

IMF Working Paper

Connected to Whom? International Interbank Borrowing During the Global Crisis

Kalin Tintchev

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Monetary and Capital Markets Department

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Prepared by Kalin Tintchev¹

Authorized for distribution by Dimitri G. Demekas

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Abstract

The unprecedented collapse of international interbank borrowing was a prominent feature of the global financial crisis that started in August 2007. This paper focuses on the drivers of the retrenchment from 32 advanced and emerging banking systems. Using novel risk-weighted indexes the paper examines whether the banking systems' access to credit was related to their domestic financial soundness and exposure to distressed international counterparties. The empirical findings suggest that both domestic and international risk factors contributed to the decline in international interbank borrowing during the crisis.

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Author's E-Mail Address: ktintchev@imf.org

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I. INTRODUCTION

The global financial crisis led to an unprecedented collapse of international interbank borrowing. The interbank turbulence that started in August 2007 was the early sign of an impending meltdown. The interbank strains intensified during the Bear Stearns debacle in March 2008, the Lehman demise in September 2008, and the sovereign debt crisis of 2010. In late 2008 the turmoil grew into a global market collapse that affected key financial centers and required concerted policy actions. Overall, interbank strains were particularly acute in Europe, where the market recovery stalled in 2010 amid escalating sovereign debt problems.

This paper examines two channels that may have affected banking systems' access to international credit. The first channel operates through the financial soundness of creditors, which impacts their ability to supply credit. The second channel operates through the financial soundness of borrowers, which affects creditors' willingness to lend.

The two channels are examined in the context of their contribution to cross-border counterparty risk during the crisis. The paper proposes an integrated approach to investigate the effects of counterparty risk on international borrowing. The approach is based on novel risk-weighted indexes that capture borrowers' and creditors' risk characteristics. Panel regression analysis isolates and compares the counterparty risk effects in advanced and emerging banking systems over the September 2007-September 2011 period.

The findings suggest that banking systems' access to international credit was negatively affected by their domestic fragilities and exposure to distressed foreign counterparties. Banking systems that were more exposed to distressed foreign lenders and borrowers suffered a stronger pullback. International funding was also withdrawn from banking systems that operated in fragile macroeconomic environments.

The paper proceeds as follows. Section II briefly reviews relevant literature. Section III defines cross-border counterparty risk. Section IV discusses the empirical model. Section V describes the variables. Section VI discusses the data. Section VII documents stylized facts. Section VIII summarizes the empirical findings. Section IX concludes.

II. RELATED LITERATURE

The literature on the banking channel of shock transmission has found a relationship between global bank soundness and contagious financial crises. Kaminsky and Reinhart (2000) show that creditors may cut lending to other countries to offset their losses in a crisis-hit country. This "common creditor" effect affects banking systems that borrow from the same international creditor.

The "sudden stop" literature has attributed abrupt dry-ups of international funding to various features of the financial and macroeconomic environment. Edwards (2004) documents the

empirical link between sudden stops and current account reversals. Kaminsky (2008) shows that the risk of a sudden stop increases with the extent of financial integration. Calvo et al. (2008) point to the link between sudden stops and reliance on short-term bank borrowing.

Earlier research on the global retrenchment has examined factors related to: (i) emerging market dependence on common creditors; (ii) global risk aversion; (iii) foreign subsidiaries dependence on parent funding; and (iv) exposure to U.S. financial assets and liabilities. Several studies have found common creditor effects in emerging markets (e.g., McGuire and Tarashev, 2008; Kamil and Rai, 2009; Arvai et al., 2009; Cetorelli and Goldberg, 2010). De Haas and van Lelyveld (2011) provide micro-based evidence that foreign subsidiaries have become a source of instability during the crisis. Milesi-Ferretti and Tille (2011) show that the retrenchment has been related to creditors' rising risk aversion. While Rose and Spiegel (2009) find no evidence of crisis propagation through exposures to U.S. financial assets, Kamin and Pounder (2010) suggest a potential role for banks' dependence on U.S. dollar funding.

Earlier analysis of the global retrenchment has abstracted from the risk characteristics of international counterparties. This is an important omission since counterparty risks matter for the analysis of the lending patterns during the crisis. The paper attempts to fill this void by: (i) proposing a novel risk-based approach, which considers not only the size of the banking systems' international exposures but also the risk characteristics of their counterparties; (ii) broadening the analysis to examine simultaneous counterparty effects on the asset and liability sides of the balance sheet; (iii) comparing the effects in advanced and emerging banking systems; and (iv) using a comprehensive measure of international borrowing.

The risk-based approach has several advantages. First, adjusting banking systems' international exposures for counterparty risk allows for more meaningful cross-country comparisons. Second, the risk-based approach is able to capture changes in counterparty risk and expected losses. Since creditors would generally reduce their unadjusted exposure to a crisis-hit country, whereas their risk-adjusted exposure may increase, indicators that measure only the exposures' size may be misleading if they are not adjusted for counterparty risk. Finally, this approach enables the analysis of risks from multiple counterparties.

III. CROSS-BORDER COUNTERPARTY RISK

Counterparty risk increases with the extent of financial interconnectedness. The role of financial interconnectedness was a key feature of the global crisis (Claessens et al., 2010). The empirical analysis in the paper investigates the impact of counterparty risk on the dislocations in international interbank markets. Owing to data limitations, the analysis is based on a highly stylized cross-country approach. This section provides theoretical underpinnings.

By definition, counterparty risk is the risk to each party of a contract that the counterparty will not fulfil its contractual obligations. In a counterparty relationship, a creditor agrees to provide funds, whereas a borrower assumes the obligation to repay them. Hence, counterparty risk has

both credit and liquidity dimensions. On the one hand, borrowers face liquidity risk since creditors might default on their obligation to provide the agreed upon funds. On the other hand, creditors are confronted with credit risk since borrowers might default on the loan.

Creditors may cut lending either because of their own problems or because of borrower problems. A deterioration in borrower's creditworthiness implies increased credit risk for the lender and increased liquidity risk for the borrower. Thus, the paper analyzes credit risk from the perspective of its impact on borrowers' liquidity conditions.

The analysis distinguishes between direct and indirect counterparties. Direct counterparties participate in the same lending relationship. By contrast, in a network of lending relationships some parties may not have direct exposure to one another but still be linked indirectly, through their exposure to a common counterparty. Figure 1a shows a simple counterparty structure, in which banks from the United Kingdom (U.K.) lend to Ireland, Singapore and South Korea. In this example, the U.K. banks are a direct counterparty to all other banks. However, the other banks are indirectly exposed to one another through their borrowing from U.K. banks.

Indirect counterparty effects are typically associated with contagion since they impose a negative network externality on third parties that do not have direct linkages to the initial crisis. Such effects arise in incomplete networks with extensive linkages among some parties and limited linkages among others.²

Indirect common creditor effects play a role in contagious financial crises. Kaminsky and Reinhart (2000) identify borrowing clusters in Asia and Latin America that depend on Japanese and Spanish banks and show how dependence on the same creditor could trigger spillovers within the cluster. In the context of the global crisis, U.K. banks could pull back from other borrowers if there is a crisis in Ireland (Figure 1a).

This paper argues that similar indirect effects could arise in lending clusters. It is not uncommon for large borrowers to depend on several major creditors. For example, some European banking systems may have large exposures to Greek sovereign debt. Such systems may be more vulnerable to cross-border liquidity pressures if they are considered more risky by foreign creditors (Figure 1b).

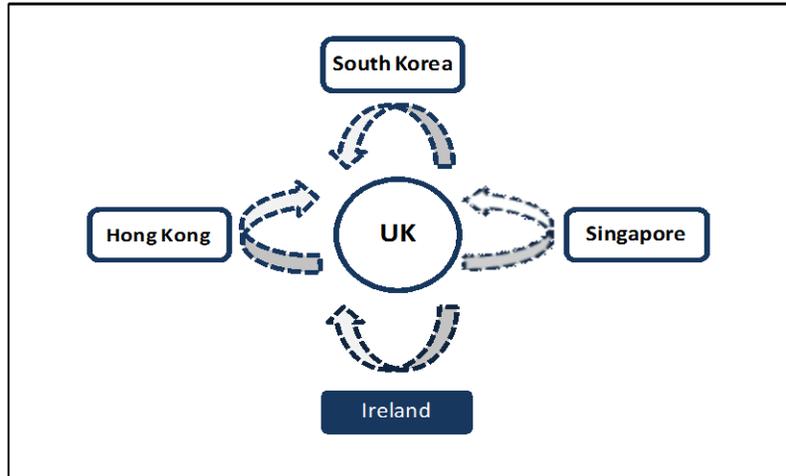
In this channel, banking systems with large holdings of distressed foreign debt would be more vulnerable to liquidity shocks. Uncertainty about the actual size of their exposures could further amplify the liquidity shocks. By analogy with the common creditor channel, this mechanism is denoted in the paper as a "common borrower" effect.

Since advanced banking systems play a dual role as lenders and borrowers in the interbank market, this could lead to mutually reinforcing creditor and borrower effects. Banking systems that are confronted both with credit losses and borrowing pressures would pull back more strongly than what would otherwise be required by their capitalization (Figure 2).

