Do changes in credit availability lead to short-run deviations from the long-run growth rate in trade? Evidence from the U.S.

Abstract

Recently, industrialized countries experienced tight financial conditions to an extent that has been unprecedented for decades. This coincided with an implosion of world trade. Is this mere coincidental or is this a result? More generally, can short-term deviations from the long-term growth rate of trade be explained by changes in the availability of external finance? Based on a 14 year sample, the answer seems to be yes. Using an error correction model, quarterly data of the U.S. was analyzed for the period 1991:4 - 2005:4. Over 70 percent of the variance in trade was explained, using income, vertical specialization, technological development and tariff rates as long-run drivers of trade, while changes in credit standards allowed for short-run deviations in the trade growth rate. Estimators of these credit standards were statistically and economically significant, and largely robust to several model specifications. Furthermore, this study finds support for the proposition that inventory investments are reduced to accommodate for credit contractions, thus reducing trade volume. Also, this paper provides a first glance on how effects of financial stress may differ for an industrialized compared to an emerging market.

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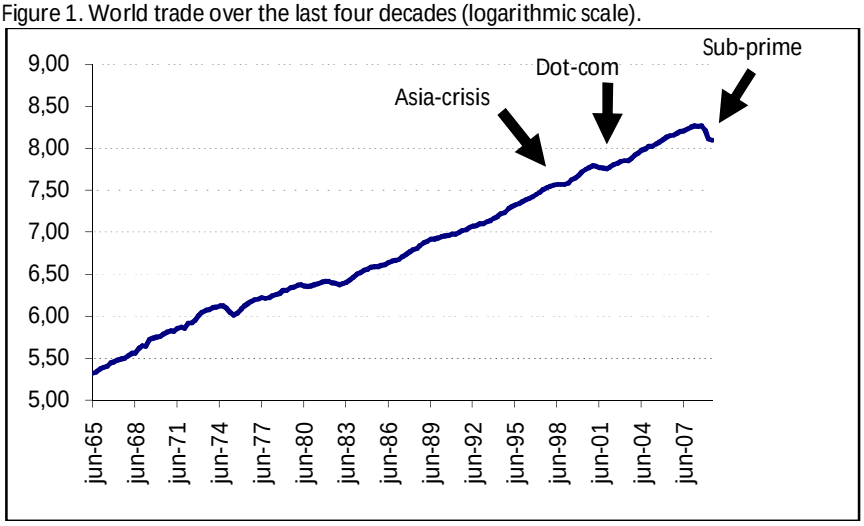
1. Introduction

After an average growth rate of eight percent over the last five years, world trade slowed in 2008 and collapsed in the fourth quarter of that year. In the last quarter of that year, world trade fell at a spectacular quarter-on-quarter growth rate of eight percent, implying an annualized 22 percent.[1] This fall was much larger than would be expected based on the fall in demand (OECD, 2009). Also, as Figure 1 shows this large a fall has been unprecedented in the last four decades.

Figure 1. World trade over the last four decades (logarithmic scale).



Source: OECD.

This figure also shows the strong upward trend in trade over the years, given some accelerations and slowdowns. This strong upward trend has been widely investigated by the economic literature, which gives four reasons to this trend. First, and most importantly, world income has increased which increased the demand for foreign products (Krugman, 2006; Baier & Bergstrand, 2001). Second, nations have reduced their barriers to trade, such as tariffs (Anderson and Van Wincoop, 2004). Moreover, technological development decreased the costs of transportation of goods (Krugman, 1995). Fourth, the decreased costs of trade enabled companies to slice their value chain (Yi, 2003; Hummels, Ishii, & Yi, 2001). In other words, through the decreased costs of trade companies are able to disintegrate their production process, and outsource some of its manufacturing or service activities abroad.

[1] Calculations based on data of the World Trade Monitor, provided by Central Planning Bureau of the Netherlands.

This upward trend has thus been a widely investigated subject in the trade literature. However, in the figure above, one can also see short-term deviations from this long trend. These short-term downward deviations seem to coincide with well-known periods of stress on financial markets. A recent example is the sub-prime mortgage crisis; others are the burst of the dot-com bubble (early 2001) and the Asia crisis (mid 1997). For the most recent fall in trade, anecdotal evidence suggests that external finance was hard to obtain (Antonucci, 2009). In addition to the fall in demand, this seems to be a reasonable explanation, since international transactions typically use external finance (Liu & Duval, 2009; Kletzer & Bardhan, 1987). Also, after these periods of financial stress, trade accelerated again. Is this mere coincidental or is there an effect?

The literature on the potential effect of the availability of external finance on trade volume is very thin (Thomas, 2009). One of the few papers written on the issue is by Ronci (2004). He studies the effect of constrained external finance on trade for 10 emerging markets during the Asia crisis. His analysis is restricted to six years prior and two years after this crisis. Thomas (2009) extends this study by investigating a longer period and uses a larger subset of countries, which also all are emerging markets. Both find support for this potential effect, though conclude differently on the size of this effect. Thomas finds lower estimates, which is not surprising given his analysis is not centered on a financial crisis. The question arises whether these found effects can be extended to structurally different countries. In industrialized countries, this effect of credit availability may be larger or smaller, or not present at all. For example, it may be larger because firms in industrialized countries are less used to constraints in external finance, compared to firms in emerging markets. It may also be smaller. One could argue that in industrialized countries, banks recover more quickly and therefore extend credit more swiftly after experiencing stress, compared to their counterparts in emerging markets.

The main goal of this study is to investigate whether short-run deviations from the long-run trend can be explained by changes in the availability of finance for industrialized countries. Based on U.S. data over the period 1991:4 - 2005:4, this effect is confirmed. Also, it is economically important: during 2001, the reduction of credit supply decreased the quarter-on-quarter growth rate of imports by an averaged 0.73 percentage point for six consecutive quarters. In extension to this finding, this paper finds support for the proposition of Guariglia (1999) that inventory investment accommodates for this reduced availability of credit. The idea is that as external finance becomes less available, firms lower their inventory investments in order to reduce their capital needs. Thus, it seems that the effect of the availability of external finance on trade runs through inventory investments. Finally, an attempt is made

to compare the effect of financial stress for industrialized and emerging countries. Using the same model as Ronci (2004), results are ambiguous, although the results suggest that the effect for industrialized countries is somewhat larger. This conclusion depends much on the extent to which exchange rate volatility rather affects the demand for imports of consumers and importers than the availability of credit. If exchange rate volatility is assumed to refer to demand rather than for credit availability, then the results suggest that the effect of financial stress on trade is larger for industrialized countries.

Thus, the goal of this study is to explain short-run deviations in trade with changes in the availability of external finance, with regard to industrialized countries. First step is a review of the relevant literature, which is done in Section 2. The instruments are described in Section 3, while Section 4 specifies the model. The results are presented in Section 5. Section 6 concludes.

2. Review of the literature

2.1. Drivers of trade

The literature on international trade is vast. The influential works of Adam Smith, David Ricardo and Heckscher and Ohlin provided a foundation for trade theory. The work of Smith emphasizes the potential benefits of disintegration of the production process, which could form a basis for (domestic) trade. The Ricardian and Heckcher-Ohlin models underline the importance of differences among countries, with respect to technology and factor endowments, respectively (Krugman, 2006).

Although these provide a foundation for trade theory, Krugman (1995) notes that the question "why has trade grown since the 1960s?" remains surprisingly disputed. By some, technological progress is seen as the main driver of trade, while others underline the removal of protectionist measures. Feenstra (1998) adds two other possible factors that spurred growth in international trade: vertical disintegration of the production process and the convergence of the size of economies. Yi (2003) finds evidence that vertical specialization, which relates to the notion of Adam Smith, has a positive effect on the growth of international trade for the U.S. The importance of convergence in economic size is tested by Baier and Bergstrand (2001), who found no effect. Furthermore, in their effort to disentangle the above mentioned effects from each other, they found that the growth of income explains the most of the growth in trade (67%), followed by tariff reductions (25%) and transportation costs (8%). Convergence of

the size of economies had virtually zero contribution. Accordingly, Baier and Bergstrand concluded that the removal of protectionist measures have been more important than technological improvements. An important limitation should be noted here though. Given the time frame, they did not catch the rapid developments in information and communication technology; performing an identical analysis on the period including the last two decades might give other results. As to the best knowledge of the author, this has not been done yet and may be an interesting investigation for further research.

Thus, the volume of international transactions has grown over the last five decades. Given the temporal division between revenues and costs, external finance is widely used to cover such transactions. This temporal difference is usually larger in international trade due to the physical transportation of goods over relatively large distances, compared to domestic trade (Kletzer & Bardhan, 1987). The next subsection investigates the possibilities to finance international transactions.

2.2. Trade finance

Financial intermediation in international transactions is done in various ways. The most common form is the letter of credit (L/C), issued by the importer's bank to ensure payment to the exporter (Huang, 2007). Others are for example guarantees and forfeiting. The common feature of all these forms is that it is typically short-term financing (less than one year). The dominant form of this type of credit provided by banks, the L/C, works as follows. When an importer places an order at a foreign firm, the foreign firm may want to ensure that he receives payment. A common way to ensure this is that the importer applies for an L/C at his bank. If the bank agrees for payment, he will send a document (the L/C) to the bank of the exporter that the bank will pay for the transaction. When payment is received by the exporter, the shipment is sent and property documents are presented to the importer's bank. Then the bank settles with the importer, and the property documents are given to the importer. This process usually takes between three weeks and two months, but may be outside this range, and depends on the nature of the good, the distance between importer and exporter and the result of the negotiation between the two trade partners.[2] An L/C is usually issued with an expiration date of 60 to 90 days. A broader range is described by Auboin and Meier-Ewert (2003): usually up to 180 days, but possibly to 360 days. When banks' appetite to extend credit suddenly contracts, this could have a severe effect on international trade. Summers (2000) mentions that during the Asia crisis international banks reduced credit lines in all

[2] Information acquired in an interview with Dr. W. Huang.

activities, including trade finance. As a consequence, firms could not finance their imports any longer. In that way, the willingness of banks to extent credit can have a direct effect on trade volume.

Although banks are an important provider of trade-related credit, it can also be offered directly by the trade partner. There are several reasons why firms would do that. Nilsen (2002) provides evidence that this is done to reduce transaction costs. The redistribution view suggests that this form of credit is often used as a substitute when bank credit is not available to a firm (Petersen and Rajan, 1997; Wilner, 2000; Fisman and Love, 2003). This is not unlimited: a firm is not a bank; extending credit is not its comparative advantage. Moreover, this may not hold in times of financial crisis. Love, Preve, and Sarria-Allende (2007) found that during the Asia Crisis, firms too reduced their trade credit, with roughly 16%. Paul and Boden (2008) argue that, given the vast amount of sales on this form credit, instability in inter-firm credit policies and practices could have serious macroeconomic consequences.

Besides credit, insurance is another important form of trade finance. Export credit agencies (ECAs) have arisen to mitigate the trade restraining effect of political risk and low quality of institutions in higher risk countries (Moser, Nestmann, & Wedow, 2008).[3] Although relatively little attention is given to ECAs, there is some empirical results about their trade promoting effect. The general test in these studies is whether exports to relatively unstable countries have increased by the increased use of export insurance. Moser, Nestmann and Wedow (2008) and Egger and Url (2006) found positive effects for the exports of Germany and Austria to such countries, respectively. However, Mah (2006) found that export insurances did not contribute to promoting export supply in Japan. Results on this issue are thus somewhat ambiguous. As mentioned before, these insurers have arisen to promote exports to relatively unstable countries. However, there are also insurers that provide coverage on industrialized countries. In contrast to the former, these insurers are private.[4]

Direct measurement of these variables is problematic, given their disaggregated level (notably L/Cs) and their private nature (notably interfirm credit and export insurance). In order to see how previous studies coped with this issue, a short review of the methodology in previous research is described below.

[3] Previous research has shown that these countries participate less in international trade. See for example Anderson and Marcouiller (2002) and Meon and Sekkat (2004).
[4] This is due to the Knaepen-package (1997), in which OECD countries agreed not to insure exports to each other, as this was seen as an export subsidy.

2.3. Instruments for trade finance in previous research

As mentioned in the introduction, the potential effect of constrained availability of trade finance is an uncovered subject in the economic literature. This might be for two reasons. First, it may have been overlooked because it may have not been as relevant as it is now (presumably). The sub-prime mortgage crisis was the onset of this study; the credit crunch that resulted has been unprecedented for a long time and therefore the potential effect may be overlooked. Second, it may be an uncovered subject because it is difficult to study. The methodology in previous related research indeed is somewhat problematic for usage in this paper, as will be discussed below. First, two IMF-papers that are directly related to this one will be discussed. Afterwards, research on financial development will be discussed.

The relationship between the availability of trade finance and trade volume for emerging markets is investigated in the papers of Ronci (2004) and Thomas (2009). Both find a significant, positive effect. The first uses an eight year time frame, centred on the Asia crisis. The supply of trade finance is proxied by the change in foreign outstanding short-term credit. As Ronci notes in his paper, a clear limitation of this measure is that trade financed by *domestic* banking sources might be irresponsive to foreign trade financing, and therefore might overestimate the reduced supply of trade finance. However, this problem is limited to the extent that firms in an emerging country might depend more on foreign rather than domestic credit availability, compared to firms in industrialized countries. This implies however that this instrument is problematic for exploring this relationship for an industrialized country, which is the goal of this study.

Thomas (2009) uses the net private capital flows as a proxy for trade finance availability and extended the study over a longer period: from 1980 to 2005. Again, this excludes domestic data on the conditions of finance. An additional limitation is the use of *net* capital flows. This might cover up significant innovations in the variables underneath. For example, the measure is obscured when increases in capital inflows and outflows increase both. Since only the difference between the two is observed, the instrument would underestimate the availability of finance in this case.

