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Supply Chains and Credit-Market Shocks: Some Implications for Emerging Markets

Yothin Jinjarak

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Yothin Jinjarak is research fellow at Asian Development Bank Institute (ADBI) and reader at the School of Oriental and African Studies (SOAS). University of London.

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Please contact the authors for information about this paper.

Email: yjinjarak@adbi.org

Asian Development Bank Institute
Kasumigaseki Building 8F
3-2-5 Kasumigaseki, Chiyoda-ku
Tokyo 100-6008, Japan

Tel: +81-3-3593-5500
Fax: +81-3-3593-5571
URL: www.adbi.org
E-mail: info@adbi.org

Abstract

Driven by the increasingly important role of supply chains in global production, this paper studies empirical association between global credit-market shocks and firm behavior towards liquidity needs across countries and industries. Focusing on the adjustment of working-capital financing, we find two pieces of supporting evidence from international firm-level panel data covering the period 2002:I–2012:IV. First, for industries where specific investment in the input supplier-customer relationship is large, firms are more exposed to credit-market shocks. We find that measures of global credit-market shocks are negatively associated with trade receivables, trade payables, and inventories, conditional on the level of contract intensity in the industries where firms operate. Second, firms in emerging markets are more vulnerable to credit-market shocks than are firms in developed countries. We are also able to verify the economic significance of sales growth, operating cash flows, cash stock, and firm size in the overall adjustment. Our findings highlight the importance of balance-sheet contagion along supply chains during the 2007–09 global financial crisis.

JEL Classification: G14, E0, F0

Contents

1. INTRODUCTION

The global financial crisis of 2007–09 was accompanied by world-wide recession and the collapse of international trade relative to output. The global crisis occurred against the backdrop of an international unbundling of production structures via supply-chain trade over the past two decades (Baldwin and Lopez-Gonzalez 2013; and Koopman, Wang, and Wei, forthcoming), especially through vertical linkages of the global production structure (Bems, Johnson, and Yi 2011). There is now a growing consensus that deterioration of credit-market conditions and credit constraints formed the main channel of crisis transmission during the latest global crisis (Amiti and Weinstein 2011; Antras and Foley 2011; Feenstra, Li, and Yu 2011).[1]

This study offers international evidence regarding the relationship between supply chains and firm behavior towards liquidity needs. We conduct international comparisons of firms across industries, studying the importance of global credit-market conditions and supply-chain activities. Our objective is to measure empirical feedback of credit-market shocks to firm behavior, using micro-level data and accounting for industry and macro-country factors. To measure the global credit-market shocks, we use time series of Ted spread (3-month United States [US] Libor minus 3-month US Treasury Bill), and its decomposition based on overnight Libor, Federal Funds Rate target, and overnight index swap rate (OIS). To account for industry and macro-country factors, we examine firms in emerging markets vis-à-vis developed markets, and study firms according to the level of industry-specific investment and contract intensity in the input supplier-customer relationship in the industry firms operate in.

Focusing on the role of supply chains in production, we empirically search for patterns in the association between global credit-market shocks and firm behavior towards liquidity needs across countries and industries. Our two testing hypotheses are (i) whether firms are more exposed to credit-market shocks when there is large industry-specific investment in the input supplier-customer relationship, i.e., contract intensity-driven balance-sheet contagion in supply chains; and (ii) whether firms operating in emerging markets are more exposed to credit-market shocks, i.e., whether financial-system inefficiency and credit misallocation became more likely during the global liquidity crisis.

Our sample spans 2002:I–2012:IV, covering a tail end of the Great Moderation in macroeconomic volatility, the ensuing financial crisis of 2007–09, and the period afterwards. Using firm-level information, this study adds to a growing literature on firm behavior and financial adjustment in the context of funding illiquidity and major economic fluctuations, underlined by the 2007–09 global-crisis experience. The findings of this literature suggest that the latest global crisis led to a significant drop of economic activities world-wide. The evidence includes, for example, that depreciation of equity prices was most severe for firms that depended on external working-capital financing (Calomiris, Love, and Peria 2012; Tong and Wei, forthcoming[2]); that credit-constrained firms drew more heavily on cash and lines of credit (Campello, Graham, and Harvey 2010);[3] and that investment-grade non-financial firms hoarded more cash

[1] See also Chor and Manova (2012) and Manova and Yu (2012).

[2] Calomiris et al. examine 17,000 firms in 44 countries; Tong and Wei study 3,823 manufacturing firms in 24 emerging countries.

[3] Campello et al. conducted a survey-based measure of financial constraint from a sample of 1,050 chief financial officers (CFOs) in the US, Europe, and Asia.

after the fall of Lehman Brothers (Kahle and Stulz 2010).[4] By and large, these findings point to the influence of sudden deterioration in credit-market conditions and the importance of working-capital needs as possible culprits for the high firm-level exposure to the global financial crisis of 2007–09.

In this paper we put the spotlight on how firm behavior towards liquidity needs is driven by a combination of credit market shocks and balance sheet contagion along supply chains. Essentially, the gist of our new research is that the real and financial effects of negative credit market conditions can be traced from the firm-level adjustment of working-capital financing, accounting for the importance of industry-specific investment in the input supplier-customer relationship in the industry firms operate in. On this premise, and motivated by the turbulent credit-market conditions of the 2007–09 global crisis, we then summarize the international evidence of firm-level working-capital financing adjustment, including trade receivables, trade payables, and inventories, as well as short-term debts.

The rest of this paper is organized as follows. Section II summarizes related theories and empirics. Section III describes data and construction of the samples. Section IV reports main the findings. Section V concludes.

2. RELATED THEORIES AND EMPIRICS

In this section, we provide an overview of earlier studies that deal with supply chains, balance-sheet contagion, credit-market conditions, and firm behavior. Our study is based on a strand of well-researched theoretical studies on balance-sheet contagion in supply chain, notably Kiyotaki and Moore (1997), as well as empirical studies on financial dependence across industries, e.g., Fisman and Love (2003). We are particularly interested in identifying empirical channels that credit-market shocks propagate through firm-level operations, and hence firm behavior towards liquidity needs, across industries and countries. We refer to “liquidity needs” as the firm-level financing demand that intertwines with industry structure and financial-system efficiency. Trade credit (receivables and payables), inventories, and short-term debts together form a core of working-capital financing, and hence are consistent with the concept of liquidity needs we are interested in. The exisiting literature on trade credit is quite extensive; see for example Petersen and Rajan (1997) and Klapper, Laeven, and Rajan 2012.[5]

It is when credit-market conditions suddenly tightened that firm behavior became even more interesting to study. When credit-markets dried up, firms faced general illiquidity, in contrast to the good times and tranquility in credit-markets when firms were able to access to all sorts of financial resources. Hypothetically, under tight credit-market conditions firms with better credit positions have a greater incentive to offer trade credit, i.e. trade receivables, to subsidize liquidity needs of their customers. On the other hand, firms with financial difficulties are more likely to ask for more trade payables from their suppliers. This is supported by evidence from small and large US firms during monetary contractions (Nilsen 2002);[6] firms in the emerging-market crises of the 1990s (Love, Preve, and Sarria-Allende 2007);[7] trade-financial linkages of Asia

[4] Kahle and Stulz study 3,198 US firms.

