Determinants of Trade Credit Supply among Developing Countries during the Financial Crisis of 2008

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Abstract

The purpose of this study is to identify the firm-specific and country-specific determinants of trade credit supply during the financial crisis of 2008 and compare among upper-middle income and lower-middle income countries. Trade credit supply is measured as average collection period. For panel data analysis, this study uses the Prais - Winsten Panel Corrected Standard Errors (PCSE) method. PCSE removes the of cross-sectional dependence issue in the panel dataset. Findings indicate that firms had to pay their suppliers earlier during the financial crisis 2008 than pre-crisis. Financial crisis significantly influenced the relationship between determinants and trade credit supply but to different levels in different income groups. Average payment periods and private credit to GDP significantly and positively increased the average collection period more in lower-middle income developing countries and less in upper-middle developing income countries. Cash flow volatility and leverage influenced the average collection period significantly and negatively during the crisis. This influence was stronger than pre-crisis and post-crisis periods, and more significant in lower-middle income countries and less in upper-middle income countries. The negative

relationship between inflation and trade credit supply is strongly negative in lower-middle income countries. Overall, the results suggest that financial crisis changed the relationship between determinants and trade credit supply and the extant of this change was different in different income group countries.

Keywords: Trade credit supply, Average collection period, Average payment period, Cash flow volatility, Panel corrected standard errors, Developing countries

1. Introduction

Studies in North America, Europe, Africa, Asia, and other parts of the world have shown accounts receivable to be a substantial portion of firms' short-term assets (Barrot, 2016; Dary & Jr, 2018; Mahmud *et al.*, 2022). Given the substantial size of the accounts receivable and the significant degree of sales that are made on credit, it is in the best interest of stakeholders and potential investors that this asset is appropriately managed. In almost all economies of the world, firms grant credit to their customers and such credit transactions exist as long as trade has existed. When sellers allow their customers to delay payment against purchased goods and services, generating accounts receivable, this phenomenon is known as trade credit supply (Ghoul & Zheng, 2016).

The importance of ensuring trade credit supply is efficiently and effectively managed is heightened during economically depressed periods (Leitch & Lamminmaki, 2011). Indeed, failures within a country's banking system during a crisis constrict the flow of funds to firms throughout the economy (Levine *et al.*, 2016). The global financial crisis of 2008 brought significant firm-level disruptions that affected trade credit supply (Klapper & Randall, 2011). Under such difficult economic conditions, the survival of financially constrained buyers may depend on the actions of their financially less constrained creditors who extend additional trade credit and/or relax payment terms (Bastos & Pindado, 2013; McGuinness *et al.*, 2018).

Credit collection period is a very crucial part in trade credit management (Ferris, 1981; Shapiro, 1973) since it has a significant impact on the selling firm's cash flow. Average collection period (ACP), also referred to as debtor days or days sales outstanding (DSO), is the average number of days taken by credit customers to pay their bills. Longer ACP may increase expected demand for the firms' products, but it may also increase the costs of delayed collection and payment default (Abor, 2017; Zeidan & Shapir, 2017). As such, the ACP is something which selling firms have to consider carefully.

Reports indicate that many firms have longer ACP. A global working capital report highlighted that Asian firms, among all the 7 regions around the world (Europe, USA, Canada, Latin America, Middle East, Asia, Australia, and Africa) have longer working capital days due to increasing trend of ACP from year 2010 to 2016 (PWC, 2015, 2017). Specifically, developing economies with upper-middle income and lower-middle income such as China, Malaysia, Thailand, and Pakistan had, on average, higher ACP compared to high-income countries (Ghoul & Zheng, 2016; Paul *et al.*, 2012).

2. Literature Review

Theoretical literature provides several motives for trade credit supply. Smith (1987) pointed out that when sellers have asymmetric information about the quality of their product, they extend trade credit to buyers, allowing them to verify the quality of the product. In other words, the choice of credit term offered by the supplier can serve as signal for the product quality (i.e., extended credit may be seen to reflect the product's good quality). Information asymmetry can also be addressed by offering money-back guarantees and warranties (Emery & Nayar, 1998). However, if the seller ceases the business, these guarantees and warranties would come to naught. Moreover, the nature of goods also determines the duration of credit period. For example, the sellers may extend trade credit for longer periods for the goods which require longer period to verify the quality (Long *et al.*, 1993).

Mian and Smith (1992) argued that it is less costly to supply goods and credit from the same source, and so suppliers can evaluate the credit risk of buyers more effectively than say financial institutions. They extended the view that sellers have cost advantages over financial institutions such as informational cost advantage, monitoring cost advantage, and goods repossession advantage. Suppliers are believed to have more information about their customers' financial health than a financial institution. They can visit the buyer's place to keep close monitoring control on them. According to price discrimination theory, sellers often used credit periods to disguise reductions in price that are unobservable by competitors, and to facilitate price discrimination among customers by allowing customers to pay much later, pay late without penalty, or take hefty discounts, all of which are difficult for a third party to observe (Brennan *et al.*, 1988; Costa and Habib, 2020; Fabbri & Klapper, 2008; Giannetti *et al*, 2021).

Meltzer (1960) describes that during economic contractions, firms with relatively more funds redistribute them (by means of increased trade credit supply) to support the customer firms that need funds. Crucial economic conditions might appear to highlight the credit redistribution role as compared to the normal business periods. This intervening role of economic conditions is also well explained by Meltzer (1960) who argued that in normal business periods, firms accumulate liquidity to favor credit restricted customers during tight economic periods by increasing average length of time for which they extend credit. In periods of tight money, trade credit supply will be increased by means of increased average collection periods (Meltzer, 1960).

2.1 Financial Crisis 2008 and Trade Credit Supply

Economists believe that, the global financial crisis of 2008 was more severe for the US economy, compared to the crises of 1930 and 1970. This crisis (2008-09) affected several economies connected with US around the world. About when and where this financial crisis started, researchers have different views. Although the crisis was initiated with risky mortgages, the severe credit crunch by the banks made it one of the largest, most complex and broadest in the US economy after the crisis of 1930 and 1970 (Love, 2011).