There are some general limitations too in these studies. Both use annual data, while innovations in trade can be more precisely observed in quarterly data. Also, the models seem to be oversimplified: only GDP, relative prices and a banking crisis dummy are controlled for. Innovations in trade policy, vertical specialization and technological development are not included. Assuming these constant is likely to lead to omitted variable bias when using a eight or even 25 year sample.

The conclusion is that, although the instruments may be used for a study on emerging markets, they are not for industrialized countries. Unfortunately, less directly related research does not provide a solution either. There are two strands of research on financial intermediaries that are related to this paper. One strand is the research on the relationship between development of the financial sector and the level of economic activity.[5] The other strand that is related to this paper investigates the role of financial development on the structure of trade. The general idea here is that financial development provides a comparative advantage to a nation in industries that rely heavily on external finance, such as the pharmaceutical industry (Kletzer & Bardhan, 1987; Beck, 2002).[6]

An important difference between these studies and this paper is that that the former investigates the effect of the status of the financial sector over the long run, while this paper aims to capture the effect of short-term changes in credit supply. This makes the instruments used in these studies not useful here. Using the amount of credit provided to the private sector, a much-used instrument for the financial status, as the assumption that supply equals demand may not hold in the short-run. Therefore, a somewhat different approach is needed here. This will be discussed in the next section.

3. Methodology

The goal of this study is to investigate the potential effect that a contraction of trade-related credit can have on trade volume for industrialized countries. The analysis will be restricted to the United States of America (U.S.), for two reasons. First, the onset of this paper is the great fall in global trade, of which the U.S. was a big part. Second, the great availability of data enables to investigate the relationship between finance and trade.

This section starts with the description of the instruments used for trade and credit availability. The instruments for the variables that need to be controlled are discussed thereafter. These variables are those that are identified by the literature and discussed in Section 2.1: income, vertical specialization, trade policy and technological development. The section ends describing the data of the variables.

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[5] Important works in this line of research are those of King and Levine (1993), Rajan and Zingales (1997) and dates back to Joseph Schumpeter (1911).

[6] Both strands find empirical evidence for their hypotheses. See for example Rajan and Zingales (1997) for the former and Svaleryd and Vlachos (2005) for the latter.

3.1 Instruments for the variables of interest

3.1.1 Trade

As mentioned earlier, finance provided by banks is usually in the form of L/Cs. This implies that imports rather than exports should be the dependent variable as the measure of trade. Imports are measured in volumes, and derived from the Department of Commerce. These figures are seasonally adjusted.

3.1.2 Bank credit availability

Preferably aggregated data on the availability of L/Cs would be used. Unfortunately, this is not available to the author. Three instruments will be used. Following the suggestion by Lown and Morgan (2006) and a report by the OECD (2009), a survey among American bankers about their credit standards is used. The second instrument is a composite index of financial stress, as proposed and constructed by the IMF (2009). The main purpose of this instrument is mainly to provide a glance at potential different consequences of financial stress for industrialized and emerging economies, because of its comparability over different countries. The third instrument is the aggregated bank credit that is actually extended.

Although these are not precise estimates for the availability of L/Cs, Summers (2000) found that banks reduce credit in times of crisis in any activity, including trade finance. This is not to say that it is proportional over all activity, but it at least implies a positive correlation among the several activities. It is therefore expected that the instruments give a reasonable representation of the availability of credit to importers.

Bank credit standards

The survey is the Senior Loan Officer Opinion Survey, which will be used only for the U.S. The question posed is the following:

> Over the past three months, how have your bank's credit standards for approving loan applications for commercial and industrial loans or credit lines – excluding those to finance mergers and acquisitions – changed? 1) Tightened considerably 2) Tightened somewhat 3) remained basically unchanged 4) eased somewhat 5) eased considerably.

The instrument used represents the *net* percentage of respondents that said to have tightened the standards on credit for commercial and industrial firms. That is, the percentage respondents reporting tightened minus percentage respondents reporting percentage respondents eased standards.

The use of credit standards instead of interest rates is based on the findings of Lown and Morgan (2006). They find that standards rather than rates have explanatory power in explaining the amount of loans provided, which is consistent with the idea that loan providers change supply via changes in standards more than through changes in rates. This finding is consistent when adding several proxies for demand for credit, such as business failure rate, expected real GDP and corporate bond spread.

There could be some distortion in this measure, since this is not specified to short-term credit. The relevance of short-term credit is the typical short-term character of trade finance provided by banks. This specification is not included in the survey. However, it is – along with the question mentioned above – in the banking survey executed by the European Monetary Union, which started in 2003. The correlation between the net percentages that responded on tightening on short-term credit and credit for large corporate is very high (r = .98). As far this could be extended over another period of time and for another area, it suggests the difference between the two is small and therefore the use of this measure for short-term credit could be justified. It should be noted though that the graph of net percentage of credit standards on large corporations is above the graph on short-term credit. This suggests that it overestimates the credit restriction that this study is looking for, again, as far as these can be extended to the U.S. This possible overestimation should be kept in mind when interpreting the results.

The sample of this survey comprises 60 domestic banks and 24 branches and international banks. Participants are typically the largest in their districts and account for about 60% of all loans by U.S. banks and about 70% of all U.S. bank business loans (Lown and Morgan, 2006).

Financial Stress Index

The second proxy for bank credit availability is the index of financial stress proposed by Cardarelli, Elekdal and Lall (2009). This index is the sum of three groups of components: the banking sector, securities market and foreign exchange market. Each of these groups of components consists of several subcomponents. A schematic overview of the construction of this instrument is shown below.

Figure 2. Construction of the Financial Stress Index (IMF).

Financial Stress Index						
Banking sector			*Securities market*			*Foreign exchange market*
Banking sector Beta (CAPM)	TED spread	Inverted term spread	Corporate debt spread	Stock market returns	Stock market volatility	Exchange rate volatility (not included)

The banking sector group components include three variables: (1) the risk of returns on banks' stocks in relation to market risk (banking sector beta), (2) a spread between interbank rates and the policy rate (TED spread), and (3) the difference between government short- versus long-term bond rate (inverted term spread). The banking beta is proposed by Illing and Liu (2006) as a proxy for banking sector-specific stress. Commonly used variables such as bank profits and loan losses are highly pro-cyclical, while relating the share prices to the overall stock market would isolate the banking specific-sector shocks. The beta is constructed in line with the standard capital asset pricing model, where a beta above one indicates that bank stocks are relatively risky. The spread between interbank rates and the policy rate is the second component and is an indicator of liquidity. The instrument is constructed by the difference between the 3-month LIBOR and the government short-term rate. The LIBOR is the leading indicator of what the minimum interbank rates should be. During relative stability, this difference is very small. A limitation to this component is that it might underestimate financial stress, since it represents a minimum rate. For example, it could be that only the most creditworthy banks are able to rent against LIBOR, while the most banks are only able to rent at LIBOR plus some percent. The inverted term spread is defined as the difference between short- and long-term government bonds. The idea is that long-term government bonds represent the equilibrium interest rate. If the difference becomes larger, this represents stress that is exerted on debtors. This proxy for interest-rate shocks is included in several indexes, such as the financial stress index for the U.S. constructed by the Bank Credit Analyst.

To proxy the stress on the securities markets, again three inputs are used: corporate debt spreads, stock market returns and stock market volatility. Corporate debt spreads are defined as corporate bond yield minus long-term government bond yield. This spread is to proxy risk in the corporate debt market (Cardarelli et al., 2009). Stock market returns are computed as the month-over-month change in the stock index, and multiplied by minus one. This is to ensure that a decline in the stock index represents additional stress. The last security market-variable is the volatility of returns on stock markets.

The FSI includes a measure for stress on the foreign exchange market is the monthly change of the real effective exchange. However, in their extensive investigation of trade costs Anderson and Van Wincoop (2004) state that "[t]here is substantial consensus that the impact of exchange rate volatility on trade is very small at best, with even the sign uncertain" (p. 719). Therefore, this measure is excluded from the stress indicator.

Thus, six variables are included into the index. All variables are standardized and weighted by giving each variable equal importance for the index. This is the common method in the literature (Illing and Liu, 2006). Although the assessment is always problematic, the index seems to perform rather well: it identified 113 periods of financial stress, defined as one standard deviation above its trend, and captures 90 to 80 percent of the banking and currency crises identified by the literature (Lall et al, 2008). This test is performed on 17 OECD countries, including the U.S., over the past three decades.[7] The data is prepared by the IMF, and the monthly data is transformed to quarterly data by averaging the concurrent months.[8]

Bank aggregate extended credit

Another instrument to measure the availability of external finance is the sum of all commercial and industrial loans provided by domestic commercial banks. This is one of the traditional instruments in studies that look into the effect of financial development on economic performance (e.g. Rajan & Zingales, 1997). In these studies, the aggregate commercial loans are assumed to reflect credit supply under the assumption that demand equals supply. This may be a reasonable assumption in the long-run. In the short-run however, supply is likely to differ from demand. The obvious limitation of this instrument is thus that it is distorted by changes in demand.

Quarterly, seasonally adjusted data is obtained from the Federal Reserve and corrected for inflation using the consumer price index (CPI).

3.1.3 Interfirm credit and Export credit insurance

Credit that is directly supplied by a trading partner is hard to obtain in high frequency. The literature uses figures derived from annual reports (e.g. Love et al., 2007). However, shocks in trade are preferred to be measured in quarterly rather than annual data. Intrapolation of these annual data would be inaccurate at best and misleading at worst. Therefore, this specific form of credit will be omitted from analysis. Furthermore, data of supply of export credit insurance in the period of interest was not available to the author, leading to omit this variable in this study as well.

[7] This increases to 100 percent if the duration of episodes is interpreted more broadly; if instead of just the peak a few quarters around the peak is interpreted as a 'stressful period'.
[8] Retrieved from the IMF website: www.imf.org

This may seem problematic as it is not likely that interfirm credit and export credit insurance remained constant over the whole period of investigation. As mentioned earlier, Love et al. (2007) found that interfirm credit supply reduced in times of financial crisis, as banks do. Furthermore, it seems likely that insurers too reduce their supply in times of financial turmoil. This would imply that omitting these two credit suppliers leads to an upward bias in the estimators of bank credit supply. This problem is however not severe: although the bank credit estimator may be biased upward, it catches the effect of credit supply in all its forms – bank credit, interfirm credit and export credit insurance. Thus, the effect of interest – i.e. the effect of credit supply on trade – is still investigated.

3.2 Control variables

Income

The variables identified by the literature will be included in the analysis. Income will be measured by the Gross Domestic Product (GDP), and corrected for seasonality and inflation. Data is provided by the Bureau for Economic Analysis.

Vertical specialization

Vertical specialization will be accounted for by using the widely used method developed by Hummels et al. (2001). In this way, vertical specialization (VS) of industry *i* is calculated by the following formula:

$$VS_t = \frac{\sum_{i=1}^{n} \left\{ \frac{imported\ intermediates_{i,t}}{gross\ output_{i,t}} * exports_{i,t} * w_{i,t} \right\}}{total\ exports_t}$$

Between brackets, the first term is the share of imported inputs into gross production. Multiplying this ratio by the amount of exports provides a value for the foreign value added in exports. This ratio is weighted to the level of imports of the industry relative to the total imports ($w[i]$). In words, this formula represents the foreign value added in domestic exports. Intermediate inputs, gross output and exports are derived from input-output tables which are prepared by the OECD. The input-output tables are prepared every five years, which leads to necessary intrapolation, which is done on a linear basis. Although it may seem harsh to create quarterly data out of five-year figures, it is reasonable to assume that the distribution of advanced technology occurs in an ever-growing way. An obvious limitation of this instrument is of course that it doesn't follow the production process of the imported intermediate. Rather, figures are aggregated to the industry level, which might obscure the measure. For example, if

the imported inputs are used more (less) than proportionate for domestic sales instead of exports, aggregation would lead to an upward (downward) bias. Hummels et al. (2001) finds that, at least for Korea, this leads to a slight downward bias. However, as is noted in their article, it is uncertain which of the two possibilities is more likely. Hummels et al. (2001) also reveals that including oil as an intermediate input seriously affects the measure for vertical specialization. Given that the variance in the oil price seriously affects the overall picture of the level of vertical specialization, the oil sector is excluded from the calculation. Shortcoming is though that oil is still in the dependent variable, imports. For interpretation reasons, the measure is scaled against the level of exports, which is the standard method used in the literature (Hummels et al., 2001). Moreover, this scaling leads to an inflation-corrected measure of vertical specialization.

Technological development

Technological development is believed to stimulate trade because it reduces the costs of distribution of goods to foreign countries. A commonly used instrument for these cost reductions is the changes in freight rates (e.g. Baier & Bergstrand, 2001). The intuition is that as technology advances, freight rates charged by carriers should decline. Due to the private nature of these freight rates, these are usually estimated using the difference in quotation of traded goods (Anderson & Van Wincoop, 2004). Some goods that enter the country are valued at c.i.f. and some goods that leave the country are valued at f.o.b.[9] Dividing the first by the latter gives an idea of the cost position of a trading partner in a bilateral setting.

However, Findlay and O'Rourke (2008), two economic historians, argue that freight rates underestimate cost reductions of trade due to technological development. They argue that quality improvements provide an upward pressure on these freight rates and do not incorporate developments such as just-in-time management and communication improvements that reduced the distribution costs. Therefore, they argue that freight rates are likely to underestimate the true cost savings due to technological development.

[9] C.i.f. stands for '(port) Costs, insurance and freight rate', while f.o.b. stands for 'free on board'. When goods are valued at c.i.f., the value includes these various costs. When they are valued at f.o.b., they do not include these costs.

