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Guillaume Plantin*, Haresh Sapra**, and Hyun Song Shin***

Abstract

This paper explores the financial stability implications of mark-to-market accounting, in particular its tendency to amplify financial cycles and the "reach for yield". Market prices play a dual role. Not only do they serve as a signal of the underlying fundamentals and the actions taken by market participants, they also serve a certification role and thereby influence these actions. When actions affect prices, and prices affect actions, the loop thus created can generate amplified responses - both in creating bubble-like booms in asset prices, and also in magnifying distress episodes in downturns.

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1　Introduction

Recent developments in financial markets have posed a challenge to commentators in their assessment of financial imbalances and the outlook for financial stability. On the one hand, signals emanating from the financial markets - in the form of low long-term interest rates, compressed yield spreads and low implied volatility - seem to indicate a benign economic outlook, underpinned by generally strong corporate and sovereign balance sheets and well-anchored inflation expectations. However, commentators also point to the vulnerability of the benign outlook to several sources of down-side risk, including doubts over the sustainability of the current pattern of global capital flows, the possibility of more aggressive tightening of official interest rates, and more generally, an overall re-pricing of credit risks (see, for instance, Bank of England (2004a, 2004b) and IMF (2005a, 2005b)).

One phenomenon that has received particular attention is the "search for yield", otherwise known as the "quest for yield" or the "reach for yield", in which financial intermediaries and investors react to the compression of yield spreads by migrating down the spectrum of credit risk to higher yielding, riskier assets. The greater flow of funds into the riskier asset classes then further contribute to the compression of yield spreads, inducing migration yet further down the risk spectrum. Central bankers and other public officials have expressed some concern at this phenomenon, airing worries that the true risks are being underpriced by the market. The Bank of England, in its most recent *Financial Stability Review* puts the matter thus.

> "Financial intermediaries and investors appear to have continued their 'search for yield' in a wide range of markets, holding positions that could leave them vulnerable to instability in the pattern of global capital flows and exchange rates, credit events or sharper-than-expected interest rate rises. A number of market participants have also discussed the possibility that risk is

1

being underpriced. In the event of an adverse shock, any over-accumulation of exposures from the mis-pricing of assets may result in an abrupt, and costly, adjustment of balance sheets." [1]

Our paper is an attempt to shed light on the phenomenon of "search for yield", focusing particular attention on the role of the accounting regime. It is our contention that, when combined with other trends in financial markets (such as financial innovation and the greater stress on short-term incentives), the marking to market of assets and liabilities may play an important role in the propagation of market dynamics that lead to the search for yield.

The proponents of marking to market have emphasized many of its merits. The market value of an asset reflects the amount at which that asset could be bought or sold in a current transaction between willing parties. Similarly, the market value of a liability reflects the amount at which that liability could be incurred or settled in a current transaction between willing parties. A measurement system that reflects the market values of assets and liabilities would, it is argued, provide a more accurate indicator of the true economic exposures faced by a firm, and hence lead to better insights into the risk profile of the firm currently in place so that investors could exercise better market discipline and corrective action on the firm's decisions. See Borio and Tsatsaronis (2004) for a wide-ranging discussion of accounting and financial stability.

The accounting scandals of recent years have further strengthened the hands of the proponents of fair value accounting. By shining a bright light into the dark corners of a firm's accounts, fair value accounting precludes the dubious practices of managers in hiding the consequences of their actions from the eyes of investors. Good corporate governance and fair value accounting are seen as two sides of the same coin.

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[1] *Financial Stability Review*, December 2004, p. 49, Bank of England, available on http://www.bankofengland.co.uk/fsr/fsr17.htm

The US Savings and Loans crisis is a case in point. The crisis stemmed in part from the fact that the (variable) interest rates on the S&Ls' deposit liabilities rose above the (fixed) rates earned on their mortgage assets. Traditional historical cost accounting masked the problem by allowing it only to show up gradually through negative annual net interest income. The insolvency of many S&Ls became clear eventually, but a fair value approach would arguably have highlighted the problem much earlier, and resolved at lower fiscal cost. See Michael (2004) for further elaboration of this point.

However, the arguments are far from being one-sided. Market prices play a dual role. Not only are they a reflection of the underlying fundamentals and actions, but they also *affect* the market outcome through their influence on the actions of market participants. A crude example of such an effect would be the loss of discretion that results when regulatory solvency requirements dictate the cutting of risky positions in the face of adverse price movements. However, the feedback from prices to actions also work through more subtle channels. The managers of a publicly traded bank are accountable to their shareholders, and the various mechanisms put in place to ensure good governance, accountability and transparency will place subtle (and sometimes not so subtle) constraints on actions. Thus, the management of a bank whose return on equity is lagging behind its peer group will feel pressure to remedy this by leveraging up its balance sheet, changing the composition of its portfolio, or cutting costs. Hedge funds, or hedge fund-like institutions who have promised a minimum absolute return on equity will feel such pressures even more acutely. Accounting numbers provide a powerful spur to managers in their actions. They serve a certification role, and hence provide justification for actions. In short, market prices serve the dual role of both *reflecting* the actions of market participants, but also serving as an *imperative* for future actions.

If decisions are made not only because you believe that the underlying fundamentals are right, but because the prices give you the external valida-

tion to take such decisions, then there is the potential for a loop whereby prices affect actions, and actions affect prices. Once the loop is established, price changes may be amplified by endogenous responses within the financial system. Mark-to-market accounting gives added potency to market prices by endowing them with the external validation role for actions.

The arguments of the proponents of fair value accounting would be overwhelming in the context of completely frictionless markets where market prices fully reflect the fundamental values of all assets and liabilities. The benchmark results from economics - the efficiency properties of competitive equilibria - could then be invoked, and no further argument would be necessary. However, when there are imperfections in the market, the superiority of a mark-to-market regime is no longer so immediate. The relevant analogy here is with the "theory of the second best" from welfare economics. When there is more than one imperfection in a competitive economy, removing just one of these imperfections need not be welfare improving. It is possible that the removal of one of the imperfections magnifies the negative effects of the other imperfections to the detriment of overall welfare. Thus, simply moving to a mark-to-market regime without addressing the other imperfections in the financial system need not guarantee a welfare improvement.

