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Trade and capital flows - substitutes or complements? An empirical investigation

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Ansgar Belke and Clemens Domnick[1]

Trade and Capital Flows – Substitutes or Complements? An Empirical Investigation

Abstract

This paper examines the linkages between the trade of goods and financial assets. Do both flows behave as complements (implying a positive correlation) or as substitutes (negative correlation)? Although a classic topic in international macroeconomics, the empirical evidence has remained relatively scarce so far, in particular for the Euro area where trade and financial imbalance played a prominent role in the build-up of the European sovereign debt crisis. Consequentially, we use a novel dataset, providing estimates for financial flows and its four main categories for 42 countries and covering the period from 2002-2012, to test the so-called trade-finance nexus. Since theoretical models stress that both flows might be influencing each other simultaneously, we introduce a novel time-varying instrumental variable based on capital control restrictions to estimate a causal effect. The results of the gravity regressions support theories that underline the complementarity between exports and capital flows. When testing the trade-finance nexus for different types of capital flows, the estimated coefficient is most pronounced for foreign direct investment, in line with theories stressing informational frictions. Robustness checks in the form of different estimation methods, alternative proxies for capital flows and sample splits confirm the positive relationship. Interestingly, the trade-finance nexus does not differ among countries belonging to the EMU, the European Union or among core and peripheral Euro area countries.

JEL Classification: F14, F15, F21, F41

Keywords: Capital flows; economic integration; Heckscher-Ohlin paradigm; interaction between trade integration and capital mobility; trade

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1 Ansgar Belke, UDE, CEPAS, and IZA; Clemens Domnick, UDE. – *The authors would like to thank Daniel Gros, Daniel Wissmann, Kathrin Ullrich, Christoph Schröder and seminar participants at the 4th INFER workshop for Applied Economics (Haifan University), for valuable comments. All remaining errors are our own.* – *All correspondence to: Prof. Dr. Ansgar Belke, Department of Economics and Business, University of Duisburg-Essen, Gebäude WST, Berliner Platz 6-8, 45127 Essen, Germany, e-mail: ansgar.belke@uni-due.de*

1 Introduction

One feature of the world economy over the recent decades has been the marked increase in economic integration. This holds especially true for trade and capital flows. For advanced economies, the volume of trade in goods and services more than quadrupled between 1980 and 2014. During the same time, financial globalization through increased capital flows even outpaced trade integration (UNCTAD, 2012; Bluedorn et al., 2013; Alberola et al., 2016; Davis and van Wincoop, 2017).

In this paper, we empirically analyze the relationship between trade and finance.[1] From a theoretical point of view, trade and financial flows might behave either as complements or as substitutes. If they are complements, trade and financial flows should exhibit a *positive* relationship, while one would expect a *negative* correlation in the case of substitutes. In his classical analysis, Mundell (1957) shows that trade and capital flows are substitutes. An increase in trade integration thus reduces the incentive for capital to flow. This view, however, has been challenged by more recent theoretical models incorporating financial frictions that point to a complementarity between trade and capital flows (Antràs and Caballero, 2009).

Analyzing the so-called trade-finance nexus is not only pivotal to gain a deeper understanding of the interaction of the forces that shape the process of globalization, but also directly relates to current international debates among policy makers that prominently focus on trade, as illustrated by the controversial and publicly scrutinized discussions concerning the NAFTA and TTIP (re)negotiations or the US-China trade deficit, but do not shed light on the role of financial integration in this process.[2] Furthermore, these linkages are also relevant when analyzing currency and financial crises (Goldberg and Klein, 1999). For instance, sudden reversals of capital flows can have severe consequences for the real economy. These considerations are especially important in the context of the sovereign debt crisis in the European Monetary Union. The introduction of the Euro fuelled large current account imbalances in the "peripheral" countries, such as Spain, induced by cheap financing by "core" countries such as Germany (Chen et al., 2013; Hale and Obstfeld, 2016). When the external imbalances came to light during the beginning of the Euro area sovereign debt crisis end-of 2009, it became a contested policy issue whether and to what extent both types of flows from the core to the periphery were related.[3]

[1] Throughout the paper we use the words financial and capital flows interchangeably, likewise for European Monetary Union and Euro area.

[2] NAFTA stands for North American Free Trade Agreement and TTIP is the acronym for Transatlantic Trade and Investment Partnership.

[3] For an economic explanation of the crisis in the Euro area, see Lane (2012), and Lane (2010) for an analysis of intra-European external imbalances.

Separately, the determinants of trade and capital flows have been analyzed through the lens of the gravity equation pioneered by Tinbergen (1962) and attracted a remarkable attention in the academic literature (Papaioannou, 2009; Head and Mayer, 2014). However, only a few academic studies investigate the interaction between both flows. Using bilateral data, these studies generally find a positive relationship between trade and financial flows. However, they are either constrained by relying on a cross-sectional framework (Aviat and Coeurdacier, 2007; Lane and Milesi-Ferretti, 2008), focusing on only one particular source country (Kalemli-Ozcan and Nikolsko-Rzhevskyy, 2010; Taylor and Wilson, 2011), or not controlling for endogeneity between trade and financial flows (Portes and Rey, 2005).

Consequently, our contribution complements the existing literature in several ways. First, we provide a comprehensive econometric analysis to test whether trade and financial flows do co-move by using a novel dataset by Hobza and Zeugner (2014). This dataset improves earlier efforts in several dimensions: it provides (i) consistent estimates of the bilateral financial *flows* between countries, (ii) by different types, (iii) covering a broad range of countries for (iv) an extended period of time, including the recent period of economic crisis.[4] Second, we split our aggregate measure of capital flows into different types, namely foreign direct investment (FDI), portfolio equity and debt as well as other investment to address their heterogeneous impact on trade. Third, we introduce a novel instrumental variable in our empirical framework, based on a time-varying index of the magnitude of capital control restrictions compiled by Fernández et al. (2015), to account for potential endogeneity. Lastly, we also contribute to the literature on the effects of monetary unions by testing whether the effect of financial flows on trade flows differed along country pairs that belonged (a) to the European Union (EU), (b) to the Euro area (EA) and (c) to a core and a peripheral EMU country.[5]

To briefly summarize our main findings, the estimation results point to a robust complementarity between trade and finance. The benchmark fixed effects regression shows that aggregate financial flows - defined as net acquisitions of foreign assets by domestic agents[6] - are statistically positively correlated with trade flows: each Euro in gross capital outflows increases exports by 25 Cents. This positive relation is robust to (a) splitting the sample across different time periods (pre- and post-crisis), (b) different estimation methods (fixed effects, random effects, pooled OLS) and (c) estimations in logarithms.

[4] There are several datasets that compile bilateral financial data, for instance Gourinchas et al. (2012), Lane and Milesi-Ferretti (2007), or Waysand et al. (2010). However, they are either constrained in the cross-sectional coverage, i.e. countries, or in their time dimension. Neither of them provides estimates of bilateral financial *flows*.

[5] We define the core as Austria, Finland, France, Germany, Netherlands, and the periphery as Greece, Ireland, Italy, Portugal, Spain.

[6] Throughout the study, a positive (negative) value of net foreign acquisitions is equivalent to an increase (decrease) in outward bilateral capital flows.

The statistically significant relationship holds even after using instrumental variable (IV) estimations: in our preferred setting, each Euro increase of capital flows raises exports by 52 Cents. The effect varies across the different types of capital flows, with FDI having the strongest positive impact on exports. However, the trade-finance nexus is not statistically different within certain country clusters, namely i) the EU, ii) the EMU or iii) between core and peripheral EMU countries.

The remained of the paper proceeds as follows: Section 2 provides an overview of the theoretical and empirical literature on the trade-finance nexus, with a special focus on the EMU. Section 3 presents our main hypothesis, the data and the empirical framework, while Section 4 discusses the estimation results. Section 5 finally concludes.

2 Related literature

2.1 Theoretical literature

The now famous Heckscher-Ohlin paradigm and the analysis of Mundell (1957) provide the starting point to study the interaction of trade integration and capital mobility. In the classical Heckscher-Ohlin-Mundell (HOM) two-goods, two-factors framework, free trade leads to factor price equalization with the rest of the world. Once factor price equalization has materialized, the mobility of international capital becomes irrelevant. Consider two countries with different endowment of capital. If both countries have the possibility to trade with each other, there is no need for capital to flow from the capital-abundant to the capital-scarce country since rate of return differences can be eliminated by trade alone. As a result, international trade and capital flows behave as substitutes. Several contributions modified the basic HOM framework with more realistic features, ranging from technological differences (Kemp, 1966; Jones, 1967) to production uncertainty (Helpman and Razin, 1978). Under these modifications, trade and factor flows can be complements with causality running from international capital to trade flows. Markusen (1983) shows that the results of Mundell (1957) are rather an exception than the rule. By comparing several models and modeling assumptions, he concludes that trade in goods and factor flows behave in general as complements.