I follow Findlay and O'Rourke and don't use this instrument. Rather, a direct instrument of technology advancement is used. In the period of interest, the main advancements in technology have been in information and communication technology (ICT). The OECD provides several indicators for these developments. The one used here is the amount of total communication access paths for OECD countries. This is the total sum of standard analogue lines, ISDN lines, DSL, cable modems and mobile subscribers. This seems to be a reasonable instrument, since it represents the use of ICT, rather than the introduction of it. At first sight it may seem a noisy one since the measure is calculated over all OECD countries, instead of a single country. However, the use of ICT in international transactions depends on ICT levels in both countries. Since the largest part of U.S. trade is with other OECD countries, this is not a problem.[10] The implicit, rather strong assumption is that trade costs reduce one-on-one in line with this proxy. Later, as one of the robustness checks, freight rates are used as well.

Trade policy

The measurement of trade policy is notoriously difficult. The inaccuracy comes from the unavailability of data, aggregation bias or because some data are only useful in combination with other data (Anderson and Van Wincoop, 2004). I follow Baier and Bergstrand (2001) and use average tariff rates. The World Bank provides data on average of tariff rates, which are unfortunately not trade-weighted. This is likely to lead to measurement bias. Anderson and Van Wincoop (2004) show that this bias is likely to be upward. Using the UNCTAD TRAINS database, they show for the year 1999 that the trade-weighted average tariff of the U.S. is below the simple average. Given that this is a control variable, an upward bias is less of a problem than a downward bias, limiting the severity of this problem.

The obvious limitation of this measure is that this captures only part of trade policy. It would be interesting to include non-tariff barriers (NTBs), such as price and quantity control measures. Unfortunately, such data is not provided by the World Bank.[11] Omitting such information could lead to a bias in the estimator for financial stress, if non-tariff barriers are correlated with financial stress. This is a possible scenario. For example, during a period of financial stress, a government might restrict foreign

[10] In the period 2000-2008, roughly 60 percent of U.S. imports came from OECD countries. Calculations are based on Department of Commerce data.

[11] UNCTAD's TRAINS database provides such data, which is available against a fee. However, according to Anderson and Van Winscoop (2004) this data is of very poor quality.

competition in favor of domestic industries by tightening import standards (rather than tariffs). This seems most plausible in a scenario of prolonged financial stress, which resulted in a recession. This would imply a lagged correlation, since financial stress preludes rather than follows after a recession. If this is the case, it would imply a positive bias in the estimator of financial stress. Whether this is a large bias depends on the size of the effect of a NTB and the extent to which the NTBs are imposed.

Table 1. Variables, abbreviations, instruments and sources

Variable	*Instrument*	*Source*	*Abbreviation*
Trade	Real imports	Department of Commerce	IM
Credit availability	- Net percentage of respondents that reported tightened credit standards	Loan Officer Opinion Survey; Federal Reserve	TCS
	- Financial Stress Index	IMF	FSI
	- Aggregated real value of commercial loans	Federal Reserve	CRE
Income	Real gross domestic product	Bureau of Economic Analysis	GDP
Vertical specialization	Foreign value added in exports, as % of total exports	OECD	VS
Technological development	ICT indicator	OECD	Techdev
Trade policy	Tariff rate index	World Bank	Tariff

3.3 Descriptives

Some descriptive data of the variables are shown in Table 2. Note that the average growth over the period 1981 till 2009:1 in imports was 1.46 percent, with a standard error of 2.70 percent.

As one can see from Table 2, the average net percentage of respondents that report tightened credit standards is not zero but a positive nine percent. Over a long period of time one would expect this to be zero. A plausible explanation would be that bankers don't feel comfortable saying that credit standards are loosened. This might feel like saying to be less critical than previous quarter. If this occurs to the same extent over the whole period investigated, this overestimation doesn't lead to a bias in the estimator.

Furthermore, the financial stress index has a mean close to zero. The highest change in this index is 5.9, which occurred during the sub-prime mortgage crisis. The largest fall was recorded in the late 1980s. The average change in the actual aggregated short-term credit that is extended is 0.5 percent, with a

maximum fall and increase of 4.5 and 5.8 percent, respectively. Both extremes also occurred during the sub-prime mortgage crisis, in the expected order: first a large increase, followed by a large fall. The aggregate tariff rates were between 6.6 and 2.7 percent. The positive value of the maximum change in tariffs represents the fact that the aggregate tariff rate has been increased in at least one observation. In fact, it happened twice: in 1993 and 2002. Technological development increased by 1.5 percent per year on average. The level of vertical specialization, measured as foreign value added in exports as a percentage of total exports, is between 19 and 51 percent. The graph is roughly S-shaped, with the largest increase in the second half of the 1990s. After 2000, the level of vertical specialization decreased somewhat. The plots of the variables over time are presented in Appendix A.

Table 2. Descriptives of the variables

Variable	*n*	*Period*	*Mean*	*St.Error*	*Min*	*Max*
Δ IM (log)	112	1981:1 – 2009:1	.01456	.02569	-.11325	.07712
TCS	76	1990:2 – 2009:1	.09672	24.81552	-.241	.836
Δ TCS	75	1990:3 – 2009:1	.00097	10.68771	-.290	.364
Δ FSI	112	1981:2 – 2009:1	.07133	1.38254	-3.57852	5.93368
Δ CRE (log)	113	1981:1 – 2009:2	.00495	.02041	-.04524	.058298
Δ GDP (log)	112	1981:1 – 2009:1	.00679	.00706	-.01653	.02230
Tariff	80	1988:1 – 2007:4	4.73251	1.42683	2.7	6.6
Δ Tariff	79	1988:2 – 2007:4	-.04937	.14893	-.6000	.2
Δ Tech dev (log)	56	1991:4 – 2005:4	.01460	.00646	.00192	.02805
VS	81	1985:4 – 2005:4	.37951	.10831	.18531	.51167
Δ VS	80	1986:1– 2005:4	.01739	.00288	.00511	-.00481
Δ VS *second difference*	79	1986:2 – 2005:4	-.00011	.00185	-.00870	.00824

Now the instruments and data are described, the next section specifies the model, before turning to the results.

4. Model specification

In order to allow for short-run deviations from the long-run growth rate, an error-correction model is preferred over a linear model. The model is thus of the form:

$$\Delta Y_t = \alpha + \Delta X_t \beta_1 + \gamma(Y_{t-1} - X_{t-1}\beta_2) + \epsilon_t \quad (1)$$

in which ΔXt refers to short-term effects and X_{t-1} to long-term effects. The term γ is the error correction parameter which should be negative so that ΔY_t tends to return to equilibrium. The size of the error correction parameter gives an indication of how quickly the function moves to its equilibrium.

The literature provides a basis to distinguish between long-term drivers and short-term drivers of trade. As mentioned in Section 2, income, trade policy, vertical specialization and technological development can be seen as long-term drivers of trade. It seems straightforward to expect a long-run equilibrium between imports on the one hand and income and tariffs on the other. For vertical specialization this could be argued as well. During this time period, imports and vertical specialization show a similar pattern: low growth in the early '90s, followed by high growth until the turn of the century, with lower growth afterwards. The same is true for the proxy of technological development. The ability to finance international transactions is expected to be a short-term effect: as credit supply is drying up, international transactions cannot be financed and trade is impaired.

The first differences of the error correction vectors are not included as they are not expected to have immediate effects. Changes in tariffs are expected to take some time before becoming effective: in this time frame, U.S. tariffs were already low to begin with. As they are reduced even further, it could take some time for importers (consumers) to recognize these price changes and to adjust their purchasing choices accordingly. The effect of technological development and vertical specialization are not likely to be immediate either. However, the change in the growth rate of production may be an indicator of business sentiment or may affect consumer confidence. In that way, it may have impact on trade as well. The first difference of GDP will thus be included. This will be included in one of the robustness checks. For now, the model is specified as such:

$$\Delta IM_t = \alpha + \beta_1 \Delta TCS_t - \gamma \{Im_{t-1} + \beta_4 GDP_{t-1} + \beta_5 Tar_{t-1} + \beta_6 VS_{t-1} + \beta_7 Techdev_{t-1}\} + \epsilon_t \quad (2)$$

In order to justify the use of an error correction model, the cointegration test proposed by Engle and Granger (1989) will be performed. Three requirements should be fulfilled. First, all variables in the equilibrium function need to be integrated to the same order. Second, the error term of the equilibrium function should be I(0). The last requirement is that the function represents equilibrium: the ECM-parameter γ in equation (2) should be negative.

Step 1: Order of integration of long-run variables

The first requirement is that all variables in the equilibrium are integrated to the same order. An augmented-Dickey Fuller test (ADF), with a trend included, fails to reject the zero-hypothesis that there is no unit root on all of the variables (results not presented). Performing the same test, but without the trend, lead to the conclusion that all variables are integrated to the first order. Exception to this is vertical specialization, which is integrated to the level of two. A Philips-Perron test is performed which confirms these conclusions. Results are summarized in Table 3.

Table 3. Stationarity tests long term variables.

Variable	*ADF test (P-value)*	*Philips-Perron test (P-value)*	*Conclusion*
Δ Imports (log)	0.0261	0.000	I(1)
Δ GDP (log)	0.011	0.000	I(1)
Δ Tariff	0.000	0.000	I(1)
Δ Tech dev (log)	.0297	0.035	I(1)
Δ Vertical specialization (log)	0.6207	0.630	I(2)
Vertical specialization (log); *second difference*	0.000	0.000	

The fact that vertical specialization is integrated to the order of two may be due to the fact that the data for this instrument is mostly created. As mentioned earlier, this vertical specialization is based on the Input-Output tables produced by the OECD every five years. This required intrapolation to quarterly data with only few real observations. Although theoretically it may be argued that this may proxy the real development in vertical specialization over time, it leads to being integrated in the order of two. I accept this feature and will use the first difference rather than the level.

With respect to the first requirement of cointegration, that is that all variables are integrated to the same order, the model as presented above is adjusted. Instead of using the level of vertical specialization, the first differences are taken. This is presented below.

$$Im_t = \alpha + \beta_1 GDP_t + \beta_2 Tariffs_t + \beta_3 Techdev_t + \beta_4 \Delta VS_t + \eta_t \quad (3)$$

Step 2: Order of integration of error term of the equilibrium function

The second requirement for cointegration is that error term η_t in the equilibrium function above does not have a unit root. An augmented-Dickey Fuller test points out that the errors are indeed integrated to

the order of zero. This result is backed by similar findings using a Philips-Perron test (MacKinnon approximate p-values for both test are between 0.000 and 0.015).

The most remarkable result is the negative sign of the proxy for technological development, which was expected to be positive. This could mean that the proxy does not capture what it should. Another possibility is the relationship may be non-linear. The second model in Table 5 points out that the latter is a possible explanation: after adding a squared version of the proxy, the sign turns positive. However, the nonlinear cointegration test proposed by Breitung (2001) points out that there is no statistical backing for the argument that the effect of technological development on imports declines or increases over time.[12] Thus, based on this test, it is not statistically justified to add a squared version of technological development. Although this result is counterintuitive, it does not have a large effect on the estimators of the variables of interest as we will see in the robustness checks in next section in which a square is added despite the result of the nonlinear cointegration test.

Table 5. Estimation of the long-run model; p-values are MacKinnon approximate p-values.

Imports $_t$ (log)	*(1)*	*(2)*
GDP $_t$ (log)	3.0303***	2.5808***
	(.1881)	(.1842)
Tariffs $_t$	-.02966*	-.0142
	(.0116)	(.0099)
Tech dev $_t$ (log)	-.2966*	4.8319***
	(.0669)	(1.0808)
Tech dev $_t$ – squared (log)		-.0338***
		(.0712)
Δ VS $_t$	2.9351	4.3713***
	(1.8569)	(1.5900)
Constant	-32.3859***	-44.5599***
	(2.6537)	(3.3972)
R-squared	0.9968	0.9978
Adj. R-squared	0.9965	0.9976
N	57	57
P-value ADF test on η	0.0150	0.0008
P-value Philips-Perron test	0.0020	0.0001

* significant at the 0.10 level
** significant at the 0.05 level
*** significant at the 0.01 level

Another remarkable result is the size of the estimator of GDP being larger than one. This is a result of what has been seen during past decades: trade has grown faster than production (Yi, 2003). This should have been captured by vertical specialization, since this should capture the fact that the value chain is

[12] Test statistic is 52*0.0018=0.0094 < 3.8 (critical value, df=1).

sliced. Apparently, this phenomenon is imperfectly measured. The extremely high level of the R-squared (0.998) is mainly due to the trend in imports (Wooldridge, 2006).

Step 3: Sign of the ECM-parameter

The last requirement for cointegration is that the term γ in (2) is negative, so that the function returns to equilibrium. Estimation of the model with credit standards as a short-term effect on imports confirms that the ECM-parameter is negative. In other words, the growth in imports returns to some equilibrium over time. Evidence for this finding will be shown in the next section.

The error correction model is thus specified:

$$\Delta IM_t = \alpha + \beta_1 \Delta TCS_t - \gamma \{Im_{t-1} + \beta_4 GDP_{t-1} + \beta_5 Tar_{t-1} + \beta_6 Techdev_{t-1} + \beta_7 \Delta VS_{t-1}\} + \epsilon[t] \quad (4)$$

Equation (4) forms a standard model on which several adjustments will be made. Estimation of this model in various forms will be done in the next section.

5. Empirical results

This section is structured as follows: first, results of estimation of the standard model as presented are discussed. Then, several robustness checks are done. Afterwards, a comparison is made to the two papers that are related closely to this one: the studies by Ronci (2004) and Thomas (2009).

5.1 Tightened credit standards

In this section, the model is applied to the data; the results are summarized in Table 6. First, only the error correction term is used to explain changes in imports. This model captures about half the variation in changes in imports (R-squared=0.53). The ECM-parameter is relatively high (-0.52), which implies a quick return of imports to its equilibrium growth rate. This is much larger in absolute terms than Thomas (2009), who finds an ECM-parameter of -0.17. This large difference may be due to a structural difference between imports in emerging markets and industrialized ones, but it could also be due to differences in the employed models. It seems plausible that both are at work here.