In 2007, the global economic growth was largely driven by the emerging economies like

Brazil, China, India, and Russia. However, the decrease in the US economic growth (which was an engine of economic growth) dramatically affected the global economy (Chor & Manova, 2012). In turn, this adversely affected upper-middle income developing countries (e.g., Malaysia and Thailand) as well as lower-middle income developing countries (e.g., Bangladesh and Pakistan) because of dollar depreciation, rise in oil prices, fall in exports and decreased bank loans (Senechal, 2011). Rashti *et al.* (2014) believed that having the proper economic infrastructure, developed economies came through this crisis rapidly compared to other economies.

In linked economies, the market volatility passes among the firms. This transmission has specific implications for the trade credit supply chain. For instance, suppliers extending trade credit can tighten the collection period due to the contraction in bank credit (Bastos & Pindado, 2013). Petersen and Rajan (1997) and Atanasova and Wilson (2004) argue that trade credit may become important for firms experiencing liquidity shocks temporarily, such as during a contraction in bank loans, as then, firms would look for alternative sources of finance to support their businesses (Fisman & Love, 2003).

The study of firms' trade credit supply during global financial crisis of 2008 has also been given importance. Numerous studies have been done to investigate the influence of crisis on firms' trade credit supply. Love and Zaidi (2010) conducted a study on the Asian crisis of 1997. This study was based on a survey done by the World Bank on manufacturing SMEs in lower-middle income and upper-middle income developing countries (Indonesia, Korea, Thailand, and the Philippines). The study observed differences in the average collection periods based on country and industry characteristics. It was found that due to the unavailability of bank loans during crisis periods, firms decreased the trade credit supply by means of reducing credit collection periods; thereby passing the crisis effect to their customers. Overall study findings did not show evidence of substitution effect of trade credit during the crisis period. Similar results were reported by Tsuruta (2013) for Japanese SMEs during the country's crisis period. Those SMEs that were highly dependent on bank loans extended less trade credit to reduce the cost of financing the trade receivables due to higher interest rates from banks.

Bastos and Pindado (2013) focusing on three upper-middle income developing economies namely, Brazil, Turkey, and Argentina during 1999 to 2003 found chain reactions among firms. Providing the reason of less access to bank loans, firms increased trade credit supply only in the initial phase of the crisis. After the initial phase, trade credit suppliers tightened their collection policies (i.e., reduced ACP) in order to avoid bad debts. This study furnished new results that trade credit can offset unavailability of bank credit only for a short span.

Countries with different development levels face uncertainty shocks differently (Swallow & Céspedes, 2013). It is reasonable to expect that firms in different countries with different income levels extend trade credit differently in response to the financial crisis. The importance of trade credit as a source of finance in both developed and developing economies during the recent global financial crisis of 2008 is stressed by several studies (Garcia-Appendini & Montoriol-Garriga, 2013; Horng *et al.*, 2014; Kestens *et al.*, 2011; Lin

& Chou, 2015; McGuinness & Hogan, 2014; Yang, 2011). Moore and Mirzaei (2014) reported that financial crisis (2008-09) altered the growth of industries in 82 developed and developing countries. Although, lower-middle-income countries faced less contraction in growth as compared to the upper-middle income and high-income countries, the crisis influenced all economies, with such effects as increased inflation and reduced GDP.

In the US, Yang (2011) examined the causal relationship between bank loan and trade credit supply and demand, before and after the financial crisis of 2008, focusing on the manufacturing firms available on Compustat database from 2005 to 2009. Results proved that firms supplied trade credit (receivable to assets ratio) when bank loan was available at the start of the crisis. After the contraction in bank loans (short-term debt to total assets), those firms decreased their receivables and increased the use of supplier finance (i.e. payables). In a similar manner, Garcia-Appendini and Montoriol-Garriga (2013) expanded the study period from 2005 to 2010 indicated the same results for US firms. During the financial crisis, cash rich US firms extended more credit to their customers.

In Belgium, Kestens *et al.* (2011) investigated the differences in the relationship between liquidity, internally generated resources, inventory, size, and trade credit supply (accounts receivable to total assets) during the crisis period, as compared to before the crisis period. Sample data for 58,589 firms was retrieved from the Belfirst database of Bureau van Dijk Electronic Publishing covering the period of 2006-2009. They found that in the crisis period, liquidity shortage caused companies to reduce trade credit supply. Firms with larger inventories and of larger size also reduced trade credit supply. However, firms with internally generated resources supplied more credit to support customers which implies that redistribution effect was active in the crisis period. Moreover, when they observed the influence of crisis on the relationship between bank loan (short-term debt) and trade credit supply, results appeared in negative relationship between them. Firms depending on bank loans before the financial crisis, extended less trade credit during the financial crisis period due to the contraction in bank loans during the crisis period.

In Ireland, the study by McGuinness and Hogan (2014) expanded the existing literature by investigating the difference for trade credit supply (proxied by ACP, accounts receivable to total assets, and accounts receivable to total sales) and trade credit demand (proxied by APP, accounts payable to total assets, and accounts payable to total sales), in 7618 SMEs, before, during and after the financial crisis of 2008 for the period 2003-2011. By employing several firm-specific (financial strength[1], firm investment, profitability) and country-specific (GDP and private credit to GDP) variables, they found that firms demanded more credit from their suppliers but extended less to their customers. Their findings supported the substitution effect of trade credit for buyer firms and redistribution effect of trade credit for seller firms.

In China, Lin and Chou (2014) conducted a study which was very similar to Yang (2011). However, they divided the sample of 1,213 firms into groups of large and small, public and private, and manufacturing and non-manufacturing to observe the differences in trade credit

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[1] Financial strength was measured by four variables; short-term debt to total assets, cash holdings, cash flow and asset tangibility.

supply, trade credit demand and bank loan before, during and after the crisis. Findings revealed that in the crisis period, because of less availability of bank loans, trade credit supply was reduced by both large and small firms.

