

Credit Conditions and Foreign Direct Investment During the Global Financial Crisis

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Abstract

This paper investigates the effect that tight credit conditions had on outward foreign direct investment flows during the 2008–2010 global financial crisis. A difference-in-differences approach is used to isolate a “credit channel” impact of the global financial crisis on foreign direct investment. The global financial crisis had a stronger negative impact

on the relative volume of outward foreign direct investment in financially vulnerable sectors in more financially developed countries, especially if these countries also experienced a banking crisis. These results suggest that lack of access to external finance can partly explain the drop in foreign direct investment during the global financial crisis.

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Credit Conditions and Foreign Direct Investment During the Global Financial Crisis[‡]

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1 Introduction

Foreign direct investment (FDI) flows declined drastically during the recent global financial crisis. According to UNCTAD statistics, global FDI outflows decreased by 15% in 2008 and a further 43% in 2009. The fact that this abrupt fall coincided with a deterioration of credit conditions worldwide suggests that credit constraints have been one of the factors hindering the expansion of multinational enterprises (MNEs) abroad. While this possibility has been evoked in various policy reports, e.g. UNCTAD (2010), it has yet to be investigated rigorously. This is the aim of this paper.

There are several channels through which a credit crisis¹ can have an influence on outward FDI.² In addition to curtailing access to external finance, it depresses demand, reduces firms' self-financing capabilities, and increases uncertainty. Testing directly for the impact of a credit crisis on outward FDI would amount to confounding these different effects. Hence, to identify a potential "credit channel" impact of the global financial crisis, we adopt a difference-in-differences approach, originally suggested by Kroszner et al. (2007), where we simultaneously exploit the variation in financial vulnerability across manufacturing sectors,³ the variation in financial development across source countries,⁴ and the widespread tightening of credit conditions during the 2008-2010 period. More precisely, in a model including country-sector, time-varying country, and time-varying sector fixed effects, we investigate whether the relative impact of the global financial crisis on outward FDI in more financially

¹We define a credit crisis as an episode during which there is a severe decline in the terms and availability of credit for consumers and firms. Papers in the special issue of the *Journal of Financial Economics* on the 2007-2008 financial crisis in the United States (Kashyap and Zingales (eds.), 2010) provide a good overview of the financing difficulties typically faced by firms during a credit crisis.

²In the context of this paper, FDI is defined as the initial fixed costs incurred by a firm expanding its activities outside the territorial boundaries of its home country through the establishment (greenfield FDI) or the acquisition (M&A FDI) of a foreign affiliate, whatever the sources of funds for this expansion.

³Following Manova (2013), we define financially vulnerable firms as firms with high requirements for external capital and/or firms with few assets that can be used as collateral. The varying prevalence of these firms in each sector translates into sectors which differ in their financial vulnerability.

⁴The World Economic Forum (World Economic Forum, 2012) defines financial development in its 2012 *Financial Development Report* as "the factors, policies, and institutions that lead to effective financial intermediation and markets, as well as deep and broad access to capital and financial services" (p.3).

vulnerable sectors varied according to a country's initial financial depth.

The intuition underlying our difference-in-differences approach is that in “normal” times, if availability of external finance matters for outward FDI, the ratio of outward FDI in financially vulnerable sectors to outward FDI in other sectors should be larger in countries characterised by high financial development (holding other factors constant).⁵ This implies that during a credit crisis, interruption of access to external finance should have a greater negative impact on the relative volume of outward FDI in financially vulnerable sectors in deep financial systems than in shallow financial systems since, in the latter countries, availability of external finance is expected to be less of a determinant of the outward FDI performance of financially vulnerable sectors in normal times. Hence, as long as financial development is important for outward FDI, a credit crisis ought to have a larger negative influence on outward FDI flows in more financially vulnerable sectors in more financially developed countries. By focusing on this specific relationship, we deepen the likelihood that our results reflect the causal impact of credit conditions on outward FDI.

Variants of this difference-in-differences approach have been employed to investigate the detrimental financial effects of the 2008-2010 global financial crisis on international trade (Bricongne et al., 2012; Chor and Manova, 2012).⁶ However, we are the first study to implement it to examine the influence of tight credit conditions on FDI during this period. This is possible thanks to our access to a unique, and under-exploited,⁷ database on sector-specific real greenfield manufacturing FDI. From a broader perspective, our study contributes to the limited literature on the effects of source countries'

⁵Engaging in FDI involves large upfront fixed costs related to market research, the modification of products to meet foreign tastes or regulatory requirements, or the establishment of distribution and servicing channels. Some of these costs may have to be incurred once and may not apply for follow on investments. However, crucially, each new FDI project also involves establishing or purchasing a production facility in the destination country. Firms with limited internal funds should rely heavily on external finance to engage in FDI since they can finance internally a small fraction only of the fixed costs of FDI. It can thus be expected that outward FDI in financially vulnerable sectors is more sensitive to access to external finance (which depends on financial development) than outward FDI in other sectors.

⁶More broadly, this approach, initially suggested by Rajan and Zingales (1998), has been used to study the impact of structural cross-sectional differences in financial development on international trade. See for example Beck (2002, 2003), Amiti and Weinstein (2011), or Manova (2013).