To model the trade-finance nexus recent contributions attempt to incorporate financial frictions into macroeconomic dynamics. The analysis of Antràs and Caballero (2009) forcefully argues that capital and trade flows are complements. In their model, higher trade integration leads to higher capital inflows to the capital-scarce country. Thus, and as opposed to earlier research, causality runs from trade to international capital flows. Other modeling approaches link trade and capital flows to the degree of maturity of financial institutions (Furusawa and Yanagawa, 2013): the less developed financial institutions are,

the more trade and capital flows behave as complements. Rose and Spiegel (2002) present a theoretical model around the argument that countries service their external debts due to the fear that default might lead to a decrease of trade. As a result, countries tend to trade more with countries they have closer financial ties with. Other studies point to transaction costs (Portes et al., 2001) or information asymmetries (Hahm and Shin, 2009) that lead to complementarity of trade in goods and financial assets.

Summarizing, the results of the theoretical literature tend to point to a complementarity between trade and capital flows. The theoretical models do not uniquely identify a common direction of causation between both types of flows, giving rise to the possibility that trade and financial flows influence each other jointly. This has important consequences for empirical studies testing the trade-finance nexus, since this kind of endogeneity requires the use of instrumental variables to estimate a causal effect.

2.2 Empirical literature

There are several strands of empirical literature that, directly or indirectly, examine the trade-finance nexus. The first strand focuses on the relationship between capital flows and trade (openness) on the *individual* country level. For instance, Broner et al. (2013) examine the general determinants of gross capital flows and their behavior over the business cycle, finding that openness to trade and capital inflows are indeed positively related. Aizenman and Noy (2008) find positive effects between openness to trade and FDI flows. They also point out that both variables do simultaneously affect each other. However, Granger causality tests show that gross FDI flows have a higher impact on trade openness than vice versa. Even though the unit of observation - i.e. an individual country as cross-sectional unit - does not allow to conclude that *bilateral* trade and financial flows co-move, this strand of literature generally finds that countries that are more open to trade also enjoy higher levels of financial integration.

Another strand of the literature uses *bilateral* country data to test the relationship between trade in goods and financial assets. Studies that look at a single source country include Taylor and Wilson (2011). Using data on gross private and public issues from the United Kingdom from 1870 to 1913 and public and private bond data for the United States from the interwar period, they find a statistically positive and robust correlation between trade and gross capital flows. According to their OLS-setting, a 1% increase in trade flows triggered a 1.17% increase in financial flows for the British pre-war period, and a 0.7% increase for US interwar capital flows. Using geographical variables such as the length of a country's coastline to instrument for trade flows, their IV estimation results remain positive and statistically significant. In another historical setting, Kalemli-Ozcan and Nikolsko-Rzhevskyy (2010) use data on Turkish trade and capital inflows (FDI) by three

source countries from 1859-1913. Since at that time Turkish exports were predominantly concentrated in the agricultural sector, they use variations in rainfall to instrument trade flows. They find empirical evidence confirming theoretical trade models that stress the complementarity between trade and capital flows. The result of complementarity between trade and capital flows stands at odds with Ahearne et al. (2004) that use cross-sectional data from 1997 for the US as source country. They find no statistically significant relationship between US purchases of foreign equity and trade in goods.

Other studies rely on multiple source and receiving countries, but focus mostly on one specific type of financial asset. There exists a vast literature showing that an increase in foreign direct investment boosts bilateral trade links.[7] By using various estimators (OLS, fixed and random effects), Rose and Spiegel (2002) empirically validate that bilateral bank lending is positively related to bilateral trade. Indeed, Blank and Buch (2010) confirm that the international activity of banks is positively related to trade in goods. The seminal paper of Portes and Rey (2005) is one of the few studies using contemporary data on financial *flows* to test the trade-finance nexus. Using bilateral gross equity flows for 14 countries between 1989-1996, they find that a 10% increase in goods trade leads to a 3.4% increase in equity flows.

In a slightly different setting, Aviat and Coeurdacier (2007) use a simultaneous gravity model framework to examine the correlation between bilateral asset holdings and trade flows.[8] They find a statistically significant positive relationship between trade in goods and asset holdings, using OLS and IV estimations based on four different instruments (legal system, fiscal treaty, interest and dividend taxation). Overall, an increase of 10% in asset holdings results in an 2% increase in bilateral trade. Lane and Milesi-Ferretti (2008) focus on the drivers of bilateral equity holdings. In their cross-sectional setting for the year 2001, bilateral equity holdings are positively correlated with bilateral trade flows. This result confirms the theoretical predictions of Obstfeld and Rogoff (2000) that trade costs induce a bias in investors' portfolio towards assets of trading partners. Concluding, these strands of the empirical literature generally support the complementarity between trade and financial flows.

[7] Complementarity of trade and FDI is confirmed by studies focusing on i) multiple source and receiving countries (Martínez et al., 2012), ii) on a single (source) country, like Portugal (Magalhães and Africano, 2007) or Malaysia (Goh et al., 2013), or iii) on mergers and acquisitions alone (Di Giovanni, 2005; Erel et al., 2012). Brouwer et al. (2008) examine trade and FDI flows in the context of the enlargement of the EMU. Their gravity specification shows that FDI stocks have a positive correlation with bilateral exports, with trade and factor flows behaving as complements. For theoretical models, see Markusen and Venables (1999) or Baldwin and Ottaviano (2001), among others.

[8] Portes and Rey (2005) show that equity flows and holdings are closely correlated.

2.3 Trade-Finance nexus and the EMU

Does joint membership in the EMU change the pattern of trade in goods and financial assets? Generally, one of the main motivations to implement the EMU was to eliminate exchange rate risks and spur economic integration. There exists a vast literature on how joining a monetary union affects trade flows, starting with the seminal work of Rose and van Wincoop (2001).[9] In the context of the Eastern enlargement of the EMU, Belke and Spies (2008) estimate that a common currency has spurred intra-EMU imports by 7%. Similarly, joining the EMU also leads to an increase in bilateral financial relationships within the monetary union by lowering transaction costs and diversification gains, as shown by Coeurdacier and Martin (2009). For instance, Schmitz and von Hagen (2011) find that the introduction of the Euro has supported financial integration between the Euro area member countries as opposed to countries that did not join.[10]

Concerning the *geographical composition* of the bilateral capital flows within the EMU, the introduction of the Euro fueled large capital flows from core countries with trade surpluses to member countries with trade deficits (Lane, 2013; Hale and Obstfeld, 2016). Furthermore, Hale and Obstfeld (2016, p. 136) state that there are " (...) several reasons why the core EMU lenders might have had a comparative advantage over financial centers in lending to GIIPS". Blanchard and Giavazzi (2002) lay out the economic theory behind these observed flows, arguing that these capital flows were indeed what open economic macroeconomic models would predict: capital "runs" downhill from richer (core) to poorer (peripheral) countries. These bilateral imbalances played an important role in the run-up (and eruption) of the sovereign debt crisis in the Euro area.

However, research on the trade-finance nexus in the Euro area is scarce. Berger and Nitsch (2013) are one of the few authors who investigate a related research question, i.e. whether country-pairs that have a surplus in bilateral trade relationships also exhibit a surplus in the financial balance vis-à-vis each other. Using a time-span from 2001-2008, they find a positive statistical effect between trade and financial linkages which especially holds for members of the Euro area. However, they approximate the bilateral financial balance by taking the difference between aggregate bilateral assets and liabilities, and consequently do not take the so-called valuation effect[11] into account which can be sizeable (Hobza and Zeugner, 2014).

[9] Glick and Rose (2002) estimate that countries joining a currency union nearly double their trade volumes. In a follow-up paper, Glick and Rose (2016) reassess their previous estimation results with different empirical specifications, a more exhaustive data set and a special focus on the EMU. In their preferred specification, joining the EMU has boosted trade among member states by around 50%.

[10] Other studies find a positive EMU effect for FDI (de Sousa and Lochard, 2011), equity (Lane and Milesi-Ferretti, 2005), bond holdings (Lane, 2006) and for bank loans (Spiegel, 2009).