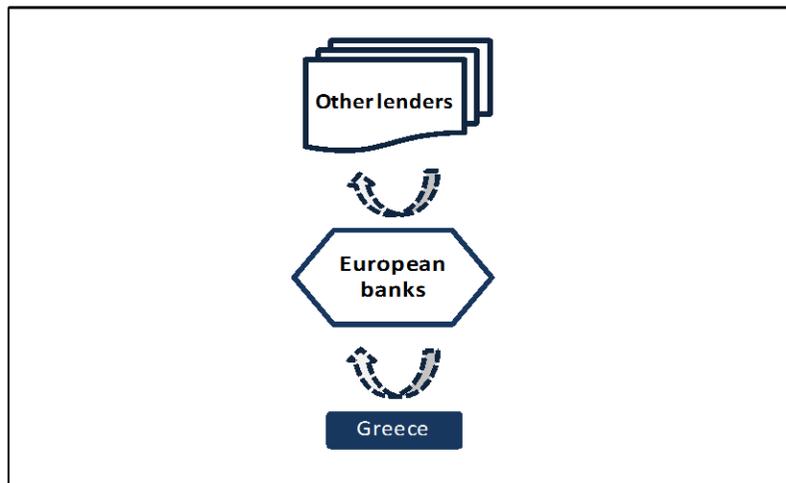
² For a discussion of complete and incomplete network structures see Allen and Gale (2000).

Figure 1. Common Creditor and Borrower Effects ^{1/}

(a) Common Creditor Effect

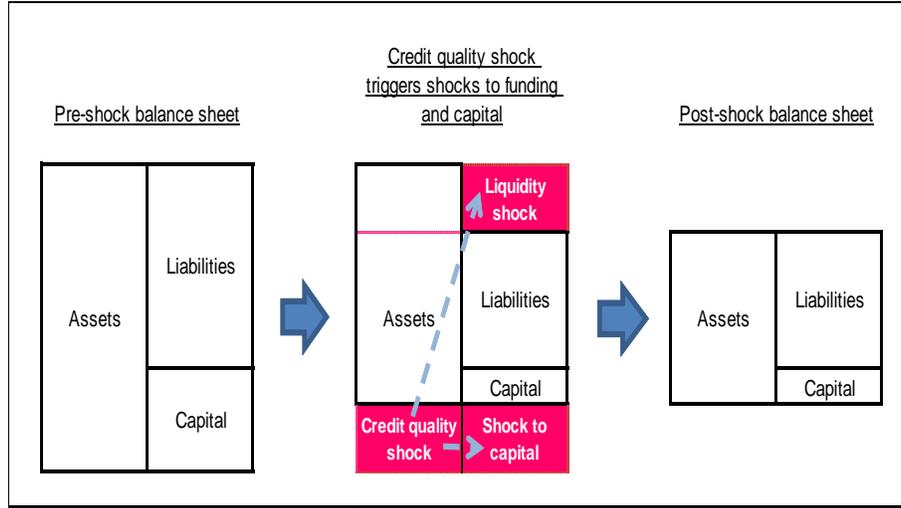


(b) Common Borrower Effect



^{1/}Trigger countries are in dark blue, dashed lines indicate funding withdrawals.

Figure 2. Balance Sheet Effects: Credit and Liquidity Shocks



IV. EMPIRICAL MODEL

The empirical analysis aims to isolate and compare the factors driving international interbank borrowing during the global crisis. The change in banking system J 's international borrowing at time t is modeled as a function of a set of borrower and creditor risk characteristics:

$$\Delta \text{Borrowing}_{j,t} = \alpha' \text{Borrower}_{j,t-1} + \beta' \text{Creditor}_{j,t-1} + \varepsilon_{j,t} \quad (1)$$

where $\text{Borrower}_{j,t-1}$ and $\text{Creditor}_{j,t-1}$ are vectors measuring the risk characteristics of banking system J and its creditors, respectively, and α and β are vectors with coefficients.

Borrower effects depend on the risk characteristics of borrowers' domestic and international lending and macroeconomic environment.

$$\text{Borrower}_{j,t} = \left[\text{Loss}_{j,t}^{BD}; \text{Loss}_{j,t}^{BI}; \text{Macro}_{j,t}^B \right] \quad (2)$$

where $\text{Borrower}_{j,t}$ is a vector measuring the risk entailed in lending to banking system J and $\text{Loss}_{j,t}^{BD}$, $\text{Loss}_{j,t}^{BI}$ and $\text{Macro}_{j,t}^B$ are indicators measuring banking system J 's expected losses on domestic and international lending and macroeconomic fragility.

An increase in borrower risk would reduce creditors' willingness to lend to the borrower. Creditors may respond to a decrease in the expected payoff on a loan by rationing credit (Stiglitz and Weiss, 1981) or charging a higher risk premium (Bernanke and Gertler, 1989).³

Similarly, creditor effects depend on the risk characteristics of creditors' domestic and international lending. Credit losses weaken creditors' capitalization and reduce their ability to supply credit. Therefore, borrowers that are exposed to distressed creditors would be vulnerable to cross-border liquidity shocks:

$$Creditor_{j,t} = \left[Loss_{j,t}^{CD} ; Loss_{j,t}^{CI} \right] \quad (3)$$

where $Creditor_{j,t}$ is a vector measuring banking system J 's risks from borrowing from creditors I through N , while $Loss_{j,t}^{CD}$, and $Loss_{j,t}^{CI}$ are indicators measuring banking system J 's international borrowing and creditors' expected losses on domestic and international lending.

V. THE VARIABLES

Cross-border counterparty risk is measured using novel risk-weighted indexes constructed from Bank for International Settlements (BIS) data on bilateral international credit and Moody's KMV banking system default probabilities. This section briefly discusses the variables using the counterparty risk terminology adopted in Section III.

A. Credit Risk Index

The credit risk index (CRE) measures the borrowing banking system's default risk:

$$CRE_{jt} = median(EDF_{Bank1}, EDF_{Bank2}, \dots, EDF_{BankN}) \quad (4)$$

where EDF_{Bankj} , $j=1, \dots, N$, are the default probabilities of the banks in the system, measured by Moody's KMV Expected Default Frequency (EDF).⁴

EDFs are empirical default probabilities derived by Moody's KMV from equity prices and accounting information. EDFs represent estimates of banks' economic solvency, which is a more reliable and timely default risk measure than book capital (see Sobehart and Stein, 2000).⁵

³ Following Furfine (2001) and Flannery and Sorescu (1996), the model assumes that there is no asymmetric information and creditors can reliably distinguish between sound and unsound banks.

⁴ The median EDF is provided by Moody's KMV as a measure of overall risk. Medians are commonly used to measure centrality of skewed distributions since unlike averages they are to a smaller degree influenced by outliers.

As a market-based indicator, EDFs incorporate the effects of domestic, international and macroeconomic risk factors. Ideally, to isolate these effects one needs different variables for each factor. While one can measure risks from international lending and the macro environment, explicit measures of “domestic credit risk” are not readily available. To deal with this measurement problem, some model specifications include both the international and macroeconomic risk variables, and the “composite” EDF measure, which captures “residual” domestic effects.⁶ Other specifications include only the EDF and the macro variables since data on international credit exposures are missing for many emerging markets.

B. Indirect Credit Risk Index

The indirect credit risk index gauges the risk characteristics of borrowers’ international lending. The index is derived by weighting the borrower’s bilateral credit exposures by the borrowers’ default probabilities and dividing the total by the borrower’s total credit. Indirect risk from lending to banking system J is given by:

$$INCRE_{j,t} = \sum_{i=1}^k w_{i,t} CRE_{i,t} \quad (5)$$

where $w_{i,t}$ denotes banking system J ’s credit to banking system I at time t , divided by banking system J ’s total credit, CRE_{ji} denotes banking system I ’s median EDF, and k is the number of banking systems that borrow from banking system J .

The index can be interpreted as the expected loss rate on international lending.⁷ The index is increasing in the size of the exposures and the default risk of the counterparties. It captures common borrower effects, since an increase in the default probability of a large borrower would lead to an increase in the expected losses of its major creditors.

⁵ Since EDFs are based on stock market data they reflect the collective judgment of a broad pool of market participants, which according to the efficient market hypothesis is based on all available information. However, due to noise in market data they may not always correctly reflect the intrinsic soundness of a particular institution.

⁶ The significance of the composite EDF variable in specifications that include also the international and macroeconomic risk factors validates this approach.

⁷ Assuming a loss given default of one, which is a reasonable assumption, if lending is unsecured. Due to noise in market data they may not always correctly reflect the intrinsic soundness of particular exposures.

C. Liquidity Risk Index

Since raising new equity is costly, undercapitalized banks would typically adjust by deleveraging, which impacts negatively the availability of interbank funds for borrowers.⁸ Deleveraging effects are measured with the liquidity risk index, in which the borrower's international liabilities are weighted by creditors' default probabilities and scaled by that borrower's total credit. Banking system J 's liquidity risk index (LIQ) is defined as:

$$LIQ_{j,t} = \sum_{i=1}^l v_{i,t} CRE_{i,t} \quad (6)$$

where $v_{i,t}$ denotes banking system J 's liabilities to banking system I at time t , divided by banking system J 's total credit, $CRE_{i,t}$ denotes banking system I 's 1-year median EDF, and l is the number of banking systems that lend to banking system J .

