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International Financial Contagion: the Role of Banks (*)

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Abstract: This paper provides an overview of recent theories of international financial contagion, with a focus on models in which the balance sheet constraints of global banks (and other financial institutions) are the key channel of international transmission.

Key words: global financial crisis, international financial contagion, international financial multiplier, global banks, bank balance sheets, capital ratio, leverage ratio, international interbank market, asset prices, credit losses, bank runs

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1. Introduction

During the recent (2007-2009) financial crisis, GDP growth and stock markets collapsed *simultaneously* in most countries around the globe. Yet, the crisis was triggered by a financial shock in the US, namely an unanticipated fall in US house prices that led to massive mortgage loan defaults by US households, and thus impaired the health of US and foreign banks that had invested in the US mortgage market. Earlier episodes of 'financial contagion' included the 1997-1998 crises, during which financial troubles that originated in Asia and Russia rapidly spread to other Emerging Market economies. The 1997-1998 crises spawned a sizable empirical and theoretical literature on mechanisms by which a financial crisis is strongly and rapidly transmitted across countries. That literature highlights that contagion may occur through a variety of channels (trade linkages, credit flows, changes in investor sentiment etc.). It points out that financial frictions are needed for financial strains to disrupt real activity. For in the theoretical world of frictionless financial markets, the financial side of the economy is a veil only, and risks are hedged efficiently. Hence, a shock to any individual may be transmitted to all others, but there is nothing wrong with this. But with financial frictions, risk sharing is incomplete, and financial shocks spill over to real activity.

This paper discusses recent theories of 'financial contagion' in which balance sheets of global banks (and other financial institutions) are the key channel of international transmission. This is motivated by the fact that the 2007-2009 crisis in the US mortgage market was transmitted to the rest of the world through cross-country banking linkages. By contrast to earlier contagion episodes, linkages due to international goods trade were of secondary importance in the global spread of the 2007-2009 crisis (countries with close trade links with the US did not suffer more than countries with weaker trade links to the US).

Empirically, the bulk of bank assets is financed by short-term debt; banks' own funds (bank capital) only account for a small fraction of total assets. Furthermore, bank assets generally have a longer maturity and are less liquid than bank liabilities. This is a source of fragility that magnifies the effect of crises. In a globalized financial system, banks hold domestic and foreign securities (stocks, bonds), and they lend to domestic and foreign households and firms; banks in different countries also lend to each other. An

adverse macroeconomic or financial shock in *one* country that lowers the capital of global banks may thus trigger a *global* asset sell-off and a *global* decrease in bank lending (credit crunch), provoking a *global* recession.

These channels of contagion are further explained below. Section 2 discusses international contagion due to portfolio adjustments of global banks, in response to an asset price shock in one country. Section 3 considers the role of the interbank linkage for international contagion. Section 4 discusses bank runs and self-fulfilling international financial crises.

2. Bank balance sheet adjustments as a channel of contagion: the international financial multiplier

Financial intermediaries, henceforth referred to as 'banks', make loans and invest in securities and other assets (e.g., real estate). They fund their asset holdings by taking deposits and issuing other forms of debt (mostly short-term), and using the bank's own funds (bank capital): Assets = Debt + Capital. A key constraint on bank activities is that banks have to back at least a fraction of their assets by bank capital: Capital/Assets $\geq k$, for some coefficient $0<k<1$. Hence, only a maximum fraction $1-k$ of bank asset holdings can be funded by debt. A constraint of this type is known as a 'bank capital requirement'. It can reflect a regulatory (legal) requirement, or market pressures. Bank capital requirements protect the interests of bank creditors. For bank capital is a buffer against a fall in the value of bank assets, and thus lowers the risk of insolvency. Also capital requirements help to limit moral hazard by bankers. A simple story is that bankers can walk away with a fraction k of bank assets without prosecution (and start a new life next period). Banks will then only be able to borrow if bank capital does not fall below a fraction k of assets.

The ratio of a bank's capital to her assets is called the 'capital ratio'; the inverse of the capital ratio is the 'leverage ratio'. If the expected return on bank assets exceeds the interest rate on bank debt, then banks have an incentive to borrow the maximum amount, and thus the capital ratio will stay close to the required capital ratio k. Empirically, the capital ratios of the major European banks and of major US *investment* banks have typically ranged between 3% and 5% in the period 1995-2010, while the capital ratios of US *commercial* banks have generally been in the range of 7%-8%.

As shown below, low capital ratios imply that asset price changes may trigger sizable adjustments of banks' asset holdings and debt positions. When banks are globally active, then *local* (country-specific) shocks can hence induce sharp and synchronized *world-wide* asset price changes. Those asset price movements can feed into real activity, and thus induce global booms and recessions. In an influential 2008 paper, Paul Krugman refers to this mechanism as the 'international financial multiplier'. This mechanism has become more and more powerful in recent decades, as the banking industry has become globalized. For example, external assets and liabilities of US banks (each) represented about 30% of US GDP in 2009; for Germany, France and the UK, external bank assets and liabilities represent more than 100% of domestic GDP.