⁷Using “*FDI Markets* database” as our search string, we obtained 55 results only in Google Scholar.

financial development on outward FDI.⁸

We find that the global financial crisis had a stronger negative impact on the relative volume of outward FDI in financially vulnerable sectors in more financially developed countries. This effect is statistically and economically significant and robust to various specification tests. While we make the initial assumption that all countries shared a similar deterioration of credit conditions during the global financial crisis, we show that the fall in the relative volume of outward FDI in financially vulnerable sectors in more financially developed countries during the 2008-2010 period was larger in countries experiencing a banking crisis. This provides additional support for a credit channel impact of the global financial crisis on FDI. By controlling for sector-specific activity, we also show that a crisis-driven fall in output cannot explain our results. Finally, a decomposition of the impact of the global financial crisis at the extensive and intensive margins of outward FDI indicates that firms responded to credit constraints by reducing mainly the size of their foreign projects. Overall, these results suggest that lack of access to external finance is partly responsible for the drop in FDI during the global financial crisis and that source countries' financial development is an important determinant of outward FDI.

The rest of the paper proceeds as follows. In section 2, we introduce our difference-in-differences models. In section 3, we describe the data used, explain how we estimate our econometric models, and provide some preliminary evidence. In section 4, we present our empirical results. Finally, we conclude in section 5.

⁸Klein et al. (2002) is one of the rare papers examining this issue. It shows that the FDI activity of Japanese firms in the United States during the Japanese banking crisis in the nineties was inversely correlated with the deterioration of the financial health of their main bank, as measured by Moody's downgrades.

2 Econometric models

In this section, we describe in general terms the two econometric models that we estimate. We will present in the next section our proxies for each variable included in our models.

We investigate the effects of tight credit conditions on outward FDI by looking at how the relative volume of outward FDI in financially vulnerable sectors responded to the 2008-2010 global financial crisis in more financially developed countries. For this purpose, we estimate the following exponential model:

$$FDI_{ist} = \exp(\beta_1[FD_i \cdot FV_s \cdot GFC0810_t] + \alpha_{is} + \alpha_{ip} + \alpha_{sp})\epsilon_{ist} \quad (1)$$

where FDI_{ist} corresponds to a measure of the cumulated value of the fixed costs incurred by parent firms located in source country i to establish a new foreign affiliate in manufacturing sector s at time t , FD_i is a time-invariant measure of financial development, FV_s is a time-invariant measure of sector-specific financial vulnerability, $GFC0810_t$ is a dummy variable which takes the value of one for the period 2008-2010, α_{is} are country-sector fixed effects, α_{ip} are country-period fixed effects (the periods are 2003-2004, 2005-2007, and 2008-2010), α_{sp} are sector-period fixed effects, and ϵ_{ist} is a multiplicative error term.⁹

The fixed effects that we include in our econometric model prevent us to estimate the effects of the global financial crisis on the absolute volume of outward FDI. However, their presence has the important advantage of reducing the possibility of our results being contaminated by an omitted variable bias due, for example, to financial development correlated with unobserved determinants of FDI or to outward FDI in financially vulnerable sectors being globally more sensitive to crisis-induced

⁹Our results are robust to the estimation of a bilateral equation, including country-sector and country-period fixed effects for destination countries.

uncertainty than outward FDI in other sectors.

The parameter β_1 indicates, holding other factors constant, how the relative volume of outward FDI in financially vulnerable sectors responded to the global financial crisis in more financially developed countries. More precisely, define the relative volume of outward FDI ($RFDI$) in financially vulnerable sectors as $RFDI = \frac{FDI_{FVH}}{FDI_{FVL}}$, where FV_H and FV_L denote outward FDI in high and low financially vulnerable sectors respectively. Consider two countries, country D with high financial development (FD_D) and country S with low financial development (FD_S), and two periods, the pre-crisis period (N) and the crisis period (C). Then $\frac{RFDI_{DC}}{RFDI_{DN}} / \frac{RFDI_{SC}}{RFDI_{SN}} = \exp(\beta_1[FV_H - FV_L] \times (FD_D - FD_S))$. $\beta_1 < 0$ would indicate that the relative volume of financially vulnerable outward FDI fell relatively more in the high financial development country than in the low financial development country following the global financial crisis. Such a result would imply that uninterrupted access to external finance is important for outward FDI, especially in financially vulnerable sectors.

The $GFC0810_t$ dummy variable, which is not country-specific, reflects the fact that credit conditions deteriorated in most countries during the 2008-2010 period. Pre-crisis international financial linkages led to the propagation to the rest of the world of the negative loan supply shocks that initially occurred in developed countries (Cetorelli and Goldberg, 2010; Berkmen et al., 2012). Nevertheless, the assumption that the reduction in the availability of external finance has been homogenous worldwide is likely to be too strong. Notably, in some countries, the combination of financial and real shocks generated a banking crisis, resulting in a strong impairment in banks' ability and willingness to lend. In a second stage, we take into account the possibility that credit conditions have been

heterogenous across countries during the global financial crisis by estimating the following model:

$$\begin{aligned}
 FDI_{ist} = & \exp(\beta_1[FD_i \cdot FV_s \cdot GFC0810_t] + \beta_2[FD_i \cdot FV_s \cdot GFC0810_t \cdot BCRISIS_i] \\
 & + \beta_3[\alpha_s \cdot GFC0810_t \cdot BCRISIS_i] + \alpha_{is} + \alpha_{ip} + \alpha_{sp})\epsilon_{ist}
 \end{aligned} \tag{2}$$

where $BCRISIS_i$ is a dummy variable which takes the value of one if a country has experienced a banking crisis during the financial crisis.¹⁰ $\beta_2 < 0$ would indicate that a banking crisis amplified the response of the relative volume of outward FDI in financially vulnerable sectors to the global financial crisis in more financially developed countries. This would be in line with tighter credit conditions in countries experiencing a banking crisis than in other countries during the 2008-2010 period. Estimation of model 2 allows us to focus even more on a credit channel impact of the global financial crisis by considering the country-specific level of financial distress in the banking sector.