[11] Unrealized capital gains that arise from local-currency asset price and currency movements are reflected in a country's net foreign asset position but not in its current account. As a consequence, the change in

Summarizing, the empirical literature on the trade-finance nexus varies predominantly along three dimensions: (i) the cross-sectional units, i.e. one vs. many source countries and the general country coverage, (ii) the estimation methods, varying between fixed or random effects panel regressions, (pooled) OLS and instrumental variable regressions, and (iii) the use of either capital flows or holdings and its different types, ranging from portfolio equity, banking flows or foreign direct investment. Many of these studies are either limited by the size of the cross-section (Kalemli-Ozcan and Nikolsko-Rzhevskyy, 2010; Taylor and Wilson, 2011), constrained in the time dimension (Aviat and Coeurdacier, 2007; Lane and Milesi-Ferretti, 2008), or do not focus on the EMU. Furthermore, only very few studies use instrumental variables to estimate a causal effect. Consequently, we complement the empirical literature by (i) using a broad country-sample with multiple sending and receiving countries and (ii) various types of capital flows, (iii) implementing multiple estimation methods, including a time-varying instrumental variable approach, and (iv) focusing on the effect of the EMU.

3 Empirical framework

3.1 Regression framework and hypothesis

Guided by the related theoretical and empirical literature, we will now proceed by empirically testing three hypotheses. The first hypothesis concerns the general interlinkage between finance and trade. In order to investigate the trade-finance nexus, we rely on a well-established framework: the gravity equation.[12] In line with previous studies (Fontagné and Pajot, 2002), our empirical gravity equation takes the following functional form

$$exports_{ijt} = \alpha + \beta_1 finflows_{ijt} + \beta_2 ln(GDP_{it}) + \beta_3 ln(GDP_{jt}) + \beta_4 ln(pop_{it}) + \beta_5 ln(pop_{jt}) + X_{ij} + \delta_i + \omega_j + \theta_t + \epsilon_{ijt} \quad (1)$$

where

- $exports_{ijt}$ stands for real exports from country i to country j in year t,

a country's net foreign asset position does not equal its current account. See Gourinchas (2008) for a thorough overview and discussion of the valuation effect.

[12] For an overview of the derivation and main applications of the gravity equation, see for instance, Bergstrand and Egger (2011) or Anderson (2011).

- $finflows_{ijt}$ represents real financial flows[13] from country i to country j in year t, consisting of the sum of FDI, portfolio flows (debt and equity) and other investment,
- ln(GDP) is the logarithm of real GDP of country i and j,
- ln(pop) is the logarithm of the population of country i and j,
- δ_i and ω_j are sending and receiving country fixed effects to absorb time-invariant country specific effects,
- θ_t are time fixed effects to control for year-specific shocks,
- ϵ_{ijt} is the idiosyncratic error term, assumed to be identically and independently distributed,
- the vector X_{ij} includes different country-pair specific gravity variables that are common in the literature. We include the distance between two countries as a proxy for trade costs and add five binary variables that are unity if i and j (i) have a common language, (ii) share a common border, (iii) had ever had a colonial link, are members of (iv) the EU and (v) the EA[14], respectively.

We can summarize hypothesis one as follows: if the coefficient of financial flows, β_1, is positive, financial and trade flows are complements. If it is negative, however, financial and trade flows are substitutes.

The second hypothesis to be tested focuses on the question of whether the trade-finance nexus varies across members of three different country clusters, i.e. (i) the EU, (ii) the EA or (iii) the core-periphery within the EA. Consequently, we expand our benchmark equation 1 by an interaction term between financial flows and the dummy variable "Region". For the country cluster EA and EU, this dummy variable equals 1 if both source and destination country belong to both the Euro area and the European Union, respectively. In case of the "core-periphery" cluster, the dummy variable takes the value 1 if the *sending* country

[13] While bilateral gross foreign assets are either positive or 0, the underlying financial flows are not. By taking logarithms of our capital flows measure, we would lose around one third of our observations and censor our sample substantially. Following Rose and Spiegel (2002) and Fontagné and Pajot (2002), we therefore include the variables of interest, real exports and real financial flows, in levels.

[14] We define member of the Euro area as those countries that entered the third stage of the EMU, i.e. that replaced their national currency with the Euro, initiated with the introduction of the Euro in 1999. The EMU consisted initially of eleven members (Austria, Belgium, Germany, Ireland, Spain, France, Italy, Luxembourg, Netherlands, Portugal, Finland); Greece joined in 2001, Slovenia in 2007, Cyprus and Malta in 2008, Slovakia in 2009 and Estonia in 2011. The subsequent accessions of Latvia (2014) and Lithuania (2015) are not taken into account since our panel lasts only up until 2012.

belongs to the core and the *receiving* country to the periphery and zero otherwise, thus reflecting the focus of the policy discussion during the sovereign debt crisis.

$$exports_{ijt} = \alpha + \beta_1 finflows_{ijt} + \beta_2 finflows_{ijt} \times REGION_{ijt} + \beta_3 REGION_{ijt} + \beta_4 lnGDP_{it} + \beta_5 lnGDP_{jt} + \beta_6 lnpop_{it} + \beta_7 lnpop_{jt} + X_{ij} + \delta_i + \omega_j + \theta_t + \epsilon_{ijt} \quad (2)$$

We do not have a prior regarding the direction of the influence. On the one hand, common rules (and a common currency) should decrease informational frictions, making capital flows *less* dependent on trade relations. On the other hand, common institutional features could also fuel relationships between countries that traditionally had low transaction costs, leading to a *stronger* complementarity. As such, a positive (negative) estimated coefficient for β_2 is evidence for a stronger complementarity (substitutability) of trade in the form of exports and financial flows between country-pairs belonging to that specific cluster compared to the other country-pairs.

By using an aggregate measure for financial flows, we restrict the four different types, namely FDI, other investment, portfolio debt and portfolio equity, to have the same effect on real exports. However, the aggregate linkage between trade in goods and financial assets might be driven only by a subset of these flows (Koepke, 2015).[15] Therefore, our third hypothesis focuses on whether exports do react heterogeneously and in an idiosyncratic way to different types of financial flows by running equation 1 for each of the four types separately.

Generally, the structure of the data allows the use of panel data methods such as fixed and random effects that can control for unobserved heterogeneity across countries and over time.[16] The main difference between the latter two models lies in the role of the individual fixed effects δ_i and ω_j. The random effects model implies that country fixed effects are uncorrelated with the explanatory variables, as opposed to the fixed effects estimator that allows the country fixed effects to be correlated with the explanatory variables. In line with the literature, we start by using and evaluating the performance of several estimators: a pooled OLS estimator to generate a first benchmark regression as well as fixed (within) and random effects to control for unobserved heterogeneity.

[15] There are other strands of literature that stress the different drivers and impacts of capital flows depending on their form. For instance, equity and debt flows have a different impact on business cycle synchronization (Davis, 2014; Blanchard et al., 2015) or on the occurrence of banking crises (Boukef Jlassi et al., 2018).

[16] Bergstrand and Egger (2011) and Baltagi et al. (2014) provide a comprehensive overview and discussion about the estimation of the gravity equation.

Lastly, as outlined in the theoretical section, financial and trade flows may influence each other simultaneously. Therefore, it is crucial to implement an instrumental variable approach to estimate a causal relationship instead of establishing mere correlations. Despite the difficulties to find adequate instruments for either of the two variables given their common drivers, we argue to have identified valid instruments for financial flows, as will be discussed in detail in Section 4.4. Consequently, we opt for modeling trade as dependent and financial flows as independent variable, even though the reverse, i.e. capital flows as dependent variable and trade as independent variable, would also be possible (Aviat and Coeurdacier, 2007).

3.2 Data

One of the core pillars of our empirical analysis are the bilateral financial flow data provided by Hobza and Zeugner (2014). Gross bilateral financial outflows are defined as net financial asset purchases of the reporting (sending) country in the partner (receiving) country.[17] Their data has some distinct advantages compared to earlier data sources such as Waysand et al. (2010). First, Hobza and Zeugner (2014) provide consistent estimations for financial flows.[18] In particular, their estimates are corrected for the valuation effect, which is crucial when deriving financial flows from financial stock data (Gourinchas, 2008). Second, it provides a broad country and time coverage and, third, it is available for different financial instruments. Generally, financial flows between two countries can also stem from more complex international transactions. This is especially true for financial centers which act as intermediaries. Financial flows to these centers will be markedly more pronounced than trade flows, potentially hiding the true relation between both variables. Consequently, we drop the financial hubs from our data set, in line with the literature (Peter, 2012).[19]

For our data analysis, we label "gross financial flows" as the sum of FDI, portfolio equity, portfolio debt and other investment flows. Data on bilateral trade relations are taken from the IMF Direction of Trade Statistics (DOTS). We use the respective consumer price index

[17] The balance of payments distinguishes between *gross* and *net* capital flows. *Net* capital outflows (NCO) are defined as NCO = ΔA - ΔL, i.e. the difference between the change of domestic holdings of foreign assets and the change of foreign holdings of domestic assets. *Gross* capital outflows ΔA represent the difference between purchases and sales of foreign investments.

