Funding liquidity risk in a quantitative model of systemic stability

Summary of Working Paper no. 372 David Aikman, Piergiorgio Alessandri, Bruno Eklund, Prasanna Gai, Sujit Kapadia, Elizabeth Martin, Nada Mora, Gabriel Sterne and Matthew Willison

The global financial crisis of 2007–09 has illustrated the importance of modelling the closure of funding markets to financial institutions and accounting for liquidity feedbacks within any model of systemic risk. This paper illustrates how such channels are incorporated into a Risk Assessment Model for Systemic Institutions (RAMSI), and outlines how RAMSI can aid assessment of institution-specific and system-wide vulnerabilities.

RAMSI aims to deliver a suite of models that should provide a rigorous and consistent quantitative framework for risk assessment, and help to sharpen the analysis of key vulnerabilities. It will provide a tool for examining the impact of key risks on a bank-by-bank and system-wide basis, and aid in the assessment of the impact of potential policy measures. The results from the suite of models will assist in the communication of risk assessment messages to risk managers in the financial sector, thereby helping shape their attitudes to risk.

The model focuses on the health of core banks in the UK financial system. For these banks, it provides a quantitative framework for assessing how balance sheets dynamically adjust to macroeconomic and financial shocks. The framework allows for macro-credit risk, interest and non-interest income risk, network interactions, and feedback effects arising on both the asset and liability side of the balance sheet. Systemic risks stem from the connectivity of bank balance sheets via interbank exposures (counterparty risk); the interaction between balance sheets and asset prices (fire sale effects); and confidence effects that may affect funding conditions.

The crisis afflicting banks in the United Kingdom and internationally has illustrated the importance of funding liquidity risk, which is captured through two complementary channels. First, an empirical model is used to project individual bank credit ratings, and assess how funding costs may change with the fundamentals of a bank. Second, a 'danger zone' model is used, in which a range of indicators determine whether a bank suffers stress so severe that it is shut out of unsecured funding markets.

The model is applied to the UK banking system based on the balance sheet vulnerabilities that existed at the end of 2007, and the results show how rising funding costs and liquidity

concerns can amplify other sources of risk. The outputs are generated by running 500 simulations capturing different outturns for the macroeconomy on a three-year forecast horizon. It should be emphasised that the results are illustrative, reflecting model properties in this preliminary version rather than being the authors' view of the likely impact on the banks in question. In terms of aggregate results for variables such as system-wide profits and total assets, there is some evidence of bimodality, insofar as there are a number of observations in the extreme tail of the distributions, which are typically associated with one or more banks failing.

The unified modelling approach demonstrates how a failing bank may trigger contagion by defaulting on interbank liabilities, selling assets in a fire sale, and undermining confidence in other similar banks. A single, extreme draw is dissected to illustrate these channels. In it, one bank defaults for fundamental reasons but causes two other banks to fail. The second bank fails because its existing vulnerabilities are exacerbated by a drain in confidence in its funding position as it is perceived to be similar to the first failed bank. And the third bank fails because it suffers counterparty losses on the interbank market and endures mark-to-market losses on its assets as a result of the depressing effect on market prices caused by the fire sales of the other two failing banks. The simulations do not incorporate any regulatory or other financial stability policy intervention. The model therefore provides an assessment of how the financial system might fare without any specific policy response.

Further development is planned to extend the model in a number of areas. A substantial area for further work is to analyse banks' cash-flow constraints and consider how defensive actions in the face of funding stress may affect the rest of the financial system and the wider macroeconomy. Another key challenge is to incorporate feedbacks from the banking sector to the real economy.

Ultimately, the future development of the RAMSI framework will be determined to a large degree by the aspects of the model that are found to be most useful in enhancing understanding and communication of financial vulnerabilities. It is envisaged that RAMSI's analytical framework will become useful in the analysis of systemic risk in the United Kingdom, and perhaps in some other countries as well.