In Italy, Deloof and Rocca (2015) investigated the relationship between financial banking development and trade credit supply in 103 provinces. The study data was retrieved from different sources. Population, economic development, and crime data was taken from Italian National Institute of Statistics (ISTAT), while local financial development data was taken from the Bank of Italy. Study found that Italian SMEs supplied more trade credit in the provinces where banking systems were more developed.

In a cross-country study on SMEs of 13 European countries, McGuinness *et al.* (2018) investigated trade credit supply differences during the financial crisis period as compared to before the financial crisis period. Findings showed that firms with high cash holdings extended more trade credit than prior to the onset of the financial crisis. Their study proved the redistribution effect of trade credit.

The extant literature on the role of financial crisis in trade credit supply is largely comprising the findings in developed economies and rarely includes findings in developing ones. In developing economies, studies often focused on trade credit demand. For instance, in a cross-country study on six upper-middle income developing Asian economies (Thailand, Malaysia, Indonesia, India, Taiwan, and China), Coulibaly *et al.* (2013) found that firms affected due to crisis, demanded more credit from their suppliers. However, trade credit supply is less observed in studies involving such economies. Except, Harris *et al.* (2019) examined the impact of cash flow volatility on trade credit supply pre-crisis and post-crisis for 21 Asian countries. Their findings revealed that firms decline receivable levels when experience high cash flow volatility. The results of these studies are still not sufficient to provide evidence regarding the extant of change in cash flow volatility and trade credit supply during the crisis period and how these changes were different among countries, because countries have different income level.

The reviewed literature provides several gaps. A few studies investigated the determinants of trade credit supply and examined the influence of the financial crisis of 2008 on these determinants in developed economies such as US, Belgium, Italy, and Ireland (Deloof & Rocca, 2015; Garcia-Appendini & Montoriol-Garriga, 2013; Kestens *et al.*, 2011; McGuinness & Hogan, 2014). Diverging results were observed depending on study period and geographical location of the firms. Harris *et al.* (2019) examine the firm-specific and country-specific determinants of trade credit supply before and after the financial crisis 2008 in 21 developing countries without showing the variations across countries. Despite the fact that the crisis influenced all economies (Moore & Mirzaei, 2014), there is insufficient evidence regarding the effect of the crisis on the relationships between the determinants and trade credit supply among developing economies particularly, upper-middle income and lower-middle income economies. Notably, little is known about how both firm and country-specific factors might influence trade credit supply or the length of the average collection period (ACP). Therefore, determinants of trade credit supply during financial crisis

2008 are not yet fully understood.

The current study intends to fill these gaps by investigating the potential differences for influence of financial crisis on both firm-specific and country-specific determinants of trade credit supply for upper-middle income and lower-middle income developing countries. This study focuses on the other determinants which are either less or not investigated with trade credit supply equally for both normal and crisis periods. In this study, determinants of trade credit supply are categorized into two groups; firm-specific and country-specific variables. This study provides several contributions to the literature. First, it explores the strong relationship between trade credit supply (average collection period) and trade credit demand (average payment period) along with other firm-specific independent variables namely, cash flow volatility, leverage and country-specific variables namely, private credit to GDP, and inflation. In addition, cash holdings, asset turnover, firm size, sales growth, and GDP are added as control variables in this study. Second, this study, by analysing the determinants of trade credit supply during the financial crisis of 2008 among upper-middle income and lower-middle income developing countries, broadened the literature on trade credit supply.

3. Hypothesis Development

According to the redistribution theory, firms redistribute funds which they receive from their suppliers to create a redistribution channel (Lin & Chou, 2014). Dary and Jr (2018) argued that access to trade credit is important for suppliers in order to supply trade credit. During the financial crisis, the relationship between APP and ACP could be more pronounced because of the scarcity of bank loans. In crisis periods, customers tend to postpone their payments to suppliers, and in response, suppliers also delay payments to their own suppliers (Bastos & Pindado, 2013). On the other hand, it is possible that suppliers extend less trade credit due to the increased risk of customers defaulting during a crisis, but demand more credit from their own suppliers (Kestens *et al.*, 2011). We expect to find a strong significant positive relationship between average payment period and average collection period for firms in crisis period.

H1: There is a stronger positive significant relationship between average payment period and average collection period during the financial crisis compared to pre-crisis and post-crisis in both income level countries.

Large cash flow balances enable firms to offer more trade credit to their customers. Supplier firms may offer lower trade credit when they experience cash flow problems. Firms experiencing low cash flow volatility are often more profitable than other firms of similar size whose cash flows is much more volatile (Norton, 2013). Similarly, high cash flow volatility may also influence firms' trade credit supply. We can expect that during the financial crisis, this negative relationship could be more significant particularly in the lower-middle income developing countries.

H2: There is a stronger negative significant relationship between cash flow volatility and average collection period during the financial crisis compared to pre-crisis and post-crisis.

H3: There is a stronger negative significant relationship between cash flow volatility and

average collection period in lower-middle income developing countries compared to upper-middle income developing countries.

Numerous studies have analysed the relationship between leverage and trade credit during the financial crisis. Some authors reported the substitution effect of trade credit by finding that trade credit was more used between buyers and sellers to overcome the scarcity of bank loans (Carbó-Valverde *et al.*, 2016; McGuinness & Hogan, 2014), others reported the complimentary effect by finding that both trade credit and bank loans were decreased (Akbar *et al.*, 2013; Love *et al.*, 2007; Love & Zaidi, 2010). In the trade credit supply literature, debt levels have positively influenced the trade credit supply (Molina & Preve, 2009; Niskanen & Niskanen, 2006). Redistribution theory also supports the positive association between leverage and trade credit supply. When a firm expects significant returns on its investment and uses more debt as it is a less expensive source of financing, the firm may offer more trade credit in terms of extended average collection period (Bragg, 2011). However, the situation could be different if suppliers bear high interest on bank loans (Tsuruta, 2013). Studies showed that during the financial crisis, bank loans play significant role for firms to offer more trade credit (Deloof & Rocca, 2015; Garcia-Appendini & Montoriol-Garriga, 2013). Fan *et al.* (2012) show that bank borrowings vary with a country's development level. We can expect that the positive relationship between leverage and trade credit supply is stronger during the financial crisis in lower-middle income countries than upper-middle income countries.