[18] Hobza and Zeugner (2014) describe how they compiled first the estimated bilateral international investment position (IIP), i.e. the gross assets held by reporting country i in partner country j, and then proceeded to estimate the underlying bilateral financial flows. For a more detailed explanation, see also the web appendix under: www.zeugner.eu/studies/finflows/Fin_flow_EA_IbAppendix.pdf.

[19] Specifically for our sample, these include: Bahamas, Bahrain, Barbados, Bermuda, Cayman Islands, Gibraltar, Guernsey, Isle Of Man, Jersey, Lebanon, Macao, Mauritius, Netherlands Antilles, Panama, Samoa, British Ist Indies, Andorra, Liechtenstein and Luxembourg. See Lane and Milesi-Ferretti (2008) for a discussion of financial offshore centers acting as intermediaries and Warnock and Cleaver (2003) for a more general discussion.

Table 1: Descriptive statistics

	Obervations	Mean	SD	Min	Max
Fin. Flows	18942	1,236	9,291	-156,752	280,257
Real Exports	18942	3,094	12,059	0	283,698
Language	18942	.074	.26	0	1
Former Colony	18942	.033	.18	0	1
Log. Distance	18942	8	1.1	4.1	9.9
Log. GDP	18942	26	1.7	22	30
Log. Population	18942	16	1.5	13	20
Debt	18942	757	7,887	-172,451	246,959
Equity	18942	479	3,469	-60,833	77,274
FDI	18942	364	2,475	-40,240	83,939
Other Investment	18942	385	6,078	-110,280	166,354
Portfolio Debt	18942	372	3,837	-64,334	125,651
Portfolio Equity	18942	116	2,411	-77,422	68,213

Notes: Financial flows are the sum of FDI, portfolio equity and debt and other investment. Exports and all types of financial flows are denominated in mio. Euros (real, 2010)

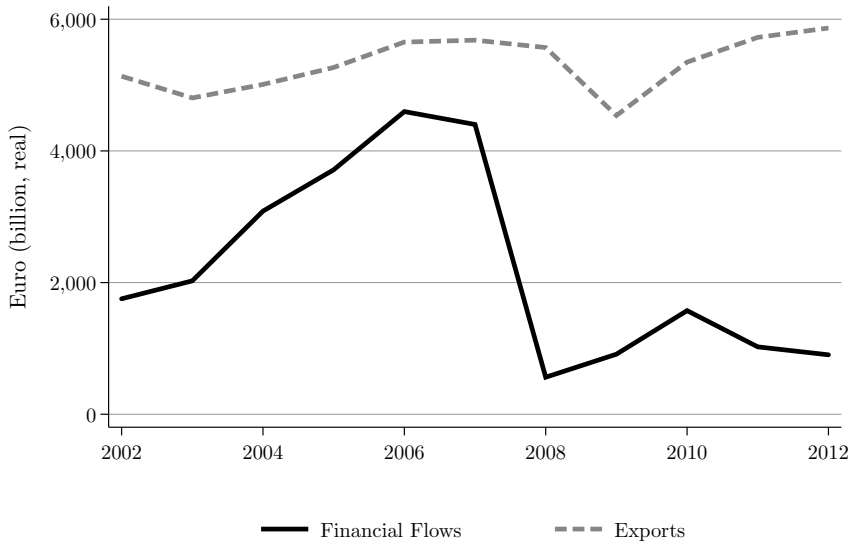
to deflate the financial (harmonized EU CPI) and export (US CPI) data, whereas the latter are then converted to Euros. Data on real GDP and population are taken from the WDI Database of the World Bank. CEPII provides the time-invariant gravity-type variables: distance, common border, former colony and common language (Mayer and Zignago, 2011). Our final sample of countries includes 42 source and host countries from 2002-2012. Table A.1 in the Appendix provides an overview of the data and the different sources.

3.3 Descriptive statistics

Table 1 presents the descriptive statistics of the main variables contained in our empirical model. On an annual basis, countries in our sample invest on average around 1,2 billion EUR in each partner country. These aggregate statistics hide, however, a significant level of heterogeneity. For instance, on a country-pair level, bilateral financial flows between the United States and the United Kingdom are the biggest in magnitude, reflecting also the interaction between two of the world's most important financial centers, New York and London. With regard to the volume, the bilateral linkages between the two countries reached their peak with 280 billion EUR (from UK to the US) in 2006, just before the outbreak of the global financial crisis.

When it comes to the type of capital flow, bilateral debt flows are, on average, with 757 million EUR around 58% larger than aggregate bilateral equity flows, with other investment

Figure 1: Exports and financial flows over time



Notes: Financial flows are the sum of FDI, other investment, portfolio debt and equity flows.

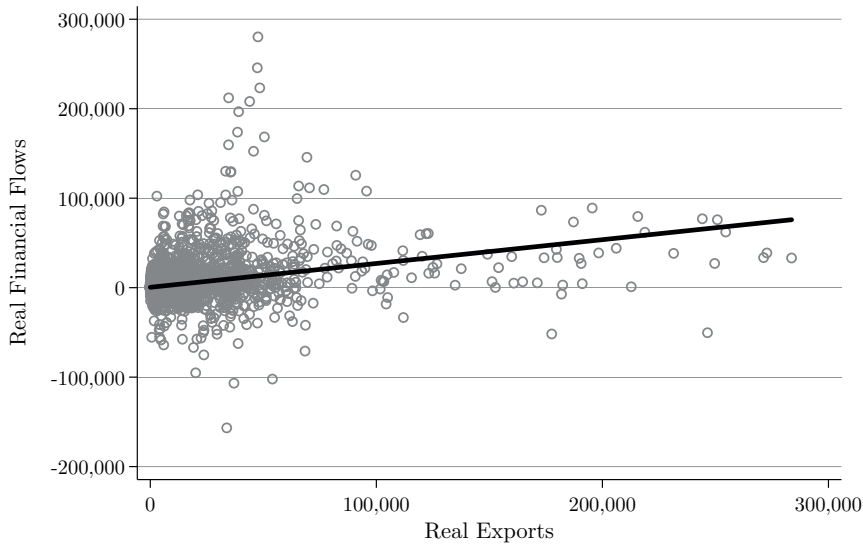
and FDI being the biggest position in debt and equity flows, respectively.[20] Mean bilateral real exports display a magnitude of 3,1 billion EUR, with Canada and the United States being the most intense trading partners.

Figure 1 plots the average bilateral capital flows and exports over time. In comparison to the development of exports, capital flows exhibit a higher volatility. A striking fact is the increase of capital flows in the period from 2003-2007, which was followed by a massive drop in 2008. The reversal of capital flows mirrors the unfolding of the financial crisis. Exports, on the other hand, just rose steadily from 2003 onward but incurred a significant drop in 2009, a year after capital flows began to shrink. Even though the decrease in exports appears minor compared to the decrease in capital flows, Baldwin (2009) suggests that global trade fell by an estimated 25%.

In Figure 2, we plot the real exports against the corresponding financial flows. As first suggestive evidence, a simple correlation coefficient between financial flows and exports indicates a positive relationship with $\rho = 0.35$.

[20] We define equity flows as the sum of FDI and portfolio equity flows and debt flows as the sum of other investment and portfolio debt flows.

Figure 2: Correlation between bilateral financial flows and exports



Notes: Financial flows are the sum of FDI, other investment, portfolio debt and portfolio equity flows.

4 Estimation results

4.1 Are trade and financial flows complements or substitutes?

Our first hypothesis investigates whether an increase in gross capital outflows is matched by an increase in bilateral exports. Or put differently: do trade and finance co-move? A positive relationship would indicate complementarity, a negative substitutability between both flows. Table 2 provides estimates of equation 1 with pooled OLS (column 1), RE (column 2) and FE (column 3). For all specifications, we cluster the standard errors at the country-pair level. In all three models, financial flows are positively correlated with exports. These results support theories stressing that trade in goods and in financial assets are not substitutes but behave as complements. The size of the effect, however, varies. The results for the pooled OLS and fixed effects model are in close range: for the former (column 1), a one Euro increase in bilateral financial flows raises exports by 0.31, and for the latter

Table 2: OLS, fixed and random effects estimation results

	(1) OLS	(2) RE	(3) FE
Financial Flows	0.310***	0.0221***	0.250***
	(0.0706)	(0.00766)	(0.0576)
Observations	18942	18942	18942
R^2	0.351		0.450
Year FEs		✓	✓
Sending FEs			✓
Receiving FEs			✓
Gravity Controls	✓	✓	✓

Notes: The dependent variable is real bilateral exports. Capital flows are the sum of foreign direct, portfolio debt and equity and other investment. Clustered standard errors at the country-pair level in parentheses. ***/**/* indicate significance at the 1%/5%/10% level.

