existing payment systems has a negative effect on trade and production (Borchert et al., 2024; Rice et al., 2020). However, these "negative" results capture the costs of the exclusion from the correspondent banking network, but it is not clear whether or if they would apply symmetrically were countries to join a payment network *in addition* to correspondent banking.

times more than the cost of the same transaction within the Single Euro Payments Area (SEPA), while sending remittances to Sub-Saharan Africa costs almost 8% of the transaction on average.

[4] Correspondent banks are international banks that offer cross-border payment services and allow payment flows to bridge across jurisdictions.

This paper investigates this question from an empirical perspective. We focus primarily on the interlinks between FPS, that is, payment systems that allow settlement in a few seconds, since these represent the frontier of an improved payment infrastructure.[5] More than 100 jurisdictions have already introduced such systems and this network continues to expand at pace (Frost et al., 2024). While initially designed for domestic use, due to their similar technical features across countries, FPS are increasingly being connected across borders through bilateral and multilateral arrangements.[6] By reducing reliance on intermediary banks, interlinked FPS could substantially decrease settlement times and costs, and improve transparency and reliability. Depending on the configuration, interlinking might also make foreign exchange (FX) transactions more efficient and might reduce exchange rate costs. Interlinking might, potentially, strengthen trade integration, especially among small economies and developing markets that, historically, have been excluded from efficient payment channels.

We use a newly constructed dataset of 84 countries and 531 payment links, provided by Ferrari Minesso et al. (2025), to examine the relationship between establishment of cross-border FPS links and bilateral trade flows. Our empirical strategy builds on the gravity model tradition; we control for standard trade determinants and incorporate novel technical and geopolitical proximity measures. To address potential endogeneity concerns—such as the possibility that trade itself makes interlinking more likely—we employ both a bias correction method (Carlson and Joshi, 2024), and a recently proposed Synthetic Difference-In-Differences (SDID) setup (Arkhangelsky et al., 2021).

Our findings indicate that the interlinking of FPS has a positive and economically significant impact on bilateral trade. The estimated effect of about 4% is roughly half the effect derived from a formal trade agreement and a quarter of the effect of a common currency area, suggesting that payment connectivity is quantitatively important for shaping cross-border economic integration. In contrast to existing studies, this estimate does not rely on specific case studies, but averages across all interlinking initiatives, including those promoted by regions already well connected by global banking (the euro area and South-East Asia). This further highlights the benefits for trade of interlinking payment systems for countries with already access to global markets through correspondent banks. Perhaps for these reasons, our average estimate is lower than that suggested by Mariani et al. (2024), which estimates trade increases of up to 30% resulting from connecting payment systems in South Africa. When we examine the heterogeneity in our sample, we find that

[5]Results are robust to the inclusion of both fast and non-fast payment system connections.

[6]These initiatives—e.g. the linkage between Singapore's PayNow and Thailand's PromptPay—aim to allow users in one jurisdiction to make payments directly to beneficiaries in another jurisdiction, via their existing domestic payment channels. Quasi-immediate settlements simplify interlinking as positions are immediately closed between the two sides of the payment. In addition, many of these systems operate under similar messaging standards, which eases the exchange of payment messages.

our results are driven by those payment systems that allow both wholesale and retail payments, and that the benefits from interlinking are larger for smaller countries and countries located in geographical areas where cross-border payments are more expensive. This evidence suggest that interlinking acts to reduce fixed trade costs since under-served countries can use interlinking as an alternative to existing expensive payment means. In addition, the effects are potentially non-linear for countries not currently benefiting from correspondent banking relations. Our findings remain robust to alternative specifications and the inclusion of controls for financial, technological, and political proximity to our baseline empirical specification.

The policy implications of our findings are substantial. First, they validate ongoing international efforts to interconnect national payment systems as part of the G20 Roadmap and confirm that these initiatives yield both tangible trade benefits as well as financial inclusion objectives. Second, they highlight the need for multilateral coordination to ensure interoperability of technical standards—similar to the ISO 20022 messaging framework—and address the legal and regulatory barriers that currently prevent seamless cross-border settlements. This should facilitate trade, increase global welfare and counter the diffusion of unregulated payment tokens, such as stablecoins, which are beyond Anti-Money Laundering (AML) and Countering Financial Terrorism (CFT) controls. Finally, they underline that, as the world's financial plumbing evolves, the geography of trade, finance and even geopolitical influence will be shaped increasingly by the interlinked payment system architecture.

A primer on the plumbing of cross-border payments. Before proceeding with the analysis, it is worth recalling how cross-border payments are typically cleared. The vast majority of international transactions are settled through so-called correspondent banking arrangements (Rice et al., 2020). A correspondent bank is a credit institution that holds deposits on behalf of other (respondent) banks and provides them with payment and settlement services. Correspondent banks tend to be large, globally active and to act as intermediaries for smaller credit institutions that need to process cross-border payments, but do not maintain direct bilateral deposit accounts. Since local banks generally do not hold accounts in the banks of all of the countries in which their client firms operate, correspondent banking relationships underpin international trade and financial flows. In the absence of direct links, cross-border transactions are routed through a network of correspondent banks: the originating bank transfers funds to its correspondent bank, which then forwards these funds to the recipient bank. This chain can involve multiple correspondents, since the correspondent bank of the originating institution may not necessarily maintain an account relationship with the final recipient. Transactions can also require currency conversion, with the US dollar frequently used as the vehicle currency, and typically are cleared through large clearing institutions, most notably US CHIPS[7] which accounts for over 97% of global dollar payments. Because each correspondent charges a fee and currency conversions entail hedging costs, in many cases, correspondent banking transactions are expensive. In addition, payments can be slow, since each of the banks in the chain must conduct AML and CFT checks and operating hours across institutions may not be aligned.

An alternative to correspondent banking is domestic payment systems interlinking. This can take different technical forms (Committee on Payments and Market Infrastructure, 2023), including single platforms or bilateral links, but in essence allows the payment systems of sending and receiving countries to settle transactions directly with one another. In this framework, the sending bank transfers funds to its domestic payment system, which, through the interlinking arrangement, transmits the payment to the receiving country's payment system and, ultimately, credits the recipient bank. This reduces both reliance on correspondent banks – as only one instead of many correspondent banking steps is needed – and their associated fees; in some cases, the interlinking platform can also handle currency conversions. In particular, by facilitating cross-border transactions, interlinking can benefit regions that are underserved or excluded from correspondent banking networks. Finally, FPS can enable settlement within seconds of payment initiation. Interlinking such systems could reduce both the cost and speed of cross-border payments, since funds would become immediately available to the receiving bank. In this paper, we quantify the impact on trade of connecting two payment systems, even conditional on the pre-existing availability of correspondent banking arrangements.

Related literature. This paper aims to contribute to the literature on the determinants of international trade. Since its introduction by Tinbergen (1962), the gravity model has been the empirical international trade literature's workhorse, providing a robust framework for the analysis of bilateral trade flows (Baldwin and Taglioni, 2006). Since the strength of the attraction between two physical objects depends on their size and relative distance, the model shows that economic size (commonly proxied by GDP) and geographical distance are central determinants of trade, with additional factors, such as shared border, common language, colonial history and cultural or religious ties, further enhancing its explanatory power. Over time, the gravity model has been enriched to capture the effects of institutional and policy variables, including currency unions (Rose, 2000), World Trade Organization membership (Rose, 2004), and trade agreements (Martin et al., 2008, 2012). More recently, the model has included geopolitical factors (Eichengreen et al.,

[7]CHIPS (Clearing House Interbank Payments System) is the largest US wholesale payment system for US dollar transactions, processing high-value domestic and cross-border payments among major financial institutions and settling them on a net basis through accounts at the Federal Reserve. The Eurosystem's T2 is another clearing platform, which processes large euro transactions involving euro area correspondent banks. China has also developed its own clearing systems, CIPS, which still relies on Swift for messaging and lags significantly behind CHIPS in terms of volumes (European Central Bank, June 2025).

2021; Gopinath et al., 2025) while the importance of distance has been revisited in the context of trade volatility and financial transactions (Mehl et al., 2024). Building on this rich tradition, our paper introduces another dimension to the gravity model by examining the role of payment system connectivity in shaping international trade flows, thereby providing new insights into the interplay between financial infrastructures and trade.

Despite strong evidence that gravity factors influence trade, there are few quantitative estimates of how payment systems, the "plumbing" of the international monetary system, affect trade flows. Rice et al. (2020) documents the retrenchment of the correspondent banking network and its effects on aggregate flows. Borchert et al. (2024) uses the same data to show that firms that lose correspondent banking relations are less likely to export while Mariani et al. (2024) examines the case of the integration of payment systems in South Africa and shows that this boosts bilateral trade among member countries. Finally, sanctions imposed on Iran and on Russia after its invasion of Ukraine have worked as a natural experiment to test the implications for trade flows of restrictions on payment systems (Berthou, 2023; Cipriani et al., 2023; Crozet and Hinz, 2020; Imbs and Pauwels, 2024). The present paper contributes by presenting an empirical quantification of the influence of interlinking payment systems on trade. In contrast to previous research that examines specific case studies, our paper considers all existing interlinks and tries to unpack the determinants of their impact on trade. We leverage on a unique new dataset of payment systems interlinks provided by Ferrari Minesso et al. (2025) to extend the standard gravity model and show the global effects of interlinking on cross-country trade flows.

The findings in Ferrari Minesso et al. (2025) suggest that the decision to interlink payment systems might be endogenous. For example, countries might interlink due to strong economic ties, historical linkages or similar geo-economic preferences. While these factors might be absorbed by the rich set of fixed effects employed in the gravity estimation framework (in the spirit of Wooldridge (2010)'s "selection on observable approach"), we go one step further by applying state-of-the-art econometric techniques to prove the causality of our estimate. First, to account for potential endogeneity of trade to payment system interlinking choice, we rely on the parametric correction method proposed by Carlson and Joshi (2024) and Carlson (2024). Second, we employ a semi-parametric approach by adopting the new SDID estimator developed by Arkhangelsky et al. (2021). Our results are robust to both estimation approaches.

The rest of the paper is organised as follows. Section 2 describes the data and methodology. Section 3 reports the baseline results; Section 4 provides some robustness and endogeneity checks. Section 5 explores the channels. Section 6 concludes.