3 Data and estimation method

3.1 FDI data

Our proxy for FDI_{ist} is the sector-specific bilateral cumulated value of the capital investments made by firms to establish a new production or processing manufacturing facility in a foreign country. This variable should capture a large fraction of the initial fixed costs incurred by multinational enterprises to produce abroad when establishing a foreign affiliate *ex nihilo*.¹¹ Data come from the *FDI Markets* database compiled by FDI Intelligence, a division of the Financial Times.¹² This database is the most

¹⁰ $[\alpha_s \cdot GFC0810_t \cdot BCRISIS_i]$ are fixed effects which account for sector-specific shocks affecting outward FDI in countries experiencing a banking crisis during the 2008-2010 period.

¹¹As previously discussed, firms may incur other fixed costs before or after this cross-border investment. While our dependent variable does not include these costs in principle, they play a role in firms' ability to self-finance their capital expenditures abroad.

¹²<http://www.FDImarkets.com/>

comprehensive source of firm-level information on cross-border greenfield investment available, covering all countries and sectors worldwide since 2003. Data include the name of the country in which the firm engaging in greenfield FDI is headquartered, the year of investment, the recipient sector, the function (nature) of the project, the type of project (new, expansion, co-location), and the capital investment (capital expenditures) associated with the FDI project.¹³ There is no minimum investment size for a project to be included but the equity stake of the foreign investor cannot be lower than 10%. Data are collated through daily searches of Financial Times newswires and internal information sources, other media sources, project data received from industry organizations and investment agencies, and data purchased from market research and publication companies. Each project is cross-referenced against multiple sources, with the main focus on direct company sources. *FDI Markets* is the primary source of greenfield FDI data for various international organizations (UNCTAD, World Banks), consultancies (the Economist Intelligence Unit), major corporations and over 100 governments.

Contrary to balance of payments FDI flows, our FDI data are available for a large number of countries and sectors, and are not distorted by “round-tripping” and “trans-shipping” phenomena.¹⁴ In addition, the *FDI Markets* database, by providing us with information on the number of projects and average size of projects, will allow us to investigate the effects of the global financial crisis on the extensive and intensive margins of outward FDI.

One drawback of this database is that it does not include data on cross-border mergers and acqui-

¹³Data on capital investment are based on the investment the company is making at the time of the project announcement or opening. The data include estimates for capital investment (derived from algorithms) when a company does not release the information. These estimates may introduce measurement error in our dependent variable, generating larger variances in our estimators.

¹⁴“Round-tripping” refers to the situation where different treatments of foreign and domestic investors encourage the latter to channel their funds into special purpose entities (SPEs) abroad in order to subsequently repatriate them in the form of incentive-eligible FDI. With “trans-shipping”, funds channeled into SPEs in offshore financial centres are redirected to other countries, leading to strong divergences between the source country of the FDI and the ultimate beneficiary owner. The *FDI Markets* database reports the ultimate parent company. Nevertheless, despite the different nature of the *FDI Markets* FDI data and the balance of payments outward FDI data compiled by UNCTAD, the coefficient of correlation between these two variables at the country-level is 0.66, significant at the 1% level.

sitions (M&A).¹⁵ However, there is no *a priori* reason to believe that greenfield and M&A outward FDI flows behave fundamentally in different ways. For instance UNCTAD (2010) reports that both greenfield and M&A FDI flows have significantly dropped during the global financial crisis.¹⁶ Hence, despite relying on greenfield FDI data, our results should be generalizable to the entire FDI universe.

Given that we do not have any parent-specific data, we can aggregate the firm-level data provided by the *FDI Markets* database at the country-sector level without any loss of information to obtain a proxy for FDI_{ist} .¹⁷ We assume that firms engaging in greenfield FDI in a given sector primarily operate in the same sector. At the most disaggregated level, the underlying data that we use to estimate models (1) and (2) correspond to 15240 greenfield FDI projects in a new production or processing manufacturing facility made by 7126 parent companies located in 111 source (developed and developing) countries, in 13 broad manufacturing sectors during the period 2003-2010.¹⁸ The largest sources of greenfield manufacturing FDI over the period 2003-2010 are OECD countries.¹⁹ This pattern ought to facilitate the identification of the effect of tight credit conditions on FDI since the major OECD countries were at the epicentre of the global financial crisis.

¹⁵Note that deal values are frequently missing in M&A databases. For instance, in the *Zephyr* database, deal values are missing for 60% of M&A transactions.

¹⁶The report puts particular emphasis on the role played by financial constraints to explain these concomitant trends.

¹⁷Of course, we do not deny that MNEs are heterogeneous firms. For example, within a given sector, firms are likely to vary in the credit constraints that they face. What we mean is that, given the FDI data that we have, we would not obtain different results by using unit-level data (Rabe-Hesketh and Skrondal, 2012). An analogous result can be found in the discrete choice location literature. Guimaraes et al. (2003) demonstrate that the conditional logit model and the Poisson regression model share the same log-likelihood function with purely location-specific determinants. This implies that the estimation of a Poisson regression model with a sample where data are aggregated by location will yield the same estimates as a conditional logit model applied on project-level data.