As observed in Section 4, the effect of GDP is large: the estimated coefficient is 1.96. As mentioned before, this effect should be captured by the slicing of the value chain. Although the estimator for the

effect of vertical specialization is indeed positive but not significant, it appears that it does not capture this effect totally. If it did, the estimator of GDP would be closer to one, and the estimator of vertical specialization would be larger. Apparently, the instrument captures part of the real vertical specialization, but not all of it. The estimators of technological development and tariffs are in contrast to expectations: technological development is negatively significant, while tariffs are positive but not significant. As discussed in the previous section, this could be the result of the proxy itself or the result of a non-linear relationship between technological development and imports. Both possibilities will be picked up in the robustness checks.

Table 6. Regression of credit standards on growth of imports

Δ Imports $_t$ (log)	*(1)*	*(2)*	*(3)*	*(4)*
Δ Tcs $_t$		.0016	-.0060	-.0082
		(.0183)	(.0183)	(.0176)
Δ Tcs $_{t-1}$			-.0190	-.0133
			(.0179)	(.0175)
Δ Tcs $_{t-2}$			-.0408**	-.0344*
			(.0178)	(.0174)
Δ Tcs $_{t-3}$			-.0383*	-.0281*
			(.0163)	(.0164)
Δ Tcs $_{t-4}$			-.0313*	-.0322**
			(.0160)	(.0154)
Δ GDP $_t$ (log)				.7452**
				(.3489)
Imports $_{t-1}$ (log)	-.5192***	-.5202***	-.4108***	-.4040***
	(.0831)	(.0183)	(.0864)	(.0833)
GDP $_{t-1}$ (log)	1.9577***	1.982***	1.7742***	1.7321***
	(.2760)	(.2788)	(.2662)	(.2572)
Tariffs $_{t-1}$	.0029	.0029	.0053	.0064
	(.0072)	(.0073)	(.0069)	(.0066)
Techdev $_{t-1}$ (log)	-.3068***	-.3063***	-.3409***	-.3170***
	(.0471)	(.0479)	(.0464)	(.0461)
Δ VS $_{t-1}$ (log)	0.9827	.9532	1.1168	1.3532
	(1.1397)	(1.1975)	(1.1559)	(1.1190)
Constant	-21.9202	-21.9182	-20.2620***	-19.8647***
	(3.1275)	(3.1584)	(2.9920)	(2.8884)
n	57	57	57	57
R –squared	0.5283	0.5284	0.6225	0.6572
Adj. R-squared	0.4820	0.4718	0.5404	0.5734

* significant at the 0.10 level

** significant at the 0.05 level

*** significant at the 0.01 level

In the second model, the contemporaneous change in the net percentage of bankers that report tightened credit standards is added. This hardly improves the model in terms of R-squared. This is due to the lagged response of bank lending to changes in lending standards, which may take up to four quarters (OECD, 2009).

After including four lags, the effect of credit tightening becomes apparent: the second, third and fourth lag are negative and significant, at least at the 0.10 percent level.[13] The coefficients may seem low at first glance (-0.041, -0.038, and -0.031, respectively), since as the descriptive table has showed, the net percentage of reports of tightened standards is in parunes, not in percentages. This means that a 1 percentage-point change in the variable leads to a -0.11 percent-point change in imports, spread out over three quarters[14]. This still may not seem impressive, but take a look at the increase in the tightening credit standards around the burst of the internet-bubble, in 2000, as shown in Appendix A. In this period, this net percentage did not change by 1 but by roughly 10 percentage-points, and for four quarters consecutively. Now the economical importance becomes observable: the restriction in credit supply during this period leads to a total reduction in imports of 4.38 percent, spread out over seven quarters. This is illustrated below.

Table 7. Time frame of the lagged effects of changes in credit standards on imports during 2000.

Quarter	*2000:2*	*2000:3*	*2000:4*	*2001:1*	*2001:2*	*2001:3*	*2001:4*	*2002:1*	*Total*
t	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	
Δ Tcs $_t$	+10	+10	+10	+10					
β_{t-2}			-0.41	-0.41	-0.41	-0.41			
β_{t-3}				-0.38	-0.38	-0.38	-0.38		
β_{t-4}					-0.31	-0.31	-0.31	-0.31	
Δ %, IM $_t$			-0.41%	-0.79%	-1.10%	-1.10%	-0.69%	-0.31%	-4.38%

This illustration shows the economical importance of the effects: during the first, second and third quarter of 2001, these increased tightened standards resulted in significant decreases in the growth rate of imports.

Caution is warranted here. Although the explained variance is high, the model does not explain all variance in imports. These estimates are thus based on a simplified model, so the proclamation *ceteris paribus* would be a dangerous one. The results may depend on the specification of the model, the choice of instruments or may be a spurious effect. To check to what extent these results may be

[13] Including more lags lead to similar results for the first four lags, while further lags are not significant.
[14] Calculation is done as follows: [0.01*(-0. 041 - 0.038 - 0.031)]*100= - 0.11

spurious or due to model specification, several robustness checks are performed. First, the possibility that banks have adjusted their credit standards because they are able to predict future economic performance is investigated. Afterwards, to correct for a possible non-linear relationship, a squared version of technological development is added. In addition, another proxy for technological development will be used. Third, several short-term variables are added. Lastly, the use of several instruments for credit availability is discussed.

5.2 Robustness checks

5.2.1 Possibility of spurious results

One could argue that the found result of the proxy for credit supply can be explained by a common determinant, and thus that the effect is spurious rather than direct. For example, a recession might be foreseen by banks. This means that future changes in GDP affects current changes in credit standards. Put differently, current changes in GDP affects lagged changes in credit standards. This current recession is also likely to decrease imports. This is tested for by including the contemporaneous change in GDP in the fourth model as reported in Table 6. However, the results remain similar, with only small decreases in the coefficients of the second, third and fourth lags.

5.2.2 Correction for technological development

As mentioned earlier, the negative sign of the estimator of technological development may be due to a nonlinear relationship, but it could also be due to the proxy itself. Both cases are investigated here. First, a square is added. Thereafter, the proxy is replaced by a more traditional proxy in the literature.

Correcting for possible nonlinearity

First, after inclusion of a squared version of the proxy for technological development, the Engle and Granger (1989) requirements for cointegration are tested again. Once more, all of the requirements are met.[15] In the first model, only the new error correction term is included. This leads to a rather similar performance of the model in explaining the variance (adj. R-squared = 0.49 versus 0.48). Overall, the

[15] The square is indeed I(1) (ADF: p-value = 0.036; Philips-Perron: p-value = 0.030); the error term of the long-run relationship is I(0) (both ADF and Philips-Perron: p-value = 0.000); the sign of the ECM parameter is negative.

estimators remain rather similar: the ECM parameter and the estimators of GDP and the first difference in vertical specialization increased somewhat (in absolute terms), while the estimator of tariffs remained similar. Conclusions in terms of significance all remain the same. The exception is technological development: instead of being significantly negative, the estimator turns positive, with a diminishing effect. Conclusions regarding tightened credit standards remain the same: the second, third and fourth lag are significantly negative, though slightly higher (-.039, -.043, -.038 versus -.041, -.038, and 0.031).

Table 8. Adding a square of technological development.

Δ Imports $_t$ (log)	*(1)*	*(2)*	*(3)*
Δ Tcs $_t$		-.0018	-.0035
		(.0180)	(.0169)
Δ Tcs $_{t-1}$		-.0144	-.0061
		(.0177)	(.0169)
Δ Tcs $_{t-2}$		-.0389**	-.0307*
		(.0173)	(.0166)
Δ Tcs $_{t-3}$		-.0430**	-.0319**
		(.0161)	
Δ Tcs $_{t-4}$		-.0383**	-.0412***
		(.0160)	(.0151)
Δ GDP $_t$ (log)			.9027***
			(.3374)
Imports $_{t-1}$ (log)	-.5828***	-.5078***	-.5254***
	(.0995)	(.0994)	(.0935)
GDP $_{t-1}$ (log)	2.0572***	1.9199***	1.9077***
	(.2884)	(.2714)	(.2546)
Tariffs $_{t-1}$	.0030	.0054	.0067
	(.0072)	(.0067)	(.0063)
Techdev $_{t-1}$ (log)	.7364	1.2746	1.7332**
	(.9064)	(.8792)	(.8422)
Techdev $_{t-1}$ (log) – squared	-.0701	-.1086*	-.1374**
	(.0608)	(.0590)	(.0564)
Δ VS $_{t-1}$ (log)	1.4666	1.7031	2.1454*
	(1.2112)	(1.1712)	(1.1108)
Constant	-26.4990***	-27.2395***	-28.6136***
	(5.0504)	(4.7844)	(4.5166)
n	57	57	57
R –squared	0.5405	0.6489	0.6980
Adj. R-squared	0.4854	0.5689	0.6156

* significant at the 0.10 level
** significant at the 0.05 level
*** significant at the 0.01 level

C.i.f./f.o.b. rates

A more traditional proxy for technological development is taken: as a proxy for the ad valorem costs of transportation, c.i.f./f.o.b. ratios are used. Results are presented in Table 9. The use of this instrument

does not affect the conclusions on the effect of changes in credit supply by much. The estimators are again negatively significant and have about the same size. Moreover, the adjusted R-squared more than doubles after inclusion of these changes in credit supply. The estimator of the freight rates is significantly negative, which it is expected to be: as freight rates decrease, trade increases. As somewhat disturbing result is the large decrease of the ECM parameter: from a -0.40 to -.25. This is disturbing to the extent that it changes conclusions on how quickly the trade growth rate returns to its equilibrium rate quite dramatically. However, conclusions on the effect of credit supply remain largely the same.[16]

Table 9. Using c.i.f./f.o.b. ratios to proxy technological development.

Δ Imports $_t$ (log)	*Standard*			*Trade balance- corrected*		
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
Δ Tcs $_t$		-.0163	-.0191		-.0184	-.0165
		(.0214)	(.0203)		(.0269)	(.0258)
Δ Tcs $_{t-1}$		-.0212	-.0156		-.0182	-.0086
		(.0204)	(.0194)		(.0249)	(.02
Δ Tcs $_{t-2}$		-.0404**	-.0356*		-.0310	-.0245
		(.0196)	(.0187)		(.0230)	(.0223)
Δ Tcs $_{t-3}$		-.0367*	-.0247		-.0243	-.0117
		(.0183)	(.0179)		(.0212)	(.0211)
Δ Tcs $_{t-4}$		-.0405**	-.0405**		-.0268	-.0277
		(.0180)	(.0171)		(.0208)	(.0200)
Δ GDP $_t$ (log)			.09501**			1.0349**
			(.3717)			(.4532)
Imports $_{t-1}$ (log)	-.1614**	-.2444**	-.2502***	-.1285	-.0806	-.1183
	(0.0802)	(.0927)	(.0878)	(.0864)	(.1149)	(.1114)
GDP $_{t-1}$ (log)	.4882**	1.0172***	1.0166***	.3758*	.3602	.4413*
	(.1935)	(.2412)	(.2284)	(.2053)	(.2624)	(.2541)
Tariffs $_{t-1}$	-.0005	.0064	.0064	-.0007	.0046	.0036
	(.0086)	(.0075)	(.0071)	(.0089)	(.0090)	(.0086)
C.i.f./f.o.b. $_{t-1}$ (log)	-.5070**	-1.8291***	-1.6575***	-.6891	-2.1542**	-1.6679**
	(.2309)	(.3269)	(.3167)	(.4931)	(.6967)	(.7011)
Δ VS $_{t-1}$ (log)	1.1138	3.5018**	3.6438***	1.4274	1.5119	1.7807
	(1.1913)	(1.3945)	(1.3216)	(1.2539)	(1.5525)	(1.4931)
Constant	-5.4875***	-12.6717***	-12.6168***	-4.2107	-4.6561***	-5.4330**
	2.0680	(2.7137)	(2.5697)	(2.1636)	(2.7307)	(2.6402)
n	72	59	59	72	59	59
R –squared	0.2063	0.4950	0.5566	0.1728	0.3042	0.3737
Adj. R-squared	0.1462	0.3898	0.4529	0.1101	0.1593	0.2271

* significant at the 0.10 level

** significant at the 0.05 level

*** significant at the 0.01 level

[16] Although the beta of the second lag of change in TCS is no longer significant at the two-sided 0.10 level, it is very close (P-value = 0.1053).

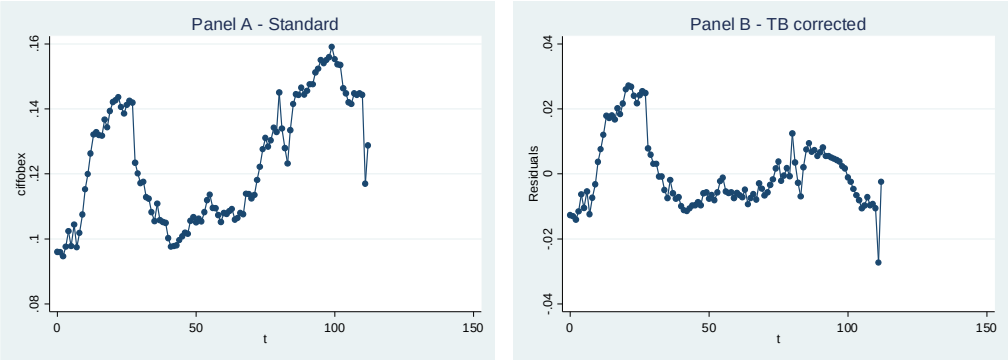
Although this is a common estimator of freight rates in the literature, it is likely to be disturbed by the deteriorating trade balance of the U.S. due to its construction. As the instrument of freight rates is constructed as the ratio of import value reported on c.i.f. basis over exports reported at f.o.b., increasing imports relative to exports leads to a change in the ratio, keeping technological development constant. This leads to an increasing ratio over time, at least partly due to increasing imports relative to exports, and therefore to underestimation of the cost savings due to technological development.