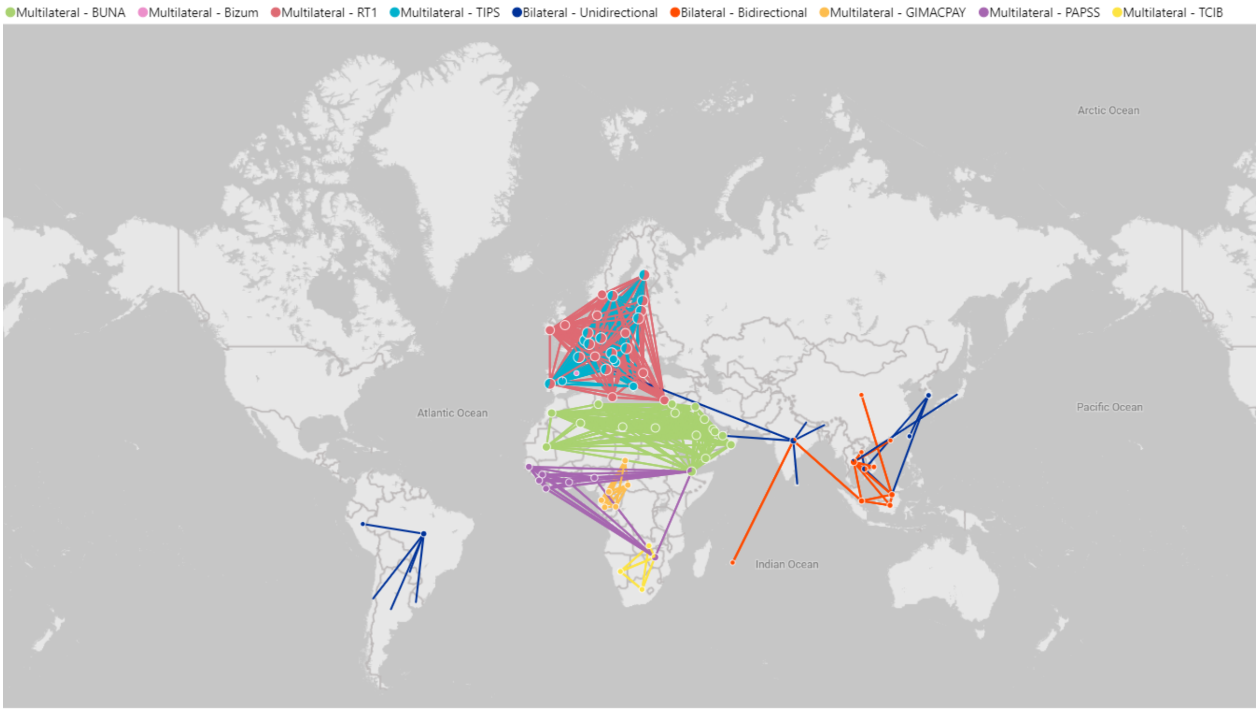
2 Data and methodology

2.1 Data sources and coverage

Our analysis is based on annual data from 2021 to 2024. We focus on this period because, before 2021 (since 2017), interlinked payment systems were limited to the euro area. Considering an earlier period would imply, *de facto*, comparing intra-euro area trade between 2017 and 2021 with rest of the world trade, which would severely confound the estimation coefficient.[8] Data are from multiple sources, as detailed below.

Payment systems interlinkages. Data on interlinked FPS are from Ferrari Minesso et al. (2025). The dataset covers 531 fast payment links among 84 countries, the main focus in this paper.

Figure 1: Map of cross-border connections of fast payment systems



Notes: Figure 1 depicts cross-border fast payment systems connections in 2024. It represents both dyadic bilateral connections, split between unidirectional and bidirectional (depending on the currencies enabled to originate a payment through the link) and multilateral connections, represented as dyads and coloured by regional platform. Source: Ferrari Minesso et al. (2025).

Figure 1 is a map of the FPS connections in 2024; Figure B.1 depicts the evolution of payment links across time. Three stylised facts emerge. First, the global FPS network is fragmented across regional blocs. These blocs are not connected to each other, due, in part, to geopolitical factors (Ferrari Minesso et al., 2025). Africa stands out with multiple alternative FPS networks

[8]Starting in 2021 has the advantage, also, of excluding 2020 when trade collapsed during the Covid-19 pandemic.

with limited connections to each other. When payment networks are fragmented, correspondent banks remain the main facilitator of cross-border payments. Second, typically, regional payment networks are centred around successful domestic fast payment initiatives. India's UPI and Brazil's PIX serve as hubs for their respective regional payments networks. The network in the euro area is built around TIPS and SEPA. In Africa, policy initiatives have shaped developments, with the two largest payment initiatives (Buna and PAPSS) both the result of efforts by local multilateral institutions. Some regions, like North America, are instead completely disconnected. In that case, there are several reasons why it has not yet interlinked. These include the fact that the US hosts the world's largest clearing house, CHIPS,[9] which is at the core of the correspondent banking network and has few domestic incentives to develop alternatives to it. Also, the North American FPS are new, have been recently developed in the US (FedNow, the Fed's FPS, was launched in 2023) or being under development in Canada. Third, trade is stronger between connected county pairs. A simple average of trade flow growth indicates that, among connected countries, trade generally is high (see Figure B.2 in the Appendix), although this measure does not control for observable or unobservable characteristics, nor for idiosyncratic shocks.

Trade flows. Trade flow data are from Trade Data Monitor (TDM) and cover aggregate bilateral trade among 243 countries and regions (defined as locations with an ISO3 code). We opted for a non-public dataset due to its higher coverage of the most recent years, which is particularly important given the short time span of our analysis.[10]

Gravity variables. The gravity model variables (e.g., Free Trade Agreements -FTAs-, geographical distance) are from the CEPII Gravity Database (Conte et al., 2022). The FTA variable was updated manually using information from the World Trade Organization website.

Currency unions and political distance. The currency union dummy is based on Lebastard (2017) and was subsequently updated by the authors; the geopolitical distance proxy is the deal point distance measure in Bailey et al. (2017).

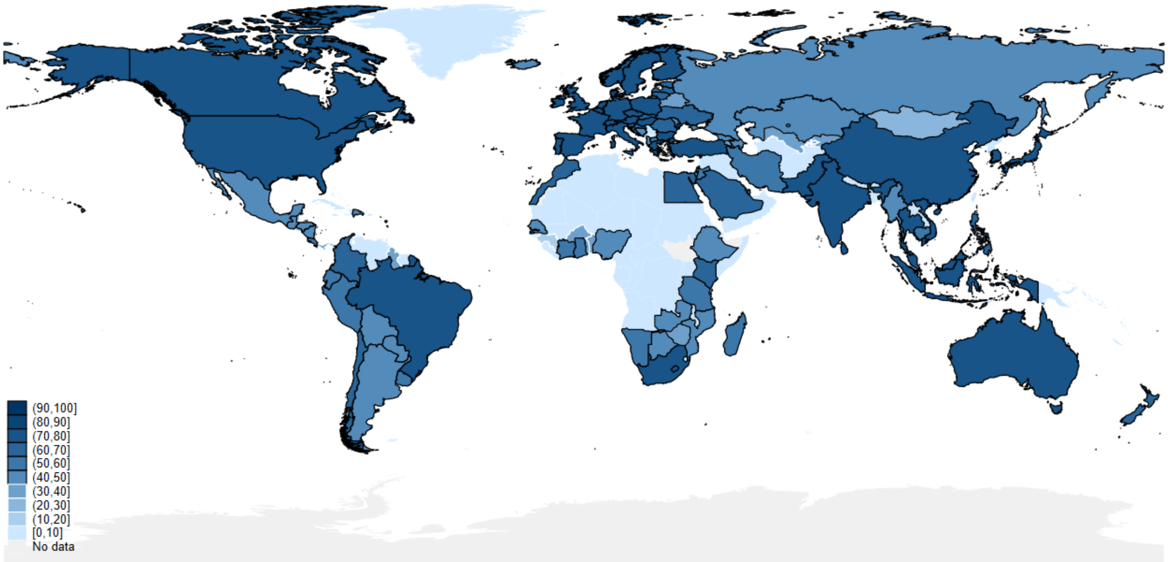
Figure 2 shows the data coverage across countries, where darker blue shading corresponds to a larger number of observations. As expected, advanced economies account for most of the sample. However, we also have complete coverage for some important emerging market economies such as China, India and Brazil. In our case, India and Brazil are particularly important as they have

[9]CHIPS is the US-based payment system used by banks to send and settle large-value payments in US dollars. It is operated by the Clearing House and is used widely for both domestic and international transactions. CHIPS is especially important for cross-border payments because many international transactions are denominated in US dollars and must pass through the US banking system to be settled. By using netting, CHIPS allows banks to settle payments efficiently while reducing liquidity needs and risk. This makes cross-border dollar payments faster, safer, and more reliable.

[10]For example, BACI from CEPII has an additional year of lag compared to TDM.

developed successful domestic FPS which serve as central nodes for interlinking initiatives in their respective regions.

Figure 2: Data coverage



Notes: Figure 2 depicts data coverage for each country as the share of complete observation units, i.e., the share of observation units with no missing data. The maximum number of observation units for each country is the number of potential trading partners (188) multiplied by the number of years covered in the dataset (4).

2.2 Empirical framework

Our empirical strategy builds on three methodologies: (i) the gravity model, (ii) the bias-correction method, and (iii) the synthetic difference-in-differences. First, we use the standard gravity model (i), extended to include a dummy for country pairs with interlinked payment systems. This variable is our main variable of interest throughout the paper. Since the gravity model is a pillar of trade economics, it seems sensible to use it as the baseline specification. However, it could be argued that connecting payment systems is endogenous to trade; Ferrari Minesso et al. (2025) shows that bilateral trade flows are correlated to the likelihood that two countries interlink their FPS. Although Ferrari Minesso et al. (2025) is not causal on trade, and the rich set of fixed effects deployed in a standard gravity regression should account for unobservable factors, that is, *selection on observables*[11] (Heckman and Robb Jr, 1985; Moffitt, 1996; Wooldridge, 2010), endogeneity cannot be excluded. For this reason, we rely on recent advances in the empirical policy evaluation literature and apply the parametric bias-correction method (ii) proposed by Carlson and Joshi (2024). By instrumenting the treatment dummy, this procedure corrects for endogeneity of treatment selection

[11]This approach relies on the "*ignorability of treatment*" assumption (given observed covariates) in Rosenbaum and Rubin (1983) which states that conditional on observables x, the treatment variable is independent of the treated and non-treated units. By controlling for *all* observables that jointly determine treatment and outcome, the econometrician can retrieve the average treatment effect by regressing the treatment variable on the outcomes.

(connecting payment systems). Our instruments are based on the data in Ferrari Minesso et al. (2025) and use domestic payment system characteristics (payment messaging standards, settlement asset used, domestic volumes of fast payments) relevant to interlinking decisions, but exogenous to bilateral trade flows.[12] As an additional robustness exercise, (*iii*) we use a recent semi-parametric method proposed by Arkhangelsky et al. (2021) to estimate the causal effect of interlinking through synthetic control and difference-in-differences. The rest of the section formally outlines specification of the econometric approach used.