(column 3) by 0.25 Euros, respectively. The coefficient for the RE model drops compared to the FE setting by around 90% to 0.02 Euros.[21]

The difference in the magnitude of the coefficient β_1 can be explained by the way the unobserved heterogeneity on the country-level is modeled.[22] Consider, for instance, the quality of institutions, such as a better administration and a judicial system that ensures the rule of law. These time-invariant variables are captured by the country-specific effects δ_i and ω_j. Generally, countries with better institutions are expected to exchange more in finance and trade (Dollar and Kraay, 2003; Papaioannou, 2009). Consequently, our variables of interest, financial flows and exports, are positively correlated with the unobserved country-specific effects. Their inclusion explains the drop in the estimated coefficient β_1 in column 3 compared to column 1. Furthermore, the assumption of the random effects model that the country-specific effects and the covariates are uncorrelated is violated (Cameron and Trivedi, 2005). In order to discriminate more formally between using a fixed or a random effects model, we employ both the Hausman and the LM test, with the latter being appropriate in the case of heteroscedasticity. Both are rejected at the 1% significance level. Therefore, we use the fixed effects estimator for our subsequent analysis, as proposed by Egger (2000).[23]

[21] Diagnostic checks reveal that our estimation results are not driven by outliers.

[22] As Egger (2002) pointed out in the context of the gravity equation, ignoring the unobserved heterogeneity and using a pure cross-sectional approach, i.e. pooled OLS, is likely to result in a severe misspecification.

[23] We test the significance of the country fixed effects using an F-test. For both the sending and receiving countries, the calculated F-statistic rejects the null hypothesis at the 1% significance level.

Table 3: Fixed effects model estimation results: country clusters I

	(1) EU	(2) EA	(3) Core - Per.
Financial Flows	0.303*** (0.108)	0.249*** (0.0689)	0.255*** (0.0612)
EU	995.8** (447.7)		
EU × Financial Flows	-0.130 (0.121)		
EA		2565.8*** (654.8)	
EA × Financial Flows		0.00713 (0.111)	
Core Periphery			1551.9 (2211.0)
Core Periphery × Financial Flows			-0.115 (0.0884)
Observations	18942	18942	18942
R^2	0.452	0.450	0.450
Year	✓	✓	✓
Sending	✓	✓	✓
Receiving	✓	✓	✓
Gravity	✓	✓	✓

Notes: The dependent variable is real bilateral exports. The regional dummy takes the value of 1 for country-pairs belonging to the European Union (column 1), the Euro area (column 2) or if the sending country belongs to the core and the receiving country to the periphery (column 3). The independent capital flow variable enters the equation in real terms. Clustered standard errors at the country-pair level in parentheses. ***/**/* indicate significance at the 1%/5%/10% level.

4.2 Does the trade-finance nexus vary for different country clusters?

Our estimation results suggest that real exports and financial flows do co-move. In this section, we analyze whether the movement of financial flows and exports varies for three specific country clusters. These clusters are based on whether both sending and receiving country are members of (i) the EU, (ii) the EA, or whether within the EA (iii) the sending country belongs to the core and the receiving country to the periphery (core-periphery).

Table 3 depicts the estimation results using fixed effect estimation with country and time specific fixed effects. Column 1 and column 2 display the results for the interaction between membership in the EU and the EA, respectively, while column 3 focuses on the core-periphery dimension.

In all three cases, the interaction terms are not statistically significant, pointing to the fact that the degree of correlation between trade and financial flows does not behave differently within our regional clusters compared to the other country pairs in the sample. Due to a significant overlap between EA and EU member states, multicollinearity issues could potentially reduce the efficiency of the estimation. As such, we re-run regression 2, but drop the EU and EA country dummy, respectively, as additional regressor. The results do, however, not change markedly, and confirm that the finance-trade nexus remains the same along the membership of the EU, EA and the core-periphery pattern (see Table A.3 in the Appendix).

4.3 Are exports driven by a particular subset of capital flows?

The analysis so far relied on the sum of portfolio debt and equity, FDI and other investment as a proxy for aggregate capital flows. In the following, we investigate whether our results are particularly driven by a subset of our four different capital flows. In a first assessment, the comparison of correlation coefficients between the different types and exports reveals that the magnitude varies (Table 4). All flows are positively related with exports, with FDI and portfolio debt having the strongest positive correlation, followed by other investment and portfolio equity. In the following, we test the reactivity of exports to the four different types of capital flows separately.

Our findings, as depicted in Table 5, point to a strong heterogeneity across different types of capital flows and their impact on exports. Specifically, exports react most strongly to foreign direct investment (column 1), followed by portfolio debt (column 3) and other investment (column 2). Apart from portfolio equity (column 4), the estimated coefficients for the other three types of capital flows are significant at the 1% level. These findings are consistent with arguments that link capital flows to informational frictions. In analogy to the theory in corporate finance, these frictions may lead to a certain "pecking order" for cross-border financial flows (Hahm and Shin, 2009). In the same vein, Daude and Fratzscher (2008) show that foreign direct investment has stronger ownership implications and higher fixed costs which makes it more information sensitive than portfolio investment. Generally, an increased volume of capital flows between two countries may also alleviate information asymmetries that lead in turn to increased exports. However, due to the

Table 4: Correlation coefficients between exports and types of capital flows

	Fin. Flows	Port. Debt	Oth. Inv.	FDI	Port. Eq.	Exports
Fin. Flows	1					
Port. Debt	0.635***	1				
Oth. Inv.	0.758***	0.200***	1			
FDI	0.480***	0.139***	0.179***	1		
Port. Eq.	0.395***	0.138***	0.0310***	0.0335***	1	
Exports	0.311***	0.245***	0.156***	0.313***	0.0553***	1

Notes: ***/**/* indicate significance at the 1%/5%/10% level.

different flow-dependent informational sensitivities, the reactivity of exports to different types of capital flows may vary.

In order to illustrate this case, consider the effect of FDI on exports from an informational-frictions perspective. Since FDI requires more interaction and deeper knowledge of the market than other forms of investment, it should also exert the biggest effect on exports (Daude and Fratzscher, 2008). As column 1 confirms, a one Euro FDI flow is associated with 1.1 Euros of additional exports, more than double the amount as in the case of portfolio debt that is ranked second with regard to its effect on exports (column 3). The magnitude of the estimated coefficient is in line with the findings of Fontagné and Pajot (2002) who estimate an increase in exports of around 1.2 US-Dollars for each US-Dollar invested. Another reason for the stronger co-movement between FDI and exports may also reflect an increase in intra-firm trade due to vertical integration since affiliates may rely on the parent company for intermediate or capital goods given the fragmentation of the production process (Goh et al., 2013). Another competing explanation concerning the different sensitivity of equity and debt investments on exports is provided by risk-sharing motives (Coeurdacier and Martin, 2009).

Table 5: Fixed effects model estimation results: types of capital flows

	(1) FE	(2) FE	(3) FE	(4) FE
FDI	1.107***			
	(0.337)			
Other Investment		0.166***		
		(0.0327)		
Portfolio Debt			0.485***	
			(0.111)	
Portfolio Equity				0.104
				(0.0887)
Observations	18942	18942	18942	18942
R^2	0.462	0.424	0.440	0.418
Year FEs	✓	✓	✓	✓
Sending FEs	✓	✓	✓	✓
Receiving FEs	✓	✓	✓	✓
Gravity Controls	✓	✓	✓	✓

Notes: The dependent variable is real bilateral exports. The different types of capital flows as independent variable enter the equation in real terms. Clustered standard errors at the country-pair level in parentheses. ***/**/* indicate significance at the 1%/5%/10% level.