The policy debate on accounting standards for financial firms has been given a sharper focus by the controversy surrounding the implementation of International Accounting Standard (IAS) number 39 governing the accounting treatment of derivatives, itself modelled closely on its US counterpart, SFAS 133. The European Union had initially set a deadline of January 2005 for all publicly quoted companies in the European Union - over 7,000 of them - to adopt IAS 39. However, the run-up to this deadline was fraught with controversy, and the EU decided to strike out key provisions of IAS 39 that relate to hedge accounting and mark-to-market rules. Discussions are still on-going (see Goodhart and Taylor (2004) for a survey).

It would only be partially true to say that the hostility toward IAS 39 is

4

attributable to its fair-value provisions. Rather, the hostility arises from the way that IAS 39 prescribes a "mixed attribute" classification, where some items are valued at market prices, but others are carried at historical cost. IAS 39 requires items on the balance sheet to be placed in four categories:

- Originated loans

- Held-to-maturity (HTM) investments

- Financial assets available for sale (AFS)

- Trading assets and other items measured at fair value

Originated loans and held-to-maturity investments are held at amortised cost. AFS assets are marked to market, but valuation changes are fed directly to shareholder equity (not via the profit and loss account). For trading assets, not only are they marked to market, but valuation changes are taken through the profit and loss account. Crucially, IAS 39 requires all derivatives to be marked to market and any changes in their valuations are to be put through the profit and loss account, unless the derivative is used to hedge cash flow and stringent hedge-accounting criteria are satisfied. IAS 39 sets out stringent hedge-accounting rules whereby the hedging relationships should be clearly documented, reliably measurable and actually effective.

Until recently, a thorough-going marking to market of financial assets and liabilities has been limited by the lack of reliable prices in deep and liquid markets. Loans, for instance, have not been traded in large enough quantities to give reliable prices. The lack of standardisation has also been an impediment to marking the loan book to market. These practical hurdles account for the "mixed attribute" nature of IAS 39.

All this is about to change. The advent of deep markets in credit derivatives is removing the practical barriers to marking loans to market. The

price of a credit default swap can be used to price a notional loan corresponding to the standardised counterpart of such a loan, much like the price of a futures contract on a bond which indicates the price of a notional bond.

Thus, whereas the debate on full-blown marking to market has not yet taken place, it is easy to envisage such discussions taking place in the very near future. Our paper is an attempt to anticipate this debate, and air some of the issues at stake. Due to the double-edged nature of marking to market mentioned above, it would be reasonable to suppose that the conduct of financial institutions will be changed irretrievably by mark-to-market accounting. Mark-to-market accounting has already had a far-reaching impact on the conduct of market participants through those institutions that deal mainly with tradeable securities, such as hedge funds and the proprietary trading desks of investment banks. However, even these developments will pale into insignificance to the potential impact of the marking to market of loans and other previously illiquid assets.

The greater immediacy of fair values for capital and profitability may become a source of procyclicality, in which the cycles of boom and bust are amplified. In buoyant economic conditions perceived credit risk might decline, leading to a rise in the fair value of banks' assets, which would in turn boost bank capital and encourage an increase in lending, so strengthening the economic upswing. These same effects would go into reverse with a vengeance in downturns. As the economy declines, perceived credit risk increases, leading to a fall in the marked-to-market value of banks' assets, which would in turn erode banks' capital. This will result in a credit crunch which could reinforce the downturns. A recent position paper from the European Central Bank conducts simulation exercises on EU banks' assets and capital that suggest strong potential for amplification of the credit cycle (see ECB (2004)). The effects of fair value accounting could, therefore, have far reaching consequences for the overall stability of the economy.

The regulators are aware of these dangers. The Basel Committee issued a

6

press release in 2004[2] suggesting that credit improvements due to asset price fluctuations on the balance sheet should be disallowed for the purposes of calculating regulatory capital so as to short-circuit some of these procyclical effects (the idea being that changes in bank capital resulting from cash flow hedges should not be fed directly into the calculation of tier 1 and tier 2 capital for regulatory purposes). However, whatever the adjustments made by the regulators, it is clear that the incentives for market participants will become sharpened by marking to market, and lead to amplification of the feedback mechanisms operating in the financial markets. The question would be *by how much*, rather than *whether*.

In what follows, we illustrate the amplifying effects of marking to market by outlining an example of a financial system, and exploring the consequences of the marking of assets and liabilities to market for market dynamics and asset prices. The example is not a fully-fledged model, but is rather an informal discussion that can serve as the precursor to such a model. As such, we will appeal to rather sweeping assumptions that belong only to a thumbnail sketch. However, we believe that the main factors identified in the framework can be given a fuller description in a more developed model.

2   Simplified Financial System

We develop our arguments in a highly simplified financial system that has three main constituents - households, financial intermediaries and pension funds.

The financial system is built solely on property, which is held by households. The households finance part of their holding of property by borrowing from the financial intermediaries. Households also have other assets. They hold a claim on the pension funds in the form of annuities and future pen-

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[2]See the press release of the Basel Committee on Banking Supervision on 8th June 2004, available on http://www.bis.org/press/p040608.htm
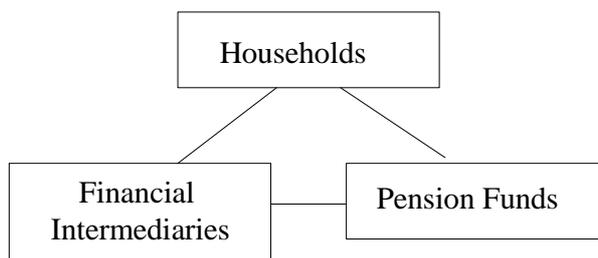
Figure 1: Constituents of Financial System

Figure 2: Household Balance Sheet

sion claims. They are also equity holders in the financial intermediaries and pension funds. These other assets as indicated on the balance sheet of the households, as depicted in figure 2.

The aggregate balance sheet of the households masks the diversity of the individual households. Some households would be more leveraged than others. The response of the household sector to changes in property prices will depend on the distribution of the mortgage liabilities within the sector. We return to this issue below.

The financial intermediaries lend to the households in order to finance the purchase of property, and the household mortgages constitute the main asset of the financial intermediaries. In turn, the intermediaries finance

8

their lending by issuing liabilities in the form of marketable bonds. We will assume that these bonds are perpetuities that pay a constant coupon, so that the bond's payoffs stream is $(1, 1, 1, \cdots)$.