The index measures the borrower's expected decline in international funding attributable to creditor problems. The variable captures common creditor effects since an increase in creditors' default probabilities would push up the indexes of their major borrowers.

Similarly to the credit risk index, the liquidity risk index represents a composite of domestic and international factors. Ideally, to isolate the two effects, one needs different variables for each factor. While it is possible to measure the international aspects of liquidity risk, an explicit measure of "domestic liquidity risk" is not readily available. Therefore, the model was estimated in two alternative specifications that use the "composite" liquidity risk index and the indirect liquidity risk index, respectively.

D. Indirect Liquidity Risk Index

Increased credit risk may prompt creditors to pull back in anticipation of future losses. Such effects are captured by the indirect liquidity risk index, in which the borrower's international liabilities are weighted by creditors' expected losses on international exposures (indirect credit risk index) and scaled by that borrower's total credit. Hence, banking system J 's exposure to indirect liquidity risk ($INLIQ$) is defined as:

$$INLIQ_{j,t} = \sum_{i=1}^l v_{i,t} INCRE_{i,t} \quad (7)$$

⁸ See for example Meh (2011).

where $v_{i,t}$ denotes banking system J 's liabilities to banking system I at time t , divided by banking system J 's total credit, $INCRE_{i,t}$ is banking system I 's indirect cross-border credit risk index, and l is the number of banking systems that lend to banking system J .

The index captures indirect common creditor effects since an increase in creditors' expected losses would drive up the indexes of their major borrowers.

E. Macroeconomic Variables

The global crisis was associated not only with cross-border financial risks but also macroeconomic fragilities. First, at the height of the crisis in late 2008, the exchange rates against the U.S. dollar depreciated sharply. Second, the crisis had a negative impact on the countries' fiscal performance. Third, demand for international credit shrank during the economic slowdown. Therefore, variables measuring currency risk, fiscal performance and economic growth control for the impact of macroeconomic factors on international borrowing.

VI. DATA

The analysis utilizes data from the BIS Consolidated Banking Statistics. BIS banking statistics are available on locational and consolidated bases. The main difference lies in the treatment of foreign subsidiaries. In the consolidated data, international borrowing includes both cross-border borrowing and local borrowing in foreign currency from foreign subsidiaries. Intra-group lending is netted out and only the net exposure is included. Conversely, international borrowing in the locational data includes gross borrowing by foreign subsidiaries from parents but excludes local borrowing from foreign subsidiaries.

The consolidated statistics were selected as a primary source for the paper given their suitability for the analysis. First, they provide a more comprehensive measure of international borrowing, which includes both cross-border lending by the head office and local lending by foreign subsidiaries. This is important for the measurement of deleveraging effects at the group level, which affect lending through subsidiaries. Second, netting out intra-group claims helps assess the net exposure of the group. Third, bilateral credit needed for the counterparty risk indexes is not readily available from the locational statistics.

The consolidated statistics are compiled on immediate and ultimate borrower bases. The analysis utilizes data on immediate borrower basis, which measure borrowing by all resident banks, regardless of their ownership. For example, borrowing by the Polish subsidiary of a German bank would be classified as a claim on the Polish banking system. The use of immediate borrower basis is warranted by the following considerations. First, despite their foreign ownership, local subsidiaries are still more exposed to the host country environment, where their

loans and deposits are located. Hence, their access to credit would be to a large extent driven by the host country risk characteristics. Second, under this approach one can better control for country-specific macro conditions than under the ultimate risk approach.⁹

The analysis of cross-border risks faced data limitations. First, the data needed for the indirect credit risk index were available primarily for advanced banking systems.¹⁰ Second, the EDFs covered only about fifty percent of the Australian and Greek banks' portfolios.¹¹ Finally, the data include only on-balance sheet exposures.

It is worth noting that the credit and liquidity risk indexes have different composition, and thus, limited direct comparability. The liquidity indexes measure borrowing from 22 banking systems, whereas the indirect credit risk index represents lending to 57 banking systems. Since the two indexes are scaled by the same denominator, the indirect credit risk index would typically have higher values. Nevertheless, the slopes of the indexes could be used to compare the changes in credit and liquidity risk in a particular period.

VII. STYLIZED FACTS

This section documents the evolution of international interbank borrowing during the global crisis. The international interbank market is an informal market, where banks lend funds to one another (BIS Economic Paper 8). The amounts contracted are large, above one million dollars, and the maturities vary between overnight and six months, but sometimes exceed one year. The transactions are typically denominated in U.S. dollars and the market has substantial cross-border volume. Interbank flows are sensitive to counterparty risk since bank dealers differentiate between banks based on their creditworthiness, which is reflected in the credit limits granted to clients and the price of the on-lend funds.

International interbank borrowing grew steadily in the last several years prior to the crisis at an average rate of 20 percent (y-o-y) (Figure 3). At the onset of the crisis such borrowing accounted for about 50 percent of international bank liabilities in advanced economies but for less than one third of the liabilities of emerging markets. International claims on banks stood at 7.6 trillion U.S. dollars at end-June 2012, down from 12 trillion U.S. dollars in March 2008.

Notwithstanding this substantial variation, international interbank borrowing evolved through three distinct periods: an initial slowdown from September 2007 to September 2008; a global collapse from September 2008 to June 2010; and a recovery in emerging markets from June 2010

⁹ Data on ultimate risk (ownership) basis are also compiled by the BIS but for a somewhat smaller sample of countries and for a shorter time period. Under this approach, borrowing, for example, by the Polish subsidiary of a German bank would be classified as a claim on the German banking system.

¹⁰ Bilateral credit is available only for six emerging banking systems (Brazil, Chile, Mexico, Panama, Taiwan and Turkey). Panama and Taiwan were left out of the analysis because of missing EDF data.

¹¹ Coverage of other systems' portfolios was at least 80 percent.

to June 2011.¹² The initial period shows divergent patterns, with borrowing decelerating in advanced Europe, but advancing further in emerging markets and the United States up to the Bear Stearns debacle in March 2008. However, it wasn't until the Lehman failure in late-September 2008 that interbank borrowing contracted on a global scale. While lending to emerging markets recovered in 2010, lending to advanced Europe remained depressed.

Overall, advanced banking systems were hit harder by the retrenchment. Emerging markets showed resilience in the first and last periods, when international borrowing continued to grow, albeit at a slower pace. These findings suggest that there was a portfolio shift from advanced banking systems to emerging markets. The cumulative changes in international borrowing from December 2007 to September 2011 also indicate a slowdown in European banking systems and a rebound in emerging markets (Figure 4).

Similarly, Moody's EDF point to a relatively uniform increase in banking distress and a divergent recovery. EDFs remained low until 2008, when they increased sharply in countries reporting subprime losses (Figure 5). EDFs rose across the board in the wake of the Lehman collapse in late-September 2008, decreased in 2009 but increased sharply again in Europe during the sovereign debt crisis.

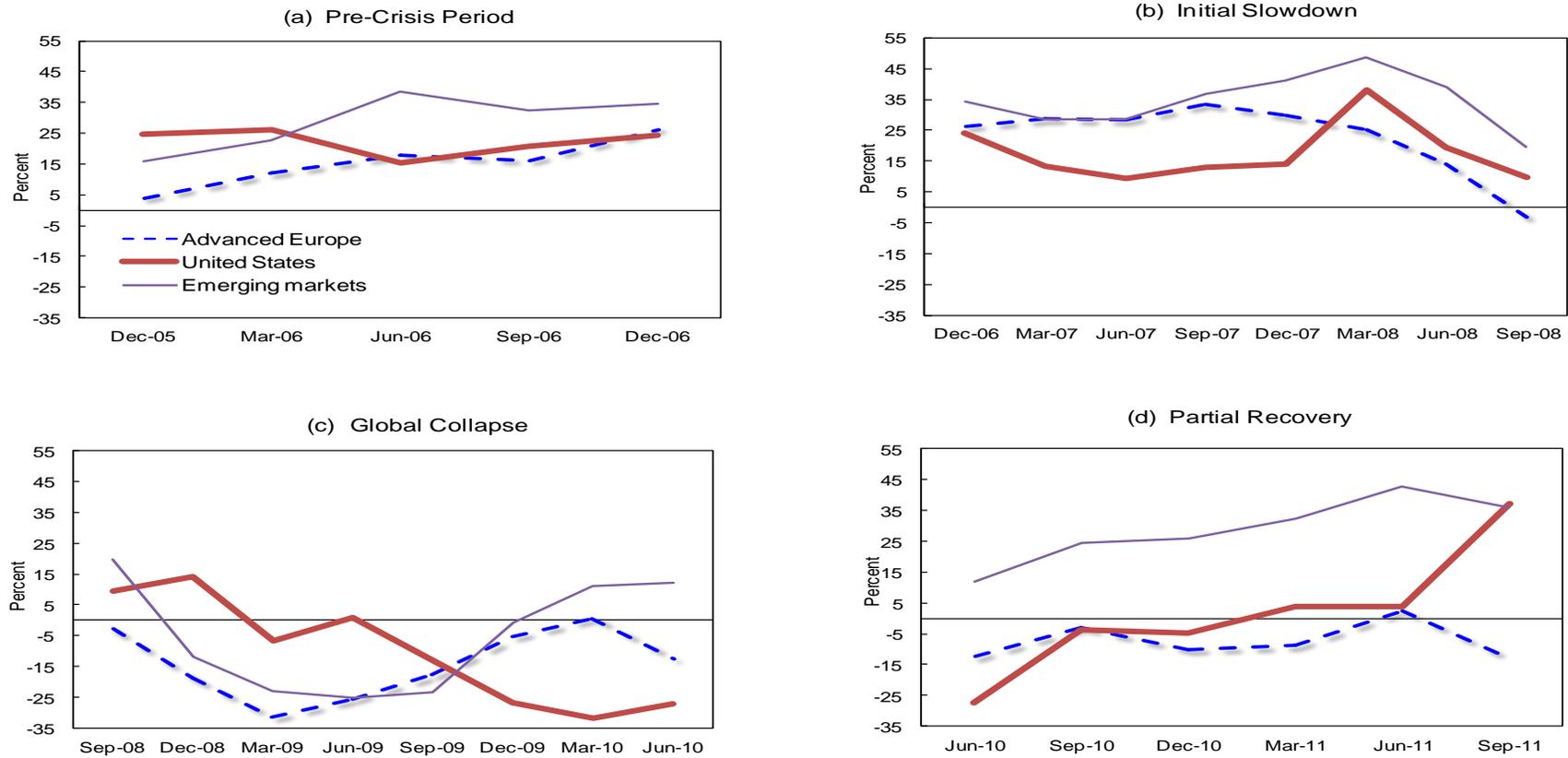
By and large, the decline in international borrowing appears related to banking systems' exposure to cross-border counterparty risks (Appendix II, Figure 6). While the pullback from Greece, Ireland, and Portugal seems largely driven by their own fragilities, indirect credit risk apparently matters for banking systems with extensive international lending (e.g., France, Sweden and Switzerland). Finally, spillovers from distressed creditors appear present in emerging markets and smaller European countries (e.g., Mexico, Singapore, and Poland).