Gravity model. Since Tinbergen (1962), the Newtonian-inspired gravity equation has served as the workhorse model for empirical analyses of the determinants of bilateral trade. Over time, this model has been extended to incorporate various trade-influencing time-varying bilateral factors, such as FTAs and currency unions. In this paper, we contribute to the gravity literature by examining the macroeconomic impact of payment systems on bilateral trade flows. The estimated model is:

$$y_{i,j,t} = \exp\left[\gamma S_{i,j,t} + \beta' X_{i,j,t} + \alpha^1_{i,j} + \alpha^2_{j,t} + \alpha^3_{i,t}\right]\varepsilon_{i,j,t} \quad (1)$$

where $y_{i,j,t}$ denotes exports from country i to country j at time t. $S_{i,j,t}$ is a dummy equal to 1 if the FPS of country i and country j at time t are connected. $X_{i,j,t}$ is a vector containing a set of bilateral and time-varying control variables: dummies for currency union and FTA.[13] $\alpha^1_{i,j}$, $\alpha^2_{j,t}$ and $\alpha^3_{i,t}$ are country-pair, origin-time and destination-time fixed effects. Note that the country-time fixed effects control for all country-specific time-varying characteristics that might have been omitted (e.g., GDP, price level), while the country-pair fixed effects control for country-pair time-invariant characteristics (e.g., geographical distance, common language, common religion, colonial links). It is important to note, also, that whether two countries are connected by correspondent banking remains constant within our sample and is captured by the fixed effect $\alpha_{i,j}$.[14] This allows us to isolate, in γ, the additional impact on trade of having a FPS connection between country i and j, in addition to them being able or not to exchange payments through correspondent banks. We add geopolitical distance as a control following Ferrari Minesso et al. (2025) who show that it

[12] If two payment systems use the same messaging standards, this makes interlinking technically simpler since it dispenses with any need for additional coding layers to facilitate their mutual exchanges of information. Interlinking becomes more complex if one of the systems settles in central bank currency while the other uses commercial bank money. These assets have different levels of settlement risk, which must be minimised to avoid a negative impact on the participants. Finally, domestic fast payment volumes are used to proxy for expected use of the interlinking arrangement, which affects the recovery of the costs of the infrastructure set-up.

[13] In Table A.3, we explore additional controls such as geographical distance, legal system and bilateral GDP.

[14] While correspondent banking has retrenched since 2014, Rice et al. (2020) show that the rate of decline in corridors has always been slow and has decreased since 2018, implying that a negligible share of the country pairs in our sample would have switched over the 4 years of the analysis.

is an important determinant of the interlinking decision. Thus, we try to control for a potential confounding factor of our primary variable of interest $S_{i,j,t}$ to allow a *causal* interpretation of γ, in line with the *selection on observables* approach in Wooldridge (2010). Following Santos Silva and Tenreyro (2006), Equation (1) is estimated using Poisson Pseudo-Maximum Likelihood (PPML) to account for zero trade flows and heteroscedasticity.

We further complement the evidence from the standard gravity specification with the results of an event study to measure the effect of the connection over time. Specifically, we estimate:

$$y_{i,j,t} = \exp\left[\sum_{l=-3}^{3} \gamma_l \, S_{i,j,t} \times time_{l,t} + \alpha^1_{i,j} + \alpha^2_{j,t} + \alpha^3_{i,t}\right] \varepsilon_{i,j,t} \tag{2}$$

where Equation (2) is closely related to Equation (1); the variables are mostly the same as in Equation (1), with the exception that, in Equation (2), the payment systems connection dummy $S_{i,j,t}$ is interacted with a time dummy for each of the three years before and after the connection (excluding the year preceding the event, which is our reference point). This allows us to test for the presence of a potential pre-trend and observe the evolution of the effect following the connection.

Correction model. To account for potential endogeneity of the payment system correction variable, we rely on the error connection model proposed in Carlson and Joshi (2024) and Carlson (2024). This is a two-step parametric estimation method for linear panel data models with sample selection. It extends the standard control function approach in Heckman (1974) by allowing for unobserved heterogeneity through heterogeneous coefficients in both the outcome and selection models. As in Heckman (1974), an exogenous variable in the selection equation is needed to identify the correction model.

Specifically, in the first stage, the treatment variable is regressed on a set of explanatory variables. We include the determinants of the interlinking decisions proposed by Ferrari Minesso et al. (2025): bilateral GDP, geographical distance and geopolitical distance. We also include payment-system specific factors, such as whether both countries use the same messaging standards when both have domestic FPS. Since they are relevant to interlinking, but do not directly affect trade flows, these variables act as exclusion restrictions to identify the model. More formally, the first-stage equation is:

$$\begin{gathered} P(S_{i,j,t}|\mathbf{X_1}) = \Phi(\beta_1'\mathbf{X_1} + u_{1,i,t}) \\ u_{1,i,j,t} \approx N(0, \sigma(\beta_2'\mathbf{X_2})) \end{gathered} \tag{3}$$

where, as in the previous specification, $S_{i,j,t}$ is a dummy equal to 1 if the payment system between the two countries is interlinked. $\mathbf{X_1}$ and $\mathbf{X_2}$ respectively control for level and volatility of the first-stage regression ($\mathbf{X_2}$ includes only GDP and geographical distance). $\Phi(\bullet)$ is the normal distribution function. Compared to the Heckman model, this equation allows heterogeneous coefficients through $\sigma(\beta_2'\mathbf{X_2})$.

The first-stage estimates are used to compute the Inverse Mills Ratios (IMR), which, then, are added to the standard second-stage regression. Including IMR corrects for endogeneity of the treatment. The IMR ($\lambda_{i,j,t}$) are computed as:

$$\lambda_{i,j,t} = \frac{\phi(\hat{\beta}_1'\mathbf{X_1}/\exp\hat{\beta}_2'\mathbf{X_2})}{\Phi(\hat{\beta}_1'\mathbf{X_1}/\exp\hat{\beta}_2'\mathbf{X_2})\exp\hat{\beta}_2'\mathbf{X_2}} \tag{4}$$

with $\Phi(\bullet)$ and $\phi(\bullet)$ being the respective normal probability and cumulative distribution functions.

The second-stage equation is the standard gravity model equation augmented by the IMR:

$$y_{i,j,t} = \exp\left[\gamma S_{i,j,t} + \beta'\mathbf{X_3} + \alpha_{i,j}^1 + \alpha_{j,t}^2 + \alpha_{i,t}^3 + \delta\lambda_{i,j,t} + \beta_4'\lambda_{i,j,t} \times \mathbf{X_2}\right]\varepsilon_{i,j,t} \tag{5}$$

where $\mathbf{X_3}$ contains the same controls as in Equation (1). The correction terms ($\delta\lambda_{i,j,t} + \beta_4'\lambda_{i,j,t} \times \mathbf{X_2}$) control for the endogeneity of $S_{i,j,t}$, $\beta_4'\lambda_{i,j,t} \times \mathbf{X_2}$ being new compared to the Heckman model. Equation (5) is estimated with PPML.

Synthetic difference-in-differences. To provide further evidence of the causality of the link between interlinking and trade, we estimate the effect of interlinking using semi-parametric methods.

Specifically, we rely on the SDID procedure proposed in Arkhangelsky et al. (2021), which combines two widely used approaches in panel econometrics - the Difference-in-Differences (DID) and Synthetic Control (SC). Similar to DID, SDID accounts for unobserved time-invariant differences between treated and control units using fixed effects and, similar to SC, it constructs optimal weights that align pre-treatment outcome trends between groups (treated and not treated). In other words, the estimator creates a synthetic pair for each treated unit, weighting non-treated observations. This synthetic unit is used as a counterfactual for the outcome for treated units had they not received the treatment. By jointly re-weighting both units and time periods, SDID minimizes reliance on the parallel trends assumption and improves robustness to systematic differences in pre-treatment patterns. This weighted double-differencing framework achieves double robustness: it provides consistent estimates if the DID model is correctly specified or the synthetic weights are well chosen. Consequently, SDID is a powerful and flexible tool for evaluating interventions when treatment is correlated with latent unit characteristics or when the standard parallel trends assumption is violated.

Formally, the estimator re-weights both units and time, to balance pre-treatment trends. An important innovation in Arkhangelsky et al. (2021) is to introduce re-weighting over time, which allows country pairs to enter the treatment group in different periods, matching the asynchronous development of interlinking initiatives across the globe. It solves an optimisation problem to find unit weights ω and time weights θ that minimise any imbalance before the treatment across groups (treated and not treated) and then runs a weighted two-way fixed effects regression:

$$(\hat{\tau}_{\text{sdid}}, \hat{\mu}, \hat{\alpha}, \hat{\beta}) = \arg \min_{\tau,\mu,\alpha,\beta} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{\omega}_{i,j} \hat{\theta}_t \left(y_{i,j,t} - \mu - \alpha_{i,j} - \beta_t - \Gamma' X_{i,j,t} - S_{i,j,t} \tau \right)^2 \quad (6)$$

where $S_{i,j,t}$ is the usual dummy. This balances the pre-treatment trends in both cross-sectional units and time periods, yielding a more robust causal effect estimate $\hat{\tau}_{\text{sdid}}$. $y_{i,j,t}$ is the logarithm of exports, β_t is a time fixed effect, $\alpha_{i,j}$ the country-pair fixed effect and $X_{i,j,t}$ is a set of controls including GDP, a common currency dummy and a dummy for the presence of a trade agreement.

However, this method requires a balanced sample and that no country pair i, j has $S_{i,j,t} = 1$ over the entire estimation sample. This has the drawback of excluding several regions with large payment system connection initiatives (e.g., the euro area, India, Brazil), which are also well served by correspondent banking. Therefore, the resulting coefficient is likely to be upward biased, reflecting the case of countries with lower access to existing international payment corridors, for example, countries in Africa.

3 Baseline results

3.1 Gravity results

Table 1 reports Equation (1) estimates with progressively saturated sets of fixed effects. As expected, the inclusion of additional fixed effects reduces the magnitude of the coefficient of the FPS connection dummy, although its statistical significance remains unchanged. In Table 1 column 4, we add the commonly used standard gravity model controls: common currency, FTA and geopolitical distance. The importance of geopolitical distance for trade flows has been highlighted in recent work, such as Gopinath et al. (2025). Ferrari Minesso et al. (2025) shows that geopolitics are also important determinants of interlinking payment systems. The results indicate that a FPS connection increases bilateral trade flows by approximately 3%. This effect is economically significant, being about half the estimated impact in this sample of trade agreements, but four times smaller than belonging to the same currency area. It is about one-tenth of the estimate in Mariani et al. (2024) based on a case study of interlinking payment systems in South Africa. One reason for this is that our coefficient reflects an average across countries, including regions well served by existing correspondent banking (such as Europe and South-East Asia), where the benefits of interlinking are likely smaller. Moreover, the effect of correspondent banking relations on trade is absorbed by the fixed effects, so our estimate reflects the additional benefit of interlinking, not just the possibility of making cross-border payments. By contrast, Mariani et al. (2024) focuses on small, under-banked countries, where the gains from interlinking are likely to be larger, in particular, by enabling firms in locations where cross-border payments were previously constrained or infeasible, to initiate such transactions. Indeed, in Section 5, when we consider a subset of initiatives in small or less integrated countries, or when we exclude the euro area in the SDID, the coefficient increases significantly.