The financial intermediaries in our framework are reminiscent of the mortgage agencies in the U.S. such as Fannie Mae. In our framework, the only real asset that underpins the financial system is property, but a more realistic framework would incorporate firms who would borrow from households by issuing corporate bonds. Claims on sovereigns could also be incorporated in a more developed framework. For our purposes, confining attention to property as the sole real asset has the virtue of narrowing down the questions. The balance sheet of the financial intermediaries is given as in figure 3.

Figure 3: Balance Sheet of Financial Intermedicaries

Pension funds hold a combination of cash and the bonds issued by the financial intermediaries on the asset side of their balance sheet. With these assets, they must meet the pension liabilities to the households. The balance sheet of the pension funds can be depicted as in figure 4.

9

Figure 4: Pension Funds' Balance Sheet

2.1 Marking Liabilities to Market

Pension funds hold a combination of cash and the bonds issued by the financial intermediaries in order to meet the pension liabilities to households. We will suppose that the pension funds are subject to regulations that require them to mark their liabilities to market (for instance, FRS 17 in the U.K.). In addition, we will assume that the pension funds are required by regulation to match the duration of their liabilities by holding assets of similar duration.

In order to mark their liabilities to market, the pension funds must calculate the present value of their stream of pension liabilities using the appropriate discount rate. In our simple framework, we do not have the full range of maturities of fixed income claims in order to accomplish this. We assume, as a crude approximation, that the zero coupon curve used to calculate the present value of pension liabilities is flat, with the intercept given by the yield of the perpetuity issued by the financial intermediary. Thus, if the price of the perpetuity is p, then the yield on the perpetuity is r such that

$$p = \frac{1}{r}$$

and the zero coupon curve used to calculate the pension liabilties is given by

$$(r, r, r, \cdots)$$

The pension funds are required by regulation to match the duration of their liabilities by holding assets of similar duration. The duration (or more accurately, the 'modified duration') of the perpetuity is the sensitivity of its price to changes in its yield. The duration of the perpetuity is defined as

$$D = -\frac{dp/dr}{p}$$

and since $p = 1/r$, the duration of the perpetuity is given by

$$D = p$$

so that the duration of the bond moves one-for-one with its price. Moreover, since the price of the bond determines its yield, and the pension fund marks its liabilities to market according to the yield on the bond, the marked-to-market value of the pension liabilities will depend on the price of the bonds issued by the financial intermediaries.

Assume that the pension funds' liability stream is the sequence

$$(\lambda_1, \lambda_2, \lambda_3, \cdots)$$

where $\lambda_1 < \lambda_2 < \lambda_3 < \cdots$. The increasing liability stream may reflect, for instance, the fact that pension flows grow with nominal earnings, and earnings rise over time. The implication of the upward-sloping profile of pension liabilities is that a unit of the pension liability stream that has the same price as the agency bond has, nevertheless, a higher duration. In other words, if q is the marked-to-market value of a unit of the pension liability such that $p = q$, we nevertheless have

$$-\frac{dq/dr}{q} > -\frac{dp/dr}{p}$$

The pension funds must match the duration of their liabilities by holding

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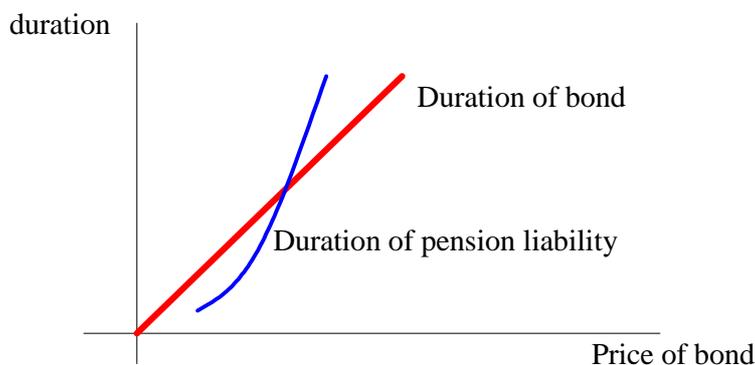
Figure 5: Duration of Pension Liability

the appropriate quantity of bonds. Since the duration of their liabilities is not replicated perfectly by the bonds, the pension funds must adjust their holding of bonds in response to changes in the price of the bond.

The demand for bonds turns out to be upward-sloping. Figure 6 illustrates the derivation of the demand for bonds by the pension funds, as shown in the top right hand panel. This relationship is derived as follows. The top left hand panel shows how the duration of the bond is increasing in its price. The bottom left hand panel shows that the duration of pension liability is an increasing function of the price of the bond. The key is the bottom right hand panel. Since the duration of the pension liability is higher than the duration of the bond, any increase in the duration of the bond will lead to an even greater duration of the pension liability, and the pension fund must hold more of the bond (and less cash) in order to match the overall duration of the liability. This leads to the upward-sloping demand for bonds.

The consequence of the duration matching requirement for pension funds is to restrict their discretion in choosing their portfolio. In response to the fall in the yield of the bond, their reaction is the perverse one of increasing their holding of the bond still further. We now turn to how the market for bonds may interact with that for property.

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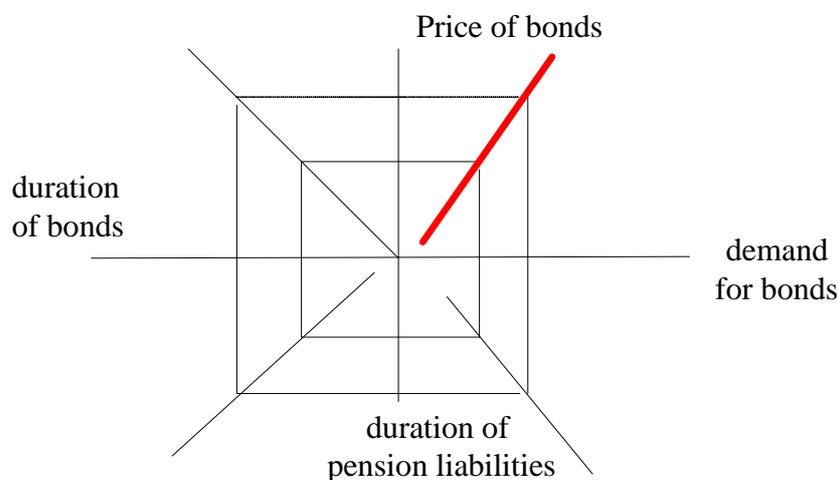
Figure 6: Pension fund demand for bonds

2.2   Bond Issuance and Property Prices

Faced with the increased demand for bonds by the pension funds, the financial intermediaries must decide whether to accommodate the increased demand by issuing more bonds.   If they do so, the financial intermediaries will be increasing the size of their liabilities, but in return will be obtaining cash on the asset side of their balance sheets.   The question is what the financial intermediaries are able to do with the cash that is so obtained.