VIII. EMPIRICAL FINDINGS

The formal analysis was conducted in two steps. In a first step, mean-comparison tests searched for heterogeneity in the dependent variable. The sample was divided in three subsamples covering advanced economies, advanced Europe, and emerging markets (Table 1). The tests compared the mean changes in international interbank borrowing in the top and bottom quartiles of each subsample, across the three subsamples, and between the September 2007–June 2010 and September 2010–September 2011 periods. The analysis found heterogeneity in each subsample, between the subsamples and between the two periods (Table 2). The results confirmed the visual evidence that lending to advanced and European banking systems was hit harder during the crisis.

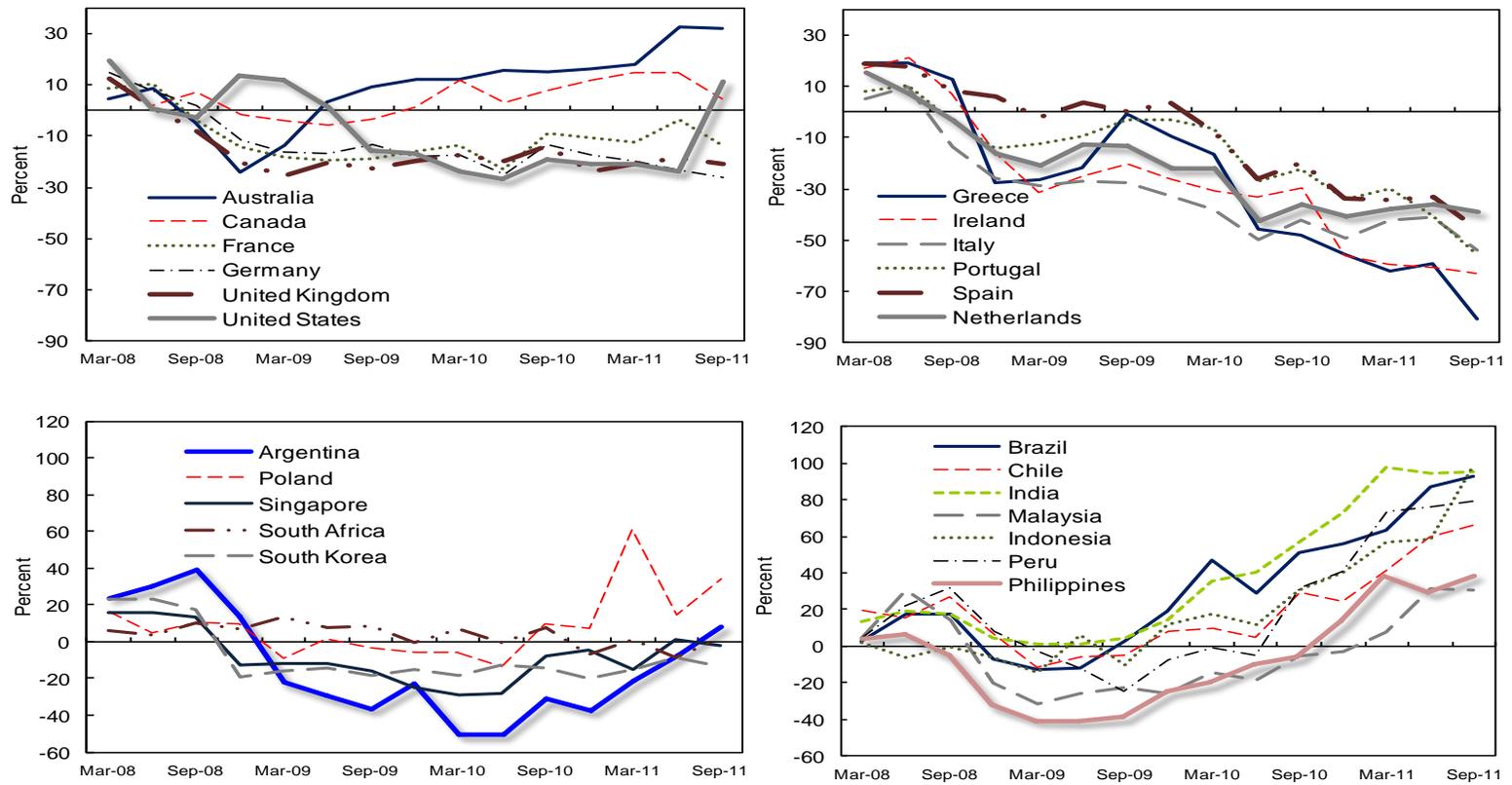
¹² Milesi-Ferretti and Tille (2011) document similar trends for total capital flows.

Figure 3. International Interbank Borrowing, December 2005–September 2011
(percent change, y-o-y)



Source: BIS consolidated banking statistics on immediate borrower basis.

Figure 4. Cumulative Change in International Interbank Borrowing, December 2007–September 2011
(cumulative change from December 2007)



Source: BIS consolidated banking statistics on immediate borrower basis.

In a second step, multivariate panel regression analysis was undertaken to disentangle the contributions of various risk factors. The empirical model has the following reduced-form specification:

$$\begin{aligned} \hat{Y}_{j,t} = & \beta_1 + \beta_2 CRE_{j,t} + \beta_3 INCRE_{j,t-1} + \beta_4 DLIQ_{j,t-1} + \beta_5 INLIQ_{j,t-1} \\ & + \beta_6 EXR_{j,t-1} + \beta_7 GDP_{j,t-1} + \beta_8 FIB_{j,t-1} + \beta_9 BREAK_{j,t} + \mu_i + \varepsilon_{j,t} \end{aligned} \quad (8)$$

where $\hat{Y}_{j,t}$ denotes the percent change (y-o-y) in banking system J 's international liabilities in quarter t ; $CRE_{j,t}$ is banking system J 's credit risk index (median 1-year EDF); $INCRE_{j,t-1}$, $LIQ_{j,t-1}$ and $INLIQ_{j,t-1}$ denote banking system J 's cross-border indirect credit risk index, liquidity risk index and indirect liquidity risk index; $EXR_{j,t-1}$ is the quarterly percent change in country J 's nominal exchange rate against the U.S. dollar, expressed as U.S. dollars per unit of domestic currency; $GDP_{j,t-1}$ is the percent change in country J 's quarterly real GDP (y-o-y); $FIB_{j,t-1}$ is the ratio of country J 's fiscal balance to GDP; $BREAK_{j,t-1}$ is a dummy for structural breaks; μ_i is a country fixed effect and $\varepsilon_{i,t}$ is a disturbance term. The regressors are expressed as percentages and generally enter with a lag of one quarter, which mitigates potential endogeneity issues.

The regression analysis compared the immediate crisis period (September 2007–June 2010) with the September 2010–September 2011 period.¹³ Owing to the small number of observations in the second period the model was fitted to the whole sample (September 2007– September 2011) and the two estimates were compared to search for differential effects.¹⁴ Tables 3-4 summarize the findings for the immediate crisis period and the extended period, respectively.