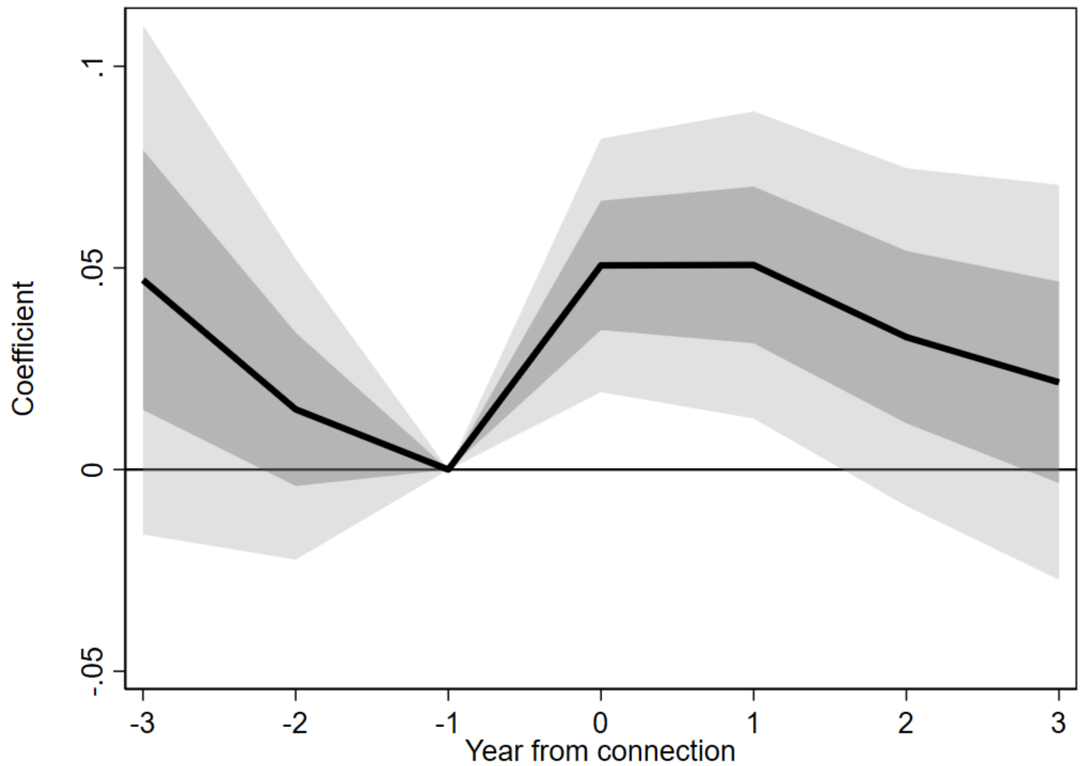
Table 1: Gravity model results

	(1)	(2)	(3)	(4)
FPS connection	0.109***	0.085***	0.043***	0.032*
	(0.029)	(0.018)	(0.015)	(0.017)
Common currency				0.123**
				(0.059)
Trade agreement				0.052
				(0.052)
Geopolitical distance				-0.136***
				(0.023)
Observations	76,516	76,516	76,507	48,626
N. connections	2864	2864	2864	2053
Pseudo-R^2	0.995	0.997	0.998	0.998
Exporter-importer FE	Y	Y	Y	Y
Exporter-year FE	N	Y	Y	Y
Importer-year FE	N	N	Y	Y
Controls	N	N	N	Y

Notes: Table 1 reports the gravity model estimates in Equation (1). Robust standard errors are reported in parentheses below the coefficients. ***p<0.01, **p<0.05, *p<0.1, +p<0.2.

Figure 3 plots the β_l coefficients of Equation (2). The results provide no evidence of pre-trends in the years preceding the establishment of a FPS connection. This pattern is reassuring, as it suggests that, prior to the treatment, treated and control country pairs followed similar trade trajectories. The connection dummy becomes positive and statistically significant in the year of connection and remains so one year after connection. However, two and three years after the connection, uncertainty increases significantly and the coefficients are no longer statistically significant. This lack of significance likely reflects the limited number of post-treatment observations, since most connections in our dataset occurred in 2023 and 2024, and the sample ends in 2024.

Figure 3: Event study - effect of connecting system payments over time



Notes: Figure 3 depicts the sequence of estimated γ_t coefficients in Equation (2). The shaded areas represent 95% and 68% confidence intervals. The regression coefficients are reported in the Table A.1 in the Appendix.

3.2 Correction model

Table 2 provides the results from the second stage of the correction model, Equation (5).[15] Notice that these estimations account parametrically for potential endogeneity as shown by Carlson and Joshi (2024).

As is common in the instrumental variables literature, the estimated effect of interlinking payment systems becomes stronger after accounting for endogeneity. Specifically, the presence of a payment system link is found to increase bilateral trade by approximately 4%. This suggests that the conventional estimates may understate the true impact due to omitted variable bias or reverse causality between trade intensity and payment infrastructure. Notably, after correcting for endogeneity, the estimated coefficients become stable across all model specifications (Table 2 columns 1–3), whereas in the baseline results, the estimates are sensitive to the inclusion of fixed effects. This stability reinforces the robustness of a causal interpretation and highlights the importance of addressing endogeneity when evaluating the effects on trade of financial integration mechanisms.

[15]See Table A.2 in the Appendix for the first-stage probit estimate.

Table 2: Correction model

	(1)	(2)	(3)	(4)
FPS connection	0.053*	0.040**	0.046***	0.037**
	(0.031)	(0.016)	(0.016)	(0.017)
Common currency				0.121**
				(0.060)
Trade agreement				0.074
				(0.058)
Geopolitical distance				-0.082***
				(0.030)
Inverse Mills ratios	-0.010	0.036***	0.034***	0.030***
	(0.014)	(0.008)	(0.008)	(0.008)
Observations	48,733	48,733	48,733	48,733
N. connections	2053	2053	2053	2053
Pseudo-R^2	0.995	0.998	0.998	0.998
Exporter-importer FE	Y	Y	Y	Y
Exporter-year FE	N	Y	Y	Y
Importer-year FE	N	N	Y	Y
Controls	N	N	N	Y

Notes: Table 2 reports the estimates of the correction model defined in Equation (5). The first-stage IMR are included in the second-stage equation along with their interactions with the variables defining the first-stage model variance. ***p<0.01, **p<0.05, *p<0.1, +p<0.2.

It shows, also, how after accounting for all sources of unobserved variation, the gravity estimate can achieve identification through “selection on observables”.

4 Robustness

4.1 Additional controls

The baseline specification is robust to several variations, whose results are presented in Table A.3 of the Appendix. Column 1 excludes euro area country pairs since intra-currency union trade could be considered internal trade and could bias the results upwards. Excluding the euro area almost halves the number of connected units in our sample. The estimated effect of payment systems interlinking remains significant, but, as expected, the currency union dummy turns insignificant. Column 2 excludes European Union country pairs leading to similar results. Column 3 includes the traditional gravity variables (common legal system, geographical distance, GDP) and, to avoid collinearity, drops all of the fixed effects. In this case, the estimated effect of interlinking is about ten times stronger, perhaps signalling that standard gravity controls do not absorb all of the unobserved heterogeneity that could confound the estimation. Column 4 excludes the smallest 5% of trade flows to ensure that the results are not driven by small country pairs. Across all the specifications, the estimated coefficients remain positive and statistically significant, with only minor variations in magnitude, which reinforces confidence in our main estimate.

Table A.4 repeats the above exercise for the correction model. Notably, after accounting for the potential endogeneity of interlinking, compared to Table A.3, the estimated coefficients become more stable across alternative specifications. In all the specifications, connecting payment systems continues to deliver around 4% increase in bilateral trade flows, with slightly higher estimates if the standard gravity fixed effects are excluded.

Table A.5 and Table A.6 in the Appendix use the extended dataset provided by Ferrari Minesso et al. (2025) which maps interlinking between both fast and non-fast payment systems. When connections between non-fast payment systems are included in the treatment variable, $S_{i,j,t}$, the number of connected pairs increase significantly, to between 1,000 and 3,000 observations depending on the specification. In the case of both the simple gravity model, Table A.5, and the correction model, Table A.6, the impact of interlinking remains positive and statistically significant. On average, interlinking increases trade flows by about 6%, so by slightly more than in the baseline model, but the coefficients are not statistically different from each other. Overall, it seems that interlinking of payment systems, in itself, is beneficial since it reduces trade costs across countries.

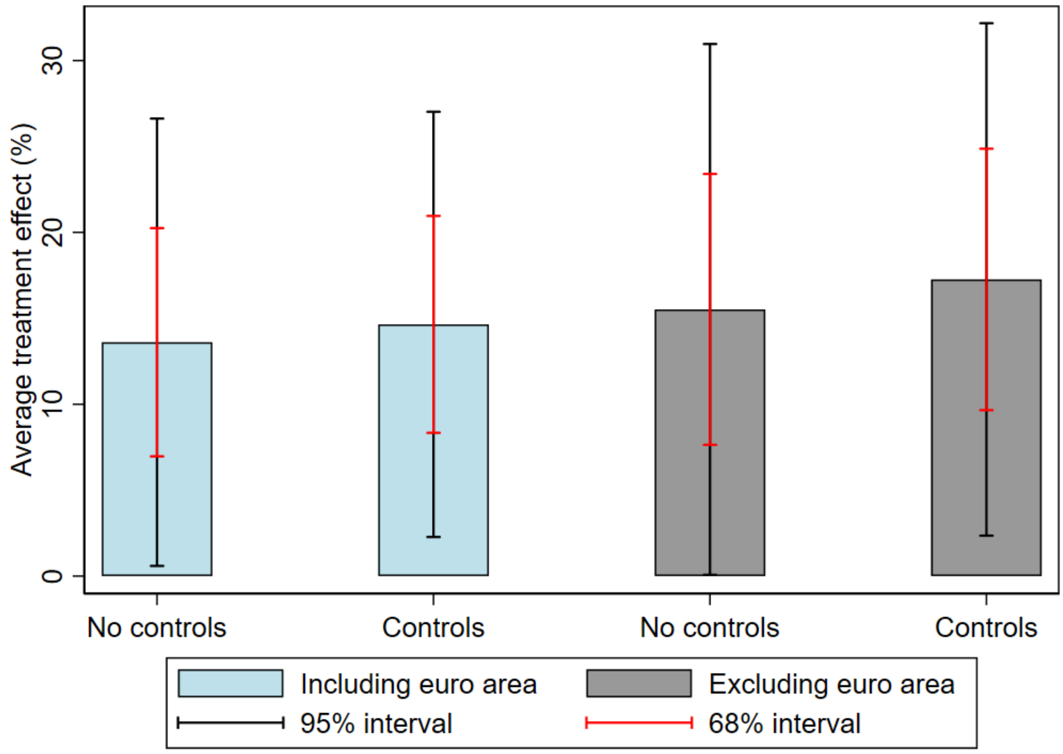
4.2 Semi-parametric estimator

As a final robustness check, we estimate the causal impact of interlinking using a semi-parametric method. We employ the SDID estimator proposed by Arkhangelsky et al. (2021), where non-connected pairs are used to create a synthetic control for connected units, which serves as a counterfactual for connected units had they never been connected. The estimator also exploits difference-in-differences to isolate the pre- and post-policy effects. This reduces the bias induced by imperfectly matched trends and provides more credible causal estimates, especially in the case of substantially different treated and control units before the intervention.