We will assume that the financial intermediaries can always find households that are willing to borrow from them in order to finance the purchase of property.   Thus, from the point of view of the financial intermediaries, they can always accommodate the greater demand for bonds by issuing new bonds, and lending the proceeds out to households, thereby increasing the mortgage claims on the households.   In effect, the financial intermediaries respond to the greater demand for bonds by increasing the size of their balance sheet - by increasing the amount of bonds outstanding and increasing mortgage claims against households.

The upshot of our assumption on the behaviour of the financial inter-

13

mediaries is that an increase in the demand for bonds by the pension funds leads to a net flow of funds into the property sector, via the financial intermediaries' balance sheets. The response of property prices to this increased flow into the property sector is crucial to our story.

It is important for our framework that the greater flow of funds into the property sector leads to an increase in property prices. A very simple way to achieve this is to assume that the price of property is established by "cash in the market" pricing, where the price is the ratio of the funds seeking to purchase property to the available supply of property. This is a variation of the Shapley and Shubik (1977) model of trade between commodities in which the price of one good in terms of another is the ratio of the quantities offered in exchange. Allen and Gale (2002, 2004) and Diamond and Rajan (2005) have recently popularized this approach to price determination in financial markets for the study of market liquidity.

Cash in the market pricing is illustrated in figure 7. If M dollars of funds are seeking to purchase property and there is supply s of property on the market, then the price of property is v dollars, where

$$v = \frac{M}{s}$$

This is equivalent to the outcome in a competitive market where the demand for property is the rectangular hyperbola M/v, and the supply is fixed at s. Figure 7 illustrates that when M increases, there is an outward shift in the demand curve and the price of property increases to v'.

Bringing the various elements of the story together, we can now trace the impact of the pension funds' increased demand for bonds on property prices. We have already commented above that as the price of bonds p increases, pension funds demand a larger holding of bonds. The financial intermediaries accommodate this increased demand for bonds by issuing new bonds, and lending out the proceeds from the bond issuance to households in return for mortgage claims against households. Finally, the households
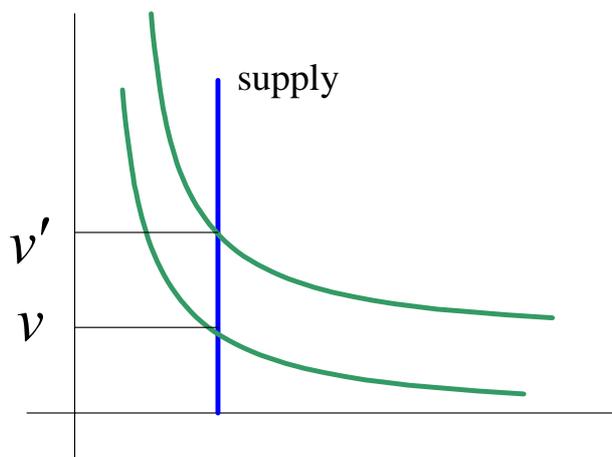
Figure 7: "Cash in the market" pricing of property

then invest the borrowed funds in the property sector, raising the price of property v. Thus, an increase in bond price p is associated with an increase in property price v. We can thus define $v(p)$ as the price of property that is consistent with bond price at p. Figure 8 depicts this function.
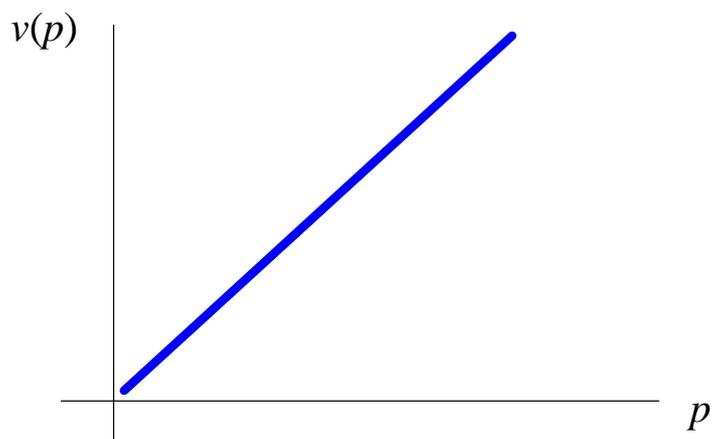

Figure 8: Property price as function of bond price

3   Search for Yield

As property price increases, the net worth of the household borrowers who
have invested in property increases. To the extent that the loans to the
household sector are collateralised against property, the rise in property price
raises the credit quality of the mortgage claims held by the financial inter-
mediaries against household borrowers, raising the marked-to-market value
of the assets on the financial intermediaries' balance sheets. In turn, the
increase in the marked-to-market value of the mortgage claims increases the
marked-to-market net worth of the financial intermediaries, leading to an
improvement in the credit quality of the bonds issued by the financial inter-
mediaries. We thus have the following chain of implications.

$$v \text{ increase}$$
$$\Downarrow$$
$$\text{increased household net worth}$$
$$\Downarrow$$
$$\text{increased net worth for FIs}$$
$$\Downarrow$$
$$p \text{ increase}$$
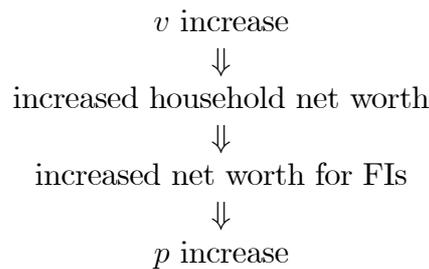
Thus, we can define the value $p(v)$ for the price of bonds that is an in-
creasing function of the price of property. Figure 9 illustrates this increasing
relationship. Since the increase in p is due to the increasing value of the
assets that back the bond, there is an upper bound to p given by the price
of the risk-free counterpart to the bond. This upper bound is indicated by
the dotted line.