Estimates were produced for the full sample and the three subsamples of advanced, European and emerging banking systems.¹⁵ In the preferred specification, the credit risk index entered contemporaneously, while the other variables were included with a one quarter lag. Owing to collinearity issues, the two liquidity risk indexes were estimated separately in alternative specifications. For comparability, specifications one through eight omitted the indirect credit risk index since it was available only for advanced and European banking systems.

¹³ June 2010 was chosen as a cut-off point because interbank credit to emerging markets started to recover afterward, whereas sovereign debt problems emerged in the euro zone.

¹⁴ Large outliers were left out of the regression analysis. Israel, Mexico, Peru and Poland emerged as outliers in the first period, whereas Colombia, Israel, Peru, and Venezuela are outliers in the second period. Japan is an outlier among advanced banking systems because of large positive interbank credit inflows at the height of the crisis, possibly related to a reversal of the yen carry trades. The overall findings are not sensitive to these outliers.

¹⁵ The groups of advanced and European banking systems overlap substantially.

On the creditor side, the formal analysis shows that cross-border deleveraging effects have a considerable impact on interbank borrowing. Banking systems that are dependent on distressed foreign creditors suffer a reduction in international borrowing. This effect, which is consistent with a common creditor channel, is statistically and economically significant.

The size of the common creditor effect varied through the crisis and was three times bigger during the immediate crisis period, when a one percentage point increase in the liquidity risk index led to an average 29 percent reduction (y-o-y) in interbank borrowing.¹⁶ The effect is statistically significant in advanced and European banking systems in both periods and in emerging banking systems in the immediate crisis period.

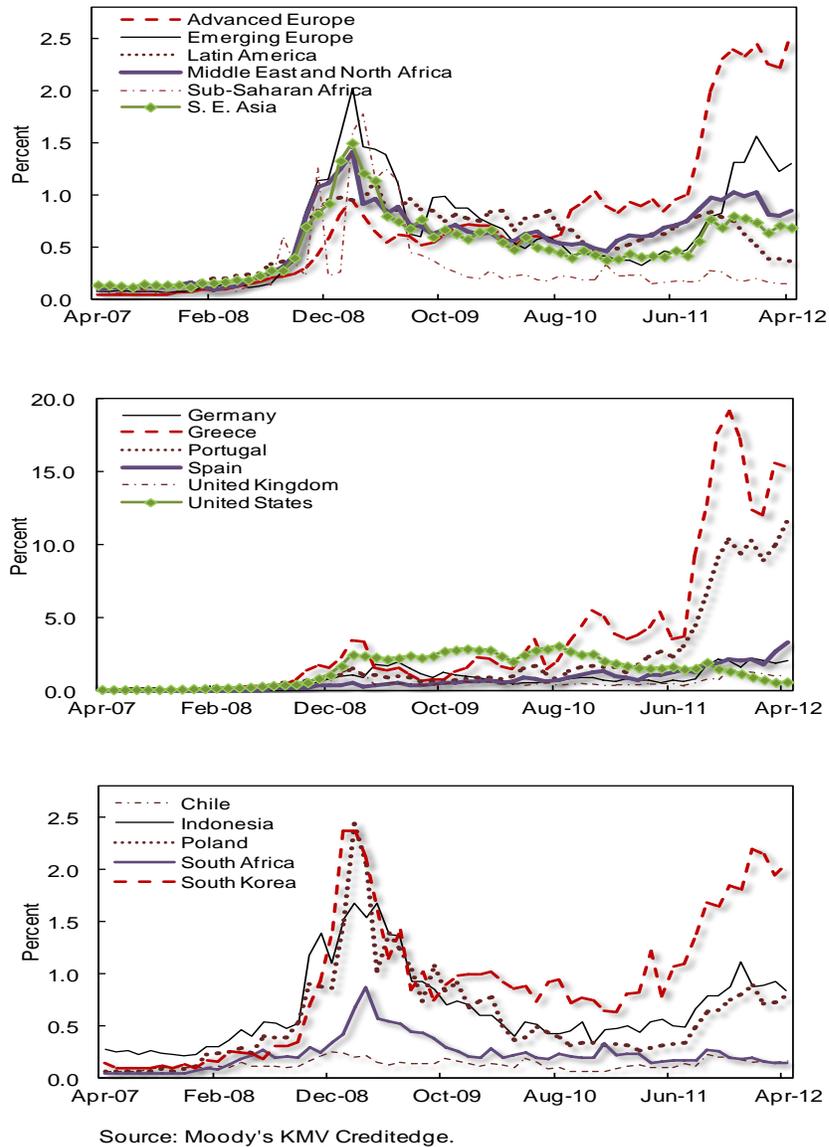
Table 1. Country Sample ^{1/ 2/}

Advanced banking systems	Emerging banking systems
Australia	Argentina
Austria*	Brazil
Belgium*	Chile
Canada	<i>Colombia</i>
Denmark*	Hong Kong SAR
Finland*	India
France*	Indonesia
Germany*	<i>Israel</i>
Greece*	Malaysia
Ireland*	<i>Mexico</i>
Italy*	<i>Peru</i>
<i>Japan</i>	Philippines
Netherlands*	<i>Poland</i>
Portugal*	Singapore
Spain*	South Africa
Sweden*	South Korea
Switzerland*	Thailand
United Kingdom*	Turkey
United States	<i>Venezuela</i>

1/ Large outliers that were left out of the analysis are in italics; the "advanced Europe" subsample is marked with asterisk.

¹⁶ A one percentage point change in the index corresponds to three standard deviations.

Figure 5. Banking System Expected Default Frequency (EDF)
(Moody's KMV one-year median EDF)



The alternative specification with the indirect liquidity risk index shows similar effects. A one percentage point increase in the indirect liquidity risk index leads, on average, to a roughly 22 percent decline in international borrowing in the immediate crisis period and a 14 percent decline in international borrowing in the extended period.¹⁷ Indirect liquidity effects are stronger in the immediate crisis period and for advanced and European banking systems.

¹⁷ A one percentage point change in the index roughly corresponds to three standard deviations.

On the borrower side, the findings suggest that weaker banks are able to borrow less internationally. This is consistent with anecdotal evidence of increased segmentation of international interbank markets during the crisis. The effect was somewhat more pronounced in the extended period, suggesting that creditors became more selective in the aftermath of the immediate crisis. A one percentage point increase in the credit risk index was associated with reductions in borrowing of 6.7 percent and 9.6 percent in the two periods, respectively.¹⁸

Previous research has largely ignored borrower effects. Such effects are statistically significant and not controlling for them may overestimate the impact of other factors. The results suggest that creditors are somewhat more sensitive to the soundness of emerging banking systems, where a one percentage point increase in the credit risk index leads to a 10 percent reduction in emerging banking system borrowing.

Banks with risky international portfolios are able to borrow less internationally. Such indirect credit risk effects are statistically significant and economically meaningful in advanced and European banking systems and more pronounced in the extended period, when a one percentage point increase in the index leads to a 8 percent decline in international borrowing.

Currency risk is statistically significant across a range of specifications. Although this effect may be to some extent attributable to the mechanical conversion of exposures in other currencies to U.S. dollars, an increase in currency risk would generally be reflected in heightened risk premiums and tightened borrowing conditions.

The estimates suggest that international borrowing is also related to economic growth and fiscal risks. Fiscal effects are present in emerging markets in both periods, while they become statistically and economically significant in advanced and European economies in the extended period. A one percentage point deterioration in the fiscal balance to GDP ratio is, on average, associated with a 0.77 percent decline in international borrowing.

IX. CONCLUDING REMARKS

This paper proposes an integrated framework to assess the impact of cross-border counterparty risk on international interbank borrowing. The analysis, based on novel risk-weighted indexes, suggests that counterparty risks played a role in the dislocations in interbank markets during the global crisis. First, international lenders differentiated between sound and unsound banking systems, particularly in the aftermath of the immediate crisis. Second, borrowers that relied on distressed lenders suffered a stronger pullback, especially in advanced and European banking systems. Finally, the risk characteristics of borrowers' international lending seem to have amplified the pullback from advanced and European banking systems.

¹⁸ A one percentage point change in the index roughly corresponds to one standard deviation.

Table 2. International Interbank Borrowing: Mean-Comparison Tests, September 2007–September 2011
(percent change, y-o-y)

	Mean 1 ^{1/}	Mean 2 ^{2/}	Difference (Mean1-Mean 2)	T-statistic	Pr(T > t)
Cross-quartile tests					
Full sample	-27.1	48.0	-75.1	-50.4	0.00
Advanced banking systems	-30.0	32.5	-62.5	-34.4	0.00
Advanced Europe	-32.5	32.2	-64.7	-31.8	0.00
Emerging banking systems	-21.9	60.5	-82.4	-39.1	0.00
Cross-sample tests					
Advanced banking systems/Emerging banking systems	-0.5	16.1	-16.6	-7.3	0.00
Advanced Europe/Other banking systems	-3.2	14.7	-17.8	-7.7	0.00
Cross-period tests					
Full sample	4.9	10.9	-6.0	-2.3	0.02
Advanced banking systems	3.1	-9.3	12.4	4.2	0.00
Advanced Europe	1.4	-14.2	15.6	4.5	0.00
Emerging banking systems	8.2	33.4	-25.2	-6.5	0.00

Note: Large outliers (Colombia, Israel, Peru, Venezuela, Mexico, and Poland) have been left out of the analysis.