Consider the following numerical example of a world with two countries of equal size, called Home and Foreign (the countries can be viewed as the European Union and the US, respectively). There is a (representative) global bank that holds both Home and Foreign assets (loans, stocks, bonds), and takes deposits from Home and Foreign households. The bank wishes to allocate 50% of her total assets to Home (Foreign) assets. Let k=0.05, i.e. the bank has to fund at least 5% of her assets using capital. Assume that, initially, the bank holds Home and Foreign assets both worth 50, that her debt is 95, and her capital 5. The initial balance sheet of the global bank is thus:

Assets	Liabilities
Home: 50	Debt: 95
Foreign: 50	Capital: 5

Consider now what happens when the value of the bank's Home assets drops by 0.5 (i.e. by 1%). This might be due to bad news about the future profits (dividends) of Home firms, which lowers the Home stock price; it could also be due to Home credit losses, i.e. defaults by Home households or firms on loans received from the global bank. As a result of this shock, the bank's capital drops to 4.5, i.e. the bank's new balance sheet becomes:

Assets	Liabilities
Home: 49.5	Debt: 95
Foreign: 50	Capital: 4.5

Note that Bank capital falls by a much larger percentage (-10%) than the fall in total assets (-0.5%). The bank's capital ratio is now 4.5/99.5=4.52%, which is smaller than the target ratio (5%).

Unless the bank's shareholders provide new capital to the bank, the bank has to reduce her debt and her total assets by 9.5, i.e. total assets and debt have to fall to 90 and 85.5, respectively--as then the capital ratio is again 5%. Assuming that the bank continues to allocate 50% of her total assets to Home assets, the adjusted balance sheet is:

Assets	Liabilities
Home: 45	Debt: 85.5
Foreign: 45	Capital: 4.5

Thus, the initial 1% fall in the value of Home assets has triggered a much bigger simultaneous reduction of the bank's Home and Foreign asset holdings and of her debt (-10%, relative to the initial balance sheet).

The sale of Home and Foreign assets by the global bank is likely to lead to a (further) fall in Home *and* Foreign asset prices, which then can lead to an additional round of Home and Foreign asset sales etc. This is likely to reduce Home *and* Foreign real activity. The spill over into the real economy may be due to the fact that the asset sell-off makes it harder for firms to fund physical investment projects and to obtain working capital; it also limits the supply of consumption and mortgage loans to households. Investment and consumption will fall thus, which lowers output. A general equilibrium model is needed for a rigorous analysis of these feedback effects (see below).[1] An equivalent vicious circle of *global* asset sales and falling asset prices can also be triggered by an adverse shock that induces depositors (or other bank creditors) in *one* country to withdraw their funds from the global bank. Of course, a similar powerful effect also operates when asset values *rise*. In our numerical example, an initial 1% *rise* in the value of Home assets will, on impact, raise the bank's capital to 5.5, and her capital ratio to 5.47%. In order to again reach a 5% capital ratio, the bank then has to increase her holdings of Home and Foreign assets and her debt by 10% (compared to the initial situation).

Much recent research has been devoted to building quantitative dynamic general equilibrium models with the mechanisms that were just described. Devereux and Yetman (2011) present a model of a two-country world with cross-country trade in equity (claims

[1] A general equilibrium set-up is also required for an account of who buys the assets sold by banks. The buyers are likely to be less productive at managing those assets, which too contributes to the drop in aggregate output.

to physical capital), and in one-period bonds. Within each country there are patient households who save, and impatient households who invest. Investors (who resemble banks) hold domestic and foreign equity, and they face a capital requirement (i.e. maximum debt depends on investor net worth). When the capital requirement does not bind, then the international transmission of macroeconomics shocks is very limited. By contrast, with binding capital requirements, balance sheet linkages across banks generate a powerful mechanism for the international transmission of shocks. Kollmann et al. (2010) model the international transmission of *defaults* on bank *loans*. A two-country world is considered, in which global banks collect deposits from households, and lend to entrepreneurs, in both countries. An unanticipated loan default in *one* country brings about a wealth transfer from banks to entrepreneurs; hence bank capital falls, which impairs the bank's ability to channel funds from savers to borrowers. The deposit rate falls while the loan rate rises, in *both* countries, thus lowering lending, investment and output in *both* countries. The important insight is that a credit loss (default) in *one* country triggers an immediate and identical fall in *both* domestic and foreign output.