¹⁸Firms can invest abroad in other “functions”, e.g. logistics, sales/customer support, or retail. We prefer to exclude these FDI projects from our sample because the broad sectoral classification adopted by FDI Intelligence may lead some projects to be included in a manufacturing sector even when their purposes are only to provide support services to this sector or to facilitate the distribution and sale of its products. By focusing on FDI in a new production or processing manufacturing facility (the ‘manufacturing function’ in the *FDI Markets* database), we strongly increase the likelihood that the parent firm truly belongs to the manufacturing industry.

¹⁹A detailed description of the patterns of greenfield FDI can be found in Davies et al. (2014).

3.2 Measures of sector-specific financial vulnerability

The external dependence and asset tangibility measures

As a first indicator of sector-specific financial vulnerability (FV_s), we use the Rajan and Zingales (1998) measure of external dependence (ED). They calculated a sector's need for external finance as the fraction of capital expenditures that were not financed with cash flows from operations for a sample of publicly traded US firms in the 1980s. For each firm, the ratio was averaged over the 1980s and the final ED measure corresponds to the sector median. The key assumption underlying the validity of their ED proxy is that the ranking it generates across sectors is stable across countries because a sector's need for external finance is intrinsically linked to sector-specific, but country-invariant, technological characteristics. By using U.S. data on publicly traded firms, Rajan and Zingales (1998) increase the likelihood that they correctly identify a sector's technological demand for external financing. Large firms typically face fewer financing obstacles than small firms and if there is any country in which firms' actual use of external finance reflects their desired level, the United States is perhaps the closest one can find given the sophistication of its financial system.

Firms which rely on external finance to conduct their day-to-day trading operations or invest in new growth opportunities at home can be expected to be those which need external financing to expand abroad. The establishment of a foreign affiliate requires substantial purchases of new foreign fixed assets, e.g. land, building, machinery. It is also plausible that any product which entails high R&D, marketing or distribution costs at home will similarly involve large customization, marketing and distribution fixed costs when produced and sold in foreign markets (Manova, 2013). The ED measure developed by Rajan and Zingales (1998) is based on a sample of large U.S. companies, which are likely to have activities abroad. This sample composition helps to make it a good proxy for the typical external financing needs of MNEs in a given sector.

Sectors not only vary in firms' reliance on external finance but also in firms' ability to access external finance. For a given technological need for external finance, raising outside finance is likely to be easier for firms in sectors structurally characterized by a high level of tangible assets. These assets can be pledged as collateral,²⁰ reducing in that way the adverse selection and moral hazard problems that lenders face. To capture this second dimension of financial vulnerability, we use the Kroszner et al. (2007) measure of asset tangibility (TANG). It corresponds to the sector-specific ratio of fixed assets to total assets and it has been calculated for the period 1980-1999 using the same methodology as Rajan and Zingales (1998). While the TANG measure is not specific to FDI activities, firms are more likely to have access to external finance, at home or abroad, when their existing assets, or the assets they wish to acquire in a foreign country, are tangible.²¹

Table 3 in Appendix A provides the values of the two measures of financial vulnerability for the thirteen manufacturing sectors present in the *FDI Markets* database. Sectors vary both in their dependence on external finance and their ability to access external finance.²²

3.3 Financial development

Our main measure of financial development (FD_i) is the domestic credit allocated to the private sector by banks and other financial intermediaries, normalised by GDP ($CREDIT/GDP$). This financial development measure, which reflects the actual use of external debt financing in the economy, has

²⁰Unlike intangible assets, tangible assets can be easily liquidated in case of default.

²¹Given that our FDI variable corresponds to capital expenditures, i.e. investment in collateralisable tangible assets, it could be argued that asset tangibility is not an appropriate measure of financial vulnerability. This may have been true if external finance was only sought to cover the costs of building a new manufacturing facility. However, outside capital is also likely to be required to invest in intangible assets complementary to the tangible assets. Engaging in FDI may then be conditional on the ability of firms to finance the intangible assets that they need to operate successfully in foreign markets. This constraint should be particularly strong for firms operating in sectors where intangible assets are at the core of their business. It is also possible that sector-specific asset tangibility matters if the loan financing the FDI project is backed by the tangible assets of the parent company. That may be the case if a domestic bank does not want to deal with the seizure of assets in a foreign jurisdiction. For these reasons, TANG ought to remain a valid measure of financial vulnerability, including in the context of this paper.

²²The coefficient of correlation between the two financial vulnerability measures is 0.04.

been extensively used in the growth, finance, and international trade literature (Levine, 2005). Data come from Beck et al. (2009). In order to reduce idiosyncratic values and avoid a potential simultaneity bias between outward FDI and financial development, we use the average values over the pre-sample 2000-2002 period. The private credit to GDP ratio varies a lot across countries (standard deviation of 49%).

We also verify that our results are robust to a time-invariant institution-based measure of financial development (*FIN_INST*). This measure corresponds to the sum of the values of two *World Bank Doing Business* indexes measuring the quality of financial institutions: the strength of legal rights index, which indicates “the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders,” and the depth of credit information index, which assesses “the rules and practices affecting the coverage, scope and accessibility of credit information available through either a public credit registry or a private credit bureau.”²³ Development of these two financial institutions should encourage lending by facilitating the use of a broad range of movable assets as collateral, increasing the rights of creditors in case of bankruptcy, and reducing informational asymmetries. The coefficient of correlation between the private credit to GDP ratio and this measure of the quality of financial institutions suggests that it is indeed the case: it is equal to 0.60, statistically significant at the 1% level.