H4: There is a stronger positive significant relationship between leverage and average collection period during the financial crisis compared to pre-crisis and post-crisis.

H5: There is a stronger positive significant relationship between leverage and average collection period in lower-middle income developing countries than upper-middle income developing countries.

Booth *et al.* (2001) offer evidence that financial institutions development levels in a country may impact firms' financing choices. The credit amount provided by financial institutions to the private sector is one of the key indicators of financial development. In less developed economies credit rationed firms rely on supplier finance, in turn, suppliers having access to bank credit extend trade credit to poor firms (Fisman & Love, 2003). On the other hand, in the presence of a less developed financial system, suppliers may find it difficult to extend trade credit for longer periods because of insufficient funds (Lins *et al.*, 2010). Therefore, during financial crises, when the financial system is adversely affected, the seller could reduce trade credit supply. As the banking system was unable to lend more, firms would have redistributed trade credit for a shorter period.

H6: There is a stronger positive significant relationship between private credit to GDP and average collection period during the financial crisis compared a stronger positive significant relationship in pre-crisis and post-crisis periods.

High commodity prices increase interest rates and cost of financing in a country (Kim *et al.*, 1998) thereby, adversely affecting the ACP. Redistribution theory implies that high inflation requires firms to lower ACP because of fall in monetary value (Ben-Horim & Levy, 1982,

1983; Schwartz, 1974). In other words, the credit amount owed by buyer firms will be significantly less at the time of payment. In this way, researchers often reported a negative relationship between inflation and ACP (Demirgüç-Kunt & Maksimovic, 2002; Molina & Preve, 2009). However, during the financial crisis period, the suppliers still can extend trade credit for longer periods if they have access to bank loans or charge higher interest rates on credit amount.

H7: There is a stronger negative significant relationship between inflation and average collection period during the financial crisis compared to pre-crisis and post-crisis periods.

4. Empirical Model and Methodology

To establish determinants of trade credit supply, we adapt the model of Harris *et al.* (2019). To examine the differences for determinants among upper-middle income and lower-middle income developing countries, we include GDP as control variable and add country dummies. Our model measures trade credit supply in terms of the average number of credit days given by seller firm to its customers (also known as average collection period (ACP) or days sales outstanding (DSO)). The literature provides several alternative measures for trade credit supply. For example, accounts receivable to total assets ratio (McGuinness *et al.*, 2018) or accounts receivable to sales ratio (Dary & Jr, 2018). These ratios depict the due amount, required to be collected from customers, or in other words, the amount invested or tied up as receivables as proportions of days of sales, total assets, or total sales, and broadly measure the trade credit supply. The results of trade credit studies have been highly sensitive to the proxy researchers have employed for trade credit supply. Notably, the speed with which a company can collect payment from customers for outstanding receivable balances is crucial for the reduction of cash requirements (Bragg, 2011). Therefore, following Harris *et al.* (2019), we employ average collection period (ACP) as the proxy of trade credit supply. Several previous studies have established cash holdings, asset turnover, firm size, sales growth, and GDP as explanatory variables therefore, we add them as control variables. Measurements of these variables, including explanatory variables used in study are as follows;

Average collection period (ACP): accounts receivable divided by total annual sales multiplied by 365 days.

Average payment period (APP): accounts payable divided by the cost of goods sold and multiplied by 365 days.

Cash flow volatility (CFV): standard deviation of cash flow (from operating activities) for 5 years scaled by the mean of those five data points (Sun & Govind, 2018).

Leverage (LEV): total debt divided by total assets.

Private credit to GDP (PGDP): Refers to financial resources provided by the financial corporations to the private sectors, such as through loans, purchase of nonequity resources, trade credits and other accounts receivable.

Inflation (INF): Inflation is measured by the change in the consumer price index (CPI).

Cash holding (CH): total cash and short-term investments divided by total assets

Asset turnover (ATO): total annual sales divided by total assets.

Firm size (FS): natural logarithm of total assets.

Sales growth (SG): sales of current year minus sales of previous year scaled by the sales of previous year.

GDP (gross domestic product in current USD): As defined by world bank, GDP is the sum of gross value contributed by all the producers in the economy including the product taxes and excluding the subsidies that are not included in the value of the products.

Our baseline model is specified as below;

$$ACP_{i,t} = \alpha_0 + \beta_1 APP_{i,t} + \beta_2 CFV_{i,t} + \beta_3 LEV_{i,t} + \beta_4 PGDP_t + \beta_5 INF_t + \beta_6 CH_{i,t} + \beta_7 ATO_{i,t} + \beta_8 SG_{i,t} + \beta_9 FS_{i,t} + \beta_{10} GDP_t + \beta_{11} CNT_t + \beta_{12} SEC_{i,t} \varepsilon_{i,t} \qquad (1)$$

Equation 1 identifies the effect of various factors on trade credit supply proxied by average collection period. This equation also includes dummies for sector (SEC) and country (CNT). To observe the differences in period and across countries, this equation will be estimated for pre-crisis period, crisis period and post-crisis period for upper-middle income countries and lower-middle income countries.