3. Financial contagion through interbank linkages

The recent financial crisis has revealed that interbank borrowing and lending is a key channel of international contagion. Because depositors have a preference for liquidity, deposits are generally available "on demand" (demand deposits). But most bank loans have a longer maturity (mortgage loans for instance). The reason why banks can engage in such a "maturity transformation" is that normally not all depositors withdraw their funds at the same time (one may think that, on average, withdrawals are compensated by new deposits). Still, banks must be able to cope with unexpected large withdrawals. For this reason, banks hold a fraction of their assets in cash or other liquid assets (i.e. in assets that can easily and rapidly be turned into cash). When choosing her holdings of liquid reserves, a bank faces the following trade-off: on the one hand, any Euro held in reserves earns the bank less interest than loans; on the other hand, if the bank does not hold enough reserves to face unexpected high withdrawals, it will have to sell less liquid assets on short notice, often at "fire sale" prices. Banks may respond to this uncertainty by holding demand deposits in other banks. Such cross-holdings of deposits allow banks to

re-allocate cash among themselves, according to their respective liquidity needs. That mechanism improves the efficiency of the banking system: for a given total liquid assets held by the banking system, each bank will be able to cope with larger idiosyncratic deposit withdrawals. Banks thus need lower total reserves to hedge against a given amount of withdrawal risk by households. Hence, they can issue more loans, which raises real activity.

This logic holds for banks within a country, but also across banks in different countries, as deposit withdrawals are likely to be imperfectly correlated across countries. Imagine, for example, that there is a natural disaster in one country and that its residents draw on their deposits at the local banks to fund unanticipated spending. This is likely to be independent of deposit withdrawals by households in other countries. Banks in the country in which the disaster occurs can more easily meet deposit withdrawals if they hold deposits in foreign banks. International cross-holdings of deposit thus facilitate international risk sharing, but they also imply that an unexpected withdrawal in one country may impact on real activity in other countries. For instance, a bank could be forced to cut its lending in order to fulfill its obligations towards her foreign counterparts. Also, for the reasons explained above, banks may end up holding less total liquid assets when there is risk-sharing via interbank linkages. This implies that a system of global interbank linkages is more resistant to a *local* increase in withdrawals, but that it may be less able to resist infrequent *global* shocks. *Global* crises might hence be magnified by cross-country interbank linkages. In this respect, the precise structure of the interbank linkages is crucial. A network in which all banks are directly linked to each other is most resilient. If setting up such a network is too costly, then it is preferable to have a series of smaller networks, rather than a 'chain' that indirectly connects all banks. The intuition for this is that, in a 'chain', if a bank faces a negative shock, it might force the next bank in the chain to liquidate assets at fire-sale values; this, in turn, can trigger fire-sales by another bank, and so on and so forth; hence, a smaller initial shock suffices to bring about the collapse of the entire system (than in a 'complete network').

The notion of balance sheet contagion has several other applications that are explored in the next section.

4. Bank-runs and self-fulfilling international crises

The maturity mismatch of bank balance sheets exposes banks to the risk of 'bank-runs', which can lead to self-fulfilling international financial crises.

As explained above, banks are able to borrow short-term and lend long-term because, in normal times, not all deposits are withdrawn at the same time. A run occurs when depositors panic and try to withdraw their money simultaneously. Imagine you are a depositor, and that you do not need your money now, and thus have no fundamental reason to withdraw. However, you know that if all depositors demand their money back at the same time, then the bank will be in trouble: it will have to sell its assets at fire-sale price, which might imply that the bank would fail. Whether you should withdraw depends thus on your expectations about the behavior of other depositors. This can lead to two possible outcomes. A no-bank-run equilibrium: expecting that no-one will withdraw, you are better-off not withdrawing; this is true also for others depositors; hence, no-one withdraws. There is also a bank-run equilibrium: expecting others to run, you are better-off running as well--if you wait, the bank will deplete her assets, and fail, before you show up; this is of course true for other depositors too, and a "bank run" can thus become a self-fulfilling prophecy.

This simple story applies too to emerging market countries. Note that these countries usually borrow short-term to finance longer term projects. They hence face the risk of a run. A run on a country is usually called a "sudden-stop" (of capital inflows). The basic story can also be enriched to study the cross-country contagion of self-fulfilling crisis.

Consider for instance two countries, each with a bank, and imagine that all depositors decide to run in the first country. If depositors in the other country believe that this will lead to a run in their country too, there will be a run. However, if depositors think the opposite, there will be no run. Note that this is the case even if the two countries are autarkic. This purely self-fulfilling equilibrium is therefore consistent with both international contagion and the absence of contagion. In reality, though, bank runs (or sudden-stops) usually follow the disclosure of some unfavorable news about economic fundamentals. Formal models of runs show that there is generally a threshold for the liquid reserves of the bank (or the economy) below which a run can occur. The bank run

threshold theory is useful for thinking about contagion because, when the same investors lend to banks in different countries, then a run in one country can affect the likelihood of a bank run in other countries. Assume for instance that there is a run in the first country, and that investors loose a substantial amount of money. Then, they might be more concerned about facing the risk of a run in the second one, and as a result a run in the second country becomes more likely. This can, for instance, happen when investors have decreasing absolute risk aversion, which implies that losses make them more risk averse. This story applies also to speculative attacks on an exchange rate peg. Imagine that speculators successfully attack the peg of a first country and thereby make sizable profits. Then they will be more eager to attack the currency peg of another country. Note that this mechanism also works the other way around: a failed attack decreases the probability of a successful attack on another currency peg.

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