International financial transmission: emerging and mature markets

Summary of Working Paper no. 373 Guillermo Felices, Christian Grisse and Jing Yang

With an increasingly integrated global financial system, we frequently observe that shocks to individual asset markets affect not only other asset markets in the same country but also the ones in other countries. Such spillover effects were noticeable during several past financial crises episodes in emerging market economies (EMEs) and have been also prevalent during the current global financial crisis which started in developed countries. From a central banking perspective, understanding the mechanisms through which shocks are transmitted across financial markets is important for gauging the impact that financial crises and volatilities in EMEs can have on the financial systems in developed countries, and *vice versa*.

Using daily data from prior to the East Asian crisis through to the early stages of the current global financial crisis, this study analyses the relationships between bond markets in the United States and EMEs. How do shocks — such as financial disruptions — in EME bond markets affect interest rates in the United States? And how do changes in US interest rates in turn affect EME bond markets? A key challenge in answering these questions is to identify a shock to a specific asset. For example, interest rates paid on risky US corporate debt and the rates paid on EME debt exhibit a high positive correlation: they tend to move in the same direction. However, we do not know whether this positive correlation is caused by EME shocks being transmitted to the United States, by US shocks affecting EMEs, or merely the result of a common shock.

Many studies deal with this problem by imposing some *ad hoc* restrictions; for example, assuming that the causality runs in only one direction. In this paper, we use a method developed by Rigobon and his co-authors, which allows us to capture all feedback effects. This method identifies a shock to a specific asset market as a period when volatility in this asset market is uniquely high; ie volatilities in other asset classes are low. Then the period can be used to identify the feedback effects from this market to other asset markets. The period of shocks identified in this way for EME bond markets capture all the known EME sovereign crises over the past decade (such as in Argentina, Brazil, Russia and Turkey).

We find that adverse shocks to EME sovereign bond spreads lead to a short-run fall in US interest. This finding supports a stylised fact that, at the time of stress, investors shift their investment away from risky assets into risk-free assets which causes prices of the risk-free assets to rise, and thus their rates to fall. This is often described as a 'flight to quality'. An adverse shock to EME bond spreads also leads to a widening in US high-yield spreads, and *vice versa*. This constitutes an important contagion channel through which crises in emerging markets can affect mature economies. What is the overall contemporaneous effect of a shock to EMEs on mature economies? On the one hand, mature economies might benefit from strong 'flight to quality', driving down the financing costs for risk-free bonds. On the other hand, an EME shock is not necessarily good news for mature economies as it will widen the spreads on other risky bonds, leading to a higher financing cost for risky corporates. In the other direction, we also find that an increase in financing costs of US riskier corporates — as happened in the early stages of the current financial crisis — can lead to a sizable increase in financing cost of EME sovereigns (although by much less than if shocks originate in EMEs themselves).

We also examine the speed and duration of shock transmission. For example, shocks that raise US interest rates initially decrease US high-yield and EME bond spreads for a very short period, but eventually widen the spreads of risky debt with a lag of about two days. Since both EME sovereign bonds and US high-yield bonds are priced as spreads over risk-free US Treasury yields with similar maturities, a rise in the US interest rates will automatically increase the interest rates paid on these risky bonds, ie higher financing cost for emerging market (EM) sovereigns and US corporates. The reverse is also true: a fall in US interest rates is likely to lead to a fall in EM and US high-yield bond spreads. This is consistent with the stylised fact that, when the safe rates are low, investors search for higher return by purchasing riskier bonds, which push up the prices and bring down the spreads on these assets. Therefore, our results support the existence of the 'financing cost' and 'search for yield' channels, but they work with a lag.