4.1 Data

The financial data of sample firms is gathered from the DataStream database for the period 2002-2018. DataStream classifies the sectors differently than the country's stock exchange and standardize these sectors for cross-country sectorial comparisons. We examine 5 manufacturing sectors namely (i) construction & materials, (ii) chemicals, (iii) food producers, (iv) industrial engineering, and (v) personal goods. To examine the difference among determinants of trade credit supply among developing countries based on their income levels, we have considered the firms from Malaysia and Thailand to be upper-middle income developing countries, whereas Indonesia and Pakistan as lower-middle income developing countries. Because our sample firms are from different countries, we gathered firm level financial data in US dollar. After excluding firms with missing data for all measures, we have used in our regressions the total sample of 7,548 firm year observations. To examine the impact of financial crisis on trade credit supply and determinants of trade credit supply, we divide our sample period in pre-crisis period as 2002-2007, crisis period as 2008-2009 and post-crisis period as 2010-2018.[2] The two primary interests of this study are to find the determinants of trade credit supply and impact of financial crisis on the relationship between determinants and trade credit supply.

5. Empirical Analysis and Results Discussion

Table 1 provides the descriptive statistics for key variables of the sample used in this study. Throughout the sample, firms were taking on average 77 days to collect their receivables. In

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[2] Previous studies also considered period 2008-2009 to control for the global financial crisis years (Cantero-Saiz *et al.*, 2021; Ibrahim & Rizvi, 2018).

contrast, firms in all countries were taking on average 46 days to pay their suppliers implying that firms have maintained good relationship with their suppliers by making early payments. The mean values of average collection period and average payment period values imply that trade credit is an important source of finance in developing countries.

Table 1. Descriptive statistics for key variables of sample

Variable	N	Mean	Median	Min.	Max.	SD
Dependent variable						
ACP	7,548	77.202	55.609	0.024	999.081	81.733
Independent variables						
APP	7,548	46.701	29.435	0.011	824.829	62.010
CFV	7,548	0.762	0.803	-9.945	14.041	2.355
LEV	7,548	0.512	0.495	-0.677	6.813	0.371
PCGDP	7,548	74.863	94.135	15.386	149.373	47.576
INF	7,548	4.670	3.526	-0.900	20.286	3.981
Control variables						
CH	7,548	0.089	0.046	0.000	0.993	0.112
TAT	7,548	1.270	1.094	0.000	9.144	0.924
FS	7,548	11.389	11.254	5.011	16.665	1.380
SG	7,548	0.146	0.078	-1.000	32.429	0.828
GDP	7,548	8.023	8.201	6.181	9.339	0.898

The above given statistics are for whole sample. To check the multicollinearity among the variables, the correlation analysis is presented in the table 2. As a general rule of thumb, multicollinearity problem is suspected if the correlation between two independent variables is above 0.80. Hence, the correlation statistics reveal that the data is appropriate and support the regression analyses of this study.

Table 2. Correlation analysis

	ACP	APP	CFV	LEV	PCGDP	INF	CH	TAT	FS	SG	GDP
ACP	1										
APP	0.368	1									
CFV	-0.091	-0.082	1								
LEV	0.047	0.210	-0.055	1							
PCGDP	0.139	-0.012	0.010	-0.276	1						
INF	-0.128	-0.039	-0.004	0.200	-0.678	1					
CH	0.005	-0.064	0.018	-0.305	0.206	-0.154	1				
TAT	-0.144	-0.200	0.071	0.094	-0.009	0.026	-0.022	1			
FS	-0.004	-0.021	0.029	-0.025	0.059	-0.066	-0.008	-0.168	1		
SG	0.026	0.027	-0.032	-0.001	-0.012	0.025	0.027	0.008	0.015	1	
GDP	0.169	0.032	0.013	-0.251	0.839	-0.623	0.188	-0.042	0.203	-0.015	1

Next, we observe the differences for all explanatory variables of the study among both income groups i.e., lower-middle income and upper-middle income. Table 3 provides the results of Mann-Whitney test for the statistical differences between both income group countries regarding mean values of trade credit supply, trade credit demand and all other explanatory variables used in this study. The findings show that trade credit was collected

earlier in lower-middle income countries. The mean and median values of average collection period appear to have been lower in lower-middle income countries (63.67 and 43.59) than the upper-middle income countries (88.60 and 66.18).

Table 3. Mann-Whitney mean ranks for determinants and trade credit supply

Variables	LMIN	UMIN	Mann-Whitney z-statistics
ACP	3151	4300	-22.814 ***
APP	3684	3851	-3.327***
CFV	3953	3624	-6.524***
LEV	4582	3094	-29.552***
PCGDP	1726	5500	-74.967***
INF	5545	2283	-64.802***
CH	3144	4305	-4.224***
TAT	3800	3753	-0.932
FS	3748	3797	-0.960
SG	3852	3709	-2.843***
GDP	1850	5395	-70.424***

Notes: LMIN is group of lower-middle income developing countries including Indonesia & Pakistan. UMIN is group of upper-middle income developing countries including Malaysia & Thailand, while. Significance levels are presented by * at 10%, ** at 5% and *** at 1%.

Firms in lower-middle income countries, compared to firms in upper-middle income countries, on average, used more debt to finance their assets, and held less cash. More generally, middle-income countries, in comparison to upper-middle income countries, had lower GDP and private credit to GDP, but higher inflation. There is some evidence to show that firms in lower-middle income countries, compared to firms in upper-middle income countries, on average, seemed to have paid their credit earlier, had higher cash flow volatility, and had higher sales growth. The z statistics indicate the differences regarding variables between both income groups are significant except asset turnover and firm size. These results clearly indicate the statistical differences between firms of lower-middle income and upper-middle income countries.

The statistical tests have been performed to check if trade credit supply and determinants are different across periods and income groups. Table 4 shows the results for the Kruskal-Wallis one-way ANOVA and two-way ANOVA tests for pre-crisis, crisis and post-crisis periods. Kruskal-Wallis test results are presented by mean ranks and two-way ANOVA results are presented by mean values. The findings show that average collection period, in comparison to pre-crisis, reduced during the crisis and increased post-crisis but not similar to the pre-crisis. It implies that trade credit supply was affected during the crisis. This finding supports the results by McGuinness and Hogan (2014) and Cantero-Saiz *et al.* (2021). Average payment period is not much different in crisis and pre-crisis periods, but higher in post-crisis period. It implies that firms took longer to pay their suppliers post-crisis, after the crisis, even though there is some evidence to suggest that firms paid their suppliers earlier during the crisis compared to before the crisis. Cash flow volatility was reduced during the crisis period and reduced further post-crisis.