We can now bring the ingredients together to examine how the price of
property interacts with the price of the bond. Let us define $h(.)$ as the
inverse of the function $v(p)$. Thus, $h(v)$ is the price p of the bond that
would give rise to price v of property. Plotting $h(v)$ and $p(v)$ on the same
figure, we can derive the combination (v, p) of property price and bond price
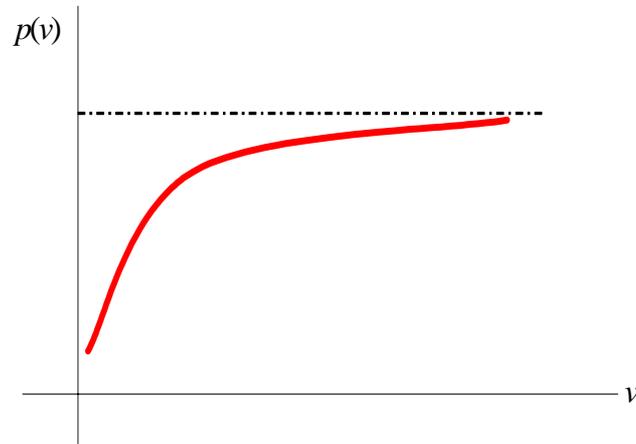
Figure 9: Bond price as a function of property price

that would be mutually consistent. This is indicated in figure 10. With this
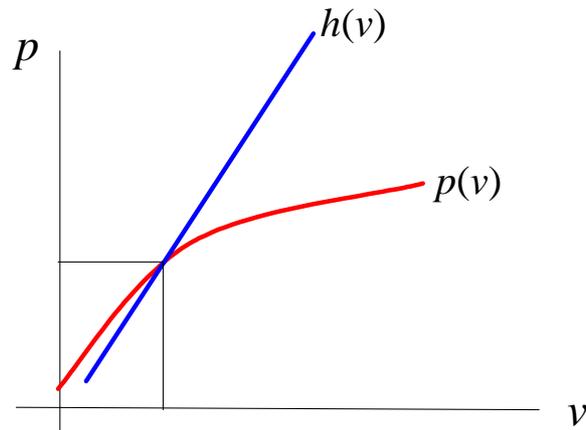
Figure 10: Joint determination of v and p

framework, we can conduct some comparative statics with respect to some of the key quantities. Let us consider first the effect of looser monetary policy (both through official interest rates and communication strategies) that induces a fall in the yield of long-maturity treasuries. See figure 11.

As the yields on long-maturity treasuries decline, this induces a shift upward in the price of bonds that is commensurate with the perceived risk-
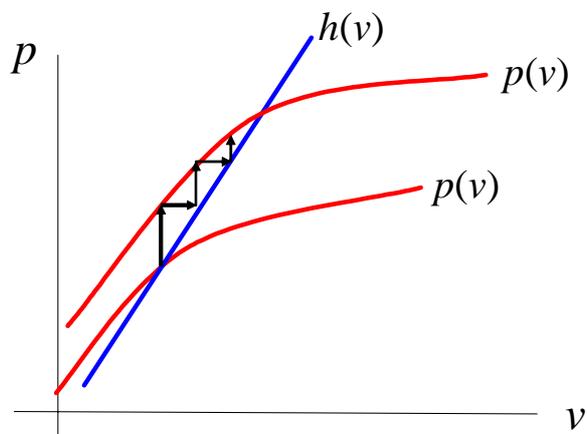
Figure 11: Effect of looser monetary policy

premium. This initial movement is indicated by the upward pointing arrow following the upward shift in the $p(v)$ curve. However, this initial change sets off a response from the property market. The higher price of bonds increases the demand for bonds from the pension funds, and this increased demand is accommodated by the financial intermediaries. The proceeds from the bond issue ends up in the property market, driving up the price of property. This second round effect is indicated by the horizontal arrow pointing right, indicating an increase in v, the price of property.

The knock-on effects then propagate through the financial system. The second-round increase in v feeds through to higher credit quality of the bonds, which induces a further increase in the price of bonds. This is indicated by the second vertical arrow, representing an increase in the price of bonds. In turn, this induces a further increase in property prices, and so on. The financial system finds its new equilibrium where the higher $p(v)$ curve meets the $h(v)$ curve.

The importance of marking assets and liabilities to market cannot be overemphasized. The slopes of the $p(v)$ curve and $h(v)$ are determined by the accounting regime in place, and these slopes largely determine the size

of the comparative statics effects. To see this, let us contrast the effect of looser monetary policy in a regime where neither assets nor liabilities are marked to market. Figure 12 illustrates the argument.

When liabilities are not marked to market, the channel of feedback from
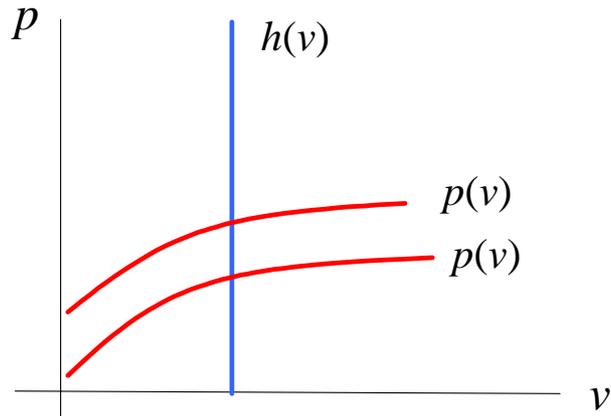
Figure 12: Historical cost regime

the price of bonds to the price of property is severed. Thus, the $h(v)$ function is vertical, indicating that the price of bonds does not have an effect on the price of property. The $p(v)$ curve may also be flatter as compared to the case when assets are marked to market due to the lesser impact of the credit improvement of the bonds. However, this feature is less important for what is to follow. The key difference between the mark-to-market regime and the historical cost regime is that the feedback channel from bond prices to property prices is less potent. The effect of looser monetary policy is simply to raise the price of bonds commensurate with the fall in the long-run treasury rate, but the second round impact on property price is blocked due to the vertical $h(v)$ curve. Under the historical cost regime, the endogenously induced increase in property price does not materialise.