We then ask how much of the forecast error variance of each variable can be explained by shocks from other variables. We find that both US short and long-term government bond yields are explained largely by their own structural shocks, across all forecast horizons. However, a very different picture emerges for US high-yield and EM bond spreads: at longer forecast horizons the variances of the errors in forecasting US high-yield and emerging market sovereign debt spreads are both largely explained by structural shocks to US short and long-term rates. In particular, shocks to US long-term government bond yields explain 60% and 75% of the forecast error variance in EM bond spreads for 5 day and 20 day ahead forecasts. This suggests that US interest rates are of primary importance for explaining the developments in markets for more risky debt, at least in the medium run.

How do different models of foreign exchange settlement influence the risks and benefits of global liquidity management?

Summary of Working Paper no. 374 Jochen Schanz

In response to greater internationalisation, financial groups have adopted a wide range of approaches to liquidity risk management, a defining characteristic of which is the degree of centralisation. Under local liquidity management, each subsidiary of a financial group maintains a separate pool of liquidity in its local currency and funds its obligations domestically in each market. Under global liquidity management, financial groups also fund liquidity shortfalls (or recycle liquidity surpluses) via intragroup, cross-currency and/or cross-border transfers of liquidity or collateral: there is a global flow of liquidity within the group.

In practice, there are many barriers to managing liquidity globally. When banks are concerned about their counterparties' credit risk, one of these barriers can be the design of the settlement infrastructure for the cross-currency transfer of liquidity. A key design feature is whether the settlements of the two currencies involved in the foreign exchange (FX) transaction occur simultaneously, or at least closely co-ordinated in time. At the moment, facilities are available for simultaneous next-day settlement, but not for simultaneous same-day settlement. This paper shows that while there are benefits to increased co-ordination for same-day settlement of foreign exchange transactions, there may also be costs for financial stability.

In order to understand the argument, consider the case of a global bank, A, with two legally independent subsidiaries in the United Kingdom and the United States, referred to as A(UK) and A(US). A(UK), which may be subject to severe credit risk, is faced with requests to make an unusually large number of payments. Incoming payments are only expected for the following day. In response to these payment requests, A(UK) could either delay the payments, or attempt to raise sufficient funds on the interbank market (for example, via an overnight loan, or via an FX swap) to be able to execute them. Suppose A(UK) decided to take out an FX swap. Each foreign exchange transaction requires two settlements, one in the payment system of each currency. When A(UK) buys sterling against dollars for same-day settlement, it effectively borrows sterling from a UK counterparty, B, and promises that its US subsidiary, A(US), will pay dollars to B's US correspondent on the same day. If the settlement of the dollar payment occurs later than the settlement of the sterling payment, then B is exposed to the risk that A(UK) might default in-between the two settlements. Once the dollar transfer has taken place, A(US) is exposed to the risk that A(UK) might default. As a result, A(UK) may be left short of liquidity for two reasons: if B is concerned about A(UK)'s credit risk, it may refuse to enter into

the foreign exchange transaction with A(UK). Or, A(UK) may also be unable to raise funds because A(US) refuses to execute the dollar transfer on A(UK)'s behalf.

The likelihood that the foreign exchange transaction will take place in the presence of counterparty credit risk depends, therefore, on the information that A(US) and A(UK)'s UK counterparty have about A(UK)'s insolvency risk. The main assumption of this paper is that information flows freely between the two subsidiaries but not between different banks. Thus, A(UK)'s domestic counterparty charges an interest rate appropriate to the *expected* risk of A(UK), whereas A(US) charges an interest rate appropriate to A(UK)'s actual risk. In both cases, the interest rate is proportional to the time the lender carries this exposure. The better co-ordinated the settlement, the less time can expire between the settlement of the sterling and dollar payments, the longer A(US)'s exposure, and the shorter the exposure of A(UK)'s UK counterparty. If A(UK)'s actual risk is higher than its UK counterparty expects, A(UK)'s cost of an FX swap increases. Conversely, the cost of an FX swap falls when A(UK)'s risk is below average. As a result, with better co-ordination, only the less risky banks find funding, while riskier banks delay payments.