Therefore, a 2SLS is done in the following way: the trade balance is regressed on the c.i.f./f.o.b. ratios and the estimated errors are obtained.[17] These errors are assumed to be the trade balance-corrected c.i.f./f.o.b. ratios, and used as proxy for technological development. As the variation in this variable is smaller than in the standard c.i.f./f.o.b. ratios, the estimator is now higher in absolute terms. Furthermore, the estimators of tightened credit standards are again negative, though not significant at the one-sided 0.05 level – like most other variables.

Based on these results, what can be concluded? First and most plainly, in line with Anderson and Van Winscoop (2004), it can be concluded that cost savings due to technological development are problematic to proxy. In this period, estimation of freight rates in the common method leads to a counterintuitive approximation of trade costs as shown in Figure 2. If anything, these instruments seem to capture price fluctuations rather than cost savings due to technological development for two reasons. First, there is no clear downward trend. Second, peaks are formed before recessions and during these recessions the ratio goes down. Looking at panel B of Figure 2, there is an upward trend in the years before 1990 (t=37) and 2000 (t=78), and a downward trend afterwards. It seems to be that as trade increases, port costs, insurance and freight rates may increase as well. This is backed by the positive correlation of change in imports and the change in trade balanced-ratio (r = .20). However, as these freight rates are more likely to capture price fluctuations, they may be an interesting variable to add as a short-term effect. This will be investigated in the next subsection, when several short-term variables are added.

[17] Results of the first stage of the 2SLS are included in Appendix B.

Figure 2. Graphs of c.i.f./f.o.b. ratios over time. Note: different scaling of the y-axes.



What can be concluded on the basis of this subsection with regard to the availability of credit? No matter what proxy was used for technology reduced trade costs, the estimators of tightened credit standards were negative and economically important. In most cases these estimators were also statistically significant. Therefore, it seems reasonable to lean towards the conclusion that the availability of credit has an effect on trade. However, conclusions on the ECM parameter may depend to a great extent to what instrument is used to proxy technological development.

5.2.3 Additional short term effects

In the model estimated in Section 5.1, only changes in the availability of credit are assumed to have short-run effects. This clearly is a simplification of the real world. To check whether the results are robust to including additional short-run effects, four additional variables are added. First, following Ronci (2004), the real effective exchange rate (REER) is included. Second, expectations are likely to influence current spending, and therefore imports, as well. In order to control for this effect, consumer confidence and business sentiment surveys are added. Third, the change in inventory levels is added to the model. Finally, as mentioned earlier, the trade balance-corrected freight rates will be included. Results are shown in Table 10.

The first model in Table 10 shows that the sign of REER is negative, which is expected as it is defined as the weighted value of foreign currencies in U.S. dollars. However, it is not statistically significant and adds little to the explanatory power of the model, as the adjusted R-squared actually decreases. Including expectations does not add to the explanatory power of the model either. Although the estimators have the expected sign, they are not – solely nor jointly – significant.

In the third model the first differenced freight rates are added. Although the sign would be expected to be negative, it is positively significant. This underlines the interpretation mentioned before: it seems to

reflect changes in price as trade increases. As trade increases freight rates increase as well. However, if one includes the lagged rather than the contemporaneous change in freight rates, then the effect becomes negative and statistically significant (results not shown).

Finally, in the fourth model, the change in inventory levels is added. Previous research has shown that cycles in economic activity are largely influenced by changes in inventory levels. For example, Blinder and Maccini (1991) estimate that changes in inventory levels accounted for 82% of the reductions in production in post-war recessions.[18] These inventories are typically financed by banks. As bank credit becomes less available, firms may lower their inventories to accompany for the reduction in external finance. Firms may initially reduce inventories because of the low adjustment costs (Guariglia, 1999). This would imply that the effect of tightened credit standards on imports runs through inventory levels.

In order to investigate whether this is the case, the first step is to add inventories into the model. If the effect of credit availability is indeed indirect, the effect should disappear after inclusion of inventories while the effect of changes in inventory should be positive. This is indeed what happens: all the estimators of changes in credit supply that have been significant in the previous model become insignificant. Moreover, the effect of the change in inventory level is economically important (β=0.36) and very close to being significant at the one-sided 0.05 level.[19] As changes in the inventory level take up a large part of the explanatory power of changes in credit supply, this suggests that the effect of credit supply on trade runs through inventory levels. In other words, in order to accommodate for restrained credit supply firms deteriorate their inventory levels to preserve liquidity.

[18] Turning to trade, as proposed by prof. dr. J. Franssoo, changes in the inventory levels may have accounted for a great deal in the fall of world trade in late 2008. NRC Handelsblad (May 12th, 2009); interview (August 27th, 2009).

[19] If one uses a one-sided 0.06 significance level, one would reject the zero-hypothesis of the estimator being zero.

Table 10. Adding the changes in real effective exchange rate and inventory level.

Δ Imports $_t$ (log)	*(1)*	*(2)*	*(3)*	*(4)*
Δ Tcs $_t$	-.0048	-.0052	-.0053	.0023
	(.0185)	(.0193)	(.0180)	(.0183)
Δ Tcs $_{t-1}$	-.0200	-.0302	-.0326*	-.0238
	(.0181)	(.0190)	(.0178)	(.0184)
Δ Tcs $_{t-2}$	-.0390**	-.0410**	-.0365**	-.0254
	(.0181)	(.0186)	(.0175)	(.0185)
Δ Tcs $_{t-3}$	-.0378**	-.0344**	-.0327**	-.0192
	(.0165)	(.0165)	(.0155)	(.0174)
Δ Tcs $_{t-4}$	-.0299*	-.0319*	-.0320**	-.0265*
	(.0162)	(.0162)	(.0151)	(.0152)
Δ REER $_t$	-.0005	-.0008	-.0005	-.0004
	(.0008)	(.0008)	(.0008)	(.0007)
Δ Consumer confidence $_t$		.0001	.0003	.0003
		(.0004)	(.0003)	(.0003)
Δ Business sentiment $_t$		.0004	.0001	.0001
		(.0003)	(.0002)	(.0002)
Δ C.I.F/F.O.B. (TB-corrected) $_t$			1.2223**	1.1348**
			(.4663)	(.4612)
Δ inventory $_t$ (log)				.3611
				(.2266)
Imports $_{t-1}$ (log)	-.4069***	-.3626***	-.3500**	-.3482***
	(.0872)	(.0915)	(.0859)	(.0844)
GDP $_{t-1}$ (log)	1.7733***	1.7098***	1.6546	1.5031***
	(.2680)	(.2759)	(.2596)	(.2722)
Tariffs $_{t-1}$	.0057	.0090	.0102	.0061
	(.0069)	(.0072)	(.0067)	(.0071)
Techdev $_{t-1}$ (log)	-.3450***	-.3520***	-.3380	-.2956***
	(.0472)	(.0491)	(.0463)	(.0527)
Δ VS $_{t-1}$	1.0810	1.2366	.8469	.0980
	(1.1650)	(1.1587)	(1.0967)	(1.1753)
Constant	-20.2737***	-19.8402***	-19.2355	-17.1189***
	(3.0120)	(3.085)	(2.9028)	3.1455
n	57	57	57	57
R –squared	0.6257	0.6489	0.6982	0.7158
Adj. R-squared	0.5343	0.5427	0.5976	0.6118

* significant at the 0.10 level
** significant at the 0.05 level
*** significant at the 0.01 level

Although this 'credit supply-driven' explanation seems a plausible one, it is not the only possible explanation: it could also be 'expectations-driven'. In other words, it could be that firms do not lower their inventory levels because they have to accommodate for contracted external finance, but do it voluntarily. For example, it could be argued that firms adjust their sales expectations. Sales expectations and credit standard tightening may be correlated due to a common factor (e.g. gloomier economic prospects). This implies that concluding that credit supply has an effect on trade through inventory adjustments would be false.

To investigate this issue, inventory investment is estimated in a model similar to Lown and Morgan (2006). This model is based on a version of the simple target adjustment of Lovell (1961), adjusted by Gertler and Gilchrist (1994). The difference with the equation of Lown and Morgan (2006) is however that the effect of tightened credit standards in not only the previous quarter is investigated, but also in quarters further back in time (defined by *h*).

$$\Delta Inv_t = \alpha + \beta_1(E_{t-1}S_t - Inv_{t-1}) + \beta_2 r_t + \beta_3 TCS_{t-h} + \beta_4 \Delta Inv_{t-1} + \beta_5 \Delta S_{t-1} + \beta_6 r_{t-1} + \beta_7 \Delta TCS_{t-h} + \varepsilon_t \quad (5)$$

where $E_{t-1}S_t$ is the expected sales level and r is the short term interest rate. I view the economy as a whole to be a single firm, and proxy sales level by GDP and inventory level by the aggregated inventory stock. As is common in the literature, actual sales is used to proxy expected sales. To proxy the average lending rate, the three month LIBOR is used. Although this is a low estimate of the interest rate that firms actually face, it is an approximation of the actual interest rate as the difference may be constant over a long period of time.

Results show that the tightening of credit standards indeed does have a negative effect on inventories. Furthermore, after inclusion of credit standards, the adjusted R-squared increased by more than a third. Furthermore, results are rather similar using the first, second and third lag in equation (5): all estimators are negatively significant at the 0.01 level.[20] The fourth lag of tightened credit standards does not significantly lead to changes in inventory levels. Apparently, this effect reduces after three quarters. This is in line with the previous result that the p-value of the fourth lag in Table 10 (model 4) was affected the least by the including inventory levels. One may argue that sales (GDP) is endogenous in equation (5). Correcting for this issue is done by using the fourth and eighth lag of GDP, which does not lead to different conclusions.

[20] Preferably, one would add them all together to equation (5). However, given the high correlations between the second, third and fourth lag of TCS, one of them is omitted by STATA to avoid high multicolinearity among the independent variables. Therefore, each of them is included seperately.

Table 11. Regressions on changes in the inventory level.

ΔInv_t (log)	(1)	(2) h = 1	(3) h = 2	(4) h = 3	(5) h = 4
$E_{t-1}St - Inv_{t-1}$	.0099	.0224**	.0237**	.0238**	.0121
	(.0072)	(.0105)	(.0109)	(.0120)	(.0131)
ΔInv_{t-1} (log)	.4300***	.2357**	.2641**	.2599**	.3789**
	(.0977)	(.1116)	(.1199)	(.1302)	(.1329)
ΔS_{t-1} (log)	.6663***	.3023	.2699**	.5203**	.5959*
	(.2102)	(.2327)	(.1178)	(.2512)	(.2710)
r_{t-1}	.0011	-.0034	.0009	-.0043	-.0034
	(.0067)	(.0086)	(.0091)	(.0095)	(.0103)
Δr_{t-1}	-.0058	-.0081	-.0141*	-.0066	-.0083
	(.0065)	(.0079)	(.0083)	(.0088)	(.0094)
TCS_{t-h}		-.0234***	-.0202***	-.0145**	-.0054
		(.0062)	(.0066)	(.0070)	(.0070)
ΔTCS_{t-h}		.0189	-.0187	-.0210*	-.0031
		(.0118)	(.0117)	(.0116)	(.0128)
Constant	-.0959	-.2070**	-.2374**	-.2220*	-.1632
	(.0678)	(.0981)	(.1028)	(.1151)	(.1266)
n	92	75	74	73	72
R –squared	0.4276	0.5691	0.5782	0.5165	0.4365
Adj. R-squared	0.3944	0.5241	0.5334	0.4644	0.3749

* significant at the 0.10 level

** significant at the 0.05 level

*** significant at the 0.01 level

Thus, given the expectations of sales, reduced credit supply leads to lower inventory investment and thereby reduces trade. However, this is based on a rather crude investigation. A more gentle way to investigate this would be to analyze firm-level data, and may be a subject for further research.

5.2.4 Different instruments for credit supply

As described in the methodology, several instruments were identified to proxy the banks' trade-related credit supply. The first alternative measure is the stress index provided by the IMF. The second is the aggregated short-term credit that is extended.

FSI

Tests of stationarity point out that the level of FSI is I(1), while the first differences are I(0).[21] Regressions are done in the same approach as in Table 6. The financial stress indicator is used to proxy for credit supply in the first two models. Results show some interesting features. First of all, the estimated effects

[21] P-values of ADF and Philips-Perron tests are 0.60 and 0.30 for the level of FSI respectively, and 0.00 for the first differences for both tests.

of the vectors in the error term are consistent with those results using tightened credit standards as a proxy for credit supply. However, the estimators on the several lags of the indicator differ from those presented in Table 6. Comparing the first model of Table 12 with the third of Table 6, one can see that in this case only the fourth lag is significantly negative. As Morgan and Lown (2006) argue, credit standards are more directly linked to the real economy than innovations in the financial sector, such as interbank rates. This implies a more lagged effect for stress on financial markets. Furthermore, the data shows that there is a lag of about one quarter between the movement in the financial stress indicator and the reported changes in credit standards. Thus, this underlines the point of Lown and Morgan: stress in the financial markets may lead banks to tighten credit standards, with a time lag, and connects the financial market with the real economy.

After taking the contemporaneous change in GDP into account, the estimator is somewhat larger. The estimated coefficient suggests that an increase of the index leads by one unit leads to a 0.4% decrease in imports, ceteris paribus. During the same period as in the illustration in Table 7, the first differences in the indicator were between 0.3 and 1.4, which implies a somewhat smaller effect. Including further lags does not lead to additional significant lagged effects, nor does it influence the significance of effect the fourth lag.

Aggregated short-term credit provided

In the third and fourth model another proxy for credit supply is used: the amount of credit that is actually provided. However, the obvious limitation is that changes in demand are not accounted for. This blurs real changes in the supply of credit, as demand may change in the same or in the other direction. Again, the level is not stationary while the first differences are.[22] Turning to the results, again, the effects of the error correction term are rather similar while the effect of credit supply is not observed. The effect of changes in credit supply is - as expected to be - positive, but not significant. The estimator of the second and fourth lag is negative, but very small compared to the estimators of the others.