19

4 Reversal

The mechanism outlined above that produces the upward shift in asset prices could also be envisaged in its reverse form, where an initial shock to the system produces an amplified response of asset prices downwards. In the downward direction, additional impetus could come from constraints on the actions of the financial intermediaries themselves. These additional channels will be discussed below. We begin, though, by working through the reversal of the mechanism that we have outlined above. Figure 13 illustrates the argument.
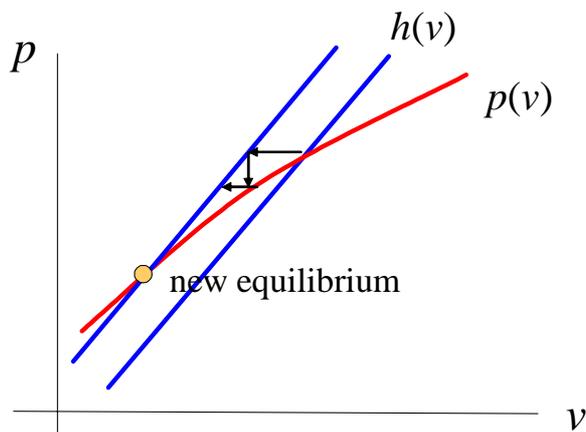
Figure 13: Fall in asset prices

Starting from the initial intersection of the $h(v)$ curve and the $p(v)$ curve, we follow through the impact of an exogenous fall in property prices, as represented by the leftward shift in the $h(v)$ curve. The first horizontal arrow pointing left is the initial fall in property price. This fall in property price lowers the equity value of households, and so lowers the marked-to-market value of the mortgage assets held by the financial intermediaries. In turn, this fall in the value of the financial intermediaries' assets lowers the credit quality of the bonds issued by them, leading to a fall in p. This fall in

p is represented by the vertical arrow pointing downward in figure 13. The fall in p then lowers the pension funds' holding of bonds. The sale of bonds by pension funds would have to be absorbed by other alternative holders. In our simplified model, it is the financial intermediaries themselves who absorb the excess supply of bonds, and cancels them while at the same time reducing their loans to the household sector, which then leads to a decrease in the funds devoted to property, leading to a fall in the property price v.

This particular sequence sketched above is, of course, peculiar to our simplified model. The important overall feature that is necessary for the story is that a fall in the bond price (a rise in the long term interest rates in bonds) leads to a fall in the property price. If we envisage the financial institution as being a mortgage agency such as Fannie Mae, then this particular feature would seem quite natural. The rise in long-term interest rates would be associated with a rise in mortgage rates, and this would have a dampening effect on the property market.

Figure 13 illustrates the interaction of the property price and the bond price following the further fall in property price. The credit quality of the assets backing the bonds decline further, leading to a further fall in bond price, which then translates into sales of bonds by pension funds and further falls in the property price. The financial system comes to rest at the new intersection point where both the property price and the bond price are considerably lower than their initial values. Depending on the relative slopes of the two curves, the eventual impact of a fall in asset prices can be very substantial. Again, the accounting regime plays a key role.

4.1 Regulatory Capital Requirements

Mechanisms that operate "on the way down" may differ from the mechanisms that operate "on the way up". To elaborate on this point, let us modify our story somewhat by supposing that the financial intermediaries hold property

directly on their balance sheet, and that they mark their holding of property to market. Neither of these assumptions is appropriate in normal times, but they are a good approximation to the situation following the bursting of a property bubble where defaulting borrowers have put property assets back to the lenders. For convenience, we refer to these intermediaries simply as "banks". Thus, the balance sheet of the banks look as below in figure 14.

Figure 14: Bank balance sheet

Assume that the assets held by the bank attract a regulatory minimum capital ratio, which stipulates that the ratio of the bank's capital - here taken to be simply its net worth - to the marked-to-market value of its assets must be above some pre-specified ratio r^*. When a bank finds itself violating this constraint, it must sell some of its assets so as to reduce the size of its balance sheet.

We continue to denote the price of land as v. Further, let us denote bank i's holding of property by e_i, its holding of other assets by c_i, and its liabilities as l_i. It would be straightforward to extend this framework to take account of interbank loans (see Cifuentes, Ferrucci and Shin (2004)). If we denote by s_i the amount of property sold by bank i, and by t_i the sale by bank i of its other assets, the regulatory capital adequacy constraint can be

22

expressed as follows.

$$\frac{ve_i + c_i - l_i}{v\left(e_i - s_i\right) + \left(c_i - t_i\right)} \geq r^* \tag{1}$$

The numerator is the equity value of the bank while the denominator is the marked-to-market value of its assets after the sale of s_i units of property and sale t_i of the other assets. The underlying assumption is that the assets are sold for cash, and that cash does not attract a capital requirement. Thus, if the bank sells s_i units of property, then it obtains vs_i of cash, and holds $v\left(e_i - s_i\right)$ worth of property. Hence, we have the sum of these (given by ve_i) on the numerator, while we have only the mark to market value of post-sale holding of property (given by $v\left(e_i - s_i\right)$) on the denominator. By selling its assets for cash, the bank can reduce the size of its balance sheet, reduce the denominator in the capital to asset ratio, and thus satisfy the minimum capital asset ratio.

By re-arranging the capital adequacy condition (1) together with the condition that s_i is positive only if $t_i = c_i$, we can write the sale s_i as a function of v. If the capital adequacy condition can be met by sales of other assets or from no sales of assets, then $s_i = 0$, but otherwise is given by

$$s_i = \min\left\{e_i, \; \frac{l_i - c_i - \left(1 - r^*\right)ve_i}{r^*v}\right\}$$

Thus, the sale of property s_i is itself is a function of v, and we write $s_i\left(v\right)$ the sales by bank i are a function of the price v. Let $s\left(v\right) = \sum_i s_i\left(v\right)$ be the aggregate sale of property given price v. Since each $s_i\left(.\right)$ is decreasing in v, the aggregate sale function $s\left(v\right)$ is decreasing in v.