1/ The column shows: (i) in the section "Cross-quartile tests" the mean percent change in international interbank borrowing in the bottom quartile of each subsample; (ii) In the section "Cross-sample tests" the mean percent change in international interbank borrowing by advanced and European banking systems, and (iii) in the section "Cross-period tests" the mean value in the respective subsample over the September 2007-June 2010 period.

2/ The column shows: (i) in the section "Cross-quartile tests" the mean percent change in international interbank borrowing in the top quartile of each subsample; (ii) in the section "Cross-sample tests" the mean percent change in international interbank borrowing by emerging and non-European banking systems, and (iii) in the section "Cross-period tests" -- the mean value in the respective subsample over the September 2010-September 2011 period.

Table 3. Panel Data Analysis: Immediate Crisis Period
 Estimation period: September 2007–June 2010, quarterly figures, fixed effects
 Dependent variable: percent change in international interbank borrowing (y-o-y)

	Full Sample		Advanced Banking Systems		Advanced Europe		Emerging Banking Systems		Advanced Banking Systems 1/		Advanced Europe 1/	
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
Cross-border counterparty risk												
Credit risk index (t)	-6.699*** (1.400)	-6.905*** (1.425)	-5.024*** (1.546)	-4.043*** (1.546)	-3.525** (1.688)	-2.680 (1.661)	-9.034*** (2.482)	-9.814*** (2.509)	-5.771*** (1.580)	-4.814*** (1.576)	-4.325** (1.734)	-3.441** (1.713)
Indirect credit risk index (t-1)									-5.580** (2.827)	-5.549** (2.659)	-5.589* (3.117)	-4.938* (2.961)
Liquidity risk index (t-1)	-28.960*** (5.189)		-30.368*** (7.433)		-28.127*** (7.865)		-24.429*** (7.713)		-24.121*** (8.025)		-22.327*** (8.451)	
Indirect liquidity risk index (t-1)		-21.641*** (4.811)		-28.261*** (5.570)		-27.327*** (5.772)		-17.654** (8.527)		-24.659*** (5.782)		-24.051*** (6.065)
Control variables												
Depreciation (t-1) 2/	1.125*** (0.168)	1.146*** (0.170)	1.608*** (0.184)	1.588*** (0.180)	1.834*** (0.227)	1.804*** (0.220)	0.526* (0.306)	0.533* (0.312)	1.555*** (0.184)	1.530*** (0.180)	1.753*** (0.230)	1.727*** (0.224)
Real GDP growth (t-1)	1.694*** (0.328)	1.684*** (0.352)	2.367*** (0.547)	2.228*** (0.515)	2.738*** (0.593)	2.542*** (0.549)	1.694*** (0.457)	1.697*** (0.504)	1.968*** (0.579)	1.740*** (0.561)	2.317*** (0.634)	2.106*** (0.605)
Fiscal balance to GDP (t-1)	0.289 (0.225)	0.399* (0.226)	0.053 (0.243)	0.099 (0.233)	0.062 (0.250)	0.102 (0.240)	0.771* (0.419)	0.915** (0.424)	0.089 (0.241)	0.110 (0.231)	0.094 (0.249)	0.114 (0.239)
Statistical breaks dummy	-3.091 (3.314)	-3.161 (3.365)	-1.598 (2.899)	-1.913 (2.835)	-1.259 (3.031)	-1.490 (2.945)	-20.407 (12.803)	-20.073 (13.065)	-1.893 (2.880)	-2.156 (2.812)	-1.559 (3.014)	-1.731 (2.931)
Constant	16.711*** (2.182)	14.930*** (2.180)	14.578*** (2.267)	15.079*** (2.086)	13.138*** (2.551)	14.052*** (2.330)	19.382*** (4.347)	16.514*** (4.492)	16.391*** (2.430)	17.336*** (2.333)	15.173*** (2.775)	16.156*** (2.637)
Number of observations	372	372	204	204	168	168	156	156	204	204	168	168
R-squared	0.44	0.42	0.55	0.55	0.57	0.58	0.39	0.34	0.59	0.59	0.61	0.61

Note: standard errors in parenthesis. *** p<0.01, ** p<0.05, * p<0.1

1/ The estimates in these columns include indirect credit risk effects.

2/ Quarterly percentage change in the nominal exchange rate, defined as US dollars per unit of domestic currency.

Table 4. Panel Data Analysis: Extended Period
 Estimation period: September 2007–September 2011, quarterly data, fixed effects
 Dependent variable: percent change in international interbank borrowing (y-o-y)

	Full Sample		Advanced Banking Systems		Advanced Europe		Emerging Banking Systems		Advanced Banking Systems 1/		Advanced Europe 1/	
	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
Cross-border counterparty risk												
Credit risk index (t)	-9.595*** (1.074)	-9.478*** (1.061)	-7.890*** (0.943)	-8.300*** (0.942)	-7.663*** (0.984)	-8.284*** (0.993)	-10.903*** (2.692)	-10.492*** (2.675)	-8.035*** (0.931)	-8.295*** (0.921)	-7.792** (0.969)	-8.228** (0.964)
Indirect credit risk index (t-1)									-7.454*** (2.587)	-8.985*** (2.428)	-8.284*** (2.898)	-10.347*** (2.764)
Liquidity risk index (t-1)	-9.643** (4.135)		-39.127*** (5.159)		-43.176*** (5.474)		5.560 (6.036)		-29.047*** (6.176)		-32.081*** (6.639)	
Indirect liquidity risk index (t-1)		-14.089*** (4.178)		-31.662*** (4.452)		-33.749*** (4.780)		0.447 (7.552)		-22.939*** (4.947)		-23.381*** (5.407)
Control variables												
Depreciation (t-1)	1.025*** (0.175)	0.980*** (0.175)	1.221*** (0.173)	1.114*** (0.178)	1.249*** (0.204)	1.103*** (0.214)	0.446 (0.337)	0.453 (0.338)	1.172*** (0.172)	1.079*** (0.174)	1.184*** (0.202)	1.063*** (0.208)
Real GDP growth (t-1)	1.440*** (0.212)	1.292*** (0.217)	0.436** (0.208)	0.283 (0.215)	0.366* (0.217)	0.234 (0.227)	2.787*** (0.414)	2.790*** (0.428)	0.349* (0.207)	0.211 (0.211)	0.269 (0.216)	0.150 (0.221)
Fiscal balance to GDP (t-1)	0.765*** (0.227)	0.685*** (0.227)	0.377 (0.235)	0.530** (0.232)	0.391 (0.247)	0.572** (0.246)	0.845** (0.406)	0.781* (0.408)	0.377 (0.232)	0.461** (0.227)	0.381 (0.243)	0.494** (0.240)
Statistical breaks dummy	-0.722 (3.400)	-0.577 (3.379)	-1.005 (2.823)	-1.039 (2.854)	-0.744 (2.974)	-0.926 (3.041)	-5.362 (11.568)	-5.012 (11.587)	-0.927 (2.785)	-0.893 (2.788)	-0.640 (2.926)	-0.722 (2.955)
Constant	15.011*** (1.969)	16.458*** (1.980)	18.842*** (1.884)	18.169*** (1.887)	19.127*** (2.134)	18.144*** (2.178)	9.807** (4.165)	11.737*** (4.393)	20.202*** (1.918)	20.317*** (1.933)	20.773*** (2.178)	20.653*** (2.219)
Number of observations	527	527	289	289	238	238	221	221	289	289	238	238
R-squared	0.30	0.31	0.42	0.40	0.43	0.41	0.25	0.26	0.48	0.48	0.49	0.49

note: *** p<0.01, ** p<0.05, * p<0.1

1/ The estimates in these columns include indirect credit risk effects.

2/ Quarterly percentage change in the nominal exchange rate, defined as US dollars per unit of domestic currency.

APPENDIX I. VARIABLE DEFINITIONS AND DATA SOURCES

Change in international interbank borrowing: percent change (y-o-y) in quarterly international claims vis-à-vis banks. *Source:* BIS Consolidated Banking Statistics on immediate borrower basis.

Credit risk index: Moody's KMV one-year median Expected Default Frequency (EDF) for banking groups. *Source:* Moody's KMV Creditedge database. For some banking systems with missing data, the median EDF of the "financials" group was used instead.

Indirect credit risk index: sum of the banking system's foreign claims, weighted by borrowers' one-year median EDFs, and divided by the banking system's total credit to the private sector. *Sources:* BIS Consolidated Banking Statistics on immediate borrower basis, Moody's KMV Creditedge database, and IMF International Financial Statistics.

Liquidity risk index: sum of the banking system's foreign liabilities, weighted by creditors' one-year median EDFs, divided by the banking system's total credit to the private sector. *Sources:* BIS Consolidated Banking Statistics on immediate borrower basis, Moody's KMV Creditedge, and IMF International Financial Statistics.

Indirect liquidity risk index: sum of the banking system's foreign liabilities, weighted by creditors' indirect credit risk index, and divided by the banking system's total credit to the private sector. *Sources:* author's calculations based on the Bank for International Settlements Consolidated Banking Statistics on immediate borrower basis, Moody's KMV Creditedge, and IMF's International Financial Statistics.