However, despite its benefits, SDID requires a perfectly balanced panel and cannot handle units that are treated throughout the entire sample. For this reason, we need to drop units with missing observations over the sample period (2021-2024). We also cannot include intra-euro area, since the euro area was the first region to interlink its payment systems in 2017. Several connections involving India and Brazil are also excluded, resulting in an interlinked network dominated by initiatives in Africa. Therefore, the empirical estimation sample is very different from Table 1, with only 369 connected pairs compared to more than 2,000 in the baseline model.

Figure 4 reports the estimated average treatment effects. We consider four specifications:

Figure 4: Synthetic difference-in-differences estimation



Notes: Figure 4 depicts the Average Treatment Effect (ATE) with standard errors based on the SDID estimator defined in Equation (6) and developed by Arkhangelsky et al. (2021). The dependent variable is the logarithm of trade; control variables are GDP, geographical distance, common currency and a FTA. The ATE is computed both including and excluding pairs that involve a euro area country. Standard errors are bootstrapped.

including and excluding trade with the euro area,[16] and including and excluding the controls used in Equation (1). Overall, we observe a roughly 10% stronger treatment effect across specifications. However, although different from zero, these estimates include more uncertainty than the gravity equation results and are not statistically different from those presented in the previous sections. Consequently, their comparatively greater magnitude should be interpreted with caution.

One explanation for these results might be that, in this case, the sample of interlinked countries is constituted almost entirely by initiatives in Africa. These countries are less connected to the correspondent banking network (Rice et al., 2020) and face higher trade frictions. Therefore, the economic impact of interlinking is stronger and closer to the findings of Mariani et al. (2024)'s case study of the payment system initiative in South Africa (estimated to have boosted trade by about 30%). Table A.7 in the Appendix presents more detailed results and also confidence intervals. The larger point estimates likely also reflect estimator differences. Using the same sample, gravity regressions yield only around 20% higher point estimates than in the baseline (Table 1), although

[16]We need to exclude intra-euro area trade from this estimation procedure, but not trade between euro area and non-euro area countries.

with substantially wider confidence intervals which overlap with those obtained using the SDID estimator (see Figure B.3 in the appendix).

5 Channels

We next explore the potential mechanisms that might enable connection between FPS to stimulate trade. Our main hypothesis is that FPS connections reduce trade costs in terms of both correspondent banking services fees and potentially exchange rate intermediation costs. Thus, the benefits should be greater in the case of interlinking arrangements that allow wholesale transactions, which account for the majority of cross-border trade, and should be larger for smaller and poorer countries where payment frictions are greater, and larger, also, for goods with higher price elasticities.

First, we re-estimate Equation (1) splitting the connection dummy $S_{i,j,t}$ between those links that allow both wholesale and retail transactions ($SW_{i,j,t}$) and those that allow only retail payments ($SR_{i,j,t}$):[17]

$$y_{i,j,t} = \exp\left[\gamma_W SW_{i,j,t} + \gamma_R SR_{i,j,t} + \beta' X_{i,j,t} + \alpha^1_{i,j} + \alpha^2_{j,t} + \alpha^3_{i,t}\right]\varepsilon_{i,j,t} \tag{7}$$

the estimation results are presented in Table 3 columns 1-4 and show that the aggregate estimates are driven by payment systems that allow both retail and wholesale transactions. After controlling for the full set of fixed effects, the coefficient of payment systems that allow only retail payments (γ_R) becomes insignificant. In contrast, the coefficient of systems that allow also wholesale transactions (γ_W) is strongly significant and almost three times larger than in the baseline. These results support the hypothesis that the benefits from interlinking depend on its impact on bilateral trade flows, which, typically, are settled through wholesale systems. This is consistent with evidence showing that exclusion from wholesale payments via the correspondent banking network reduces bilateral trade (Borchert et al., 2024; Rice et al., 2020). Since aggregate trade is mostly settled through wholesale transactions, our main results are driven by those systems that directly connect wholesale payments. The estimated coefficient (around 0.17) is in line with prior estimates of cross-country wholesale interlinking in the Southern Africa region.

Next, we compare the impact of interlinking between large and small country pairs. Payment channels involving smaller economies generate fewer payment flows and, hence, less revenue. For this reason, smaller countries tend to be less connected to global payment networks and face higher

[17] We distinguish between the two by checking the information on the platforms' or central banks' websites. The links allowing wholesale transactions are those with Brazil Pix, BUNA, GIMACPAY and PAPSS, and the bilateral connection between Malaysia and Singapore.

Table 3: Gravity model results differentiating between payment system connections

	(1)	(2)	(3)	(4)	(5)	(6)
Wholesale & retail connection	0.171***	0.209***	0.136***	0.178***		
	(0.040)	(0.038)	(0.027)	(0.031)		
Only retail connection	0.095***	0.059***	0.020	-0.007		
	(0.035)	(0.021)	(0.017)	(0.018)		
FPS connection × big					0.043***	0.032*
					(0.015)	(0.017)
FPS connection × small					0.584+	0.718**
					(0.455)	(0.308)
Common currency				0.143**		0.123**
				(0.059)		(0.059)
Trade agreement				0.056		0.052
				(0.052)		(0.052)
Geopolitical distance				-0.136***		-0.136***
				(0.023)		(0.023)
Observations	76,516	76,516	76,507	48,626	76,507	48,626
N. connections	2864	2864	2864	2053	3028	2224
Pseudo-R^2	0.995	0.997	0.998	0.998	0.998	0.998
Exporter-importer FE	Y	Y	Y	Y	Y	Y
Exporter-year FE	N	Y	Y	Y	Y	Y
Importer-year FE	N	N	Y	Y	Y	Y
Controls	N	N	N	Y	N	Y

Notes: Columns 1-4 report the gravity model estimates in Equation (7); columns 5 and 6 report estimates in Equation (8). As a robustness check, we re-estimate this table with our correction model instead of the gravity model (Table A.8 in the appendix), results hold. Robust standard errors are reported in parentheses below the coefficients. ***p<0.01, **p<0.05, *p<0.1, +p<0.2.

costs for cross-border payments because there are fewer banks willing to service them (Financial Stability Board, 2024; Rice et al., 2020). We would therefore expect them to have higher ex-ante payment costs and benefit more from interlinking. To test this hypothesis, we divide connected countries into two groups: (*i*) *small* country pairs, defined as those with a combined GDP in the lowest 25^{th} percentile,[18] and (*ii*) *large* country pairs with a combined GDP in the highest 25^{th} percentile. The corresponding specification is written as:

$$y_{i,j,t} = \exp\left[\gamma_1 S_{i,j,t} \times small_{i,j} + \gamma_2 S_{i,j,t} \times big_{i,j} + \beta' X_{i,j,t} + \alpha^1_{i,j} + \alpha^2_{j,t} + \alpha^3_{i,t}\right]\varepsilon_{i,j,t} \tag{8}$$

$small_{i,j}$ is a dummy variable that takes the value 1 if the country pair is classified as small. $big_{i,j}$ takes the value 1 for country pairs that do not belong to the small category. All other variables are defined as in Equation (1).

Table 3 columns 5-6 present the estimated coefficients γ_1 and γ_2 from Equation (8). We see that the effect of connecting FPS between small countries is much stronger than the effect of connecting FPS between large countries. This supports our hypothesis that FPS connections affect trade primarily by reducing fixed transaction costs.

[18]To measure size, we use GDP rather than observed trade flows since trade volumes might be endogenous.

The absence of bilateral measures makes it difficult to directly test the role of cross-border payment costs. Data limitations are substantial, since intermediaries do not disclose transaction volumes, fees or prices, and payment markets are fragmented across many actors in several jurisdictions. To our knowledge, the most comprehensive available source of these data is the dataset compiled by the Financial Stability Board (FSB), to monitor progress under the G20 Roadmap for Enhancing Cross-Border Payments.[19] The FSB reports measures for the cost of sending funds across macro-regions, conditioning on transaction size and distinguishing between business and retail payments. Although these data are necessarily aggregated and do not provide bilateral country-level measures, they offer informative variation to assess the potential role of transaction costs in shaping cross-border linkages. We assign each country in our sample to the corresponding FSB macro-region and use the average cost of Business-To-Business (B2B) transactions to proxy for cross-border payment trade frictions. This measure is interacted with the interlinking indicator to capture heterogeneity in the effects of FPS integration across regions with different underlying transaction costs. Specifically, we estimate:

$$y_{i,j,t} = \exp\left[\gamma_1 S_{i,j,t} + \gamma_2 S_{i,j,t} \times C_{i,j,t} + \beta' X_{i,j,t} + \alpha^1_{i,j} + \alpha^2_{j,t} + \alpha^3_{i,t}\right]\varepsilon_{i,j,t} \tag{9}$$

$C_{i,j,t}$ is the average cost of sending B2B payments between countries i and j, proxied by the average costs observed in their respective macro-regions. If interlinking operates primarily by reducing payment frictions, we expect the interaction coefficient γ_2 to be positive. Table 4 reports the estimated coefficients, distinguishing between total costs, transaction fees, and foreign exchange fees. Consistent with this mechanism, once the interaction term is included, the stand-alone effect of interlinking is fully absorbed, indicating that the gains from interlinking are concentrated in those country pairs that faced higher cross-border payment costs. The results suggest further that these gains are driven by reduced transaction fees rather than FX fees. This pattern is consistent with interlinking lowering intermediation costs—potentially by weakening market power in correspondent banking relationships or reducing the number correspondents involved or facilitating lower-cost access to destinations not directly served by global banks. However, we find no evidence that interlinking operates through FX fees. This result might be explained by the fact that many FPS still rely on banks to provide FX services, hence interlinking does not directly dents exchange rate intermediation costs for the moment. As a robustness check, we rerun Equation (9) with our correction model (Table A.9 in the appendix), results hold.