3.4 Banking crises

We define a banking crisis dummy variable ($BCRIS_i$) which takes the value of one if a source country has been formally identified as having experienced a banking crisis during the period 2008-2010.

We rely on the classification of Laeven and Valencia (2013) to identify banking crises episodes. A

²³Data, definitions, and more information can be found at <http://www.doingbusiness.org/data/exploretopics/getting-credit>. The measure ranges from 1 to 15 (worst to best). We use the average value of each index over the 2005-2006 period to construct our institution-based measure.

banking crisis is characterized by significant signs of financial distress in the banking system (e.g. bank runs, large losses, bank liquidations) and large-scale policy interventions to support distressed financial institutions. Laeven and Valencia (2013) also make a distinction, that we will exploit, between borderline (two policy interventions) and systemic cases (at least three policy interventions). In our sample, the 23 crisis-affected countries are: Austria, Belgium, Denmark, France, Germany, Greece, Hungary, Iceland, Ireland, Kazakhstan, Latvia, Luxembourg, Netherlands, Nigeria, Portugal, Russia, Slovenia, Spain, Sweden, Switzerland, Ukraine, United Kingdom, United States.

Following Laeven and Valencia (2013), we create an alternative measure of banking crisis which is based on the evolutions of real GDP growth and nominal private credit growth. This alternative banking crisis dummy variable takes the value of one if, during the period 2008-2010 and in a given year, a country has experienced both negative real GDP growth and a slowdown in nominal private credit growth. With this alternative methodology, 49 countries are identified as having suffered from a banking crisis.

Some descriptive statistics can be found in Table 4 in Appendix B.

3.5 Estimation method

It is common in the FDI literature to model the conditional mean of $\ln(FDI)$ instead of the conditional mean of FDI . One fundamental problem with using log-linear models is that observations for which the FDI value is equal to zero are dropped from the sample.²⁴ This truncation issue does not arise when the conditional mean of FDI is modeled directly using an exponential function, as we have done in equations (1) or (2). Consistent estimation of the conditional mean parameters can be achieved by using a Poisson fixed effects estimator. This estimator is robust to distributional misspec-

²⁴48% of the observations in our sample take the value of zero. They correspond to cases where no FDI in a given sector of a given country is recorded in the FDI database that we use.

ification and therefore, as long as the conditional mean function is correctly specified, this estimator is consistent even if the dependent variable is continuous (Winkelmann, 2008; Wooldridge, 2010).²⁵ We use the Hausman et al. (1984) conditional maximum likelihood version of the Poisson fixed effects estimator, which does not involve the inclusion of a large number of dummy variables to account for the time-invariant country-sector specific effects; the fixed effects are conditioned out from the model estimation and are therefore not treated as parameters to be estimated. Standard errors are clustered at the country level to deal with potential correlation of errors over time and across sectors.

Other methods have been suggested in the literature to deal with zero values, e.g. $\ln(\text{FDI}+\text{constant})$ by OLS or different variants of the Tobit model. However, the Monte-Carlo simulations of Santos Silva and Tenreyro (2006) and Head and Mayer (2013) indicate that all these alternative estimators perform poorly in presence of heteroskedasticity, which is present in our data. The main reason is that log-linearization of multiplicative models induces a correlation between the transformed error term and the explanatory variables. On the other hand, the Poisson QMLE is robust to various patterns of heteroskedasticity.²⁶

3.6 Preliminary evidence

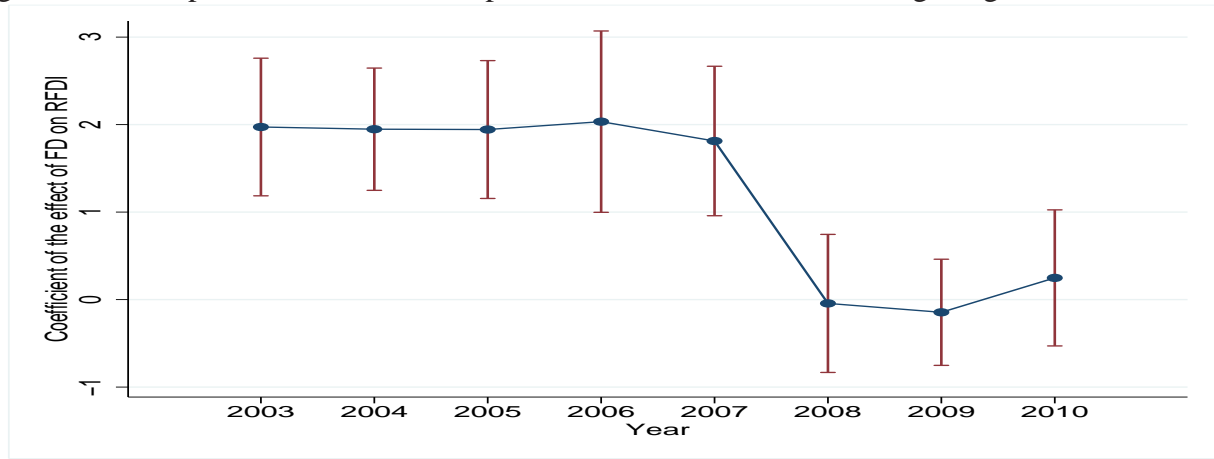
Figure 1 reports the time-varying coefficient γ_{1t} on the interaction term between financial development and sector-specific financial vulnerability, following the estimation of the following model: $FDI_{ist} = \exp(\gamma_{1t}[FD_i \cdot FV_s] + \alpha_{it} + \alpha_s + \alpha_s \cdot GFC0810_t)\epsilon_{ist}$. In the years preceding the global financial crisis, financial development has a large statistically significant positive impact on the relative volume of outward FDI in financially vulnerable sectors. Empirical evidence of this effect is new to the FDI literature. However, during the global financial crisis, this positive effect vanishes completely. These