[5] See also Fabbri and Klapper, 2009.

[6] See also Choi and Kim (2005).

[7] Love et al. conduct a panel analysis on six emerging market countries.

and the US based on international input-output production structure (Escaith and Gonguet 2011); as well as indirect evidence based on international co-movement of equity returns affected by trade credit links (Albuquerque, Ramadorai, and Watugala 2012).

Credit-market shocks can propagate both directly and indirectly through firm-level liquidity needs. Directly, the credit-market shocks may affect liquidity needs via the disordering of interconnected financial obligations across firms, particularly between upstream firms and downstream firms along the supply chain. Indirectly, credit-market shocks may worsen the financing capacity of firms via depreciated collateral values and asset prices, which then subsequently weaken the balance-sheets of the firms. The empirical evidence suggests that credit channels can affect small and large firms asymmetrically (Bernanke and Gertler 1989; Gertler and Gilchrist 1994); influence the link between interconnected financial obligations and business cycles (Kiyotaki and Moore 1997; Kiyotaki and Moore 2002); increase output correlation withtrade credit in supply chain (Raddatz 2010); and even increase the cross prediction of equity returns among economically related supplier and customer across industries (Menzly and Ozbas 2010).

The importance of liquidity needs expands beyond the trade-credit part of working-capital financing. Inventories are typically purchased on open accounts and funded partially or entirely by trade payables. As a result, inventory policy is inevitably affected by credit-market conditions (e.g., Haley and Higgins 1973; Schiff and Lieber 1974; and Bougheas, Mateut, and Mizen 2009). In addition, along the supply chains any inventory decision of downstream firms can impose production externality on upstream firms (Lee, Padmanabhan, and Whang 2004), and also determine how the upstream firms may extend lines of credit (i.e., trade receivables) to their downstream counterparts. Note that lost sales, in addition to production externality, can also motivate input suppliers to provide trade credit to their customers (Daripa and Nilsen 2011), strengthening the linkages of credit-market conditions, trade credit, inventory holdings, and working-capital financing (Fisman 2001). Credit-market shocks may also influence inventory holdings, more heavily on liquidity-constrained firms without immediate access to financing from the credit-markets (Kashyap, Lamont, and Stein 1994).

Further, credit-market shocks can have compounding effects on working-capital financing, affecting trade receivables, trade payables, inventories, as well as short-term debts simultaneously. Depending on the allocation efficiency of the financial system, trade payables and short-term debts can be either complements or substitutes (Burkart and Ellingsen 2004). Implicit interest rates of trade payables may rise above interest rates of short-term debts, whereby the interest differentials can be justified by insurance and default premiums to compensate suppliers faced with increasingly higher cost of funding (Cunat 2007), most severely during deteriorating credit-market conditions. However, note that implicit interest rates of trade credit can also sometimes be zero (Ng et al. 1999).

Empirical work has been hampered mostly by lack of data. Cross-country firm-level data sets (including ours) do not contain specific details at firm-level of input-output production structure, and together with information on credit-market accessibility (creditworthiness, size of bond, bank loans, terms of credit, etc.).[8] To get around this, we attempt to disentangle firm behavior towards liquidity needs by accounting for

[8] International input-output data have become increasingly more available; see Trade in Value Added (TiVA) from the Organisation for Economic Co-operation and Development (OECD) and the World Trade Organisation (WTO) and International Input-Output tables from Institute of Developing Economies-Japan External Trade Organization (IDE-JETRO).

industry and macro-country factors. Two empirical observations need to be made. At the industry level, the effectiveness of trade credit is dependent on product-market competition and type of products (Burkart, Giannetti, and Ellingsen 2011), industry-specific nature of operation (i.e., inventory management, relationship specificity between input supplier and customer, product quality), and credit worthiness of firms involved (Ng, Smith, and Smith 1999; Long, Malitz, and Ravid 1993). Hence, accounting for industry-specific factors can help understand responsiveness of firms and industries to credit-market shocks, in terms of working-capital financing needs, including trade receivables, trade payables, inventories, and short-term debts.

At the country level, working-capital financing and trade credit are more accessible for incorporated firms and firms in well-developed financial and legal institutions (Demirguc-Kunt, Love, and Maksimovic 2006). Accounting for macro-country factors, i.e., comparing emerging-market firms vis-à-vis developed-market firms, can also help understand the importance of dependence on external finance on liquidity needs of firms in countries with less efficient and unstable financial institutions.[9] Towards this end, we use international firm-level data to estimate (a) importance of input-output production structure from the industry-specific contract intensity of input supplier-customer relationship; and (b) influence of financial market inefficiency by comparing emerging-market firms and developed-economy firms. By combining these cross-cutting aspects of the real and financial sectors, our work can also be viewed as an application of studies on the role of business networks (Rauch 2011) for investigating empirically international macroeconomic and financial issues.