4.4 Endogeneity

Up to this point, we have treated financial flows as exogenous and, thus, as a valid regressor. Theoretical models, as outlined in Section 2, established that financial and trade flows are potentially affecting each other simultaneously. Furthermore, our financial flows data are estimated and may contain measurement error, a fact acknowledged by Hobza and Zeugner (2014). The measurement error and potential reverse causation between trade and finance require the use of instrumental variable methods, a challenge in the context of the trade-finance nexus (Collins et al., 1997). While the measurement error attenuates the OLS and FE estimator towards zero, the direction of the simultaneity bias is more difficult to establish.[24]

In this context, we propose two different instrumental variable specifications. The first is a novel approach based on an index measuring the intensity of restrictions of capital flows across borders by Fernández et al. (2015). The authors provide broad indicators on

[24] Consider the simultaneous relationship of exports and financial flows as governed by the two following simplified equations: $exports_{ij} = \beta_1 finflows_{ij} + u_{ij}$ and $finflows_{ij} = \gamma_1 exports_{ij} + z_{ij}$. Simultaneity of capital flows and exports leads to an upward bias under the assumption that γ_1 and $\beta_1 > 0$ and $\gamma_1 + \beta_1 < 1$. For a further discussion, see Wooldridge (2010, 2015).

a country's stance towards outward and inward capital controls, building on the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER) and enhancing previous work by Schindler (2009) in coverage both in depth and scale. We create our time-varying instrumental variable capital control index by summing the index of *outward* capital restrictions from sending country i with the index of *inward* capital flow restrictions in country j. An increase in this index reflects the fact that either the sending of the flows from country i or the receipt of the flows by country j is getting more difficult, impacting bilateral capital flows negatively. In order to be valid, instrumental variables must be both relevant and exogenous, meaning that the instrument must be (strongly) correlated with financial flows but not with the error term (Cameron and Trivedi, 2005). Regarding relevance, previous research established that capital account openness is positively related to financial flows (Hattari and Rajan, 2011).

In a second specification and following previous studies (Beck, 2002; Aviat and Coeurdacier, 2007), we use variables popularised by the "law and finance" literature as instruments for capital flows. In a string of papers, La Porta et al. (1997, 1998) find that the legal origins and practices have a significant effect on the development of financial markets. Specifically, we use an index referring to the strength of (i) creditor and (ii) shareholder rights in a given country provided by La Porta et al. (1998).[25] We complement our sample by data on creditor and shareholder rights for transition economies provided by Pistor et al. (2000). In all specifications, we employ the bilateral sum of the creditor and shareholder rights, respectively, to instrument for bilateral financial flows.[26] As before, these instruments are valid if they affect exports only through financial flows but do not have a direct effect on exports or are correlated with any omitted variable that also affects exports.

Table 6 depicts our estimation results. In column 1, we include financial flows with a one-period time lag in order to minimize simultaneity concerns. Secondly, we instrument the financial flow variable with its first lag (column 2). While the coefficient in column 1 does not differ markedly from our benchmark results (Table 2 column 3), it doubles nearly in size in column 2. In both cases, the coefficients remain positive and statistically significant.

[25] La Porta et al. (1998) provide an index for "rule of law" which has also an effect on the development of financial markets. However, the empirical realisation of the Hansen J-statistic indicated that the set of instruments was not valid, i.e. rejected the null hypothesis of no correlation between our instruments and the error term when including the "rule of law" index in our IV regressions. Consequently, we dropped the variable from our IV specifications.

[26] Caporale et al. (2015) focus on the effect of trade and financial linkages on business cycle synchronization. They use the degree of credit information, provided by the World Bank, to instrument capital flows, which we tried to use for our empirical investigation as well. When running our instrumental variable estimations, the empirical realisation of the Hansen J-statistic suggested that the credit information index was not a valid instrument. We consequently dropped the index from our analysis.

Table 6: Instrumental variable model estimation results

	(1) FE: Lag	(2) IV: Lag	(3) IV: Capital contr.	(4) IV: Law	(5) IV: all IVs
Financial Flows $_{t-1}$	0.248***				
	(0.0501)				
Financial Flows		0.585***	0.522**	1.190***	1.237***
		(0.169)	(0.205)	(0.433)	(0.438)
Observations	17220	17220	15466	1482	1190
R^2	0.455	0.390	0.439	0.525	0.538
F-statistic excl. instr.			12.20	16.02	11.22
Kleibergen-Paap p-val.			0.00	0.00	0.00
Hansen J-statistics p-val.			.	0.18	0.26
Sending	✓	✓	✓		
Receiving	✓	✓	✓	✓	✓
Year	✓	✓	✓		
Gravity	✓	✓	✓	✓	✓

Notes: The dependent variable is real bilateral exports. Capital flows are the sum of foreign direct, portfolio debt and equity and other investment. Column 1 uses one-period lagged financial flows as predetermined regressor. Column 2 makes use of one-period lagged financial flow as instrument for current financial flows. Column 3 uses the sum of outward capital flow restrictions of sending country i with inward capital flows restrictions of receiving country j as instrumental variable for capital flows. Column 4 uses the sum of bilateral shareholder and creditor rights as instrumental variables for capital flows. Column 5 uses the instrument from column 3 and the two instruments from column 4. Column 1-3 are estimated with fixed effects panel instrumental variable models, column 4 and 5 as a cross-section with OLS including receiving country fixed effects. Clustered standard errors at the country-pair level in parentheses. ***/**/* indicate significance at the 1%/5%/10% level.

Column 3 shows the IV results based on our time-varying capital control instrument. The coefficient doubles in magnitude compared to our benchmark FE results (Table 2 column 3) and remains significant at the 5% level. This result is what we would expect given a bias towards zero due to measurement error that got magnified (reduced) by a downward (upward) simultaneity bias. The instrument enters significantly in the first stage regression and the F-statistic of our excluded instruments (first stage regression) amounts to 12.20, surpassing the rule-of-thumb value of 10 (Staiger and Stock, 1997). The Kleibergen-Paap LM statistic rejects the null hypothesis that our model is underidentified. Due to the limited availability of our capital control index, our sample size for estimating our IV model in column 3 drops by around 3000 observations compared to our benchmark fixed effects regression.[27]

[27]Running the benchmark FE estimation with the same IV sample as in column 3 leads only to a marginally different coefficient, see column 1 in Table A.4 in the Appendix.

Column 4 presents the *cross-sectional* regression results based on our two instruments stemming from the "law and finance" literature. Since these instruments are time-invariant, we calculate the mean of our regressors over the sample period and employ OLS including receiving-country fixed effects. The first stage regression shows that both instruments are sufficiently strong. The F-statistic of our excluded instruments (first stage regression) amounts to 16.02 which is above the rule-of-thumb value of 10, and the Kleibergen-Paap LM statistic indicates that our model is not underidentified. In contrast to the IV approach in column 3 where we only used one instrument, in column 4 we use two instruments. This enables us to perform an overidentifying restriction test. Assuming that at least one of the two instruments is exogenous, the empirical realisation of the Hansen J-statistic shows that both instruments can in fact be considered as exogenous. As a further robustness check, we include the mean of the capital flow restriction index used in column 3 as an additional instrument to our cross-sectional regression specification of column 4. The results are displayed in column 5. The empirical realisation of the Hansen J-statistic still supports the inclusion of all the instruments as not correlated with the error term, providing further support for the validity of the use of the capital control restriction index in column 3.

The estimated coefficient of financial flows remains positive and statistically significant at the 1% level, but nearly quadruples in size with regard to our benchmark estimation results in column 3 Table 2. The difference in the magnitude of the coefficient in columns 3 and 4 is related to two issues: First, we are estimating a cross-sectional regression that does not allow to include time fixed effects as well as source and receiving country fixed effects jointly. As such, we cannot rule out that omitted factors correlated with financial flows are driving our results. Secondly, our sample size is reduced markedly due to missing observations for the instrumental variables.[28] Overall, the results of this section show that - using two different sets of instruments to address concerns related to the simultaneity of trade and capital flows and measurement errors in capital flows - our main conclusions remain unchanged: capital flows have a strongly significant effect on exports.

4.5 Robustness checks

Our empirical results show that financial flows and exports are positively linked. This positive relationship holds after instrumenting capital flows with a bilateral capital controls' index. In this section, we provide further robustness checks.

Our sample includes both the eruption of the global financial crisis in 2007 and the subsequent sovereign debt crisis in the Euro area that started in 2010. The crisis and

[28] In column 2 of Table A.4 in the Appendix, we run an OLS regression with receiving country fixed effects based on the identical IV sample as in column 4. The estimated coefficient is still lower than compared to the results of column 4, supporting our hypothesis that measurement error and simultaneity between capital flows and exports exert a downward bias.