²⁵Santos Silva and Tenreyro (2011) show that the Poisson quasi-maximum likelihood estimator (QMLE) is well behaved even in the presence of a large number of zeros in the sample.

²⁶In addition, their simulations suggest that the Poisson QMLE does not suffer from an incidental parameters problem.

two observations are consistent with (i) financial development promoting outward FDI in “normal times”, especially in financially vulnerable sectors; and (ii) a severe tightening of credit conditions during the 2008-2010 global financial crisis, with the magnitude of the associated fall of outward FDI being relatively larger in the financially vulnerable sectors of countries characterized by high financial development.

Figure 1: The impact of financial development on RFDI: before and during the global financial crisis



Note: FD: financial development; RFDI: relative volume of outward FDI in financially vulnerable sectors. The capped spikes delimit a 95% confidence interval.

The next section presents our empirical results where we investigate in depth the effects of a tightening of credit conditions on the relative volume of outward FDI in financially vulnerable sectors in more financially developed countries. This amounts to estimating the difference in the value of γ_1 pre- and post-crisis in a model with additional controls.

4 Results

4.1 Initial results

Our results are presented in Table 1. Column (1) shows that the negative impact of the global financial crisis on the relative volume of outward FDI in financially vulnerable sectors was stronger in more financially developed countries. The coefficient on the triple interaction term is negative and statistically significant.²⁷ In column (2), a similar result is obtained when we use an institution-based measure of financial development instead of an outcome-based measure. The estimates are also economically significant. They indicate, holding other factors constant, that the ratio of relative outward FDI in financially vulnerable sectors during the global financial crisis to relative outward FDI in financially vulnerable sectors during non-crisis years was about 20-30% lower in a highly financially developed country like the United States than in a less financially developed country such as Italy.²⁸

Table 1: Financially vulnerable outward FDI, financial development, and the global financial crisis

	<i>Volume of outward FDI, by sector</i>				
	(1)	(2)	(3)	(4)	(5)
ED × CREDIT/GDP × GFC0810	-1.596*** (0.336)		-1.949*** (0.499)		-1.323*** (0.347)
ED × FIN_INST × GFC0810		-0.162** (0.078)			
Control function term			0.479 (0.652)		
TANG × CREDIT/GDP × GFC0810				5.446*** (1.949)	3.669* (1.880)
Observations	5504	5336	5504	5504	5504

***p<0.01 **p<0.05 *p<0.10. Cluster-robust standard errors in parentheses. Time-invariant country-sector fixed effects, time-varying country fixed effects, and time-varying sector fixed effects are included in all regressions. ED: sector-specific measure of dependence on external finance. GFC0810: global financial crisis 2008-2010. TANG: sector-specific measure of asset tangibility.

In column (3), we adopt an IV approach to address any potential endogeneity bias. In line with the

²⁷Similar results are found when we use the log of the private credit to GDP ratio or the log of the stock market capitalisation to GDP ratio. They also hold when we control for the sector-specific impact of the few currency crises which occurred during the period 2008-2010.

²⁸Relative outward FDI in financially vulnerable sectors is defined as the ratio of outward FDI in the Transportation Equipment sector (a typical high ED sector; 75th percentile of ED) to outward FDI in the Beverages sector (a typical low ED sector; 25th percentile of ED). The private credit to GDP ratio for the United States is 1.70 and the private credit to GDP ratio for Italy is 0.74. Regarding the quality of financial institutions, on a scale of 1 to 15, the United States scores 15 and Italy scores 9.

rest of the literature, e.g. Rajan and Zingales (1998) and Kroszner et al. (2007), we use as instrument for the interaction term the interactions of legal origin dummy variables with the ED variable and the GFC0810 dummy variable.²⁹ Given our use of a nonlinear model, we implement a control function approach instead of the standard two-stage least squares estimator. This consists of including the residuals of the first-stage regression, estimated by OLS, in our econometric model.³⁰ The positive sign of their coefficient suggests that the effect of the global financial crisis may have been underestimated. However, the lack of statistical significance of this coefficient indicates that we cannot reject the null hypothesis that the triple interaction term is exogenous.³¹

In columns (4) and (5), we take into account that sectors not only vary in firms' reliance on external finance but also in firms' ability to access external finance. Raising outside finance is likely to be easier for firms in sectors characterized by a high level of tangible assets. In column (4), we interact our measure of asset tangibility, the TANG variable, with the private credit to GDP ratio and the GFC0810 variable. The coefficient on the interaction term is large and statistically significant and has an expected positive sign, given that TANG is an inverse proxy of financial vulnerability.³² It indicates that the ratio of relative outward FDI in financially vulnerable sectors during the global financial crisis to relative outward FDI in financially vulnerable sectors during non-crisis years was about 59% lower in a highly financially developed country like the United States than in a less financially developed country such as Italy.³³ In column (5), we include both the $ED \times CREDIT/GDP$

²⁹Data on legal origin dummy variables come from La Porta et al. (1999).