3. DATA AND PRELIMINARY ANALYSIS

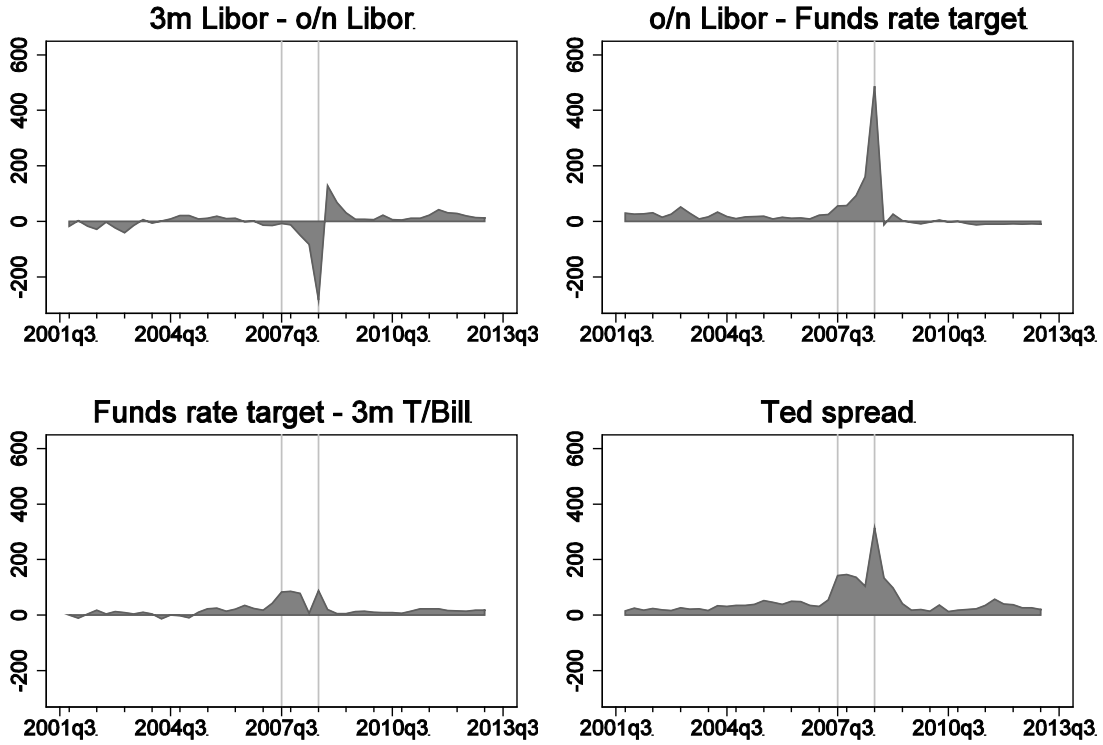
This first section describes the credit-market shocks and their evolution over time. We then report our firm-level data, comprising balance-sheet variables at quarterly frequency and covering a comprehensive number of industries and countries from 2002:I–2012:IV, provide the construction of sample, industry and country classification, as well as discuss data limitations. The main variables of interests are working-capital financing components: trade receivables, trade payables, inventories, and short-term debts. As mentioned previously, the focus on trade receivables, trade payables, short-term debts, and inventories is underlined by the emerging-market crises of the 1990s (Love, Preve, and Sarria-Allende 2007; Bougheas, Mateut, and Mizen 2009). These variables are also important based on financial-accounting consideration: inventories plus trade receivables, minus trade payables, is the net working-capital, which, together with short-term debts, reflect firm behavior towards liquidity needs.

To measure credit-market shocks, we use Ted spread and its decomposition as follows. Firstly, Ted spread can be decomposed into (i) 3-month Libor (USD) minus overnight Libor (USD); (ii) overnight Libor minus Fed Funds Target rate; and (iii) Fed Funds Target minus 3-month US Treasury Bill. Following Hamilton (2008), we denote a sum of the former two components “liquidity-premium” shocks and the last component ”flight-to-quality” shocks. This decomposition of credit-market shocks is shown in Figure 1.1 (in basis points) for the past 10-year period. Ted spread is normally below 50 basis points, but the credit-market events from 2007–09 demonstrated that the spread can go above 200 basis points for extended periods. The liquidity-premium [that is, the sum of (i) and (ii) components of Ted spread] increased significantly from 2007:III to 2009:II, reflecting a higher probability of default prevailing in the interbank

[9] See for example the case of international trade of Africa in Berman and Martin (2012).

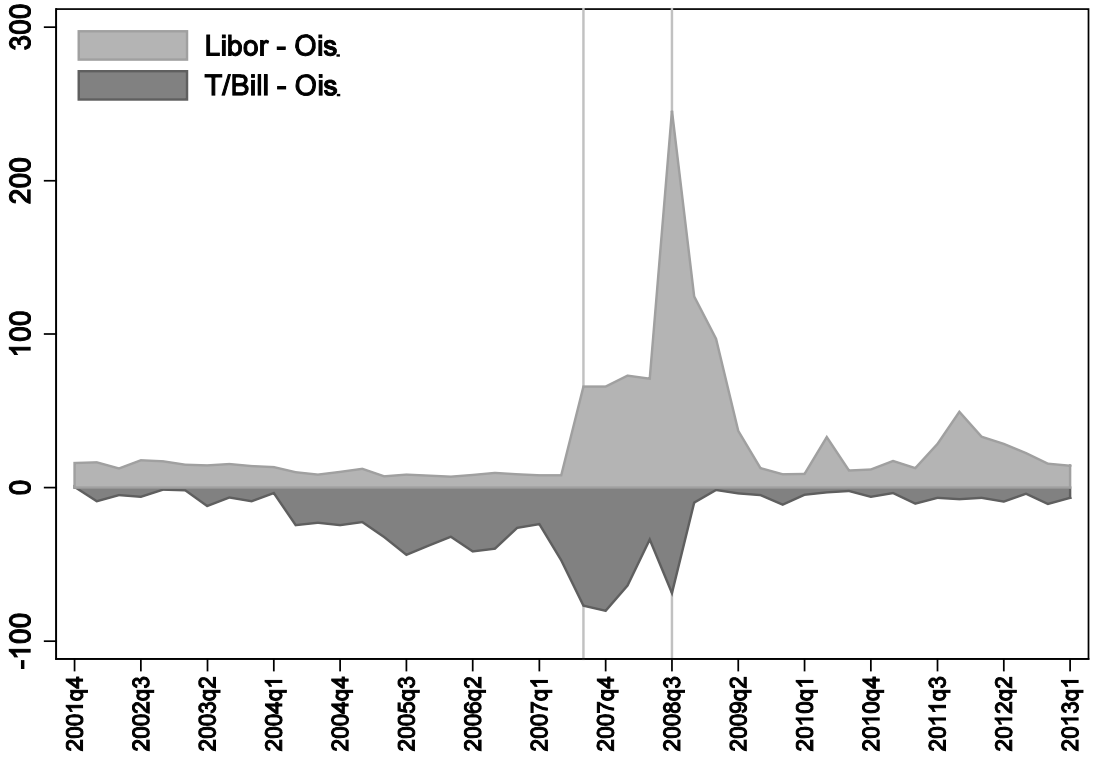
markets. The flight-to-quality [component (iii) of Ted spread] also increased during the same period, which may reflect flight of investors into safe assets (i.e., lenders hoarding cash liquidity government Treasury assets) as well as forward-looking expectation that the financial markets placed on the Federal Reserve policy during the market volatility period.

Figure 1.1: Credit-Market Shocks: Ted Spread and US Libor, in basis points



Secondly, Ted spread can be decomposed into (a) 3-month Libor minus Ois (overnight index swap rate) and (b) Ois minus 3-month US Treasury Bill. Following Brunnermeier (2008) and Sengupta and Tam (2008), this decomposition of credit-market shocks is shown in Figure 1.2. In the Figure, the sum of the two shaded-areas is effectively Ted spread. Libor-Ois spread can be considered as a measure of illiquidity in global credit-markets. As noted by Brunnermeier, while Libor-Ois spread is not affected by a collateral effect on US Treasury bonds, T/Bill-Ois captures effectively the demand for collateral in the crisis period (i.e., flight to safety). Henceforth, Libor-Ois is our alternative measure of the liquidity-premium, and Ois-T/Bill is an alternative measure of flight-to-quality shock in our analysis (dubbed, liquidity-premium II and flight-to-quality II, respectively).