Table 7: Fixed effects model estimation results: sample split

	(1) 2002 − 2008	(2) 2009 − 2012	(3) 2002 − 2007	(4) 2008 − 2012
Financial Flows	0.215***	0.385***	0.233***	0.319**
	(0.0424)	(0.135)	(0.0407)	(0.129)
Observations	12054	6888	10332	8610
R^2	0.442	0.478	0.444	0.467
Year FEs	✓	✓	✓	✓
Sending FEs	✓	✓	✓	✓
Receiving FEs	✓	✓	✓	✓
Gravity Controls	✓	✓	✓	✓

Notes: The dependent variable is real bilateral exports. Capital flows are the sum of foreign direct, portfolio debt and equity and other investment. Clustered standard errors at the country-pair level in parentheses. ***/**/* indicate significance at the 1%/5%/10% level.

spill-overs could potentially influence the pattern of trade and capital flows. Regarding financial flows, Broner et al. (2013) show that they react to variations of the business cycle and are pro-cyclical, while others point to a striking global factor driving capital flows patterns (Forbes and Warnock, 2012a,b; Herrmann and Mihaljek, 2013; Bruno and Shin, 2015). Alas, there exists a well-established literature that links trade flows robustly to business cycle fluctuations (Baxter and Kouparitsas, 2005; Singh, 2010).

Our empirical setting controls for time-specific yearly factors that could potentially drive both trade and capital flows as well as for real GDP in both the source and the host country. Nevertheless, there exists the possibility that the beginning of the crisis period marked a structural break for the trade-finance nexus. To test this hypothesis, we split our panel in two sub-periods: a "pre-crisis" period from 2002-2007 (2002-2008) and a "crisis" episode from 2008-2012 (2009-2012).[29] As our results displayed in Table 7 suggest, the different time splitting does not change the basics of our previous empirical findings since the coefficient remains positive for both sub-periods. Yet, the correlation between exports and financial flows was stronger during the "crisis" period (column 2 and column 4, respectively). The magnitude of the estimated coefficient nearly doubles, potentially reflecting that the scale of the crisis could indeed have led to a stronger interlinkage between both types of flows (Milesi-Ferretti and Tille, 2011; Galstyan and Lane, 2013).

We have already established the fact that the inclusion of countries that act as financial centers could potentially distort the trade-finance nexus. Therefore, we continue to exclude

[29] As Lane (2013) notes, capital flows in the EMU started to reverse in the final quarter of 2008.

Table 8: Fixed effects model estimation results: financial centers

	(1) FE: without FC	(2) FE: - IE	(3) FE: - BE and CY
Financial Flows	0.250***	0.276***	0.283***
	(0.0576)	(0.0666)	(0.0697)
Observations	18942	18040	16302
R^2	0.450	0.455	0.436
Year	✓	✓	✓
Sending	✓	✓	✓
Receiving	✓	✓	✓
Gravity	✓	✓	✓

Notes: The dependent variable is real bilateral exports. Column 1 depicts the benchmark estimation results from Table 2 that exclude the financial centers as identified by Peter (2012). Column 2 additionally drops Ireland. Column 3 furthermore excludes Belgium and Cyprus, following Lane and Milesi-Ferretti (2017). Capital flows are the sum of foreign direct, portfolio debt and equity and other investment. Clustered standard errors at the country-pair level in parentheses. ***/**/* indicate significance at the 1%/5%/10% level.

countries that might be regarded as financial centers, following the suggestions of Lane and Milesi-Ferretti (2017). In Table 8, we depict our benchmark regression from Table 2 (column 1), then proceed by dropping successively Ireland (column 2) as well as Belgium and Cyprus (column 3). In all cases, the estimated coefficient remains positive, statistically significant, and actually increases in size.

A further robustness check concerns the functional form of the regression equation. Further above, we have estimated the patterns between exports and financial flows in levels. In the following, we repeat the estimation of equation 1 with two logarithmic transformations of the financial flows data. Following Papaioannou (2009), our first transformation relies on the log-modulus transformation introduced by John and Draper (1980). Specifically, we transform the financial flows using equation 3:

$$L(x) = sign(x) * log(|x| + 1) \tag{3}$$

As said, we add one to the logarithm of the absolute value of the variable x (in our case capital flows) and multiply it with its sign. Adding the constant ensures that values of zero in the original scale are preserved in the transformed scale.

When applying our second transformation to capital flows, we divide each observation of capital flows by the smallest value $min(capital flows)$ such that the resulting fraction is always (marginally) higher than -1, following Tran and Dinh (2014) and Fontagné and

Table 9: Fixed effects and PPML model estimation results: logarithmic transformations

	Log-Modulus		Re-Scaling	
	(1) FE	(2) PPML	(3) FE	(4) PPML
Log. Financial Flows (I)	0.00991***	0.00531***		
	(0.00125)	(0.000989)		
Log. Financial Flows (II)			-0.0651	0.0365**
			(0.0820)	(0.0183)
Observations	18940	18940	18942	18942
R^2	0.883	0.911	0.883	0.911
Sending	✓	✓	✓	✓
Receiving	✓	✓	✓	✓
Year	✓	✓	✓	✓
Gravity	✓	✓	✓	✓

Notes: The dependent variable is real bilateral exports. Capital flows are the sum of foreign direct, portfolio debt and equity and other investment. Clustered standard errors at the country-pair level in parentheses. ***/**/* indicate significance at the 1%/5%/10% level.

Pajot (2002), and add one Euro before taking the logarithm to assure that the re-scaled variable is positive.

$$ln\left(1+\frac{capitalflows}{|min(capitalflows)|+1}\right)\begin{cases}<0, & \text{for capital flows} < 0\\ =0, & \text{for capital flows} = 0\\ >0, & \text{for capital flows} > 0\end{cases} \tag{4}$$

We run our benchmark regression (equation 1) using both transformations for capital flows. These two transformations allow us to implement the Poisson pseudo-maximum likelihood estimator (PPML), first proposed by Santos Silva and Tenreyro (2006). The PPML gained popularity in the recent empirical gravity literature since it tackles the problems of heteroskedasticity and the well-known "zero trade flows" while allowing for the

inclusion of fixed effects.[30] As it is common in the literature, we add one Euro to our trade data before taking the logarithm to preserve the zeros, i.e. $ln(x+1)$ (Hale et al., 2013).

The corresponding results are shown in Table 9. The first two columns that use the log-modulus transformation confirm our previous findings. Capital flows are positively and statistically significantly linked to exports, with a 10% increase raising exports by 0.1%. The PPML estimator also points to a robust positive link between both types of flows (column 2). The results using the second transformation differ, however. Using FE (column 3), higher capital flows lead to smaller exports, but the estimated coefficient is not significant. Yet, the PPML specification (column 4) results in a positive estimated coefficient that is significant at the 5% level. Here, a 10% increase in capital flows leads to a 0.4 % increase in exports. Arguably, as Fontagné and Pajot (2002) note, the estimation results for the re-scaling method are subject to the data transformation process, and the resulting estimations depend significantly on it. As such, the coefficients, especially of column 3 and 4 in Table 9, have to be interpreted cautiously. Nevertheless, the results of the log-log specifications tend to support our findings in the preceding sections, i.e. that exports and capital flows do co-move and are thus complements, not substitutes.

Apart from their estimated financial *flows*, Hobza and Zeugner (2014) provide data on the underlying asset holdings. As a further robustness check, we use the levels and the difference of the logarithm of gross bilateral asset holdings, i.e. $log(capitalstock)_t - log(capitalstock)_{t-1}$ as another proxy for bilateral capital flows, following Galstyan and Lane (2013) and Beck et al. (2016). As noted already in Subsection 3.2, taking the difference in (log) assets does not correct for valuation effects, which can be quite sizable (Papaioannou, 2009). The results for the estimated pattern between financial asset holdings both in levels and differences and exports are presented in Table 10. The level of financial assets is positively related to exports and statistically significant at the 10% level for both the FE and the PPML estimator, while the estimated coefficient, β_1, does only marginally vary. In both cases, a 10% increase in assets boosts exports by around 2%. These magnitudes lie in the range of those estimated by Aviat and Coeurdacier (2007). When we proxy bilateral financial flows with the difference of the logarithm of financial holdings, the estimated coefficient also remains positive and statistically significant (column 3).

[30] The PPML is a useful estimator whether trade flows follow a Poisson distribution or not. Santos Silva and Tenreyro (2011) adapt the general framework of Santos Silva and Tenreyro (2006) to show that the PPML is generally well behaved in the case of a large proportion of zeros in the data. Several studies rely on the PPML estimator, for instance Bergstrand et al. (2015).Head and Mayer (2014) provide an overview of the performance of various estimators, like Tobit, Gamma PML or Poisson PML. See also Gómez-Herrera (2013), and Burger et al. (2009) for a more critical approach regarding the PPML estimator.