[22] P-values of ADF and Philips-Perron tests are 0.30 and 0.79 for the level of CRE (log) respectively, and 0.024 and 0.025 for the first differences.

Table 12. Using FSI and CRE as a proxy for credit supply.

Δ Imports $_t$ (log)	*FSI*		*CRE*	
	(1)	*(2)*	*(3)*	*(4)*
Δ Credit supply $_t$	.0006	.0002	.1536	-.0704
	(.0014)	(.0013)	(.1921)	(.1963)
Δ Credit supply $_{t-1}$	.0016	.0011	-.0653	-.1064
	(.0015)	(.0013)	(.2382)	(.2227)
Δ Credit supply $_{t-2}$	.0000	-.0003	-.2696	-.1931
	(.0015)	(.0013)	(.2367)	(.2226)
Δ Credit supply $_{t-3}$	.0009	.0009	.1664	.1536
	(.0015)	(.0013)	(.2306)	(.2153)
Δ Credit supply $_{t-4}$	-.0029*	-.0043***	-.1059	-.1366
	(.0015)	(.0014)	(.1925)	(.1800)
Δ GDP $_t$		1.1935***		1.1059***
		(.3325)		(.3954)
Imports $_{t-1}$ (log)	-.4865***	-.4336***	-.4804***	-.4487***
	(.0886)	(.0803)	(.0931)	(.0876)
GDP $_{t-1}$ (log)	1.8480***	1.7440***	1.9537***	2.0970***
	(.2810)	(.2522)	(.3445)	(.3256)
Tariffs $_{t-1}$	.0025	.0066	.0041	.0128
	(.0080)	(.0072)	(.0092)	(.0092)
Techdev $_{t-1}$ (log)	-.2952***	-.2777***	-.3419***	-.3988***
	(.0516)	(.0462)	(.0889)	(.0854)
Δ VS $_{t-1}$	.9099	1.5065	1.4120	2.2630*
	(1.1543)	(1.0423)	(1.3248)	(1.2731)
Constant	-20.7005***	-19.9276***	-22.1532***	-24.5332***
	(3.2103)	(2.8699)	(4.1867)	(3.9985)
n	57	57	57	57
R –squared	0.5862	0.6783	0.5536	0.6198
Adj. R-squared	0.4963	0.5997	0.4566	0.5268

* significant at the 0.10 level

** significant at the 0.05 level

*** significant at the 0.01 level

The fact that there is no significant positive effect may give an intuition what happens to demand with respect to supply. For example, during times of financial stress, firms may want to obtain additional credit since less cash is flowing in. On the other hand, their demand for external finance may decrease since gloomier prospects may reduce the incentive to invest. It is important though to stay conservative here, as the results are compared to one another which are of course based on simplified models. Assume that the survey on tightened credit standards is a precise instrument for credit supply, and the estimated effect as reported in Table 6 is the true effect of restrictions of the supply of credit. As mentioned above, the effect is not significant for the observed quantity of credit obtained by firms. These data not only represent changes in supply, but also changes in the demand for credit. If demand would remain equal, we would expect the estimator to be positively significant. However this is not the case. Apparently, shifts in demand have downplayed the effect of shifts in supply. Although caution is

warranted, based on these results, one may conclude that demand also decreases when banks restrict their supply. This builds on an analysis given in Appendix C.

5.3 Comparison to Thomas (2009) and Ronci (2004)

As mentioned earlier, two previous studies are directly related to this one. This raises the question how these results compare to those of the aforementioned papers. There are two ways to do this. One could estimate the model presented in this paper for two different types of countries. Consistent data on this model is difficult though, especially for vertical specialization. The other option is to apply the models presented by Thomas and Ronci to data for two different types of countries, and compare the results for the U.S. to those presented above.[23] This is difficult to do with regard to Thomas (2009) since his model is not explicitly specified in his paper. Ronci (2004) does however present his model, and is specified as follows:

$$\Delta Im_t = \alpha + \beta_1 \Delta Im_{t\_1} + \beta_2 \Delta Fin_t + \beta_3 \Delta GDP_t + \beta_4 Relpm_t + \beta_5 \Delta Crisis_t + \varepsilon_t \qquad (6)$$

in which *Fin* is the supply of trade related credit, *Relpm* is the relative price of imports compared to the CPI, and *Crisis* is a dummy variable that takes the value of one whenever the country suffers a financial crisis.

Estimation of this model is done for both the U.S. and Brazil. The financial stress indicator provided by the IMF is used, since data on credit standards is not available for both countries. This indicator is constructed in similar fashion, given two differences (Balakrishnan, Danninger, Elekdag, & Tytell, 2009). The inverted term spread is not included in the indicator for Brazil. Furthermore, the exchange rate volatility is not excluded. For now, I follow the construction as proposed for emerging markets by the IMF for Brazil and the construction as described in Section 3 for the U.S. These differences in construction lead to differences in the descriptives, as shown in Table 13 and Figure 3.

[23] Of course it would be better to do both options to get a more comprehensive view.

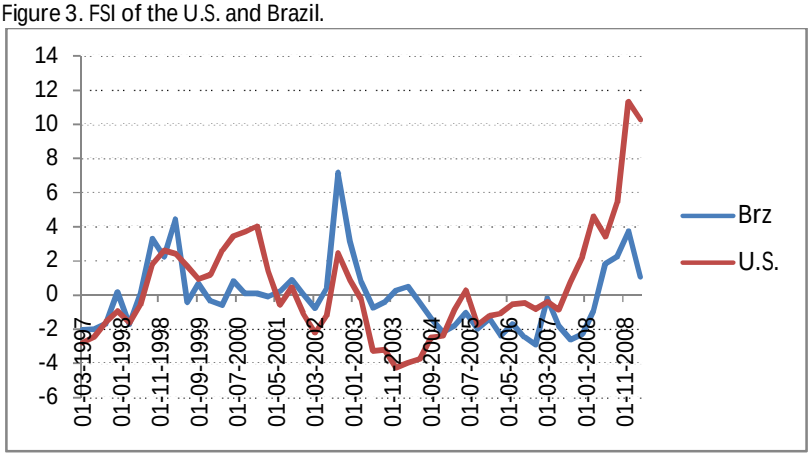
Table 13. Descriptives of both financial stress indicators.

Country	*FSI*	*n*	*Mean*	*Std. Dev.*	*Min.*	*Max.*
U.S.	Level	49	.4256	3.1913	-4.2709	11.3344
	First difference	48	.2722	1.5707	-3.0297	5.9337
Brazil	Level	49	-.0760	2.0194	-2.8951	7.1815
	First difference	48	.0646	1.8743	-4.8477	6.7412

Data on imports and real GDP for Brazil are derived from the National Statistics Institute (IBGE). Relative prices are calculated by dividing the import priced deflator by the consumer price index. Source is again the IBGE. The data is unfortunately restricted to a different time frame compared to the previous analysis: 1996:4 until 2009:1, but results in roughly the same sample size (n = 49).

Defining when a country suffers a financial crisis is always prone to discussion (Love et al., 2007). In Figure 3 the levels of both indicators are displayed. A reasonable dummy value may be two, since all components of the index are standardized. The level is greater than two during well known periods of financial crisis. In 1998, it coincides with the Asia Crisis for Brazil and the collapse of LTCM for the U.S. In 2000, it coincides with the burst of the dot-com bubble for the U.S. and the political crisis of Brazil in 2002.[24] Also, the sub-prime mortgage crisis of 2008 coincides with a level above two. Therefore, the dummy is assigned a value of one when the level of the indicator is above two, and a value of zero when the indicator is below two.

Figure 3. FSI of the U.S. and Brazil.



[24] The political crisis of the scandal involving president Da Silva-Cruz led investors to liquidate their investments, which led to a financial crisis (Jensen & Schmith, 2005).

Estimation of the model proposed by Ronci (2004) leads to some interesting differences between the countries. The model works far better for the U.S. than for Brazil: the R-squared is larger for the U.S. (0.71 and 0.55 respectively). Zooming in on the financial indicators, there is another remarkable result: the second lag is significant at the 0.05 level for Brazil, rather than only the fourth forth. This could mean two things: innovations in the financial markets take less time in Brazil to affect trade, or this could be a result of the differences in construction of the indicators. This will be checked for later. Another noteworthy result is the different sizes of the coefficients: for Brazil both significant estimators are almost twice as large as the one of the U.S. These two results suggest that the effect of financial stress, and presumable credit supply, is larger for emerging markets compared to industrialized ones.

Table 14. 'Ronci-regressions' on the U.S. and Brazil, using FSI as a proxy for credit supply.

Δ Imports $_t$ (log)	*U.S.*		*Brazil*	
	(1)	*(2)*	*(3)*	*(4)*
Δ Imports $_{t-1}$ (log)	.5677***	.5047***	-.03959	.0598
	(.1667)	(.1669)	(.1618)	(.1467)
Δ FSI $_t$	.0004	.0003	.00025	-.0041
	(.0019)	(.0019)	(.0041)	(.0050)
Δ FSI $_{t-1}$		-.0025		-.0072
		(.0019)		(.0059)
Δ FSI $_{t-2}$		-.0031		-.0119**
		(.0023)		(.0049)
Δ FSI $_{t-3}$		.0011		-.0055
		(.0021)		(.0045)
Δ FSI $_{t-4}$		-.0062***		-.0115***
		(.0023)		(.0041)
Δ GDP (log)	1.1038*	1.1711*	.8190	.4512
	(.5608)	(.6108)	(.7788)	(.7754)
Δ Relpm	.4982	.3750	1.2882**	1.3019**
	(.2808)	(.3190)	(.6232)	(.5506)
Crisis (dummy)	-.0018	.0008	-.0440*	-.0058
	(.0095)	(.0083)	(.0223)	(.0313)
Constant	-.0090	-.0018	.0119	.0090
	(.0070)	(.0043)	(.0102)	(.0103)
n	47	44	47	44
R-squared	0.5917	0.7104	0.3142	0.5492
Adj. R-squared	0.5419	0.6338	0.2305	0.4299

* significant at the 0.10 level

** significant at the 0.05 level

*** significant at the 0.01 level

However, this result could also be due to differences in the construction in the indicator. To control for differences in construction, several checks are performed. The results of these checks presented in Table 15 and are compared to the results presented in Table 14. The first test is the removal of the inverted spread in the indicator of the U.S. This has a large effect on the estimator for the significant lagged effect of the financial stress indicator: it is reduced from -0.0062 to -0.0039. Thus, the difference

between Brazil and U.S. becomes even larger by excluding this component, and underlines prior conclusion.

The second test is the addition of the volatility in the exchange rate in the indicator of the U.S. that was removed for reasons described in Section 3. This leads to an increase of roughly 10 percent in the absolute value of the coefficient of the fourth lagged difference of the index. This implies that the identical coefficient in Table 12 may have been underestimated. More interestingly, it also suggests that exchange rate volatility does have a negative effect on trade. This is in contrast to the conclusion made by Anderson and Van Wincoop (2004), at least for the U.S. However, the large difference between Brazil and the U.S. still remains.

The third check is the exclusion of volatility in the exchange rate of the indicator of Brazil (model 3). The result is that the second and fourth lags are no longer significant. This is mainly due to the reduced coefficient, since these have decreased more than the standard errors have increased. This could also explain why the effect was also significant in the second rather than just in the fourth lag: uncertainty about the exchange rate may lead to a direct increase of the costs for importers and consumers, which leads to a decrease in imports. The much larger estimated effect of financial stress for Brazil compared to the U.S. thus heavily depends on the volatility of the exchange rate. However, volatility in the exchange rate seems to refer to increased costs for importers rather than reduced credit availability from banks. This would suggest an opposite conclusion to the one based on Table 14: the effect of reduced availability of trade-related finance is larger for the U.S. than for Brazil. Caution is warranted here though. Volatility in the exchange rate may also affect credit supply, since a depreciation of the domestic currency puts pressure on foreign debts.

In order to check whether these results depend to large extent to the sub-prime mortgage crisis, which also is not included in the analysis in Section 5.1 and 5.2, the last check excludes observations after the fourth quarter of 2007. This has not a large effect on the estimators: the estimator for the fourth lagged change in the indicator is -0.0052, compared to -0.0062 for the U.S., and still significant at the 0.05 level. For Brazil, the estimated effect of the second lagged difference in the indicator is -0.011, compared to -0.012, but is only significant at the 0.10 level. The effect of the fourth lag remains almost equal (-0.011 versus -0.012). Thus, the results found in Table 15 do not totally depend on the inclusion of data during the sub-prime mortgage crisis. The exclusion does however a large effect on the performance of the model for the U.S.: the R-squared reduces from 0.71 to .45 for the U.S. For Brazil this fall is much smaller

(from 0.55 to 0.50). The coefficients (and the standard errors) of the variables of interest remain however rather similar.

Table 15. Robustness checks for 'Ronci-regressions'.