Figure 1.2: Credit-Market Shocks: Overnight Index Swap Rates (Ois), in basis points



Source: Author's calculation

Our firm and industry data are drawn from several sources. The firm-level balance-sheet variables are from Compustat Fundamental Quarterly (CFQ). The data series are reported quarterly. Based on CFQ panel data, we follow the literature and construct the variables of interest—Trade Receivables/Total Sales, Trade Payables/Cost of Goods Sold, Inventories/Cost of Goods Sold, Short-Term Debts/Total Assets, Cash Stock/Total Assets, Sales Growth, and Operating Cash Flows/Total Assets—after which we have a comprehensive set of firm-level samples from 2002:I to 2012:IV, covering 3,407 to 11,919 firms quarterly, for 334 NAICS 4-digit industries in 106 countries.[10]

The main advantages of our CFQ sample are (i) quarterly firm-level information for a period of 10 years and (ii) country and industry coverage. This allows us to examine firm response to liquidity needs and credit-market shocks in detail and over a long period. Alternative panel data sets in previous studies are either restricted to a smaller number of countries, or only available at annual frequency, and therefore cannot capture the economic significance of credit-market shocks on firm behavior in medium-to long-term. Two limitations of CFQ data should be noted. First, CFQ data include only listed firms, and contain no information on credit accessibility and risk-rating details. Second, CFQ data neither have information on multinational/foreign-affiliate status, nor on domestic/export market sources of firm-level revenue. These two limitations limit the validity ofour assessment on firm behavior as credit-market access, reliance on different types of credit, as well as inventory policy at the firm level can be crucial to understanding credit worthiness, nature of firm operation, and international business

[10] Appendix A.1 provides sample coverage of firms, countries, and industries; Appendix A.2 reports the histograms of quarterly firm observations in the sample.

environment, and hence firm behavior towards liquidity needs. However, we are not aware of any comprehensive international firm-level, non-proprietary, and quarterly data that we can gather all such information currently available for empirical analysis along our line of inquiries.[11]

To further organize the firm-level data for econometric analysis, we proceed as follows. First, we use an industry-specific measure of contract intensity of the input supplier-customer relationship.[12] This measure is based on a differentiated-product classification (Rauch 1999) and a proportion of inputs that require relationship-specific investments in production (Nunn 2007).[13] Essentially, this industry contract-intensity is constructed from input-output tables, identifying the proportion of intermediate inputs that are sold on an organized exchange and reference priced in trade publications (based on Rauch [1999] classification): organized exchanges and reference priced indicate market thickness and therefore a low level of relationship specificity. In the estimation, we will use industry-specific numerical values of this contract-intensity measure. If we sort firms by contract-intensity level into four quartiles, the top two quartiles are classified as high contract-intensity firms, and about half of the sample is classified as high contract-intensity industries. We note that the contract-intensity measure (Nunn 2007) is constructed at 6-digit North American Industry Classification System (NAICS), and we apply this measure to 4-digit NAICS based on industry level of CFQ firm-level data.

Second, firms are classified into "emerging-market firms" vis-à-vis "developed-economy firms," based on their localities, following the World Bank's country classification; firms located in high-income countries are classified as developed-economy firms.[14] The industry contract-intensity and country-income classifications provide a realistic way, subject to large firm-level information, of accounting for, respectively, the industrial structure across industries and financial-system efficiency across countries, both of which are consistent with the theoretical and empirical underpinnings discussed in Section II.

[11] On a related note, since firm size is one determinant of access to external finance, given the choice of denominators, and as firm size distribution differs across countries, we report a regression-based summary of firm size distribution in Appendix A.3, showing an association between log firm size and log rank. Firms are ranked separately for non-EM and for EM sub-samples, according to Total Assets, Total Sales, and Cost of Goods Sold. The coefficient estimates of log rank suggest that the firm size distributions in the two groups of countries are different from each other (based on R^2, the explanatory powers of both sub-samples may appear quite similar). A test of equality of coefficients between sub-samples rejects the null at 1% level, suggesting discernible differences between non-EM and EM samples and supporting our separation of the two groups for the main estimation. See Alfaro, Charlton, and Kanczuk (2009) for a comprehensive study specifically focusing on the firm size distribution of firms globally.

[12] A relationship-specific investment and interconnected financial obligations between a firm and its supplier, may also be viewed as trade costs along the supply chain of production.

[13] For industries not classified at the 4-digit NAICS, we assign the mean of 2-digit NAICS; for the rest, most of which are services-related industries, we assign the lowest value of contract intensity (fourth quartile).

[14] Emerging markets firms make up 57% of the sample. There are some overlapping between the industry disaggregation and the country disaggregation: 38% of low contract-intensity firms are emerging-market firms, and 65% of high contract-intensity firms are developed-economy firms.

Table 1: Firm Characteristics by Contract Intensity and Country Groups

Average				
Group	**Industries**		**Countries**	
Variable	Low Contract	High Contract	Developed	Emerging
Trade Receivables/Total Sales	0.33	0.41	0.37	0.37
Trade Payables/Cost of Goods Sold	0.37	0.43	0.41	0.40
Inventories/Cost of Goods Sold	0.34	0.50	0.39	0.47
Short-Term Debts/Total Assets	0.12	0.12	0.11	0.14
Cash Stock/Total Assets	0.12	0.13	0.13	0.12
Sales Growth	0.32	0.32	0.31	0.34
Operating Cash Flows/Total Assets	0.04	0.04	0.04	0.04
Number of firm-quarter observations	106,803	106,337	135,590	77,550

Standard Deviation				
Group	**Industries**		**Countries**	
Variable	Low Contract	High Contract	Developed	Emerging
Trade Receivables/Total Sales	0.34	0.34	0.33	0.37
Trade Payables/Cost of Goods Sold	0.39	0.41	0.40	0.40
Inventories/Cost of Goods Sold	0.42	0.49	0.45	0.49
Short-Term Debts/Total Assets	0.12	0.12	0.11	0.13
Cash Stock/Total Assets	0.11	0.12	0.11	0.11
Sales Growth	0.71	0.70	0.72	0.69
Operating Cash Flows/Total Assets	0.07	0.08	0.07	0.08
Number of firm-quarter observations	106,803	106,337	135,590	77,550

Industries classified as high (low) contract-intensity have an average proportion of inputs that require relationship-specific investments in production at the level of two highest (lowest) quartiles of contract-intensity measure. Countries are classified as developed economies if they are high-income according to the income classification of World Bank.
Source: Author's calculation.