Table 10: Fixed effects and PPML model estimation results: asset holdings in levels and differences

	Asset Holdings		Differences	
	(1) FE	(2) PPML	(3) FE	(4) PPML
Financial Holdings	0.192***	0.197***		
	(0.0111)	(0.0239)		
Financial Holdings (Difference)			0.0362***	0.00140
			(0.00676)	(0.0102)
Observations	39143	39143	35650	35650
R^2	0.864	0.901	0.854	0.882
Sending FEs	✓	✓	✓	✓
Receiving FEs	✓	✓	✓	✓
Year FEs	✓	✓	✓	✓
Gravity Controls	✓	✓	✓	✓

Notes: The dependent variable is real bilateral exports. Capital flows are the sum of foreign direct, portfolio debt and equity and other investment. Clustered standard errors at the country-pair level in parentheses. ***/**/* indicate significance at the 1%/5%/10% level.

5 Conclusions

International economics has not yet conclusively clarified the relationship between financial and trade flows: Can they be considered as complements, as suggested by Antràs and Caballero (2009), or as substitutes, following Mundell (1957)? The nature of the relationship between the two flows is of crucial interest to gain a better understanding of the interplay between two important drivers of globalization and economic integration.

In order to investigate the relationship between bilateral trade and capital flows, the so-called trade-finance nexus, we rely on a novel dataset by Hobza and Zeugner (2014) that provides estimates of bilateral gross financial outflows - defined as net purchases of foreign financial assets by domestic agents - for 42 sending and receiving countries from 2002-2012. Based on these data, we estimate the effects of capital flows on exports in a gravity framework. Our results suggest that capital flows and exports are complements, i.e. we find a positive relationship between the two that is statistically as well as economically significant. Our benchmark regression indicates that, ceteris paribus, a one Euro increase in capital flows leads to a 0.25 Euros increase in exports. A battery of robustness checks confirms the positive pattern between both types of flows. As exports and financial flows are likely to influence each other simultaneously, we have used two different instrumental

variable strategies to identify an exogenous movement of capital flows, i.e. not related to bilateral exports, to establish a *causal* relationship: (i) a new time-varying index for bilateral capital flow restrictions based on Fernández et al. (2015), and (ii) two cross-sectional indices on the quality of creditor and debtor rights by La Porta et al. (1998). Both instrumental variable approaches confirm our previous results, i.e. we find a positive and statistically as well as economically significant effect of capital flows on trade, with an increase of one Euro of trade in financial assets leading to an estimated increase of around 0.5 Euros in exports. As such, gross capital outflows - i.e. net purchases of foreign financial assets by domestic agents - drive exports, supporting theories that stress the complementarity between both types of flows.

Since bilateral imbalances within the European Monetary Union are considered to be a main driver for the eruption of the sovereign debt crisis in 2009, we investigate potential variations in the trade-finance nexus along three distinct country-pair clusters. However, we do not find any evidence that the effect is stronger within (i) the European Union, (ii) the European Monetary Union and (iii) among country pairs with the sending and receiving country being from the core and periphery of the EMU, respectively. Splitting up the aggregate bilateral capital flows into its four components, we find that capital flows that are more sensitive to information, like FDI, have a stronger impact on exports. This finding is in line with theories that stress informational frictions as driver for a positive linkage of trade in goods and financial assets.

Our findings have several policy implications. With regards to the EMU, the outbreak of the sovereign debt crisis evidently demonstrated that some Euro area countries need to change their economic model from relying on domestic consumption towards more export-led growth. Indeed, as for instance Belke et al. (2014) point out, the economic recovery in these member states significantly depends on a strong export performance to boost growth and employment. Therefore, policy initiatives such as the banking or capital markets union that have the goal to integrate fragmented financial markets can have important real consequences since an institutional framework that facilitates the cross-border acquisition of financial assets will also improve the increase of cross-border trade of goods and services. This insight also relates to current issues in international policy making - such as discussions on trade imbalances - that mostly neglect the important role of financial integration in this process. On the other hand, the complementarity between trade and financial flows has also implications for economies with a rather closed capital account that are currently undergoing structural transformation and target to increase their export performance. One way to achieve this aim would be by lifting the capital control restrictions, therefore increasing financial flows and thus trade in goods and services.

More research on the trade-finance nexus seems warranted. It would be interesting to validate our estimation results with new data on capital flows that improve on the already impressive efforts of Hobza and Zeugner (2014) both in country coverage and extending over a longer time period. Such a sample would allow to investigate whether the relationship between trade and capital flows is different between emerging markets and advanced economies, or whether the introduction of the Euro in 1999 had a significant influence on the patterns of both flows. Another fruitful area for future research concerns the combination of empirical analyses with rigorous theoretical underpinnings that investigate the drivers and channels of the trade-finance nexus in order to distinguish which of the various theoretical models is supported by the data. These include, among others, approaches that incorporate macroeconomic dynamics, such as a changing industrial structure (Jin, 2012, 2013), or models focusing on the role of financial conditions, such as trade finance or financial constraints (Ahn et al., 2011; Manova, 2013; Antràs and Foley, 2015; Chan and Manova, 2015).

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APPENDIX

Table A.1: Data sources and data construction

Variable	**Source**
Financial flows	Financial flow data are made available on the homepage of Stefan Zeugner `http://www.zeugner.eu/studies/finflows/`
Exports	IMF trade statistics (downloaded via Thomson Reuter Datastream)
GDP, population	World Development Indicators, available at: `http://data.worldbank.org/data-catalog/world-development-indicators`
Gravity variables	CEPII, available at: `http://www.cepii.fr/CEPII/en/bdd_modele/presentation.asp?id=8`
US CPI	Fred Database, available at: `https://fred.stlouisfed.org/`
Euro area CPI	Eurostat, available at: `http://ec.europa.eu/eurostat/de`
Capital account restrictions	Fernández et al. (2015) available at: `http://www.nber.org/data/international-finance/`
Creditor and shareholder rights	La Porta et al. (1998), available at: `http://faculty.tuck.dartmouth.edu/rafael-laporta/research-publications/` and Pistor et al. (2000)

Table A.2: Sending and receiving countries

Australia, Austria, Bahrain, Barbados, Belgium, Bermuda, Bulgaria, Canada, Chile, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hong Kong, Hungary, Iceland, Ireland, Israel, Italy, Japan, Latvia, Lebanon, Lithuania, Luxembourg, Macao, Malta, Mauritius, Mexico, Netherlands, New Zealand, Norway, Panama, Poland, Portugal, Romania, Samoa, Singapore, Slovakia, Slovenia, South Korea, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States

Table A.3: Fixed effects model estimation results: Country clusters II

	(1) EU	(2) EA	(3) Core - Per
Financial Flows	0.304*** (0.108)	0.249*** (0.0690)	0.257*** (0.0612)
EU	1712.1*** (450.7)		
EU × Financial Flows	-0.126 (0.121)		
EA		2890.9*** (648.8)	
EA × Financial Flows		0.00646 (0.111)	
Core Periphery			3361.1 (2066.3)
Core Periphery × Financial Flows			-0.116 (0.0885)
Observations	18942	18942	18942
R^2	0.450	0.450	0.448
Year FEs	✓	✓	✓
Sending FEs	✓	✓	✓
Receiving FEs	✓	✓	✓
Gravity Controls	✓	✓	✓

Notes: The dependent variable is real bilateral exports. Financial flows are the sum of foreign direct investment, other investment, portfolio debt and equity flows (real). In column 1, we drop the dummy "EU", in column 2 we drop the dummy for EMU, and in column 3 we drop them both. Clustered standard errors at the country-pair level in parentheses. ***/**/* indicate significance at the 1%/5%/10% level.

Table A.4: Instrumental variables regression results: Comparison

	(1) FE	(2) OLS
Fin. Flows	0.227***	1.074***
	(0.0525)	(0.263)
Observations	15466	1482
R^2	0.484	0.526
Sending FEs	✓	
Receiving FEs	✓	✓
Year FEs	✓	
Gravity Controls	✓	✓

Notes: The dependent variable is real bilateral exports. Financial flows are the sum of foreign direct, portfolio debt and equity and other investment (real). Column 1 is estimated with fixed effects panel models, column 2 as a cross-section with OLS including receiving country fixed effects. Column 1 and 2 are based on the identical sample size used for the IV regressions in column 3 and column 4 of Table 6, respectively. Clustered standard errors at the country-pair level in parentheses. ***/**/* indicate significance at the 1%/5%/10% level.