[19] Data are available at https://www.fsb.org/2025/10/g20-roadmap-for-cross-border-payments-consolidated-progress-report-for-2025/. Data are reported by region, distinguishing between transaction type, intermediary and transaction amounts for the period 2023–2025. We average across intermediaries and amounts and use the percentage total, fee and foreign exchange (FX) costs. For years prior to 2023, we hold observations fixed at their 2023 level. This choice is supported by evidence that payment costs changed very little before the Roadmap was implemented.

Table 4: Gravity model results interacting with cross-border transaction costs

	(1)	(2)	(3)
FPS connection	-0.040	-0.004	0.080
	(0.044)	(0.021)	(0.065)
Common currency	0.144**	0.128**	0.109*
	(0.059)	(0.059)	(0.061)
Trade agreement	0.050	0.050	0.051
	(0.051)	(0.051)	(0.051)
Geopolitical distance	-0.140***	-0.140***	-0.140***
	(0.023)	(0.023)	(0.023)
FPS connection × total cost	0.039*		
	(0.023)		
FPS connection × transaction fees		0.084***	
		(0.029)	
FPS connection × FX fees			-0.036
			(0.047)
Observations	44,856	44,856	44,856
N. connections	2041	2041	2041
Pseudo-R^2	0.998	0.998	0.998
Exporter-importer FE	Y	Y	Y
Exporter-year FE	Y	Y	Y
Importer-year FE	Y	Y	Y
Controls	Y	Y	Y

Notes: Table 4 reports the estimates from Equation (9). The interlinking dummy is interacted with the average cost of sending money from the region of origin to the destination country region as reported by the FSB. Robust standard errors are reported in parentheses below the coefficients. ***p<0.01, **p<0.05, *p<0.1, +p<0.2.

Additional evidence on the relationship between interlinking and cross-border payment costs is provided by remittance data. Figure B.4 in the Appendix shows that, in a standard gravity specification, interlinking is associated negatively to remittance costs. However, these results should be interpreted with caution. Data on remittance costs are sparse—covering approximately 1,000 observations and 40 bilateral corridors—which introduces substantial uncertainty into the estimates.[20]

We next examine whether the effects of FPS connections differ across different types of goods: high-tech and low-tech goods. The strong differentiation and limited replicability of high-tech goods confer quasi-monopoly power on producers, resulting in lower price elasticity of demand. To compare high- and low-tech goods, we rely on the US Census *Advanced Technology Products* classification, which groups goods according to their technological intensity. We re-estimate Equation (1) redefining $y_{i,j,t}$ as the sum of HS6-level trade flows within each of the product categories (high tech or low tech), rather than as total bilateral trade. The results by product type are

[20]Data on remittance costs are from the World Bank *Remittance Prices Worldwide database*, available at http://remittanceprices.worldbank.org.

presented in Table 5.

Table 5: Gravity model - high tech and low tech goods

	(1) High tech	(2) High tech	(3) Low tech	(4) Low tech
FPS connection	-0.024	-0.029	0.057***	0.054**
	(0.025)	(0.024)	(0.016)	(0.021)
Common currency		-0.147***		0.167**
		(0.050)		(0.067)
Trade agreement		-0.027		0.052
		(0.053)		(0.057)
Geopolitical distance		-0.107***		-0.142***
		(0.033)		(0.024)
Observations	54,942	35,088	74,735	47,574
N. connections	2799	2012	2855	2047
Pseudo-R^2	0.997	0.998	0.997	0.998
Exporter-importer FE	Y	Y	Y	Y
Exporter-year FE	Y	Y	Y	Y
Importer-year FE	Y	Y	Y	Y
Controls	N	Y	N	Y

Notes: Table 5 reports the gravity model estimates defined in Equation (1), using either high-tech or low-tech trade flows. These flows are classified at the HS6 product level as high- or low-technology goods and are then aggregated at the country level. The technological classification follows the US Census *Advanced Technology Products* list. ***p<0.01, **p<0.05, *p<0.1, +p<0.2.

We find that while the connection between FPS does not significantly affect trade in high-technology goods, it has a positive impact on non-high-tech trade flows. This is unsurprising since, typically, high-technology goods exhibit low volume-to-price elasticity, making them less sensitive to reductions in transaction costs. The results are robust to the estimation using the two-step procedure in Equation (5) and are reported in the Appendix(Table A.10).

6 Conclusion

This paper provides robust empirical evidence of the significant role of interlinking FPS for fostering international trade. Using a unique dataset of over 2,000 cross-border payment systems connections and employing parametric and semi-parametric methods, we demonstrate that interlinking payment systems increase bilateral trade volumes by approximately 4%. The estimated effect, while smaller than in the case of a formal trade agreement or a common currency, underlines the substantial economic benefits of enhanced payment connectivity. Compared to the prior literature, our estimate has the advantage of not being based on a specific case study, but rather on averages across all interlinking initiatives, including those between countries already able to access global markets through correspondent banks. Unpacking heterogeneity in the sample shows that the benefits of payment system interlinking are greater for systems that allow both retail and wholesale transactions, for smaller countries which tend to be underserved by existing payment means, and countries located in regions where cross-border payments are more expensive. Our results suggest that indeed the benefits of payment system interlinking might come from reduced cross-border payment costs. They are also robust across a wide range of specifications and models, including parametric and semi-parametric methods.

Our findings highlight the transformative potential of interlinked FPS to reduce trade costs, improve efficiency, and facilitate cross-border economic integration, particularly for smaller economies and developing markets, which, historically, have been excluded from efficient payment channels.

These evidence carry significant policy implications. First, they justify efforts to integrate cross-border payment systems to try to reduce trade frictions and increase welfare gains derived from cross-country specialization. Second, they emphasize the need for continued international efforts to interconnect payment systems, such as those outlined in the G20 Roadmap, since these initiatives not only promote financial inclusion but also produce tangible trade benefits. Third, they stress the importance of achieving multilateral coordination to ensure interoperability through common standards, to address regulatory and legal barriers and make interlinking easier. In an era where trade risks fracturing along geopolitical lines, interlinking payment systems, which reduce trade costs, could also help reduce the costs of geopolitical fragmentation.

Future extensions might consider the impact across financial flows, with particular emphasis on the volatility and size of capital flows and remittances.

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Appendix

A Additional tables

Table A.1: Event study regression

	(1) Exports
Connected year -3	0.047+
	(0.032)
Connected year -2	0.015
	(0.019)
Connected year 0	0.051***
	(0.016)
Connected year +1	0.051***
	(0.019)
Connected year +2	0.033+
	(0.021)
Connected year +3	0.022
	(0.025)
Observations	76,507
Exporter-importer FE	Y
Exporter-year FE	Y
Importer-year FE	Y

Notes: Table A.1 reports the sequence of estimated γ_t coefficients in Equation (2). Robust standard errors are reported in parentheses below the coefficients. ***p<0.01, **p<0.05, *p<0.1, +p<0.2.

Table A.2: First-stage regression

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
GDP	0.093***						0.024***
	(0.004)						(0.002)
Geographic distance		-0.566***					-0.049***
		(0.009)					(0.005)
Common language			0.031***				0.011***
			(0.003)				(0.003)
Former colony				-0.017***			-0.020***
				(0.006)			(0.006)
Same payment standards					0.266***		0.011+
					(0.019)		(0.007)
FPS						0.393***	0.200***
						(0.026)	(0.022)
Observations	177216	177,216	167264	177192	177,216	177216	167,240
Log-likelihood	-11004	-11004	-10562	-10991	-9917	-8420	-7960

Notes: Table A.2 reports the correction model first-stage estimates defined in Equation (3). Robust standard errors are reported in parentheses below the coefficients. ***p<0.01, **p<0.05, *p<0.1, +p<0.2.

Table A.3: Gravity model – robustness

	(1) Exclude euro area	(2) Exclude European Union	(3) Gravity controls	(4) Exclude small trade flows
FPS connection	0.037**	0.037**	0.353***	0.032*
	(0.017)	(0.018)	(0.068)	(0.017)
Common currency	0.096	0.031	0.012	0.126**
	(0.094)	(0.075)	(0.074)	(0.059)
Trade agreement	0.052	0.055	0.863***	0.052
	(0.052)	(0.052)	(0.077)	(0.052)
Geopolitical distance	-0.142***	-0.153***	-0.174***	-0.136***
	(0.024)	(0.024)	(0.048)	(0.023)
Same legal system			0.225***	
			(0.054)	
Geographic distance			-0.770***	
			(0.025)	
Bilateral GDP			1.443***	
			(0.020)	
Observations	47,486	46,520	50,057	46,470
N. connections	1019	579	2055	2050
Pseudo-R^2	0.998	0.998	0.691	0.998
Exporter-importer FE	Y	Y	N	Y
Exporter-year FE	Y	Y	N	Y
Importer-year FE	Y	Y	N	Y
Controls	Y	Y	Y	Y

Notes: Table A.3 reports the gravity model estimates in Equation (1). Column 1 excludes euro area country pairs, column 2 excludes European Union country pairs, column 3 adds other standard gravity controls and drops all of the fixed-effects and column 4 excludes pairs in the bottom 5% of the distribution of trade flows. Robust standard errors are reported in parentheses below the coefficients. ***p<0.01, **p<0.05, *p<0.1, +p<0.2.