Depreciation: quarterly percent change in the nominal exchange rate against the U.S. dollar, defined as U.S. dollars per unit of national currency. *Source:* IMF Global Data Source.

Real GDP growth: percent change in quarterly real GDP. *Source:* IMF Global Data Source.

Fiscal balance to GDP: quarterly fiscal balance as a percent of nominal GDP. *Source:* IMF Global Data Source. For Austria, Belgium, Greece and Portugal net operating balance since other data were not available. *Source:* IMF International Financial Statistics.

Statistical break dummy: the dummy variable identifies statistical breaks in the series based on a table published by BIS as an annex to the consolidated banking statistics. *Source:* BIS.

APPENDIX II. DATA CAVEATS

The analysis faced some constraints due to data limitations.

First, the variables measuring international borrowing and cross-border counterparty risk are not fully comparable. While the borrowing variable is compiled on a “residency” basis and includes borrowing by domestic banks and foreign subsidiaries, the indexes measure the risks faced by domestic-owned banks.

Second, the numerator and denominator of the indexes are compiled on different bases. The numerator represents consolidated data for domestic banks, while credit to the private sector in the denominator includes lending by all resident banks, including foreign subsidiaries. However, excluding foreign subsidiaries from the definition of the banking system may seriously underestimate the size of systems with large foreign ownership.

Third, there are inconsistencies with regard to the composition of the indirect credit risk index. The international credit variable includes claims on banks, nonbanks and sovereigns, while its level of risk was measured with banking system EDFs only since EDFs for the other sectors were not available. Nevertheless, since during the period under investigation the perception of country risk was dominated by banking problems, the bank EDFs would be a reasonable proxy and correlated with the EDFs for other sectors.

Fourth, there may be noise in the data due to exchange rate effects. BIS data are expressed in U.S. dollars and may change from period to period even if the actual positions remain unchanged because claims in other currencies are converted into U.S. dollars. Although it was not possible to adjust for exchange rate conversions since there is no data on currency composition, the exchange rate in the model controls to some extent for such effects. The results should not be considerably affected by exchange rate effects since international interbank transactions are typically contracted in U.S. dollars (see BIS Economic Paper 8).

Finally, the use of aggregate data may affect the reliability of the results, since the relationships may be driven by different banks. For example, the deterioration in aggregate banking system soundness may be attributable to one bank, while the decline in international borrowing may be due to reduced borrowing by another bank.

APPENDIX III. SUPPLEMENTARY FIGURES AND TABLES

Figure 6. Cross-Border Counterparty Risk Indexes

(a) Advanced Banking Systems

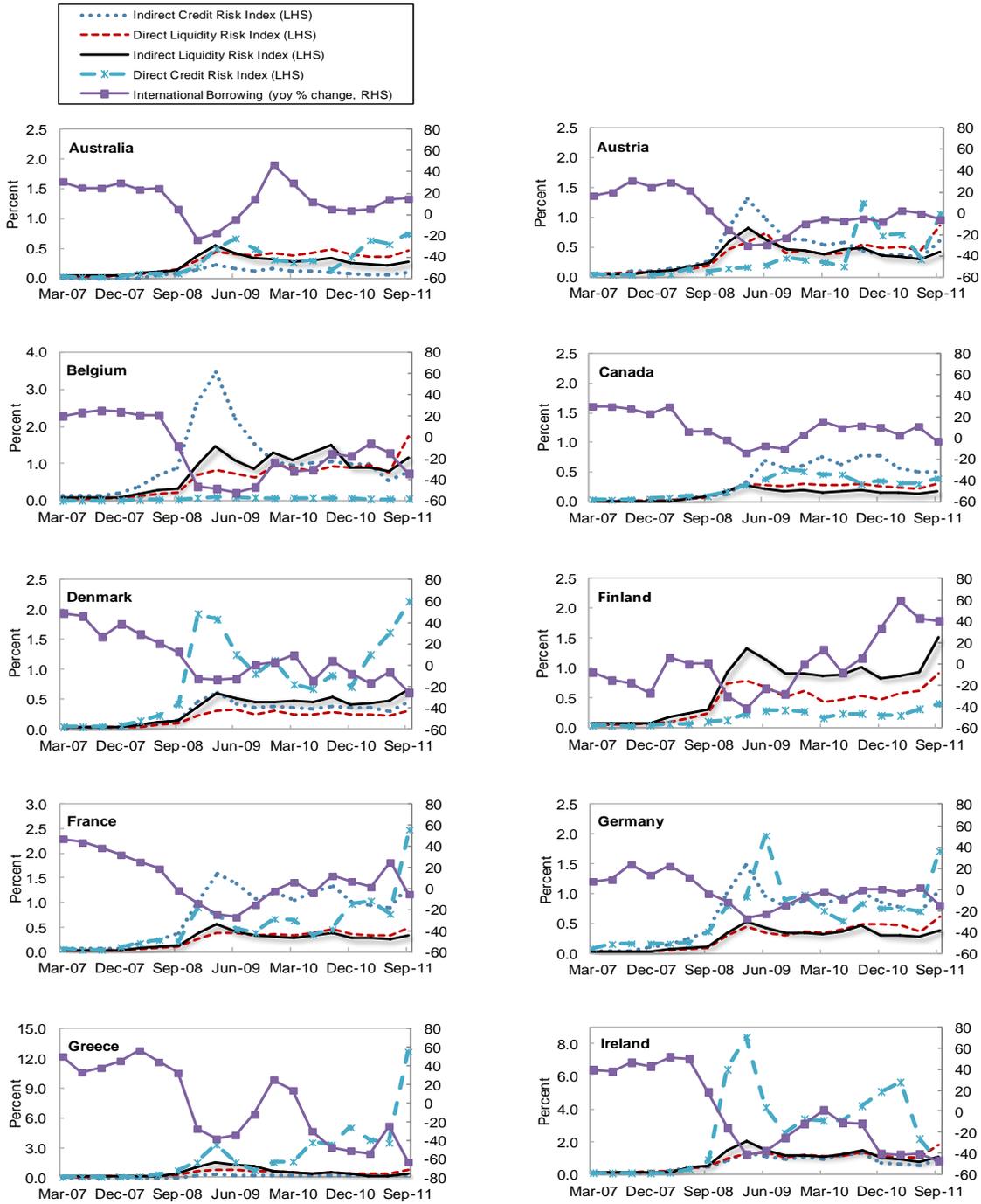


Figure 6. Cross-Border Counterparty Risk Indexes (continued)
 (a) Advanced Banking Systems (Concluded)

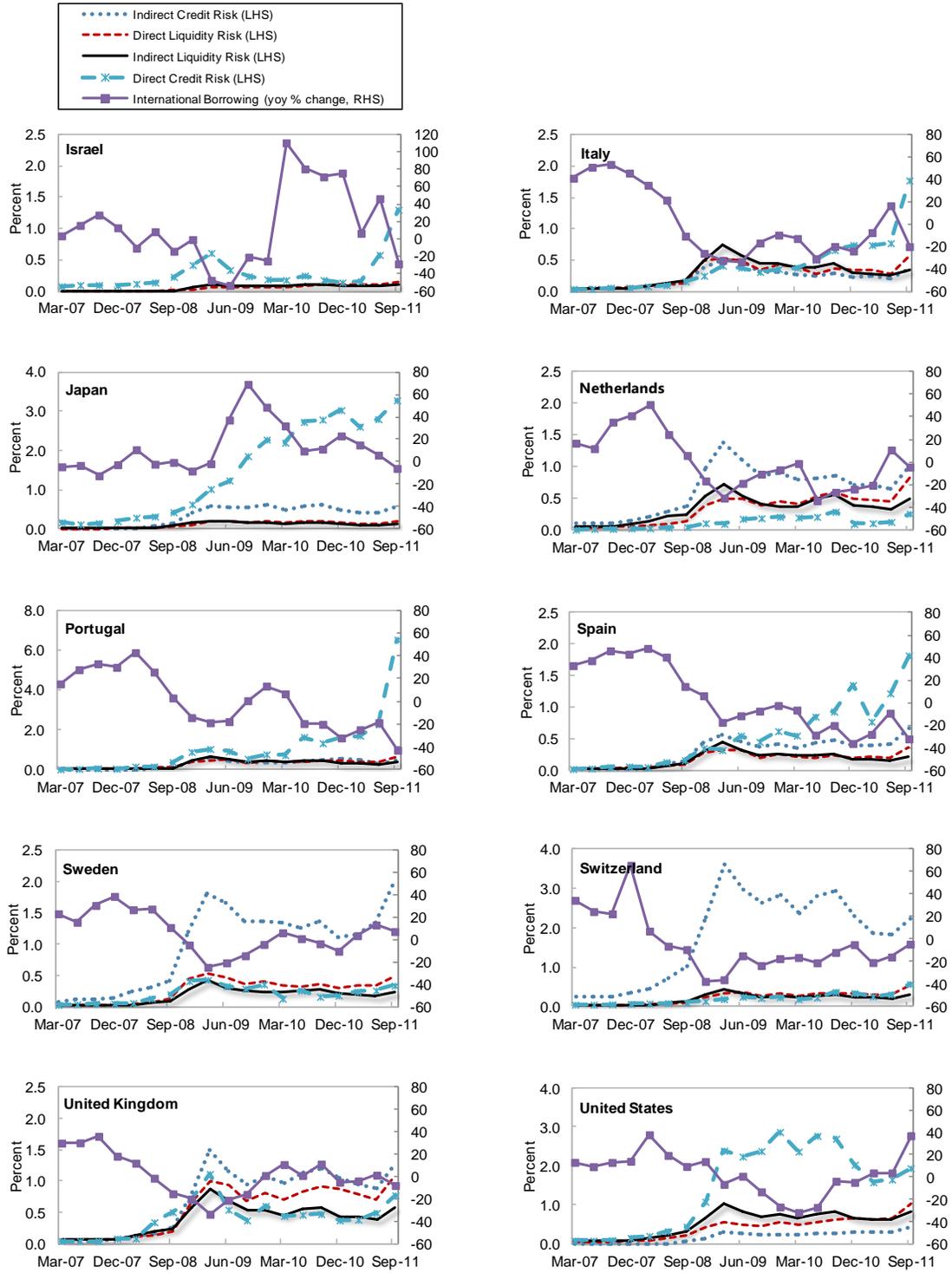


Figure 6. Cross-Border Counterparty Risk Indexes (continued)