Table 4. Determinants and trade credit supply for pre-crisis, crisis and post-crisis periods

Variables	Kruskal-Wallis Mean ranks				Two-Way ANOVA					
	Pre-Crisis	Crisis	Post-Crisis	K-W H Stats	Pre-Crisis		Crisis		Post-Crisis	
					LMIN	UMIN	LMIN	UMIN	LMIN	UMIN
ACP	3858	3626	3752	8.423**	58	95	62	81	68	86
APP	3626	3481	3939	51.131***	42	43	38	41	53	50
CFV	3977	3854	3622	43.632***	0.73	0.85	0.72	0.91	0.74	0.71
LEV	4010	3863	3598	58.688***	0.65	0.45	0.63	0.41	0.60	0.40
PCGDP	3325	3481	4140	242.115***	25.70	103.4	26.30	105.80	24.50	128.10
INF	3925	4577	3496	198.648***	7.50	2.40	13.20	2.70	6.40	2.00
CH	3641	3661	3889	23.441***	0.07	0.09	0.06	0.1	0.06	0.12
TAT	3869	3946	3673	19.206***	1.30	1.4	1.4	1.4	1.2	1.20
FS	3217	3706	4162	301.548***	11	11	11.3	11.4	11.6	11.70
SG	4318	3358	3505	259.115***	0.21	0.22	0.13	0.06	0.11	0.11
GDP	2660	3697	4535	1184.297***	6.80	8.30	7.20	8.70	7.60	9.00

Notes: LMIN is group of lower-middle income developing countries including Indonesia & Pakistan. UMIN is group of upper-middle income developing countries including Malaysia & Thailand, while. Pre-crisis period is 2002 to 2007, crisis period is 2008-2009 and post-crisis period is 2010 to 2018. Significance levels are presented by * at 10%, ** at 5% and *** at 1%.

Firms' leverage was reduced in the crisis period and further reduced post-crisis, further reduced post-crisis, particularly for firms in lower-middle income countries. Cash holding was lowest in pre-crisis period and increased in crisis and post-crisis period. The cash holding increase in post-crisis period is more pronounced in upper-middle income countries. Generally, asset turnover increased during crisis period. There is some evidence to suggest that the crisis increased asset efficiency which could be due to the greater reduced assets (downsizing) relative to reduced sales during the crisis.

However, the reduced in asset efficiency post-crisis could be due to the increased assets relative to increased sales after the crisis. The fall in asset efficiency post-crisis was significant for firms in upper-middle income countries. Firm size was higher during the crisis and post-crisis for lower-middle income countries. It implies that crisis did not reduce firm size. Firm size increased during the crisis and post-crisis in lower-middle income countries. Sales growth was higher during crisis and post-crisis for lower-middle income countries. Crisis reduced sales growth in lower-middle income countries, and sales growth only partially recovered post-crisis. Private credit to GDP increased pre-crisis to post-crisis period. Crisis did not reduce private credit per GDP. Private credit to GDP increased during the crisis in lower-middle income countries. Inflation was higher in the crisis and lower in post-crisis in lower-middle income countries. It implies that crisis increased inflation, but inflation fell post-crisis, particularly for lower-middle income countries. GDP was higher post-crisis than crisis, and higher in crisis than pre-crisis, in lower-middle income countries. Crisis did not reduce GDP. GDP increased during crisis and post-crisis in lower-middle income countries.

In this section, empirical results for determinants and trade credit supply relationship pre-crisis, crisis and post-crisis are discussed. Several empirical studies have adopted

different techniques to find the determinants of trade credit supply before, during, and after the financial crisis using panel data. Panel data allows to control the unobservable and individual heterogeneity. Panel data can minimize the bias that might arise when taking a large data set for several thousand units by aggregating firms into broad aggregates (Baltagi, 2008; Gujarati, 2008).

In panel data estimation, due to the unobserved country-specific determinants, we added variables for private credit to GDP, inflation, and GDP to account for country-specific that may exist across our sample. In time-series-cross-sectional data, when repeated observations over time in some cross-sections are obvious, there is a tendency for this type of data to display some problems. Specifically, time-series data exhibit autocorrelations while cross-section data display heteroscedasticity. These make standard errors estimated by ordinary least squares (OLS) incorrect (Katz & Bailey, 2011). We run Wooldridge and Breusch-Pagan test as suggested by Greene (2012) to find the serial correlation and heteroskedasticity in the data. The P values for these two tests show the significance at 1% (see Table 4), which indicates the existence of serial correlation and heteroscedasticity in our data. In addition, cross-sectional dependence is also assessed through Frees (1995) test. Overlooking this may lead to biased findings (Certo & Semadeni, 2006; Hoechle, 2007). The Q value (36.666) being greater than the values of critical alpha significance levels (1%, 5% and 10%) confirm the presence of cross-sectional dependence in panel data.

Table 5. Diagnostics

Serial-Correlation		Heteroskedasticity	
F Value	23.724	Chi2	5680.480
Prob > F Value	0.000	Prob > Chi2	0.000
Frees' Test for Cross-Sectional Dependence			
Frees' test of cross-sectional independence	36.666		
Critical values from Frees' Q distribution			
alpha (p = 0.10)		0.152	
alpha (p = 0.05)		0.200	
alpha (p = 0.01)		0.293	

Consequently, to deal with above-mentioned issues in time series cross-sectional data, the Prais-Winsten Corrected Standard Errors (PCSE) method produce robust covariances (Beck & Katz, 1995). PCSE removes the heteroscedastic and cross-sectional dependence problems across panels (Moundigbaye *et al.*, 2018). Thus, this study used Prais-Winsten PCSE regression method to explore the determinants of trade credit supply. Table 5 presents the variations for the regression results of the panel corrected standard errors (PCSE) regressions estimating the effects on average collection period of the listed firm-specific and country-specific variables for pre-crisis, crisis and post-crisis periods.