Let us suppose that sales of property by banks can be absorbed by other constituents in the economy, provided the price is low enough. To give form to this idea, suppose that there is an exogenous demand function for property given by $d\left(v\right)$. An equilibrium price of property is a price v for which

$$s\left(v\right) = d\left(v\right)$$

23

An initial shock to the property price may have an amplified response, if the additional sales of property cause price to fall further. The argument is illustrated in figure 15.
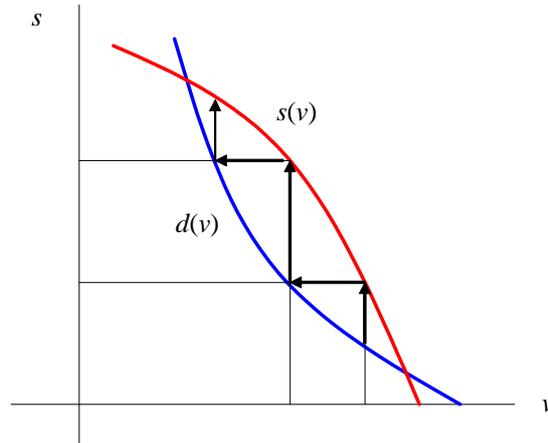

Figure 15: Amplified fall in property price

Consider a shock to the property price. The price adjustment process can be depicted as a step adjustment process in the arc below the $s(v)$ curve, but above the $d(v)$ curve. The process starts with a downward shock to the price of property. At the new lower price the forced sales of the banks places a quantity of property on the market as indicated by the $s(v)$ curve. However, the additional supply of property pushes the price further down as implied by the $d(v)$ curve. This elicits further sales, implying an increased supply as implied by the $s(v)$ curve. Given this increased supply, the price falls further, and so on. The price falls until we get to the nearest intersection point where the $d(v)$ curve and $s(v)$ curve cross. Equivalently, we may define the function Φ as

$$\Phi(v) = d^{-1}(s(v))$$

and an equilibrium price of property is a fixed point of the mapping $\Phi(.)$. The function $\Phi(.)$ has the following interpretation. For any given price v, the value $\Phi(v)$ is the market-clearing price of the illiquid asset that results

24

when the price of the illiquid asset on the banks' balance sheets are evaluated at price v. Thus, when $\Phi(v) < v$, we have the precondition for a downward spiral in the illiquid asset's price. The price that results from the sales is lower than the price at which the balance sheets are evaluated.

The lessons here are quite general. Changes in asset prices may interact with externally imposed solvency requirements or the internal risk controls of financial institutions to generate amplified endogenous responses that are disproportionately large relative to any initial shock. An initial shock that reduces the market value of a firm's balance sheet will elicit the disposal of assets or of trading positions. If the market's demand is less than perfectly elastic, such disposals will result in a short run change in market prices. When assets are marked to market at the new prices, the externally imposed solvency constraints, or the internally imposed risk controls may dictate further disposals. In turn, such disposals will have a further impact on market prices. In this way, the combination of mark-to-market accounting and solvency constraints have the potential to induce an endogenous response that far outweighs the initial shock.

Regulators are familiar with the potentially destabilizing effect of solvency constraints in distressed markets. To take one recent instance, the decline in European stock markets in the summer of 2002 was met by the relaxation of various solvency tests applied to large financial institutions such as life insurance firms. In the U.K., the usual 'resilience test' applied to life insurance companies in which the firm has to demonstrate solvency in the face of a further 25% market decline was diluted so as to preempt the destabilizing forced sales of stocks by the major market players.[3]

The LTCM crisis of 1998 can also be seen as an instance where credit interconnections and asset prices acted in concert as the main channel prop-

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[3]FSA Guidance Note 4 (2002), "Resilience test for insurers". See also FSA Press Release, June 28th 2002, no FSA/PN/071/2002, "FSA introduces new element to life insurers' resilience tests".

agating widespread market distress (see BIS (1999), IMF (1998), Furfine (1999), Morris and Shin (1999)). Furfine, for instance, cites the arguments used by the Federal Reserve to justify intervention during the LTCM crisis in 1998. The Fed wanted to contain the disruption that the liquidation of LTCM would impose on the markets where LTCM was a significant player, in order to avoid the spillover to other market participants without direct credit relationships with LTCM.

More generally, our paper follows the recent theoretical literature on banking and financial crises that has emphasizes the limited capacity of the financial markets to absorb sales of assets (see Allen and Gale (2004), Gorton and Huang (2003) and Schnabel and Shin (2004)), where the price repercussions of asset sales have important adverse welfare consequences. Similarly, the inefficient liquidation of long assets in Diamond and Rajan (2005) has an analogous effect. The shortage of aggregate liquidity that such liquidations bring about can generate contagious failures in the banking system.

One conclusion is that prudential regulation (in the form of minimum capital requirement ratios or other solvency constraints) when combined with mark-to-market rules can sometimes generate undesirable spillover effects. Marking to market enhances transparency but it may introduce a potential channel of contagion and may become an important source of systemic risk.

Of course, any policy conclusions should also recognize the incentive effects of such rules. The adjustment mechanism outlined above only considers the *ex post* stability effects of capital requirements and marking to market for given portfolio choices and not the positive *ex ante* effects on incentives. For example, capital requirements and mark-to-market rules may deter financial institutions from taking excessive risks *ex ante*. However, even if we modelled these ex ante incentive effects explicitly, the level of optimised liquid assets and capital held by financial institutions may still be suboptimal from the point of view of minimising systemic risk as individual institutions do not internalise the externalities of network membership. As long as the

26

problem is one of externalities, leaving it up to individual institutions will not resolve the problem.

4.2 Balance Sheet Interconnections

So far we have not mentioned counterparty risk, or the possiblity of defaults. There has been a substantial body of work that has examined balance sheet interlinkages as a possible source of contagious failures of financial institutions. Most papers calibrate the models using actual cross-exposures in real banking systems (or an approximation of them) and simulate the effects of a shock to the system resulting from the failure of one or more institutions. Sheldon and Maurer (1998) study the Swiss banking system. Upper and Worms (2002) consider the German system. Furfine (1999) analyses interlinkages in the US Federal Funds market. Wells (2002) focuses on the UK banks. Elsinger et al (2002) consider an application to the Austrian banking system, and provide a stochastic extension of the framework (using the concept of value at risk). Cifuentes (2002) uses the same framework to analyse the link between banking concentration and systemic risk.

The main focus of these papers is on finding estimates of interbank credit exposures. Once this is determined, systemic robustness is assessed by simulating the effects on the system of the failure of one bank at a time. Importantly, solvency is assessed based on fixed prices that do not change through time. Such an assumption would be appropriate if the assets of the institutions do not undergo any changes in price, or if solvency is assessed based on historical prices. Invariably, a consistent finding of these papers is that systemic contagion is never significant in practice, even in the presence of large shocks. In the absence of price effects, this is hardly surprising, as interbank loans and deposits represent only a limited fraction of banks' balance sheets. Conventional wisdom is also that collateralisation may have mitigated this risks further.