³⁰If the instruments are valid, the first-stage residuals control for the potential endogeneity of the suspect variable, parameters are consistently estimated (as long some assumptions are satisfied), and the statistical significance of their coefficient provides the basis for a robust (to assumptions) endogeneity test (Wooldridge, 2010).

³¹The first-stage (cluster-robust) F -statistic indicates that the instruments are relevant, with a value slightly above the threshold identified as Staiger and Stock (1997) to qualify an instrument as strong ($F \approx 10$). However, doubts have been raised about the validity of using legal origin dummy variables as exogenous instruments for financial development (Manova, 2013). Hence, results of column (3) should be interpreted as simply showing that our findings are robust to a common instrumental variables strategy in the Finance and Growth literature.

³²We follow other papers (Braun, 2003; Manova et al., 2011; Manova, 2013) by not inverting this measure such that a higher value corresponds to a lower tangibility of assets. Hence, a higher TANG value indicates *lower* financial vulnerability.

³³Relative outward FDI in more financially vulnerable sectors is defined here as the ratio of outward FDI in the Trans-

\times GFC0810 and the TANG \times CREDIT/GDP \times GFC0810 interaction terms in the same regression to capture simultaneously the reliance of firms on external finance and their ability to raise outside finance. Coefficients on the interaction terms are statistically significant and have the expected signs, confirming that a sector's financial vulnerability is shaped both by firms' reliance on external finance and the ability of these firms to gain access to external finance.

In this section, we have found that the impact of the global financial crisis on the relative volume of outward FDI in financially vulnerable sectors has been greater in more financially developed countries. These results indicate that credit conditions have an influence on FDI.

4.2 Extensions: banking crises, sector-specific output, and margins of FDI

Table 2 presents additional results. We notably deepen our focus on a credit channel effect of the global financial crisis on outward FDI by looking at the mediating role played by banking crises.

Model (2) is estimated in columns (1)-(3). Column (1) shows that the impact of the global financial crisis on the relative volume of outward FDI in financially vulnerable sectors in more financially developed countries was magnified by the occurrence of a banking crisis. The negative and statistically significant coefficient on the interaction term between the triple interaction term and a banking crisis dummy variable implies that the ratio of relative outward FDI in financially vulnerable sectors during the global financial crisis to relative outward FDI in financially vulnerable sectors during non-crisis years was about 44% lower in a highly financially developed country *experiencing a banking crisis* like the United States than in a less financially developed country *not experiencing a banking crisis* such as Italy, i.e. a 14 percentage points fall relative to a situation where the highly financially developed country did not experience a banking crisis. In column (2), we make a distinction between transportation Equipment sector (a typical low TANG sector; 25th percentile of TANG) to outward FDI in the Beverages sector (a typical high TANG sector; 90th percentile of TANG).

Table 2: Extensions: banking crises, sector-specific output, margins of FDI

	<i>Outward greenfield FDI, by sector</i>					
	<i>Volume</i>			<i>Number of projects</i>	<i>Average size</i>	
	(1)	(2)	(3)	(4)	(5)	(6)
ED × CREDIT/GDP × GFC0810	-1.380*** (0.362)	-1.394*** (0.375)	1.458 (1.007)	-1.455*** (0.387)	-0.218* (0.127)	-1.125*** (0.419)
(ED × CREDIT/GDP × GFC0810) × BCRIS	-1.251** (0.598)					
(...) × systematic BCRIS		-1.493* (0.776)				
(...) × borderline BCRIS		-0.267 (1.096)				
(...) × alternatively defined BCRIS			-3.617*** (1.054)			
ln(sector-specific value added _t)				0.575 (0.413)		
ln(sector-specific value added _{t-1})				0.060 (0.189)		
Observations	5504	5504	5504	2886	5504	2652

***p<0.01 **p<0.05 *p<0.10. Cluster-robust standard errors in parentheses. Time-invariant country-sector fixed effects, time-varying country fixed effects, and time-varying sector fixed effects are included in all regressions. ED: sector-specific measure of dependence on external finance. GFC0810: global financial crisis 2008-2010. BCRIS: banking crisis.

systemic and borderline crises. We find that a banking crisis only amplified the effects of the global financial crisis when it was systemic. In column (3), we use the alternative measure of significant financial distress in the banking system, based on the joint observation of negative output growth and deceleration of private credit growth. The coefficients on the interaction terms suggest that the volume of relative outward FDI in financially vulnerable sectors declined in a statistically significant way only in countries exhibiting signs of a banking crisis. Overall, the distinction between countries according to the degree of financial distress in their banking system during the 2008-2010 period provides strong support for a credit channel effect of the global financial crisis on FDI.³⁴

In column (4), we include the contemporaneous and first lag of sector-specific value added to control for the effects of the global financial crisis working through manufacturing activity.³⁵ The

³⁴We also investigated whether the impact of the global financial crisis on the relative volume of outward FDI in financially vulnerable sectors in more financially developed countries was greater in more “financially integrated” economies, as reflected by the ratio of the sum of foreign debt liabilities and assets to GDP in 2007 or the outstanding amount of international loans from non-resident banks to GDP ratio (Data from Lane and Milesi-Ferretti (2007) or Beck et al. (2009)). We failed to find any statistically significant additional effect. A banking crisis appears thus to give a superior signal about the degree of financial distress in the banking sector of a given country during the period 2008-2010.