(b) Emerging Banking Systems

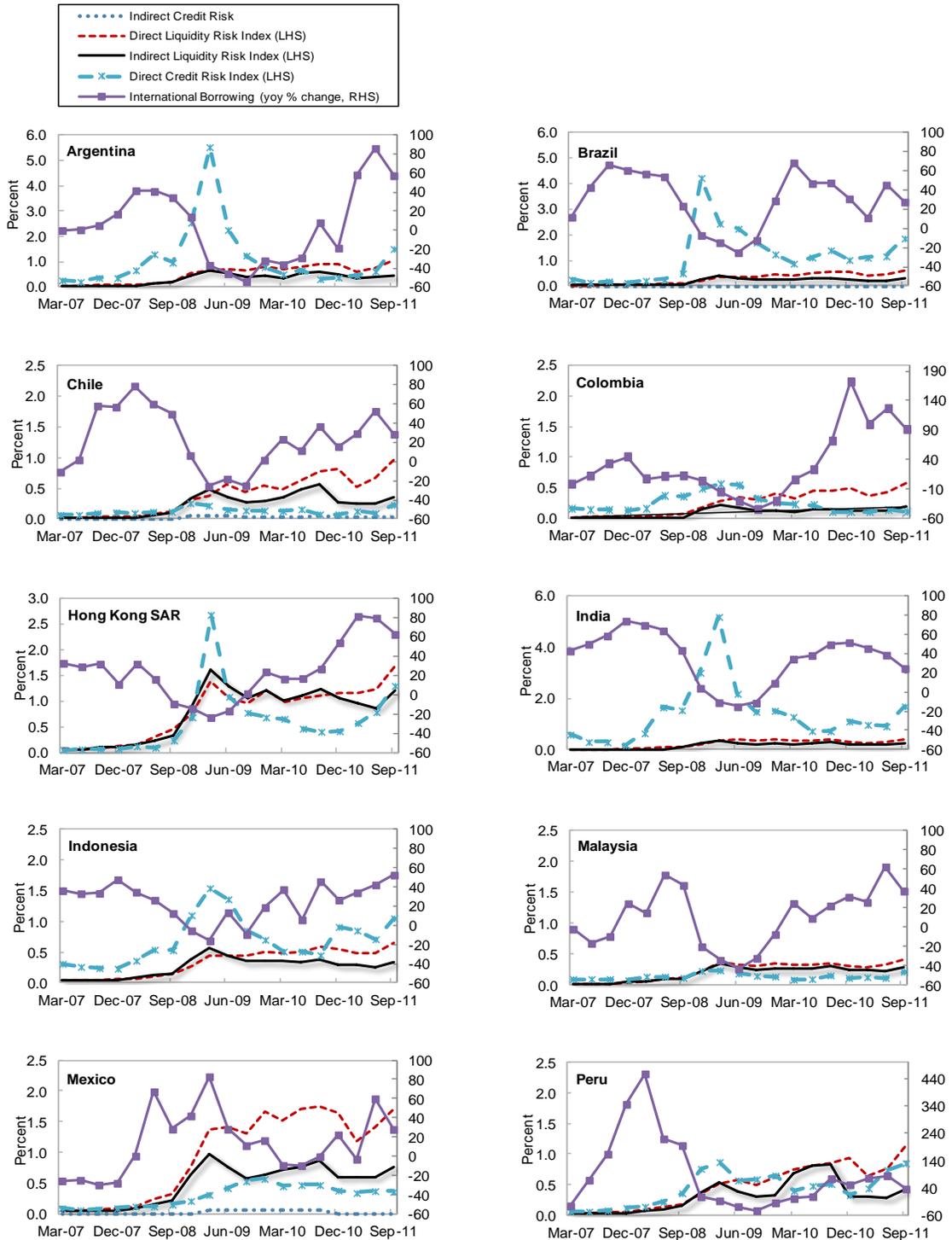
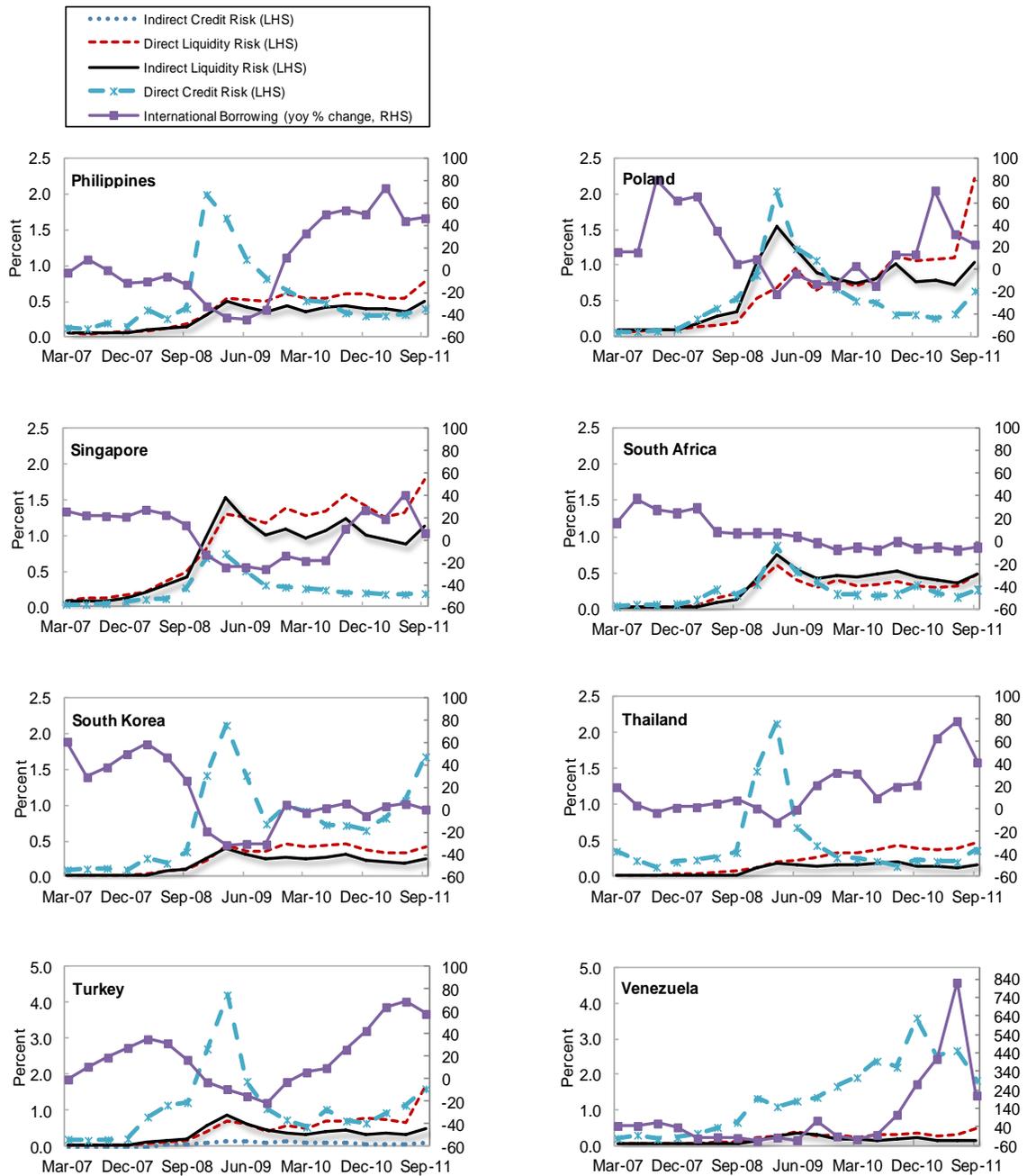


Figure 6. Cross-Border Counterparty Risk Indexes (continued)

(b) Emerging Banking Systems (Concluded)



Source: BIS consolidated banking statistics on immediate borrower basis.

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