Table 1 provides summary statistics of the sample. The first two columns present a summary of low contract-intensity firms vis-à-vis high contract-intensity firms. An average proportion of inputs that require relationship-specific investments of input supplier-customer in production supply-chains for the high contract-intensity group (low contract-intensity group) is 0.6 (0.1). Table 1 suggests that high contract-intensity firms use more trade receivables and trade payables, hold larger inventories, carry roughly the same short-term debts and cash stock, and have similar rate of sales growth and level of operating cash flows, compared with low contract-intensity firms. The next two columns present a summary for a developed economy firms vis-à-vis emerging-market firms. On average, emerging-market firms in our sample use the same level of trade receivables and trade payables as developed market firms, have larger inventories and short-term debts, hold the same amount of cash, have higher sales growth, and have the same level of operating cash flows. To formally test whether these differences and similarities of working-capital financing across industries and countries are associated with firm behavior towards liquidity needs in the presence of credit-market shocks, we conduct an econometric analysis in the following section.

4. ESTIMATION RESULTS

We now carry out a formal test on international firm-level panel data. The main focus is on the adjustment of working-capital financing: trade receivables, trade payables, inventories, and short-term debts, as our dependent variables that represent firm behavior towards liquidity needs. Given a large amount of information across industries and countries, we use the panel-estimation method, controlling for industry and macro-country factors. The aim here is to understand and summarize empirical association of credit-market shocks and firm behavior based on a standard econometric approach. The controlling variables include credit-market shocks (and its decomposition using Libor and Ois, i.e., liquidity-premium and flight-to-quality), a binary indicator (0/1) for emerging-market firms, a numerical measure of industry contract-intensity of input supplier-customer relationship, together with benchmark determinants; cash stock/total assets, sales growth, operating cash flow/total assets, a post 2007q3 dummy variable, a time trend, and quarterly and country fixed effects. The estimation period is 2002:I to 2012:IV. The fixed-effects regression model is specified as

$$Y_{ijt} = \theta(\textit{Contract Intensity})_i + \delta(\textit{Emerging Markets})_j + \phi(\textit{Credit Market Shocks})_t + \beta X_{ijt} + \alpha_i + \gamma_j + \eta_t + \varepsilon_{ijt}$$

where i denotes firm, j country, and t quarterly period; Y denotes the dependent variables (trade receivables/total sales, trade payables/total cost of goods sold, inventories/cost of goods sold, and short-term debts/total assets); α denotes firm fixed-effects; γ country fixed-effects; η quarterly fixed-effects; X is a set of determinants, and ε denotes the error term.

Table 2.1: Panel Estimation of Firm-Level Response to Credit-Market Shocks: Ted Spread

Dependent variable / Explanatory variable	(1) Trade Receivables / Total Sales	(2) Trade Payables / Cost of Goods Sold	(3) Inventories / Cost of Goods Sold	(4) Short-Term Debts / Total Assets
Contract Intensity	14.18***	13.60***	23.23***	.08
	(.31)	(.36)	(.43)	(.11)
Emerging-Market Firms (0/1 binary variable)	16.89	-10.60	1.04	-5.35
	(13.08)	(15.24)	(18.09)	(4.41)
Credit-market Shocks	-.07	-.65***	-.11	.03
	(.20)	(.23)	(.28)	(.07)
x Contract Intensity	-.94***	-1.05**	-1.49***	-.15
	(.36)	(.42)	(.50)	(.12)
x Emerging Markets	-2.32***	-2.76***	-1.87***	.41***
	(.23)	(.27)	(.32)	(.08)
Cash Stock / Total Assets	-2.54***	2.53***	-25.04***	-28.07***
	(.68)	(.79)	(.94)	(.23)
Sales Growth	8.35***	13.74***	19.57***	-.42***
	(.29)	(.34)	(.41)	(.10)
Operating Cash Flow / Total Assets	-60.06***	-28.78***	-56.17***	-31.78***
	(1.15)	(1.35)	(1.60)	(.39)
log Size (assets)	-1.13***	.63***	-1.54***	-.76***
	(.04)	(.05)	(.06)	(.01)
Post-2007q3 (0/1 variable)	16.66***	41.11***	29.43***	-9.13***
	(2.10)	(2.44)	(2.90)	(.71)
Time trend, since 2007q3	-12.53***	-19.43***	-11.29***	1.14***
	(1.15)	(1.34)	(1.59)	(.39)
R^2	.16	.16	.13	.18
Observations	213,140	213,140	213,140	213,140
Quarterly effects	Yes	Yes	Yes	Yes
Country effects	Yes	Yes	Yes	Yes

Ted Spread is 3-month US Libor minus 3-month US Treasury Bill. Fixed-effects estimation with standard errors in parentheses (***, **, * denote statistically significant at 1, 5, 10%). Sample period: 2002:I to 2012:IV.
Source: Author's calculation

Tables 2.1–2.3 provide estimation results. As the baseline estimation, Table 2.1 reports coefficient estimates from panel regressions using contract intensity as a measure of industry-specific investment in input supplier-customer relationship and Ted spread as a measure of global credit-market shocks. Tables 2.2 and 2.3 follow on, with the abovementioned decomposition of Ted spread into liquidity-premium and flight-to-quality, using Libor, Federal Funds Rate target, and Ois.

In Table 2.1, the coefficient estimates on the industry-specific contract intensity (row 1) suggest that this variable is positively associated with trade receivables, trade payables, inventories, and short-term debts; these empirical associations are all statistically significant, except one relating to short-term debts, supporting the

importance of the supply-chain relationship for working-capital financing. A binary indicator for emerging-market firms (row 2) suggests that firms in emerging markets are associated with more trade receivables and inventories, whereas the opposite applies to trade payables and short-term debts, though these associations are not statistically significant. We find that the global credit-market shocks (row 3) are negatively associated with trade receivables, trade payables, and inventories, but positively associated with short-term debts; however, only the coefficient estimate on trade payables is statistically significant, suggesting that credit-market shocks impact financing needs along supply chains particularly on the lines of trade credit that firms normally received from their input suppliers.

We can make further observations from the interactions between credit-market shocks, industry contract-intensity, and the emerging-market binary indicator. For trade receivables, trade payables, and inventories, their negative associations with credit-market shocks have become larger with higher industry contract-intensity (row 4); the coefficient estimates are also statistically significant. The evidence is consistent with balance-sheet contagion: faced with shortage of liquidity supply, firms reduced trade receivables to their customers, and firms also received less trade payables from their input suppliers. This interconnected adjustment along supply chains became more significant with large specific investments in the input supplier-customer relationship in the industries.[15]

Next, we look at interactions between credit-market shocks and emerging-market firms (row 5). The coefficient estimates suggest that for trade receivables, trade payables, and inventories, negative associations with credit-market shocks are larger for emerging-market firms; the coefficient estimates are also statistically significant. On the other hand, the interaction terms suggest that short-term debts of emerging-market firms increased more than short-term debts of developed-market firms, consistent with some observations that banking and financial sectors in emerging markets were less afflicted by the global credit-crunch of 2007–09 that started in the capital markets of western and developed economies.