Δ Imports $_t$ (log)	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*
Country	*U.S.*	*U.S.*	*Brazil*	*U.S.*	*Brazil*
Δ Imports $_t$ (log;	.5555***	.4678***	.1041	.4357**	-.0590
first lag)	(.1650)	(.1702)	(.1650)	(.1842)	(.1637)
Δ FSI $_t$	-.0001	.0005	.0004	-.0008	-.0052
	(.0017)	(.0017)	(.0056)	(.0024)	(.0058)
Δ FSI $_{t-1}$	-.0001	-.0024	-.0060	.0010	-.0059
	.0019869	(.0016)	(.0065)	(.0021)	(.0070)
Δ FSI $_{t-2}$	-.0004	-.0022	.0013	-.0025	-.0106*
	(.0019)	(.0019)	(.0042)	(.0022)	(.0054)
Δ FSI $_{t-3}$	.0020	.0008	.0000	.0009	-.0044
	(.0022)	(.0019)	(.0049)	(.0021)	(.0048)
Δ FSI $_{t-4}$	-.0039**	-.0068***	-.0051	-.0052**	-.0113**
	(.0017)	(.0022)	(.0044)	(.0024)	(.0045)
Δ GDP $_t$ (log)	1.136785**	1.4056**	1.5885*	1.1711	1.0719
	(.6948)	(.7023)	(.8328)	(.6108)	(.8723)
Δ Relpm $_t$	.28034	.1918	.7944	.1814	1.4362
	(.3318)	(.3199)	(.6256)	(.5048)	(.7486)
Crisis $_t$ (dummy)	-.0015	-.0011	-.0221	-.0018	-.0201
	(.0096)	(.0097)	(.0285)	(.0083)	(.0390)
Constant	-.0028	-.0024	.0022	.0008	.0062
	(.0046)	(.0043)	(.0101)	(.0050)	(.0118)
n	44	44	43	39	39
R-squared	0.7233	0.7271	0.4896	0.4466	0.5003
Adj. R-squared	0.6479	0.6549	0.3504	0.2749	0.3453

* significant at the 0.10 level

** significant at the 0.05 level

*** significant at the 0.01 level

In conclusion, these results suggest that the effect of restrained credit supply is larger for industrialized countries than for emerging markets. This is based on the argument that the effect of exchange rate volatility refers to importer and consumer costs rather than the supply of credit. A possible explanation could be that firms in emerging markets may be less dependent on external finance. Previous research has shown that, as their financial system develops, countries tend to specialize in industries that rely more on external finance (Svaleryd & Vlachos, 2005; Beck, 2002). It can be argued that if firms in industrialized countries depend more on external finance, they may get hurt more in times of credit crunch. However, these results are very thin. Again, it is based on the argument that exchange rate volatility refers to costs of imports rather than the supply of credit. Furthermore, it is based on a two-country sample, using a 12 year time frame. Further research may be interesting to (dis)confirm this proposition.

Since it is argued in section 2 that the model as proposed by Ronci (2004) does not include all relevant variables for a ten-year time frame, the question remains how these results are influenced by using an underspecified model. Comparing the results presented in Table 14 with those found in Table 12, one can conclude that the model by Ronci (2004) overestimates the effect of credit supply - at least for the U.S.: the estimated effect of the financial stress indicator in the Ronci model is larger than that based on the model as specified in Section 4 (β=-.006 versus β=-.004). This underlines the notion of Thomas (2009) who – based on a different model – also suggested that Ronci (2004) overestimated the effect of external finance on trade.

6. Conclusion

This paper started with the spectacular fall in world trade in 2008:4 that could not be explained by a fall in demand only. Could this fall be better explained when the reduction in the supply of credit was included? The answer seems to be yes. For the U.S., imports fell by an annualized 18 percent in the fourth quarter of 2008. Using only the change in GDP, one would have expected a fall of only 6 percent, ceteris paribus. If one accounts for changes in credit supply, a fall of 12 percent would have been expected.[25] Thus, it seems that credit supply do matter in enabling trade.

This paper studied the effect of credit supply on trade. In doing so, an error correction model was used to estimate short-run deviations from the long-run growth rate of trade. In this model, innovations in credit supply made for short-run deviations, while income, trade policy, technological development and vertical specialization made for the long-run growth rate of trade. Credit supply was measured by the Loan Officer Opinion Survey, regarding the changes in credit standards. Income was measured by GDP, while the non-weighted tariff rate was used to proxy trade policy. Furthermore, technological development is proxied by the use of an instrument provided by the OECD, which captures the implementation of ICT. In order to measure the level of vertical specialization, the instrument proposed by Hummels et al. (2001) is used. Based on a 14 year sample, results showed that constraints in credit

[25] Using changes in tightened credit standards as proxy for credit supply, with estimators as obtained in Table 6 (model 4).

supply negatively affect imports, with a lag of two to four quarters. This result is robust for several specifications of the error correction term.

Some limitations should be noted. First, these results are based on the U.S. As the goal of the study was to investigate whether the effect of credit supply to trade could be found for industrialized countries, this is clearly a limitation. Moreover, the proxy of credit supply is no hard data, but a survey. This comes with several limitations, one of them being that the intensity of a contraction is not measured, only the percentage of respondents that reported that credit was constrained. However, this problem is somewhat reduced by the fact that this percentage did not represent a dummy variable, but had a range of [-100, 100]. Moreover, this credit supply refers only to banks' credit supply. The supply of other forms of external finance, such as export credit insurance and interfirm credit, is likely to have an effect as well on trade. As these may move together with banks' credit supply, the effect of the latter is likely to be overestimated. Therefore, results should be interpreted with caution with regard to changes in banks' credit standards. However, this overestimation of the effect of bank credit supply does not mean that the effect is not there at all: credit supply – in all its forms – affects trade. Furthermore, estimation of vertical specialization was problematic. Following previous research, this was done based on OECD input-output tables. However, these were available for every five years only. Given that the study used quarterly data, this required intrapolation.

Although the main analysis was to investigate whether credit supply has an effect on trade, there were some additional interesting findings as well. This paper provides support for the proposition that the effect of constraints in credit on trade works through inventory adjustments. The reasoning is that as credit becomes less available, firms reduce their inventory levels in order to reduce their working capital, which is typically financed by banks. This implies that the large fall in trade as observed in the sub-prime mortgage crisis may be the partly due to inventory deterioration, invoked by constraint credit. Further research on this issue may be interesting, as this paper provides only a glance on this issue.

This paper also made an attempt to compare the effects of stress on the financial markets for industrialized and emerging markets. Findings suggested that this effect is larger for the industrialized countries. This is based on the assumption that volatility in the exchange rate reflects increased costs of goods and services for importers and consumers, rather than the supply of credit. The result could be explained by taking into account that industrialized countries are more active in external finance-

intensive sectors, and therefore shocks in the availability of external finance could have a stronger impact on trade. Further research on this issue would be interesting, using more countries and a consistent measure for the availability of credit.

So, based on these results, what can be expected to happen to world trade after its recent collapse? If we are to believe the Senior Loan Officer Opinion Survey, credit standards have been easing since the first quarter of 2009. Given the lagged effect of changes in credit standards, one would expect that the depressing effect of previous tightening ends in the third quarter of 2009. Thus, it seems that its recovery is quite swift. However, an interesting question would be what will happen to world trade in the long run, say over the next few decades. What implications the sub-prime mortgage had on the long-run growth rate would be an interesting issue for further research. As governments have increased their debts to save banks, consumer spending in industrialized countries seems to be impaired. However, to what extent could it be affected? Furthermore, how is technological development affected by seemingly increased volatility in credit supply? Also, would it be valuable to slice the value chain further, or are we at a point of saturation? As a large body of research has focused on why trade *has* grown over the past few decades, answering these questions should shine some light on how trade will grow in the next few decades.

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References

Anderson, J. and Marcouiller, D. (2002). Insecurity and the Pattern of Trade: an Empirical Investigation. *Review of Economics and Statistics*, 84, 342 – 52.

Anderson, J.E. and Van Wincoop, E. (2004) Trade costs. *Journal of Economic Literature*, 42, 691 – 751.

Antonucci, D. (2009). European Economics Update: Trade Finance – still costly and hard to get. *Capital Economics*, June 4th 2009.

Auboin, M., and Meier-Ewert, M. (2003). Improving the availability of Trade Finance during Financial Crises. *World Trade Organisation Discussion Papers No. 2.*

Baier, S.L. and Bergstrand, J.H. (2001). The Growth of World Trade: Tariffs, Transport Costs, and Income Similarity. *Journal of International Economics*, 53, 1 – 27.

Balakrishnan, R., Danninger, S., Elekdag, S. and Tytell, I. (2009). The Transmission of Financial Stress from Advanced to Emerging Economies. *IMF Working Paper, WP/09/133*.

Beck, T. (2002). Financial Development and International Trade: Is There a Link? *Journal of International Economics*, 57, 107 – 31.

Blinder, A.S. and Maccini, L.J. (1991). Taking Stock: a Critical Assessment of Recent Research on Inventories. *Journal of Economic Perspectives*, 5, 73 – 96.

Breitung, J. (2001). Rank Test for Nonlinear Cointegration. *Journal of Business and Economic Statistics,* 19, 331 – 340.

Cardarelli, R., Elekdag, S., and Lall,S. (2009). Financial Stress, Downturns and Recoveries. *International Monetary Fund working paper* 09/100. May 2009.

Egger, P. and, Url, T. (2006). Public Export Credit Guarantees and Foreign Trade: Evidence from Austria. *The World Economy*, 29, 199 – 214.

Feenstra, R.C. (1998). Integration of Trade and Disintegration of Production in the Global Economy. *Journal of Economic Perspectives*, 12, 31 – 50.

Findlay,R. and O'Rourke, K.(2008) *Power and Plenty: Trade, War, and the World Economy in the Second Millennium*. Princeton: Princeton University Press.

Fisman, R. and Love, I. (2003). Trade credit, financial intermediary development, and industry growth, Journal of Finance 58, 353 – 374.

Funatsu, H. (1986). Export Credit Insurance. *The Journal of Risk and Insurance*, 53, 679 – 92.

Gertler, M. and Gilchrist, S. (1994). Monetary Policy, Business Cycles, and the Behaviour of Small Manufacturing Firms. *The Quarterly Journal of Economics*, 109, 309 – 340.

Guariglia, A. (1999). The Effects of Financial Constraints on Inventory Investment: Evidence from a Panel of UK Firms. *Economica*, 66, 43 – 62.

Greene, W.H. (2008) *Econometric Analysis*, 6th edition. New Jersey: Pearson Education, Inc.

Hummels, D., Ishii, J. and Yi,K. (2001). The Nature and Growth of Vertical Specialization in World Trade. *Journal of International Economics*, 54, 75 – 96.

Huang, W. (2007) *Institutional Banking for Emerging Markets: Principles and Practice*. Chichester: Wiley and Sons.

Hur, J., Raj, M., Riyanto, Y. (2006). The Impact of Financial Development and Asset Tangibility on Export. *World Development*, 34, 1728 – 41.

Illing, M. and Liu, Y. (2006). Measuring Financial Stress in a Developed Country: An Application to Canada. *Journal of Financial Stability*, 2, 243 – 65.

King, R.G. and Levine, R. (1993a). Finance and Growth: Schumpeter Might Be Right. *Quarterly Journal of Economics*, 108, 717 – 737.

Kletzer, K. and Bardhan, P. (1987). Credit Markets and Patterns of International Trade. *Journal of Development Economics*, 27, 57 – 70.

Krugman, P.R. (1995). Growing World Trade: Causes and Consequences. *Brooking Papers on Economic Activity*, 1, 327 – 77.

Krugman, P.R. and Obstfeld, M. (2006). *International Economics: Theory and Policy*. Boston: Pearson Education.

Lall, S., Cardarelli, R. And Elekdag, S. (2008). Fiancial stress and economic downturns. *In World Economic Outlook, October 2008, IMF.*

Liu, W. and Duval, Y. (2009). Trade Finance in times of crises and beyond. *Asia-Pacific Research and Training Network Alerts*, Issue 3, April.

Love, I., Preve, L.A., and Sarria-Allende, V. (2007). Trade Credit and Bank Credit: Evidence from recent fiancial crisis. *Journal of Financial Economics*, 83, 453 – 69.

Lovell, M. (1961). Manufactureers' Inventories, Sales Expectations, and the Acceleration Principle. *Ecnometrica*, 29, 293 – 314.

Lown, C. and Morgan, D.P. The Credit Cycle and the Business Cycle: New Findings Using the Loan Officer Opinion Survey. *Journal of Money, Credit, and Banking*, 38, 1575 – 97.

Mah, J.S. (2006). The Effect of Export Insurance Subsidy on Export Supply: The Experience of Japan. *Journal of Asian Economics*, 17, 646 – 652.

Manova, K. (2008). Credit Constraints, Equity Market Liberalizations and International Trade. *Journal of International Economics*, 76, 33 – 47.

Meon, P. and Sekkat, K. (2004). Does the Quality of Institutions Limit the MENA's Integration in the World Economy? *The World Economy*, 27, 1475 – 98.

Moser, C., Nestmann, T., and Wedow, M. (2008). Political Risk and Export Promotion: Evidence from Germany. *The World Economy*, 31, 781 – 803.

Nilsen, J.H. (2002). Trade Credit and the Bank Lending Channel. *Journal of Money, Credit and Banking*, 34, 226 – 53.

Ng, C.K., Smith, J.K., and Smith, R.L. (1999). Evidence on the Determinants of Credit Terms Used in Interfirm trade. *The Journal of Finance*, 54, 1109 – 29.

OECD Economic Outlook, interim report. March 2009. General Assessment of the Macroeconomics Situation.

Paul, S. and Boden, R. (2008). The secret life of UK trade credit supply: Setting a new research agenda. *The Accounting Review*, 40, 272 – 281.

Petersen, M.A., and Rajan, R.G. (1997). Trade Credit: Theories and evidence. *The review of financial studies*, 10, 661 – 91.

Rajan, R.G. and Zingales, L. (1998). Financial Dependence and Growth. *American Economic Review*, 88, 559 – 86.

Reinhart, C.M. and Rogoff, K.S. (2009). The Aftermath of Financial Crises. *American Economic Review*, 99, 466 – 472.

Ronci, M. (2004). Trade Finance and Trade Flows: Panel Data Evidence from 10 Crises. *IMF Working paper, WP/04/225*.

Svaleryd, H. and Vlachos, J. (2005). Financial Markets, the Pattern of Industrial Specialization and Comparative Advantage: Evidence from OECD Countries. *European Economic Review*, 49, 113 – 44.

Summers, L.H. (2000). International Financial Crises: Causes, Prevention and Cures. *The American Economics Review*, 90 (2), 1 – 16.