Table A.4: Correction model – robustness

	(1) Exclude euro area	(2) Exclude European Union	(3) Gravity controls	(4) Exclude low trade flows
FPS connection	0.042**	0.041**	0.172**	0.037**
	(0.018)	(0.018)	(0.069)	(0.017)
Common currency	0.149+	0.075	-0.060	0.124**
	(0.097)	(0.078)	(0.085)	(0.059)
Trade agreement	0.077+	0.076+	0.938***	0.074
	(0.058)	(0.059)	(0.084)	(0.058)
Geopolitical distance	-0.091***	-0.103***	-0.214***	-0.082***
	(0.032)	(0.033)	(0.069)	(0.030)
Same legal system			0.199***	
			(0.055)	
Geographic distance			-0.825***	
			(0.050)	
Bilateral GDP			1.303***	
			(0.064)	
Inverse Mills Ratios	0.030***	0.026***	-0.066**	0.030***
	(0.008)	(0.009)	(0.028)	(0.008)
Observations	47,593	46,627	50,254	46,594
N. connections	1019	579	2055	2050
Pseudo-R^2	0.998	0.998	0.695	0.998
Exporter-importer FE	Y	Y	N	Y
Exporter-year FE	Y	Y	N	Y
Importer-year FE	Y	Y	N	Y
Controls	Y	Y	Y	Y

Notes: Table A.4 reports the correction model estimates defined in Equation (5). The first-stage Inverse Mills Ratios are included in the second-stage equation along with their interactions with with the variables defining the variance of the first-stage model. Column 1 excludes euro area country pairs, column 2 excludes European Union country pairs, column 3 adds other standard gravity controls and drops all of the fixed-effects and column 4 excludes pairs in the bottom 5% of the distribution of trade flows. Robust standard errors are reported in parentheses below the coefficients. ***p<0.01, **p<0.05, *p<0.1, +p<0.2.

Table A.5: Gravity model results - fast and non-fast payment systems

	(1)	(2)	(3)	(4)
Payment system connection	0.147***	0.113***	0.091***	0.060***
	(0.028)	(0.020)	(0.015)	(0.017)
Common currency				0.140**
				(0.058)
Trade agreement				0.053
				(0.052)
Geopolitical distance				-0.133***
				(0.023)
Observations	76,516	76,516	76,507	48,626
N. connections	5098	5098	5098	3720
Pseudo-R^2	0.995	0.997	0.998	0.998
Exporter-importer FE	Y	Y	Y	Y
Exporter-year FE	N	Y	Y	Y
Importer-year FE	N	N	Y	Y
Year FE	N			
Controls	N	N	N	Y

Notes: Table A.5 reports the gravity model estimates in Equation (1). As payment system connection variable, $S_{i,j,t}$, we consider interlinking of fast and non-fast payment systems. Robust standard errors are reported in parentheses below the coefficients. ***p<0.01, **p<0.05, *p<0.1, +p<0.2.

Table A.6: Correction model - fast and non-fast payment systems

	(1)	(2)	(3)	(4)
Payment system connection	0.110***	0.047**	0.058***	0.059***
	(0.032)	(0.023)	(0.017)	(0.017)
Common currency				0.140**
				(0.059)
Trade agreement				0.077+
				(0.058)
Geopolitical distance				-0.085***
				(0.030)
Inverse Mills Ratios	-0.010	0.036***	0.034***	0.030***
	(0.014)	(0.008)	(0.008)	(0.008)
Observations	48,733	48,733	48,733	48,733
N. connections	3720	3720	3720	3720
Pseudo-R^2	0.995	0.998	0.998	0.998
Exporter-importer FE	Y	Y	Y	Y
Exporter-year FE	N	Y	Y	Y
Importer-year FE	N	N	Y	Y
Controls	N	N	N	Y

Notes: Table A.6 reports estimates from the correction model defined in Equation (5). As payment system connection variable, $S_{i,j,t}$, we consider interlinking of fast and non-fast payment systems. The first-stage Inverse Mills Ratios are included in the second-stage equation along with their interactions with the variables defining the variance of the first-stage model. Robust standard errors are reported in parentheses below the coefficients. ***p<0.01, **p<0.05, *p<0.1, +p<0.2.

Table A.7: Synthetic difference-in-differences

	(1) ATE	(2) Standard errors	(3) Observations	(4) N. of connections	(5) N. of clusters
Full sample - no controls	0.14***	0.07	69,432	369	17,358
Full sample - controls	0.15***	0.06	66,724	369	16,681
Exclude EA - no controls	0.16**	0.08	69,264	331	17,316
Exclude EA - controls	0.17***	0.08	66,556	331	16,639

Notes: Table A.7 reports the synthetic difference-in-differences estimates developed by Arkhangelsky et al. (2021). ATE stands for Average Treatment Effect. The dependent variable is the logarithm of exports; control variables are GDP, geographical distance, a common currency dummy and a FTA dummy. The ATE is computed including and excluding units in the euro area (EA). Standard errors are bootstrapped. ***p<0.01, **p<0.05, *p<0.1, +p<0.2.

Table A.8: Correction model results differentiating between payment system connections

	(1)	(2)	(3)	(4)	(5)	(6)
Wholesale & retail connection	0.156***	0.255***	0.187***	0.184***		
	(0.038)	(0.032)	(0.030)	(0.030)		
Only retail connection	0.031	-0.003	0.009	-0.002		
	(0.036)	(0.017)	(0.018)	(0.019)		
FPS connection × big					0.046***	0.037**
					(0.016)	(0.017)
FPS connection × small					0.702**	0.722**
					(0.309)	(0.310)
Common currency				0.141**		0.121**
				(0.059)		(0.060)
Trade agreement				0.078+		0.074
				(0.058)		(0.058)
Geopolitical distance				-0.083***		-0.082***
				(0.030)		(0.030)
Inverse Mills Ratios	-0.010	0.037***	0.034***	0.030***	0.034***	0.030***
	(0.014)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Observations	48,733	48,733	48,733	48,454	48,733	48,454
N. connections	2053	2053	2053	2053	2053	2053
Pseudo-R^2	0.995	0.998	0.998	0.998	0.9980.998	0.998
Exporter-importer FE	Y	Y	Y	Y	Y	Y
Exporter-year FE	N	Y	Y	Y	Y	Y
Importer-year FE	N	N	Y	Y	Y	Y
Controls	N	N	N	Y	N	Y

Notes: Table A.8 columns 1-4 report the gravity model estimates in Equation (7); columns 5 and 6 report the estimates in Equation (8). Regressions are augmented with the Inverse Mills Ratios and their interactions. Inverse Mills Ratios are derived as in Equation (3). Robust standard errors are reported in parentheses below the coefficients. ***p<0.01, **p<0.05, *p<0.1, +p<0.2.

Table A.9: Correction model results interacting with cross-border transaction costs

	(1)	(2)	(3)
FPS connection	-0.027	0.004	0.096+
	(0.044)	(0.021)	(0.064)
Common currency	0.138**	0.125**	0.102*
	(0.060)	(0.059)	(0.061)
Trade agreement	0.071	0.072	0.073
	(0.057)	(0.057)	(0.057)
Geopolitical distance	-0.087***	-0.088***	-0.087***
	(0.031)	(0.031)	(0.031)
FPS connection × total cost	0.034+		
	(0.023)		
FPS connection × transaction fees		0.079***	
		(0.029)	
FPS connection × FX fees			-0.043
			(0.046)
Inverse Mills Ratios	0.029***	0.029***	0.029***
	(0.008)	(0.008)	(0.008)
Observations	44,684	44,684	44,684
N. connections	2041	2041	2041
Pseudo-R^2	0.998	0.998	0.998
Exporter-importer FE	Y	Y	Y
Exporter-year FE	Y	Y	Y
Importer-year FE	Y	Y	Y
Controls	Y	Y	Y

Notes: Table A.9 reports estimates from Equation (9) augmented with the Inverse Mills Ratios and their interactions. Inverse Mills Ratios are derived as in Equation (3). The interlinking dummy is interacted with the average cost of sending money from the region of the origin to the region of the destination country as reported by the FSB. Robust standard errors are reported in parentheses below the coefficients. ***p<0.01, **p<0.05, *p<0.1, +p<0.2.

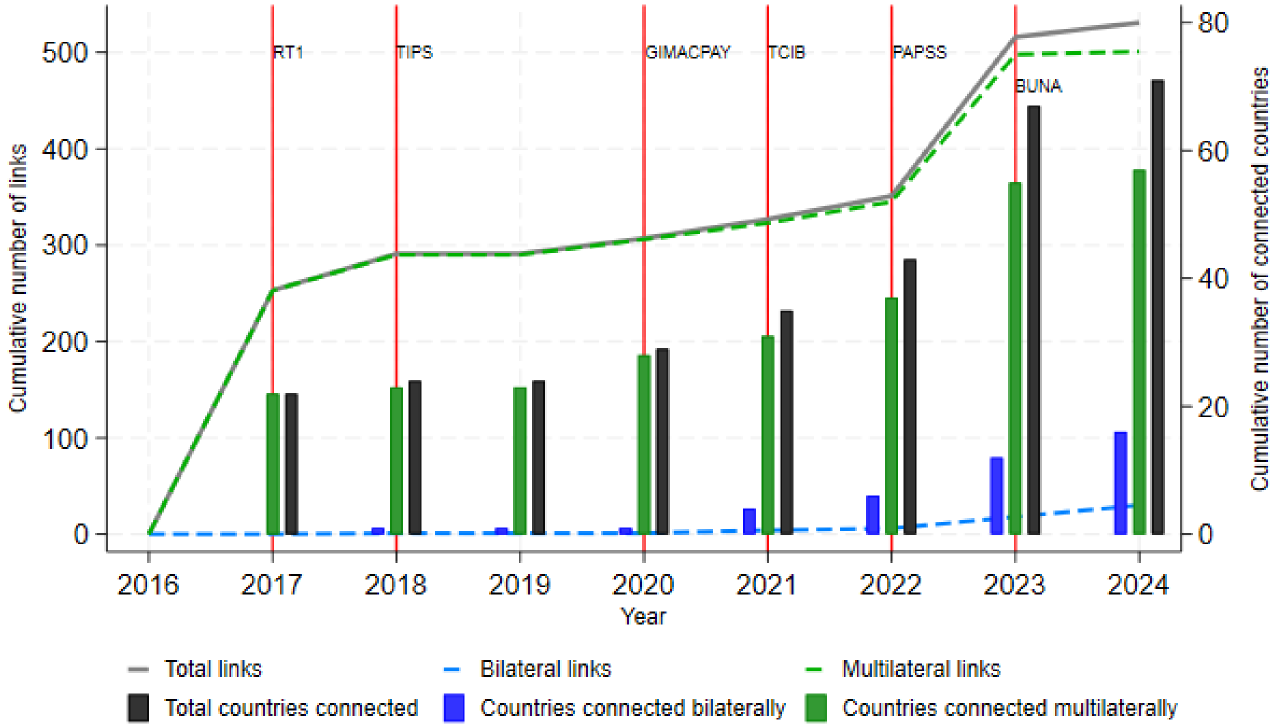
Table A.10: Correction model - high tech and low tech goods

	(1) High tech	(2) High tech	(3) Low tech	(4) Low tech
FPS connection	-0.020	-0.026	0.069***	0.059***
	(0.024)	(0.025)	(0.021)	(0.022)
Common currency		-0.130**		0.164**
		(0.051)		(0.068)
Trade agreement		0.080		0.068
		(0.064)		(0.067)
Geopolitical distance		-0.087*		-0.079**
		(0.045)		(0.032)
Inverse Mills Ratios	0.113***	0.095***	0.085***	0.073***
	(0.026)	(0.029)	(0.020)	(0.021)
Observations	35,255	35,255	47,681	47,681
N. connections	2012	2012	2047	2047
Pseudo-R^2	0.998	0.998	0.998	0.998
Exporter-importer FE	Y	Y	Y	Y
Exporter-year FE	Y	Y	Y	Y
Importer-year FE	Y	Y	Y	Y
Controls	N	Y	N	Y

Notes: Table A.10 reports the correction model estimates defined in Equation (5), using either high-tech or low-tech trade flows. These flows are classified at the HS6 product level as high- or low-technology goods and are then aggregated at the country level. The technological classification follows the US Census *Advanced Technology Products* list. ***p<0.01, **p<0.05, *p<0.1, +p<0.2.