Based on the panel regressions of Table 2.1, we are also able to verify the effects of standard determinants of working-capital financing. Firms that extend more trade receivables to their customers are associated with firms that have lower cash stock, higher sales growth, lower operating cash flow, and are small in size. Firms that receive more trade payables from their input suppliers are associated with firms that have lower higher stock, higher sales growth, lower operating cash flow, and are large in size. Firms that stock more inventories are associated with firms that maintain lower cash stock, higher sales growth, lower operating cash flow, and are small in size. Firms that use more short-term debt are associated with firms that have lower cash stock, lower sales growth, lower operating cash flow, and are small in size. Finally, we also find that the post-2007 period saw higher level, yet declining, trade receivables, trade payables, and inventories; and lower level, yet rising, short-term debt, implying a degree of mean reversion of these variables after the global crisis of 2007–09.

[15] Our evidence from the worldwide crisis of 2007–09 is in contrast with the evidence from the Asian crisis of the 1990s, whereby liquidity was redistributed via trade payables from financially stronger firms to weaker ones in the period during and following the crisis (Love, Preve, and Sarria-Allende 2007).

Table 2.2. Panel Estimation of Firm-Level Response to Credit-Market Shocks: Ted Spread & Libor

Dependent variable / Explanatory variable	(1) Trade Receivables Total Sales	(2) Trade Payables Cost of Goods Sold	(3) Inventories Cost of Goods Sold	(4) Short-Term Debts Total Assets
Contract Intensity	14.38***	13.63***	23.47***	.12
	(.32)	(.37)	(.44)	(.11)
Emerging-Market Firms (0/1 binary variable)	17.42	-9.99	1.78	-5.34
	(13.08)	(15.23)	(18.08)	(4.41)
Liquidity Premium I	-2.21***	-2.29***	-1.38***	.31***
	(.32)	(.37)	(.44)	(.11)
x Contract Intensity	.40	-.81	-.07	.23
	(.60)	(.70)	(.83)	(.20)
x Emerging Markets	.90**	.77*	1.77***	.34***
	(.38)	(.44)	(.53)	(.13)
Flight to Quality I	4.75***	2.97***	2.81***	-.64***
	(.55)	(.64)	(.76)	(.18)
x Contract Intensity	-3.87***	-1.69	-4.78***	-.91***
	(1.00)	(1.17)	(1.39)	(.34)
x Emerging Markets	-9.68***	-10.66***	-10.28***	.61***
	(.64)	(.75)	(.89)	(.22)
Cash Stock / Total Assets	-2.59***	2.49***	-25.06***	-28.06***
	(.68)	(.79)	(.94)	(.23)
Sales Growth	8.36***	13.76***	19.60***	-.41***
	(.29)	(.34)	(.41)	(.10)
Operating Cash Flow / Total Assets	-59.91***	-28.63***	-56.07***	-31.81***
	(1.15)	(1.34)	(1.60)	(.39)
log Size (assets)	-1.14***	.62***	-1.54***	-.76***
	(.04)	(.05)	(.06)	(.01)
Post 2007q3 (0/1 variable)	14.75***	39.30***	29.41***	-8.38***
	(2.10)	(2.45)	(2.91)	(.71)
Time trend, since 2007q3	-11.44***	-18.33***	-11.03***	.79**
	(1.15)	(1.34)	(1.59)	(.39)
R^2	.16	.16	.13	.18
Observations	213,140	213,140	213,140	213,140
Quarterly effects	Yes	Yes	Yes	Yes
Country effects	Yes	Yes	Yes	Yes

Liquidity Premium I is measured by 3-month US Libor minus Federal Reserve Funds Rate Target. Flight to Quality I is measured by Federal Reserve Funds Rate Target minus 3-month US Treasury Bill. Fixed-effects estimation with standard errors in parentheses (***, **, * denote statistically significant at 1, 5, 10%).
Source: Author's calculation.

Table 2.1 summarizes a number of pieces of supporting evidence for the importance of the supply-chain relationship in the transmission of financial shocks in the international firm-level sample. Table 2.1 is based on a baseline measure of credit-market shocks, that is, the oft-cited Ted spread shown earlier in Figure 1.1. Next, we explore in Tables 2.2 and 2.3 the decomposition of Ted spread into liquidity-premium and flight-to-quality, introduced in Section III. Shown in Table 2.2 are coefficient estimates from the panel regressions, with the same variable specification as in Table 2.1, except that now we use overnight a Libor and Federal Funds Rate target to decompose the credit-market shocks into the liquidity-premium I [3-month Libor (USD) minus overnight Libor (USD)] and the flight-to-quality I [overnight Libor minus Fed Funds Target rate; plus Fed Funds Target minus 3-month US Treasury Bill]; following Hamilton (2008), shown in Figure 1.1. In Table 2.3 we use Ois to decompose the credit-market shocks into the liquidity-premium II [3-month Libor minus Ois (overnight index swap rate)] and the flight-to-quality II [Ois minus 3-month US Treasury Bill]; following Brunnermeier (2008) and Sengupta and Tam (2008), shown in Figure 1.2.

We find that the sensitivity checks using alternative measures of liquidity-premium (I, II) and flight-to-quality (I, II) shown in Tables 2.2 and 2.3 provide additional information for the analysis. While the liquidity-premiums have similar associations, on average, with the dependent variables as have the pre-decomposition of Ted spread in Table 2.1, their interactions with industry contract-intensity and emerging-market firms are different. What is noteworthy in these two tables is that flight-to-quality has largely positive associations, on average, with the dependent variables, in contrast to the associations of the dependent variables with Ted spread. However, the interactions of flight-to-quality with industry contract-intensity and with emerging-market firms are consistent with those of Ted spread in Table 2.1. It seems that the effects of illiquidity and flight to safe collateral are not quite the same on the adjustment of working-capital financing.