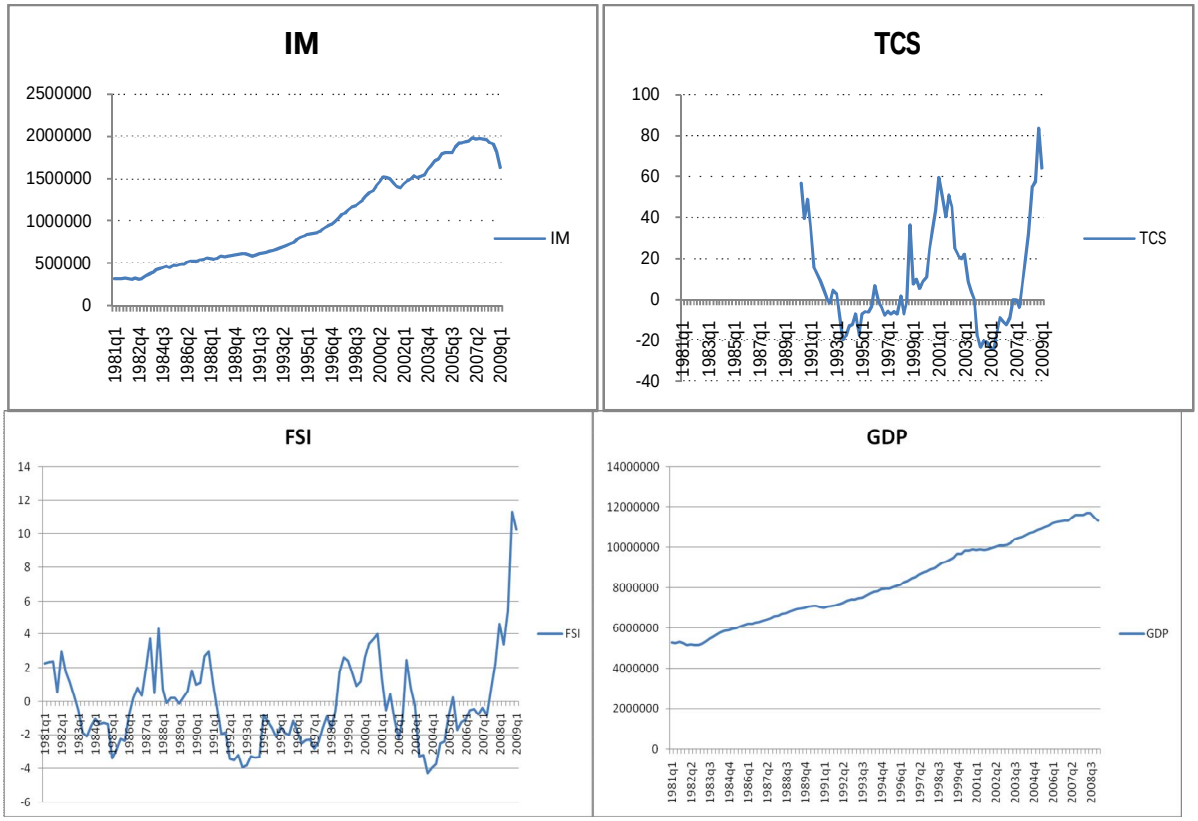
Thomas, A. (2009). Financial Crises and Emerging Market Trade. *IMF working paper, SPN/09/04.*

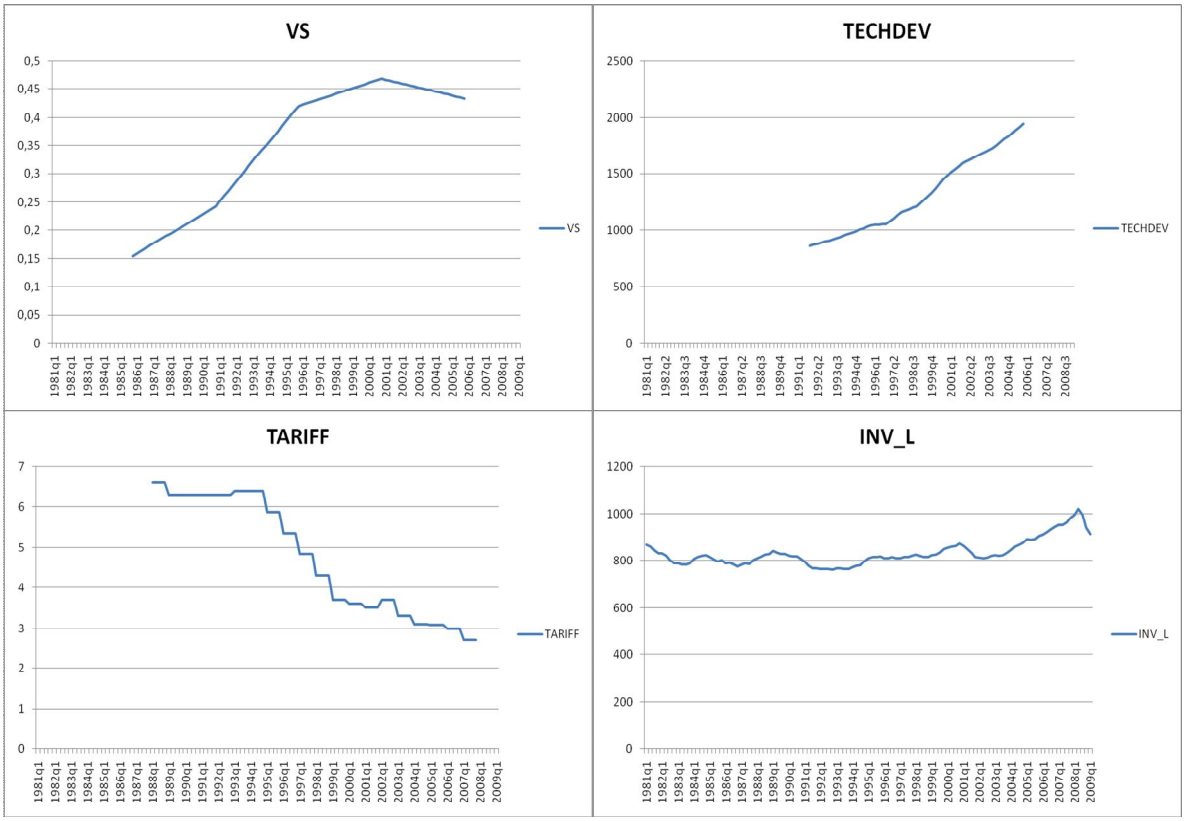
Wilner, B. (2000). The Exploration of Relationships in Financial Distress: The Case of Trade Credit. *Journal of Finance*, 55, 153 – 78.

Wooldridge, J.M. (2006). *Introductory Econometrics: A modern approach*, 4th edition. New York: Southwestern Publishers.

Yi, K. (2003). Can Vertical Specialization Explain the Growth of World Trade? *The Journal of Political Economy*, 111, 52 – 102.

Appendix A: Plots of recurring variables.





Appendix B: 2SLS, first stage

C.i.f./f.o.b. $_t$	*(1)*
Trade balance $_t$	-.2525***
	(.0168)
Constant	.1078***
	(.0014)
n	113
R-squared	0.6693
Adj. R-squared	0.6664

* significant at the 0.10 level

** significant at the 0.05 level

*** significant at the 0.01 level

Appendix C: Shifts in demand and supply for credit.

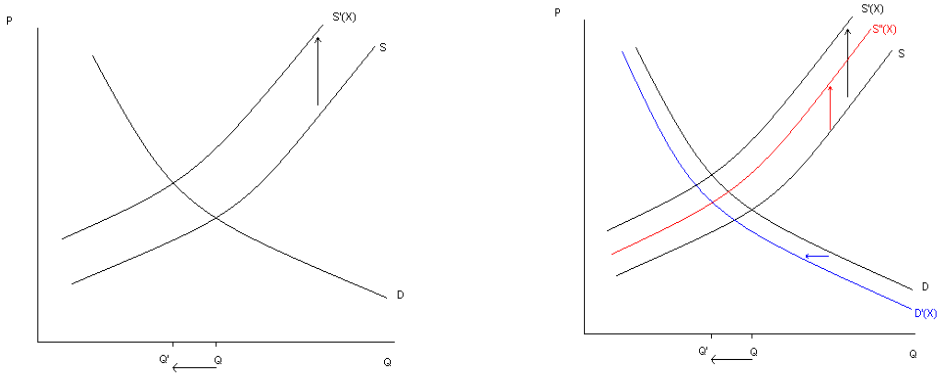
In an attempt to reason how changes in demand occur, based on these results, an illustration will be made. Let's start with a text-book supply-demand graph for credit with prices on the vertical and quantities on the horizontal axis as presented in Figure 4. Assume that the market is in equilibrium. Assume that by the induction of some factor (X), banks reduce their credit for any given price. In other words, supply shifts upward from S to S'. What happens to demand with respect to the induction of X?[26] There are three possibilities: (1) it does not shift, it only moves along the curve, towards the higher equilibrium price; (2) it increases for any given price, e.g. because the expected revenues will be lower, so the demand curve shifts to the right; (3) it reduces for any given price, e.g. less investment given gloomier prospects due to the occurrence of X, so the demand curve shifts to the left.

Whatever happens to demand, we only observe a change in quantity from Q to Q'. This change in Q would represent the change in supply if demand would not shift at all. In that case, the aggregated amount of provided credit would be an adequate instrument for credit supply. The key notion is that if we would be able to observe the actual shift in supply, and compare it to the observation in which both supply and demand shifts occur, then we would be able to say something about the shift in demand.

An important assumption is to be made: suppose that the change in credit standards adequately proxies shifts in credit supply, so there is no distortion of demand effects. In that case, we have observed the effect of supply shifts to trade, namely in Table 6. This effect is significant. In Table 12, the result of distortion of supply by demand effects can be observed. Although the coefficients are not equal to zero, they are not positively significant either. Thus, based on these results, we cannot conclude that they are different from zero. This implies that using an instrument in which supply and demand effects occur, one would underestimate the effect of credit supply.

[26] An 'occurrence of X' may for example be low performance of many bank loans: in reaction to this, banks restrain their credit supply, while firms may observe this stress in financial markets as a prelude of a recession, since a financial crisis is likely to be followed by a recession (Reinhart & Rogoff, 2008).

Figure 4. Estimation of change in supply of credit.



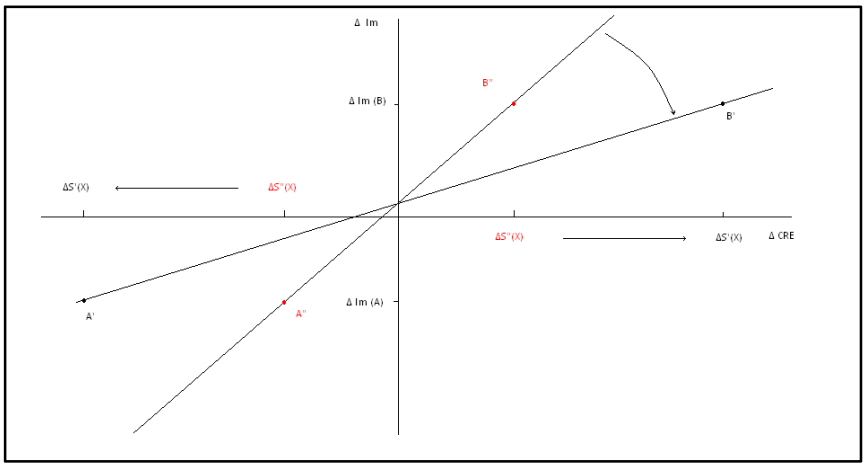
So how does this help to identify the underlying shift in demand? Two steps need to be made. First, let's go back to the textbook graph of demand and supply. Note that, in Table 12, the change in Q in the supply-demand graph is our estimate for the change in supply. If demand does not shift, this would be a valid instrument for credit supply. If it does, it is not. Let's assume that by induction of X, demand reduces for any given price. In other words, demand shifts to the left. In that case, Q does not only decrease because supply shifted upward, but also because demand shifted to the left. In that case, the change of Q overestimates the change in supply if you would assume that demand does not change ($\Delta S'(X) > \Delta S''(X)$).

The intuition here is that by comparing the results using an instrument which only captures changes in credit supply with the results using an instrument that captures *both* changes in supply and demand, one could find out what how demand changes. In other words, by comparing the results presented in Table 6 and 12, one could find out what happens to demand for credit.

From Table 6, we obtain that this coefficient should be significantly positive. However, Table 12 tells us that this coefficient is not different from zero. Thus, one can conclude that demand does not remain constant but actually changes. The result that the estimators in Table 12 are not positively significant implies that changes in credit supply are overestimated. This is shown in Figure 5. Relating to Figure 4, instead of estimating the change in credit correctly as $\Delta S''(X)$, it is estimated to be $\Delta S'(X)$. This works in both ways. As one can see, overestimation of the change in credit supply results in underestimation of the effect of credit supply as the line that describes the relationship between imports and credit supply flattens. Assuming that the difference between the two instruments of credit supply is the distortion of

changes in demand, one can conclude that in occurrence of X not only supply of but also demand for credit contracts.

Figure 5. Estimation of the effect of a change in credit supply.



However, this analysis is based on three important assumptions. First, the change in credit standards is assumed to estimate shifts in credit supply. If this instrument overestimates the change in credit supply, this could have lead to the wrong conclusion. Second, the estimator of the aggregate observed credit is assumed to be zero. In occurrence of a Type II error, the conclusion could be different. In that case, one should standardize the instruments before drawing conclusions, since the two have different distributions. Since the estimator of CRE is not significantly different from zero, there is reason to believe that there is no effect, which made standardization not necessary. Furthermore, the market for credit is assumed to be in equilibrium in each quarter. Nonetheless, *based on these results and assumptions*, it can be concluded that demand shifts in same direction as supply. Further research may be interesting to (dis)confirm this finding.