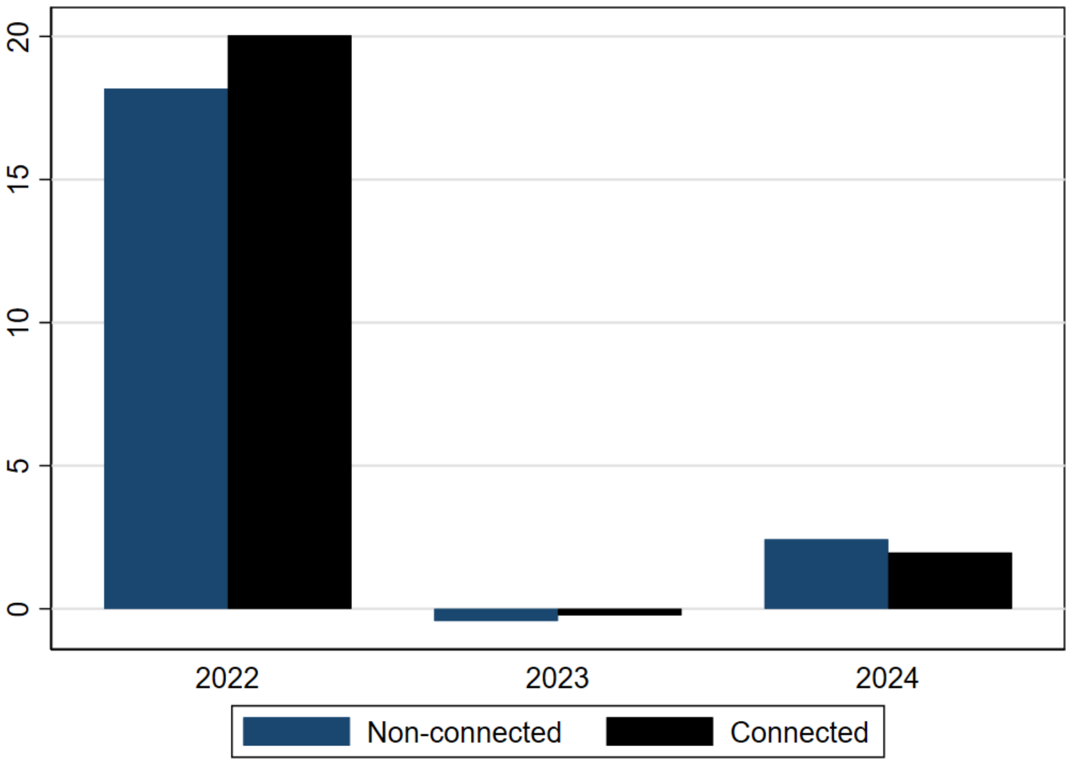
B Additional figures

Figure B.1: Timeline of cross-border connections of fast payment systems



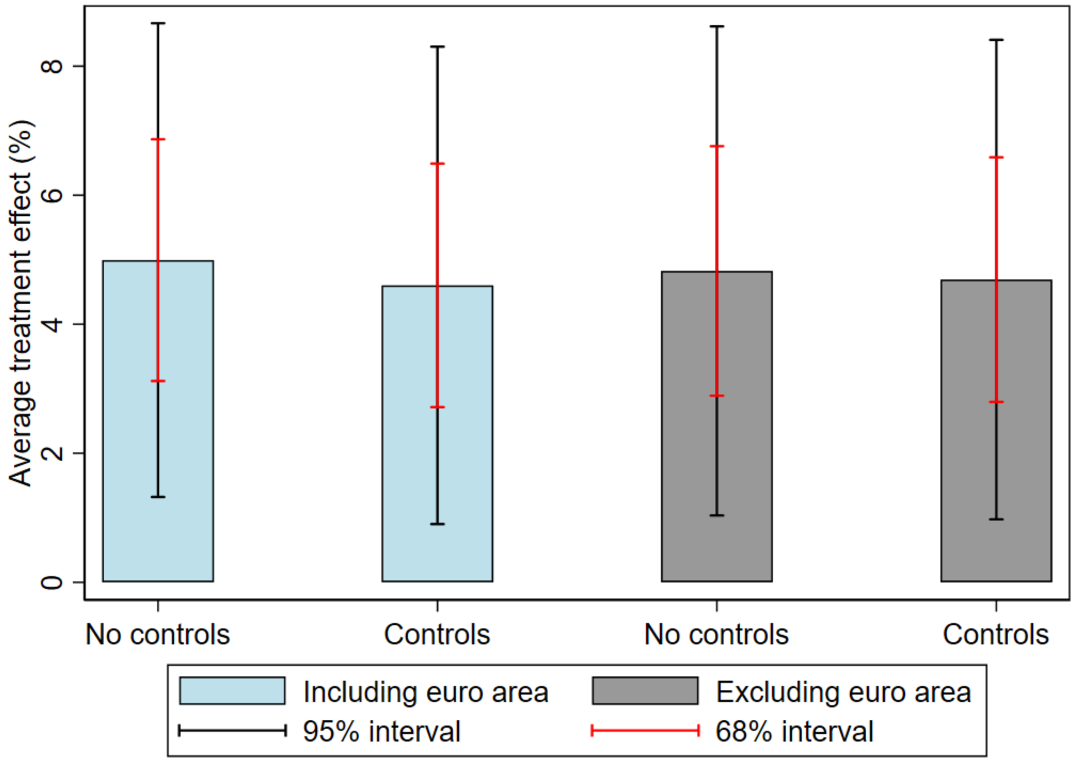
Notes: Figure B.1 depicts the evolution of cross-border fast payment systems connections since 2017. Data are from Ferrari Minesso et al. (2025).

Figure B.2: Average trade growth



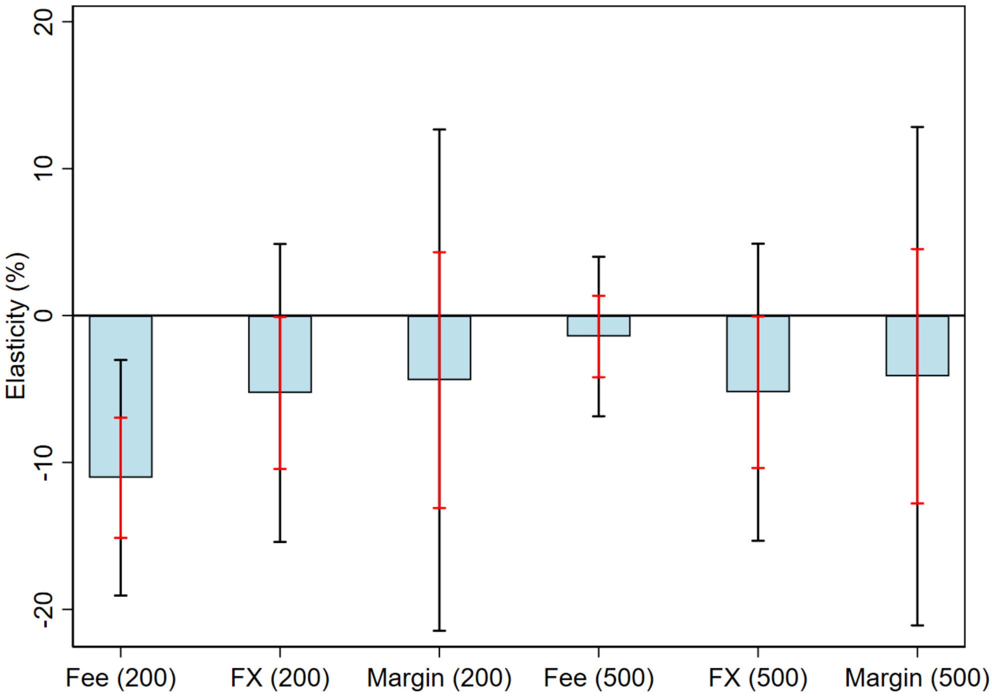
Notes: Figure B.2 depicts the average bilateral trade growth between connected (black line) and non-connected (blue dashed line) countries expressed in percentage points. The black dashed line shows the average bilateral trade growth between connected countries before the first interlinking agreement. Averages are computed without weighting.

Figure B.3: Gravity estimation using same sample as synthetic difference-in-differences



Notes: Figure B.3 depicts the average treatment effect (i.e. the regression coefficient) with standard errors based on the gravity model estimate using the same sample and controls as in the synthetic difference-in-differences estimator. The model is estimated with PPML.

Figure B.4: Cost of remittances and interlinking



Notes: Figure B.4 depicts the coefficient of the interlinking dummy (× 100) from a gravity regression in which the left-hand-side variable of interest is remittance costs. Remittance cost data are taken from the World Bank's Remittance Prices Worldwide database. Apart from this substitution, the specification is identical to that in Equation (1) and includes the same set of control variables. The dependent variables are the remittance fee, the FX cost, and the FX margin for transfers of USD 200 and USD 500, respectively. All costs are expressed in local currency units. Owing to data limitations on remittance costs (covering 367 "country corridors" worldwide, from 48 remittance-sending countries to 105 receiving countries), the estimation sample is substantially smaller than in the baseline model, comprising approximately 1,000 observations and only 48 connections.

Acknowledgements

The authors would like to thank O. Arce, K. Avrai, M. Ca' Zorzi, G. Kalogeropoulos, D. Lodge, C. Lucifora, A. Mehl, F. Pires, D. Sondermann, I. Van Robays, T. Vlassopoulos and participants to the 4th Banca d'Italia, European Central Bank and World Bank conference "Trade, value chains and financial linkages in the global economy", the 18th FIW research conference "International Economics", and seminars at the European Central Bank.
The views expressed in this paper are those of the authors and do not necessarily reflect those of the European Central Bank or the Eurosystem.

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PDF ISBN 978-92-899-7716-6 ISSN 1725-2806 doi:10.2866/3206893 QB-01-26-076-EN-N