The results in Table 6 depicts that the average payment period and trade credit supply relationship did not change fundamentally due to the financial crisis, and persisted significantly positive throughout different periods, and across all income groups. Thus, *H1* is accepted. The coefficients before and after the crisis for lower-middle income countries were similar, but

the coefficient was higher during the crisis. Thus, for the firms in the lower-middle income countries, the crisis appeared to have strengthened the positive relationship between trade credit demand and trade credit supply. This might imply that when suppliers of firms in the lower-middle income countries reduced the offered credit period due to the crisis, the firms in turn, reduced the credit period offered to their customers, but at a higher rate than before the financial crisis. This could have reflected the firms' desperate effort to improve their own performance during the crisis. In contrast, the coefficients before and during the crisis for upper-middle income countries were similar, but the coefficient was lower post-crisis. For the firms in the upper-middle income countries, the crisis did not appear to alter the strength of the positive relationship between trade credit demand and trade credit supply, but post-crisis, the relationship appeared to have weakened. This might imply that when suppliers of firms in the upper-middle income countries reduced the offered credit period due to the crisis, the firms in turn, reduced the credit period offered to their customers in about the same rate as before the crisis. However, when the suppliers increased the offered credit after the crisis, the firms increased the credit offered to their customers but at a lower rate than before or during the crisis. This could have reflected the firms' recovery effort to improve their own performance after the crisis. Taken together, these results imply that the trade credit supply of firms in lower-middle income countries were more sensitive to the trade credit demand during the crisis, but the trade credit supply of firms in upper-middle income countries were less sensitive to the trade credit demand after the crisis.

Table 6. Regression estimates based on pre-crisis, crisis and post-crisis periods

	Full Sample			Lower-middle income			Upper-middle income		
	Pre-Crisis	Crisis	Post-Crisis	Pre-Crisis	Crisis	Post-Crisis	Pre-Crisis	Crisis	Post-Crisis
APP	0.311***	0.513***	0.263***	0.195***	0.409***	0.332***	0.537***	0.550***	0.237***
	(0.000)	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.000)*
CFV	-0.953***	-2.537***	-0.219	-1.411***	-3.619***	-3.041***	-0.702	-1.061**	0.001
	(0.011)	*(0.000)*	*(0.526)*	*(0.000)*	*(0.000)*	*(0.000)*	*(0.373)*	*(0.029)*	*(0.999)*
LEV	-6.499*	-20.769***	11.921***	-5.894**	-27.896***	-1.452	-6.482	-21.472***	33.393***
	(0.065)	*(0.007)*	*(0.006)*	*(0.022)*	*(0.000)*	*(0.770)*	*(0.383)*	*(0.002)*	*(0.002)*
PCGDP	0.557***	0.698***	0.097	0.400	1.620**	0.429**	0.724***	0.835***	0.102
	(0.002)	*(0.017)*	*(0.584)*	*(0.334)*	*(0.039)*	*(0.021)*	*(0.007)*	*(0.000)*	*(0.721)*
INF	-0.032	-0.489	-0.713	-0.573**	-1.956***	-0.686**	2.708**	-0.087	-1.091
	(0.937)	*(0.210)*	*(0.170)*	*(0.044)*	*(0.000)*	*(0.037)*	*(0.015)*	*(0.435)*	*(0.382)*
CH	-15.646	-50.127**	-15.040	7.869	-58.971***	82.986**	-10.607	-53.579***	-16.274
	(0.201)	*(0.018)*	*(0.154)*	*(0.626)*	*(0.001)*	*(0.032)*	*(0.710)*	*(0.000)*	*(0.262)*
TAT	-8.616***	-1.263	-8.575***	-6.222***	-1.602	-12.891***	-9.181***	-2.660***	-4.973**
	(0.000)	*(0.295)*	*(0.000)*	*(0.000)*	*(0.410)*	*(0.000)*	*(0.001)*	*(0.000)*	*(0.024)*
FS	0.811	-4.579***	2.168	2.492**	-3.841	-1.742*	4.257	-4.899***	1.658
	(0.544)	*(0.011)*	*(0.079)*	*(0.034)*	*(0.091)*	*(0.094)*	*(0.133)*	*(0.000)*	*(0.439)*
SG	0.590	0.884	-2.506***	9.859***	4.925	0.000	1.869	-4.223***	-1.767
	(0.548)	*(0.907)*	*(0.002)*	*(0.000)*	*(0.667)*	*(1.000)*	*(0.559)*	*(0.000)*	*(0.063)*
GDP	-13.570**	30.851	-21.276	2.571	-115.900	0.231	-31.041***	68.183***	-21.5489
	(0.013)	*(0.161)*	*(0.072)*	*(0.598)*	*(0.373)*	*(0.229)*	*(0.000)*	*(0.000)*	*(0.347)*
Constant	142.919***	-121.347	212.391**	88.237***	1005.673	61.587***	238.087***	-548.365***	260.003
	(0.000)	*(0.504)*	*(0.027)*	*(0.008)*	*(0.330)*	*(0.002)*	*(0.000)*	*(0.000)*	*(0.186)*
Observations	2664	888	3996	1446	482	2169	1218	406	1827
R^2	0.4476	0.341	0.3642	0.530	0.286	0.177	0.430	0.848	0.448

For cash flow volatility, the coefficients were higher during the crisis. The strength of this negative relationship is highly significant in lower-middle income countries. Thus, *H2* and *H3* are accepted. Thus, the crisis appeared to have strengthened the negative relationship between cash flow volatility and trade credit supply for the firms in lower-middle income countries. Higher coefficient size in post-crisis compared to the pre-crisis could have reflected that firms were not able to recover their cash flows problems as expected after the crisis period. In addition, for the firms in lower-middle income countries, change in cash flow volatility is significantly associated with trade credit supply in the normal business period, while for upper-middle income countries, the coefficient was significantly negative during the crisis period only. Before crisis and after crisis period, the coefficients of cash flow volatility were not significant. This might imply that firms in upper-middle income countries experienced higher cash flow issues in the crisis period thus decreased their investment in trade credit supply i.e., reduced offered credit period. These results imply that trade credit supply of firms were sensitive to the change in cash flow volatility but only in lower-middle income countries, and more sensitive during the financial crisis, but not in upper-middle income countries. Our results support the findings by Molina and Preve (2009) and Harris *et al.* (2019) that firms cut their investment in receivables when experience high cash flow volatility.