Table 2.3. Panel Estimation of Firm-Level Response to Credit-Market Shocks: Ted Spread & Ois

Dependent variable / Explanatory variable	(1) Trade Receivables Total Sales	(2) Trade Payables Cost of Goods Sold	(3) Inventories Cost of Goods Sold	(4) Short-Term Debts Total Assets
Contract Intensity	14.17***	13.79***	23.47***	.16
	(.32)	(.38)	(.45)	(.11)
Emerging-Market Firms (0/1 binary variable)	16.82	-10.63	1.09	-5.30
	(13.08)	(15.23)	(18.08)	(4.41)
Liquidity Premium II	-1.30***	-1.94***	-.18	.60***
	(.29)	(.33)	(.40)	(.10)
x Contract Intensity	-1.08**	-.36	-.60	.17
	(.51)	(.59)	(.71)	(.17)
x Emerging Markets	.27	.27	-.33	.14
	(.33)	(.38)	(.46)	(.11)
Flight to Quality II	3.11***	2.70***	.01	-1.49***
	(.59)	(.69)	(.82)	(.20)
x Contract Intensity	-.59	-3.06**	-4.05***	-1.07***
	(1.08)	(1.26)	(1.49)	(.36)
x Emerging Markets	-9.50***	-11.18***	-6.21***	1.10***
	(.69)	(.81)	(.96)	(.23)
Cash Stock / Total Assets	-2.60***	2.46***	-25.07***	-28.07***
	(.68)	(.79)	(.94)	(.23)
Sales Growth	8.36***	13.76***	19.59***	-.41***
	(.29)	(.34)	(.41)	(.10)
Operating Cash Flow / Total Assets	-59.96***	-28.70***	-56.20***	-31.84***
	(1.15)	(1.34)	(1.60)	(.39)
log Size (assets)	-1.13***	.63***	-1.53***	-.76***
	(.04)	(.05)	(.06)	(.01)
Post 2007q3 (0/1 variable)	19.39***	42.65***	27.33***	-11.44***
	(2.15)	(2.51)	(2.98)	(.73)
Time trend, since 2007q3	-13.38***	-21.27***	-13.69***	.19
	(1.18)	(1.38)	(1.63)	(.40)
R^2	.16	.16	.13	.19
Observations	213,140	213,140	213,140	213,140
Quarterly effects	Yes	Yes	Yes	Yes
Country effects	Yes	Yes	Yes	Yes

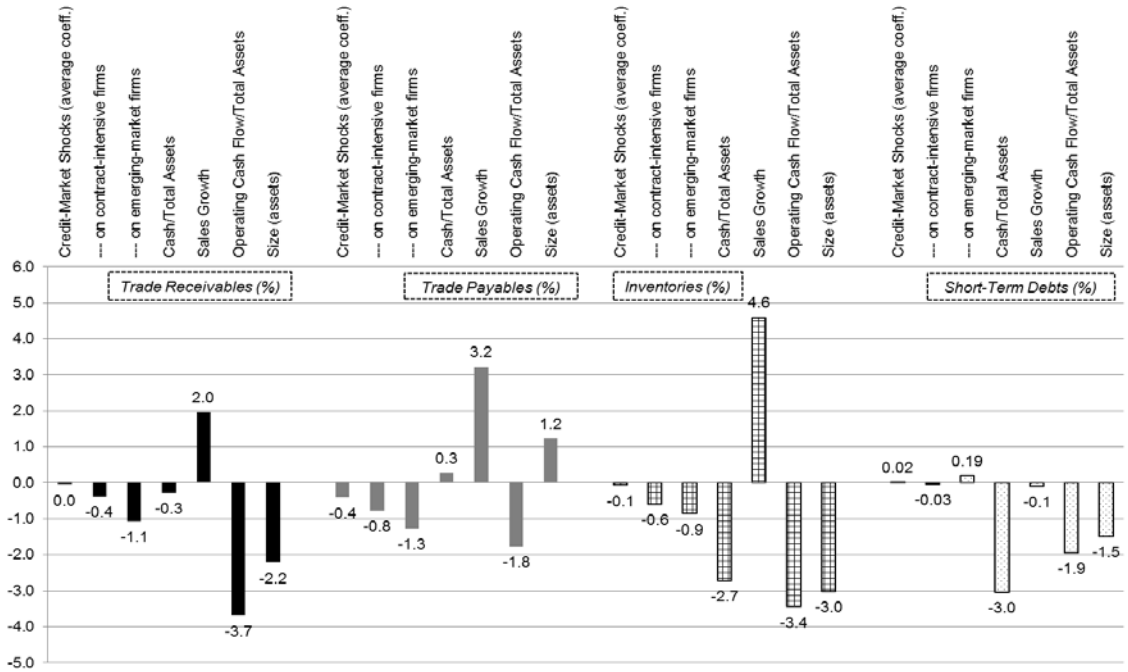
Liquidity Premium II is measured by 3-month US Libor minus Ois (Overnight Index Swap Rates). Flight to Quality II is measured by Ois minus 3-month US Treasury Bill. Fixed-effects estimation with standard errors in parentheses (***, **, * denote statistically significant at 1, 5, 10%).
Source: Author's calculation

Without more detailed firm-level data, it is difficult to discern the real differences between liquidity-premium and flight-to-quality shocks on the firms studied. Comparing the coefficient estimates across Tables 2.1–2.3, we note that trade receivables were smaller with lower liquidity-premium especially where industry contract-intensity is large (column (1) of Table 2.3); this is likely due to balance-sheet contagion in the supply chains discussed earlier. We also note that both trade receivables and trade payables were smaller with lower flight-to-quality (column (1) of Table 2.2 and column (2) of Table 2.3) especially where industry contract-intensity is large, and for emerging-market firms; this is likely due to investors fleeing into safe assets and shortage of collateral, not financial illiquidity per se. We believe that contract-level data (i.e., similar to that of Klapper, Laeven, and Rajan [2011]), but with international coverage) should help disentangle these important aspects of credit-market shocks and supply chains.

We summarize similarities and differences of the associations between the dependent variables and explanatory variables in Figure 2. Essentially, for each explanatory variable we estimate its economic significance by multiplying a coefficient estimate based on Table 2.1 with a standard-deviation adjustment of the explanatory variable. The size of economic significance is represented by the height of each bar in Figure 2. In sum, sales growth, operating cash flow, cash stock, and firm size have the largest economic significance on working-capital financing. Yet, we can also see that the economic significance of credit-market shocks is non-negligible if one takes into account their interactions with industry and macro-country factors. A standard deviation increase of Ted spread is associated with a greater than 1% drop in trade receivables, trade payables, and inventories.

In a nutshell, the international firm-level panel estimation explains reasonably well the dependent variables, capturing the firms' behavior in relation to liquidity needs we are interested in. However, the findings do not address other empirical challenges, including reverse feedback and identification issues, i.e., common factors that may drive both the preconditioning explanatory variables (i.e., cash stock, growth, and operating cash flows) and the dependent variables. For instance, following negative liquidity shocks, production and sales growth may drop due to shortage of working-capital financing, which worsens liquidity needs (i.e., trade payables, short-term debts, and operating cash flows) for the firms. Such a string of events disrupts production and sales growth upstream and downstream, thus leading to balance-sheet contagion that can result in higher liquidity needs of the firm.

Figure 2: Economic Significance of Credit-Market Shocks on Emerging-Market Firms and Contract-Intensice Firms



Source: Author's calculation.

5. CONCLUSION

Using a sample of international firms from 106 countries spanning 2002:I–2012:IV, we focus on balance-sheet variables that capture firm behavior towards liquidity needs and the adjustment of working-capital financing: trade receivables, trade payables, inventories, and short-term debts. We find supporting evidence that firms are more exposed to credit-market shocks when they are in industry supply-chains that require large specific investment and contract intensity in the input supplier-customer relationship.