³⁵Data come from UNIDO Industrial Statistics Database (INDSTAT4), <http://www.unido.org/en/resources/statistics/statistical->

coefficients on both variables are jointly statistically significant at the 10% level, suggesting that “larger” sectors generate more outward FDI. This can be the outcome of a higher number of producers, higher average firm-scale, or more internal finance. The inclusion of these measures of sector-specific activity has little impact on the coefficient of the triple interaction term, which remains large, negative, and statistically significant at the 1% level.³⁶ Hence, the credit channel effect of the global financial crisis that we have highlighted throughout this paper does not appear to be a simple proxy for sector-specific output shocks.

We end this section by exploring in turn the impact of the global financial crisis on the extensive and intensive margins of outward FDI. In column (5), the dependent variable is the number of FDI projects while in column (6) the dependent variable is the average value of the FDI projects.³⁷ In both columns, the coefficient on the triple interaction term is negative and statistically significant. However, its magnitude and statistical significance is much larger in column (6), suggesting that MNEs have responded to the lack of access to external finance mainly by reducing the size of their foreign projects.

5 Conclusion

We showed in this paper that the fall in FDI during the global financial crisis can be partly explained by the decline in the availability of external finance. This result complements those of the trade literature on the effects of credit conditions on international trade and highlights the role played by source

databases.html. We include the first lag of sector-specific value added to take into account that outward FDI may depend on past cash flows.

³⁶Without the inclusion of these two variables and keeping the sample constant, the coefficient on the triple interaction term is almost the same as in column (4).

³⁷It is important to note that modelling the average size of the cross-border investments conditional on positive FDI does not result in a sample selection issue. Given that we are interested in how the global financial crisis influences average project size when FDI occurs, the observations for which outward FDI is positive form an appropriate subsample of the population of interest (Wooldridge, 2010)

countries' financial development in promoting outward FDI. Findings of this paper also provide some evidence on the worldwide nature of the credit constraints generated by the global financial crisis.

Several policy implications can be derived from this paper. Governments wishing to encourage the internationalization of their firms should adopt policies which promote financial development, such as the implementation of a legal framework which is more conducive to lending. Given the large fixed costs associated with FDI and the difficulties of some firms to gain access to external finance, e.g. small and medium enterprises in financially vulnerable sectors, public financial support targeting specifically firms looking at expanding abroad may also be considered.³⁸ Finally, during a banking crisis, public intervention appears crucial to restore the well-functioning of financial markets and avoid negative international financial spillovers.

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³⁸See Bannò et al. (2014) for an examination of the impact of public support on the outward FDI of small and medium enterprises in Italy

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Appendices

A Measures of financial vulnerability and matching with FDI data

The *FDI Markets* database classifies the FDI projects into very broad recipient sectors, which are loosely aligned with 1987 U.S. SIC codes. We match the manufacturing broad sectors to the corresponding three-digit ISIC codes (rev.2) reported in Rajan and Zingales (1998) and Kroszner et al. (2007); when the *FDI Markets* categories covered several sectors, we used the median value of the financial vulnerability measure for these sectors.³⁹ Table 3 indicates how the matching was done.

Table 3: Measures of sectors' financial vulnerability

Broad <i>FDI Markets</i> Sectors	Corresponding ISIC code in RZ/KLK	ED median value	TANG median value
Beverages	313	0.08	0.40
Food & Tobacco	311+314	-0.16	0.28
Textiles	321+322+323+324	-0.03	0.14
Wood Products	331+332	0.26	0.30
Paper, Printing & Packaging	341+342	0.19	0.32
Alternative Energy, Biotechnology, Chemicals, Pharmaceuticals	352	0.22	0.27
Rubber	355	0.23	0.36
Plastics	356	1.14	0.38
Ceramics & Glass, Building & Construction Materials	361+362+369	0.06	0.42
Metals	371+372+381	0.09	0.32
Business Machines & Equipment, Engines & Turbines, Industrial Machinery, Equipment & Tools, Space & Defence	382	0.45	0.22
Communications, Consumer Electronics, Electric/Electronic Components, Medical Devices, Semiconductors	383	0.77	0.21
Aerospace, Automotive OEM, Automotive Components, Non-Automotive Transport OEM	384	0.31	0.23
<i>Average</i>		<i>0.28</i>	<i>0.30</i>
<i>Standard deviation</i>		<i>0.35</i>	<i>0.08</i>

Notes: ED: external dependence. TANG: asset tangibility. RZ: Rajan and Zingales (1998), KLK: Kroszner et al. (2007).

³⁹We always use the ED value for the three-digit broad ISIC sectors. In some cases, these broad sectors may not include data on subsectors, for which Rajan and Zingales (1998) and Kroszner et al. (2007) provide four-digit level specific ED values.

B Summary statistics

Table 4: Summary statistics

Variable	Mean	Std. Dev.	N
Outward FDI flows (US\$ million)	286.06	1040.53	5504
Number of projects	2.74	7.29	5504
Average project size	95.59	218.43	2839
Credit to GDP ratio	0.73	0.49	5504
Quality of financial institutions	10.26	3.28	5336