Cifuentes, Ferrucci and Shin (2004) construct a model that incorporates both channels of contagion - direct balance sheet interlinkages among financial institutions and contagion via changes in asset prices. Their results suggest that systemic risk in network models of bank failure may be quite large when the counterparty risks arising from chains of failures is augmented by changes in asset prices, even in the presence of collateralisation. The reason is that the risk that materialises is not a credit risk but a market risk. This is a dimension to systemic contagion that is not addressed by the usual network models that keep prices constant.

5 Concluding Remarks

Debates on accounting standards have generated considerable controversy, but these debates are likely to become even more prominent in the future, and rightly so. Much hangs on the outcome of these debates.

It can be argued that mark-to-market accounting has already had a far-reaching impact on the conduct of market participants through those institutions that deal mainly with tradeable securities, such as hedge funds and the proprietary trading desks of investment banks. However, even these developments will pale into insignificance to the potential impact of the marking to market of loans and other previously illiquid assets. Financial innovation through the advent of credit derivatives has opened up the possibility of finding surrogate prices for standardized loans, much like the role played by bond futures based on notional bonds. Feasibility is no longer a hurdle to a thorough-going application of marking to market (or will not remain a hurdle for long). The relevant question for policy makers is this: *even if we could mark to market, do we want to*?

Far from being an obscure and arcane debate about measurement, accounting issues take on huge significance for financial stability. In this sense, accounting is too important to be left just to the accountants. It deserves

attention from central bankers and other policy makers as a cornerstone of the policy toward financial stability.

References

[1] Allen, F. and D. Gale (2002) "Financial Fragility," forthcoming in the *Journal of the European Economic Association*, typescript available on http://fic.wharton.upenn.edu/fic/papers/01/0137.pdf.

[2] Allen, F. and D. Gale (2004) "Financial Intermediaries and Markets," *Econometrica* 72, 1023-1061.

[3] Bank for International Settlements (1999): "A Review of Financial Market Events in Autumn 1998", CGFS Publication Number 12, Bank for International Settlements, http://www.bis.org/publ/cgfs12.htm.

[4] Bank of England (2004a) *Financial Stability Review*, June 2004, http://www.bankofengland.co.uk/fsr/fsr16.htm

[5] Bank of England (2004b) *Financial Stability Review*, December 2004, http://www.bankofengland.co.uk/fsr/fsr17.htm

[6] Borio, C. and K. Tsatsaronis (2004) "Accounting, Prudential Regulation and Financial Stability: Elements of a Synthesis" *Journal of Financial Stability*, 1, 111-135.

[7] Cifuentes, R. (2002), 'Banking Concentration and Systemic Risk', presented at the Annual conference of the Central Bank of Chile, December, forthcoming in the conference volume.

[8] Cifuentes, R., G. Ferrucci and H. S. Shin (2004) "Liquidity Risk and Contagion" forthcoming in the EEA conference volume of *Journal of the European Economic Association*, available on http://www.nuff.ox.ac.uk/users/Shin/working.htm

[9] Diamond, Douglas and Raghuram Rajan (2005) "Liquidity Shortages and Banking Crises" *Journal of Finance*, 60, pp. 615

[10] Elsinger, H., A. Lehar and M. Summer (2002), 'Risk Assessment of Banking Systems', Mimeo, Oesterreichische Nationalbank, August.

[11] European Central Bank (2004) *Fair Value Accounting and Financial Stability*, European Central Bank Occasional Paper, No. 13, http://www.ecb.int/pub/pdf/scpops/ecbocp13.pdf

[12] Furfine, C. (1999), 'Interbank Exposures: Quantifying the Risk of Contagion', *BIS Paper*, No 70, June.

[13] Goodhart, C. and A. Taylor (2004) "Procyclicality and volatility in the financial system: the implementation of Basel II and IAS 39" working paper, Financial Markets Group, London School of Economics

[14] Gorton, Gary and Lixin Huang (2004) "Liquidity and Efficiency" *American Economic Review* 94(3), 455-483

[15] International Monetary Fund (1998)*World Economic Outlook and International Capital Markets: Interim Assessment*, http://www.imf.org /external/pubs/ft/ weo/weo1298/ index.htm

[16] International Monetary Fund (2005a) *World Economic Outlook*, April 2005, http://www.imf.org/external/pubs/ft/weo/2005/01/index.htm

[17] International Monetary Fund (2005b) *Global Financial Stability Report*, April 2005, www.imf.org/external/pubs/ft/GFSR/2005/01/index.htm

[18] Jackson, P. W. Perraudin and V. Saporta (2002), "Regulatory and "economic" solvency standards for internationally active banks", *Journal of Banking and Finance* 26 pages 953-976.

[19] Michael, I. (2004) "Accounting and Financial Stability" *Financial Stability Review*, June 2004, pp.118 – 128, Bank of England.

[20] Morris, S. and H. S. Shin (1999) "Risk Management with Interdependent Choice" *Oxford Review of Economic Policy*, 15, 52-62 Autumn (1999), reprinted in the Bank of England *Financial Stability Review*, 7 (November), 141-150 (1999).

[21] Plantin, G., H. Sapra and H. S. Shin (2004) "Marking to Market: Panacea or Pandora's Box" working paper, London School of Economics http://www.nuff.ox.ac.uk/users/Shin/working.htm

[22] Schnabel, Isabel and Hyun Song Shin (2004) "Liquidity and Contagion: the Crisis of 1763" *Journal of the European Economic Association*, 2(6), 929-968.

[23] Shapley, L. S. and M. Shubik (1977) "Trade Using One Commodity as a Means of Payment" *Journal of Political Economy* 85, 937-968.

[24] Sheldon, G. and M. Maurer (1998), 'Interbank Lending and Systemic Risk: An Empirical Analysis for Switzerland', *Swiss Journal of Economics and Statistics*, No 134, pages 685-704.

[25] Upper, C. and A. Worms (2001), 'Estimating Bilateral Exposures in the German Interbank Market: Is there a Danger of Contagion?', *BIS Paper*, No1, March.

[26] Wells, S. (2002), 'UK Interbank Exposures: Systemic Risk Implications', *Financial Stability Review*, Bank of England, December, pages 175-82.