Delaying payments thereby becomes a signal for high solvency risk, and this signal becomes more precise when the co-ordination in FX settlement increases. In practice, a bank's failure to execute payment requests that are contractually due might therefore trigger further liquidity outflows. Other creditors of A(UK) might refuse to roll over funds and eventually drive A(UK) into insolvency. To keep the model tractable, I do not model these further consequences of A(UK)'s inability to make payments in detail but simply assume that A(UK) incurs a fixed cost if it delays payments beyond their due date.

The main result of the paper is that better co-ordination of FX settlements has two, potentially offsetting, effects on risk. On the one hand, it reduces the likelihood that solvency shocks are transmitted from one institution to another. If a bank was close to insolvency, it would not be able to refinance itself at all in response to liquidity outflows, neither domestically nor via FX transactions. Should such a bank eventually default, this default shock remains more contained because it had not entered (additional) loan agreements as part of an FX swap, or an overnight loan. But on the other hand, that bank would have to delay the payment of its obligations beyond their due date.

Inflation dynamics with labour market matching: assessing alternative specifications

Summary of Working Paper no. 375 Kai Christoffel, James Costain, Gregory de Walque, Keith Kuester, Tobias Linzert, Stephen Millard and Olivier Pierrard

The main task of central banks is to maintain price stability by controlling inflation and, for this reason, it is important to understand what drives the dynamics of inflation. A long tradition in monetary economics has assigned the labour market a central role in inflation dynamics. Not least given the wide diversity in labour market structures, institutions and policies across Europe, and the world more generally, it is of interest to know whether or not heterogeneity in certain aspects of the labour market matters for inflation dynamics and, hence, monetary policy.

This paper analyses and compares existing approaches to modelling the labour market, explaining their implications for the behaviour of inflation. The paper highlights which of the particular features of each modelling approach are most important for driving inflation dynamics and provides a structure to the rich variety of modelling approaches in previous work. In so doing, we follow an active strand of research that has set out explicitly to model individual workers and firms, who take time to form job matches. The rationale for so doing comes from the belief that the slow responses of employment and unemployment to changes in demand are a natural place to look for the origins of the slow response of inflation to changes in demand.

We start by examining what euro-area data suggests happens to labour market variables after an unexpected fall in interest rates (ie a monetary policy shock). We find that output rises significantly above its steady state, that inflation rises, that wages per employee also rise but by less than output (in percentage terms), that employment rises significantly, and unemployment falls and, finally, that most of the adjustment in labour is borne by the number of employees rather than by hours worked per employee.

We then consider a standard macroeconomic model with unemployed workers looking for jobs, firms posting vacancies, and a clear distinction between employment and hours worked. Building on this, we replace certain assumptions about the labour market structure by others, one at a time. First, we consider alternative ways that firms and workers can decide on how many hours each worker works. Then, we consider the effect of wage negotiations being staggered, with wages fixed for some time and what happens when we, additionally, tie the wages of newly hired workers to those of existing workers in a firm. Next, we consider interactions at the firm level between price and wage-setting. We then consider various types of hiring costs before moving on to consider search on-the-job, and finish by considering what happens when job destruction varies over the cycle. In each of the cases we provide intuition for the effect that a specific modification of the baseline model has on inflation dynamics.

We find that the baseline model predicts a response of inflation to changes in interest rates that is too large relative to the data. Allowing search on-the-job and considering different types of hiring cost does not seem to affect this result. However, when our baseline model is combined with the assumption that once employers and employees have agreed on an hourly wage, the employer chooses how many hours his employees will work, staggered wages help to smooth the reaction of wages resulting in a smaller response of inflation to an interest rate change. Inflation responds even less when we account for the firm-specific nature of labour. But, in this case, the model also has implications for the responses of unemployment and vacancies that do not match the data.

More generally, by analysing a wide range of institutional features of the labour market, we show that only those institutional features that affect or generate a direct channel from wages to inflation matter for how inflation responds to interest rate changes. By contrast, institutional features that leave this channel unaffected matter much less for inflation dynamics.