For leverage, the coefficients were significantly and negatively higher in the crisis period in comparison to pre-crisis and post-crisis in both lower-middle income countries and upper-middle income countries. Thus, *H4* and *H5* are not accepted. The crisis appeared to strengthen the negative relationship between leverage and trade credit supply. This implies high interest rates on bank loans during the crisis period did not allow firms to extend the offered credit period. In lower-middle income countries, influence of leverage on trade credit supply became insignificant after the crisis which might happened because firms continued to redistribute their own suppliers' credit to customers in term of extended offered period. In contrast, the coefficient of leverage is significantly positive in upper-middle income countries after the crisis. This could imply that firms in upper-middle income countries after the crisis period gained access to low interest bank loans and extended offered credit period to their customers. Overall, financial crisis adversely influenced the ability of firms to redistribute their bank loans by extending offered credit period.

For country-specific factors, coefficients for private credit to GDP in both lower-middle income and upper-middle income countries were strongly positive in the crisis period. Thus, *H6* is accepted. The stronger positive coefficient in lower-middle income countries could indicate that development of financial institutions in these countries was not severely affected due to crisis relative to financial institutions in upper-middle income countries. In upper-middle income countries, the coefficient was not significant after the crisis meaning that firms' trade credit offered period was no longer dependent on financial institutions' development post crisis. Overall, these results imply that firms in developing countries during the financial crisis strongly relied on the development of financial institutions to extend the offered credit period. For inflation, the coefficients were negative through pre-crisis, crisis and post-crisis periods but the coefficient was strongly negative during the crisis period

comparative to pre-crisis and post-crisis in lower-middle income countries only. This imply that high inflation in lower-middle income countries caused firms to reduce the trade credit offered period. In upper-middle income countries, the coefficient of inflation was significantly positive in pre-crisis period however, during the period of crisis and post-crisis the coefficients were not significant. Thus, *H7* is partially supported. In control variables, for cash holdings and trade credit supply, the significant negative relationship imply that financially stronger firms, to maintain the liquidity levels, tighter the credit terms during the financial crisis and reduced the offered credit periods (Kestens *et al.*, 2011). Similarly, asset turnover, firm size, and sales growth negatively influenced the firms' offered credit periods during the financial crisis. Countries with higher GDP growth might have more developed financial institutions so firms in these countries were better able to extend the offered credit period.

Past studies offered that financial crisis is a significant factor in influencing the relationships between trade credit supply and its determinants. Our findings provide empirical evidence of this influence. There has been significant evidence for the impact of financial crisis on trade credit supply in many developed economies (Harris & Roark, 2017; McGuinness *et al.*, 2018; Yang, 2011) and for developing countries. Studies (see (Coulibaly *et al.*, 2013; Harris *et al.*, 2019)) have reported decrease in the trade credit supply levels across firms in the developing economies during the financial crisis 2008. However, the determinants of trade credit supply and impact of financial crisis 2008 might be different among the developing countries of different income levels. We find that the financial crisis changed the relationships between determinants and trade credit supply for our sample firms in upper-middle income and lower-middle income countries.

6. Conclusion

Firms supplying trade credit to their customers enjoy multiple benefits (Petersen and Rajan, 1997; Molina and Preve, 2009). It is crucial to identify the factors that may significantly influence the credit periods firms will offer to customers. We considered firm-specific and country-specific determinants and find relationship with trade credit supply before, during and after the financial crisis 2008 among 4 developing countries: 2 from upper-middle income level and 2 from lower-middle income level. We find that firms in developing demand and supply trade credit simultaneously. Financial crisis caused firms to reduce both average payment period and average collection period. In addition, we find significant increase in the credit period during the financial crisis 2008. Our results indicate that due to high cash flow volatility firms reduced average collection period. Additionally, because high cash flow volatility during the financial crisis caused firms to reduce more average collection period, these findings also indicate the risk that is apparent in firms of upper-middle income and lower-middle income developing countries. These results extend the findings of Harris *et al.* (2019).

Firms with greater access to bank loan supply more trade credit. Studies (see (Coulibaly *et al.*, 2013; Harris *et al.*, 2019; Hill *et al.*, 2017) have shown that firms in developing countries experience more difficulty in accessing bank loans which contracts their investment in trade

receivable. Similarly, we find that during the financial crisis, firms in developing countries because of difficulties to access bank loans reduce average collection period. Similarly, if the financial institutions of countries are well developed, firm can get more access to bank loans and then extend the average collection period to support customers during the crisis period.

This study is leaving the part that how firms decide the trade-off in costs and what terms they offer their customers for payment of credit. Financial crisis also deteriorated the inventory levels that could be another determinant to be investigated by future research. Besides firm-specific and country-specific factors, future researchers may consider the effects of country's legal structure and monetary policy on trade credit supply. Our results have important implications for firm managers, implying that not only firm-specific, but also country-specific factors determine the trade credit supply in developing countries. In normal times, firms would manage their trade credit supply policies more effectively. In the case of financial crises, however, the high cash flow issues and less access to bank loan could make it difficult for firms. Our results identify the factors that should be considered while formulating working capital policies in these developing economies. Further, understanding these factors helps to develop policies which provide buffer to financial crisis.

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