Additional information is gained from the decomposition of credit-market shocks. Trade receivables were smaller with liquidity-premium shock, especially where industry contract-intensity is large; this is likely due to balance-sheet contagion in the supply chains. Secondly, both trade receivables and trade payables were smaller with flight-to-quality shock, especially where industry contract-intensity is large, and for emerging-market firms; this is likely due to flight into safe assets and shortage of collateral, and not financial illiquidity per se. More detailed contract-level data should help to identify these differences

Our analysis also suggests that any conclusion drawn simply from reduced-form estimation and any single real and financial variable may be misplaced in the understanding of supply chains and credit-market shocks. The estimates provided serve as one possible scenario for the credit-market shocks–liquidity needs channel. In practice, firms can take other price and non-price measures to offset liquidity constraints that may arise from the types of credit-market shocks examined here, or other types of financial and real shocks. Hence, this study should be considered complementary to other possible explanations.

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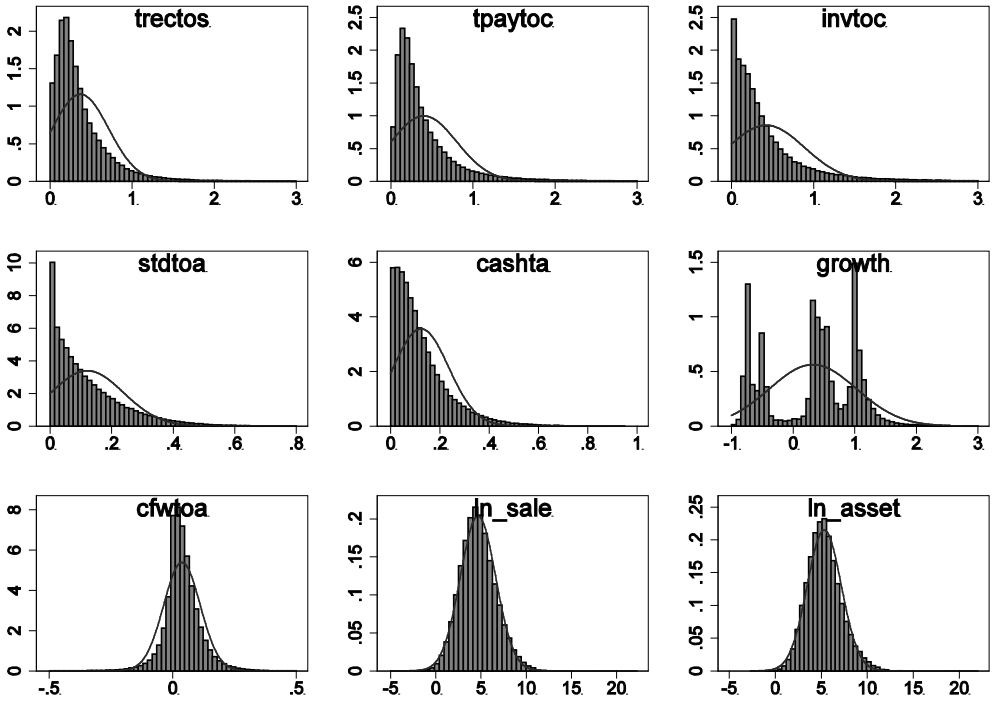
APPENDIXES

Appendix A.1: Data Coverage

Firm observations drawn from the Compustat Fundamental Quarterly

Period	Number of Firms	Number of Countries	Number of Industries (NAICS 4 digit)
2002q1	3,407	50	280
2002q2	2,437	54	272
2002q3	2,861	51	267
2002q4	3,884	80	292
2003q1	4,164	55	303
2003q2	3,051	62	283
2003q3	3,565	60	291
2003q4	4,349	80	298
2004q1	5,256	62	307
2004q2	3,371	64	292
2004q3	4,659	69	306
2004q4	4,979	85	306
2005q1	6,790	72	318
2005q2	5,156	72	313
2005q3	6,828	78	320
2005q4	7,112	90	320
2006q1	8,134	80	326
2006q2	6,520	75	318
2006q3	8,149	83	330
2006q4	8,064	89	328
2007q1	9,521	84	334
2007q2	7,523	83	329
2007q3	8,824	86	333
2007q4	8,611	92	331
2008q1	9,829	87	331
2008q2	7,755	85	324
2008q3	8,997	88	326
2008q4	8,592	93	326
2009q1	10,033	87	330
2009q2	7,630	86	320
2009q3	8,744	88	327
2009q4	7,697	91	320
2010q1	11,594	99	339
2010q2	8,590	98	326
2010q3	9,840	101	337
2010q4	9,935	105	333
2011q1	11,816	99	340
2011q2	8,972	102	324
2011q3	10,087	101	334
2011q4	9,687	106	330
2012q1	11,919	99	339
2012q2	8,783	100	324
2012q3	9,192	92	332
2012q4	6,432	86	311

Appendix A.2: Histograms of Firm-Level Data



This figure shows histograms of Trade Receivables/Total Sales (trectos), Trade Payables/Cost of Goods Sold (tpaytoc), Inventories/Cost of Goods Sold (invtoc), Short-Term Debts/Total Assets (stdtoa), Cash Stock/Total Assets (cashta), Sales Growth (growth), Operating Cash Flows/Total Assets (cfwtoa), log Sales (ln_sale), and log Size by Assets (ln_asset). Total number of observations = 213,140 firm-quarters from Compustat Fundamental Quarterly, 2002:I to 2012:IV.

Appendix A.3: Firm Size Distribution in the Sample

Size	log(Total Assets)		log(Total Sales)		log(Cost of Goods Sold)	
Rank	non-EM	EM	non-EM	EM	non-EM	EM
log(Rank: non-EM firms)	2.03 (0.04)***		2.12 (0.04)***		2.15 (0.04)***	
log(Rank: EM firms)		2.70 (0.04)***		2.85 (0.04)***		2.92 (0.04)***
constant	-7.21 (0.30)***	-14.82 (0.31)***	-8.45 (0.30)***	-16.53 (0.30)***	-9.13 (0.28)***	-17.59 (0.32)***
R^2	0.65	0.75	0.67	0.77	0.68	0.77
Firms	4,654	9,445	4,654	9,445	4,654	9,445

This table reports an association of log(size) and log(rank) among firms in the Compustat Fundamental Quarterly data, for non-EM (developed economies) and for EM (emerging markets) samples. Firms are ranked for non-EM and for EM samples, using pre-crisis data (2002:I–2012:IV), according to their Total Assets, Total Sales, and Cost of Goods Sold, as shown respectively in each column. Robust standard errors are in parentheses, with *** denotes statistical significance at 1%.