

Asymmetric Information, Financial Intermediation and the Monetary Transmission Mechanism: A Critical Review

Iris Claus and Arthur Grimes

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AUTHORS

Iris Claus
The Treasury
PO Box 3724
Wellington
NEW ZEALAND

Email Iris.Claus@treasury.govt.nz
Telephone (64) (4) 471 5221

Arthur Grimes
Victoria University of Wellington
PO Box 600
Wellington
NEW ZEALAND

Email Arthur.Grimes@vuw.ac.nz
Telephone (64) (4) 463 6834

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NZ TREASURY

New Zealand Treasury
PO Box 3724
Wellington 6008
NEW ZEALAND

Email information@treasury.govt.nz
Telephone 64-4-472 2733
Website www.treasury.govt.nz

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Abstract

Macroeconomic models currently used by policy makers generally assume that the workings of financial markets can be fully summarised by financial prices, because the Modigliani and Miller (1958) theorem holds. This paper argues that these models are too limited in describing how monetary policy (and other) shocks are transmitted to the economy and points to new directions. The models are too limited because they disregard an information asymmetry between borrowers and lenders and the importance of financial intermediaries not only for individual depositors but the economy as a whole. Incorporating financial market interactions into macroeconomic models will enhance the understanding of the transmission mechanisms of monetary policy and other shocks.

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KEYWORDS

Financial intermediaries; credit channel; monetary transmission mechanism; open economies

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Asymmetric Information, Financial Intermediation and the Monetary Transmission Mechanism: A Critical Review

1 Introduction

To conduct monetary and fiscal policies successfully, policy makers must have an accurate assessment of the timing and effects of their policies on the economy. This includes an understanding of the monetary transmission mechanisms through which monetary policy affects the decisions of firms, households, financial intermediaries and investors that alter the level of economic activity and prices. This paper argues that macroeconomic models currently used by policy makers are too limited in describing the transmission mechanisms and points to new directions.

Interest and exchange rates are the prototypical channels through which monetary policy affects the economy in contemporary models used by policy makers.¹ The assumption in these models is that the workings of financial markets can be fully summarized by financial prices, because the Modigliani and Miller (1958) theorem holds.

Under the assumptions that financial markets are complete and information and transaction costs are non-existent, the Modigliani and Miller (1958) theorem states that the mix of debt and equity used to finance firms' expenditures does not affect the expected profitability of the project – the same investment decisions would be made, irrespective of the mix of debt and equity finance. Fama's (1980) extension of the Modigliani-Miller theorem to the entire financial system allows the abstraction from considerations of credit market conditions in macroeconomic models.

While the complete market assumption remains important in economics, the assumption of zero information and transaction costs (or perfect information) has come under increasing criticism since Akerlof's (1970) seminal paper, which illustrated how imperfect information between buyers and sellers can cause market malfunctioning. With imperfect information, the market price reflects buyers' perception of the *average* quality of the

¹ See, for example, the Reserve Bank of New Zealand's *Forecasting and Policy System* (Black, Cassino, Drew, Hansen, Hunt, Rose and Scott, 1997), the New Zealand Treasury *NZTM* model (Szeto, 2002), the Federal Reserve Board of Governors' *FRB/US* model (Brayton and Tinsley, 1996), the International Monetary Fund's *MULTIMOD* model for industrial countries (Laxton, Isard, Faruquee, Prasad and Turtelboom, 1998), the Bank of Canada's *Quarterly Projection Model* (Black, Laxton, Rose and Tetlow, 1994) or the Australian Treasury's *TRYM* model (Commonwealth Treasury 1996a, 1996b).

product being sold, and sellers of low quality products will receive a premium at the expense of those selling high quality goods. As a result, some high quality sellers will stay out of the market, which will lower the average quality of the product and price of the product even further, leading more high quality sellers to stay out of the market. The process will continue and may preclude the market from actually opening. Efficient markets require some mechanisms for overcoming the imperfect information problem.

In financial markets, an information asymmetry arises between borrowers and lenders because borrowers generally know more about their investment projects than lenders do. Intermediaries, which specialise in collecting information, evaluating projects and borrowers, and monitoring borrowers' performance, can help overcome the information problem. Financial intermediaries thus exist *because* there are information and transactions costs that arise from imperfect information between borrowers and lenders. This implies that the assumptions upon which the Modigliani-Miller theorem is based, and thus the macroeconomic models used by policy makers, do not hold. Conditions in financial and credit markets can affect the real economy; and interest and exchange rates are an incomplete description of the monetary transmission mechanism.

The remainder of the paper proceeds in six further sections. Section 2 describes the standard interest and exchange rate channels of the monetary transmission mechanism as they are typically incorporated in macroeconomic models. These channels are too limited as they abstract from credit market interactions. The idea that the credit creation process can have real economic effects is not new and section 3 reviews traditional theories of the role of credit markets including Wicksell's early writings on monetary dynamics and Fisher's (1933) "debt-deflation theory of great depressions". Current theories are discussed in section 4 and the credit channel of the monetary transmission mechanism as it is currently characterised in the literature is described in section 5. A number of dynamic general equilibrium models that account for an explicit role of credit market frictions in business cycle fluctuations have been developed recently. These are discussed in section 6. None of the models is complete and section 7 summarises and concludes with a brief assessment of avenues for future research.

2 Interest and exchange rate channels²

A central bank derives the power to influence wholesale money market interest rates from the fact that it is the monopoly supplier of high-powered money (also known as outside money or the monetary base). Although the institutional details differ from country to country, the operating procedure of central banks is generally similar. Central banks choose the price at which they lend high-powered money to the inter-bank market. The quantitative effect of a change in the official central bank lending rate on other interest rates, and on financial market conditions more generally, depends on the extent to which a policy change is anticipated, how the change affects expectations of future policy, interest rates and inflation, and the degree of nominal price rigidities.

Real (inflation expectations adjusted) interest rates reflect the opportunity cost of current expenditure relative to expenditure in some future period, since earning a return in the interim enables greater consumption or investment at a later date. Changes in real interest rates alter the incentives to consume and invest in the present versus consuming and investing in future.

² The channels described in this section reflect those typically incorporated in macroeconomic models of the type listed in footnote 1. Specific references to these and other sources are therefore not noted separately in the discussion that follows.

Movements in short-term interest rates affect longer-term interest rates, at which financial institutions typically lend to and borrow from businesses and consumers, as illustrated by the expectations hypothesis of the term structure of interest rates. The expectations hypothesis states that, for any choice of holding period, the expected return is the same for any combination of bonds of different maturities. For example, the rate of return from holding a one-year note should be the same as holding two successive six-month notes.³

Real interest rates more closely reflect the costs and benefits of deferring expenditure than nominal interest rates as they account for the loss of purchasing power due to inflation. The link between nominal rates, set by the central bank and financial intermediaries, and real interest rates is through the Fisher equation. The Fisher equation decomposes the observed nominal interest rate into an expected inflation component and an expected real rate and can be written as

$$1 + i_{t,t+k} = (1 + r_{t,t+k}) \cdot (1 + E_t[\Pi_{t,t+k}]) \quad (1)$$

where all values are in discrete time, $i_{t,t+k}$ denotes the nominal rate of return on lending (or the cost of borrowing) from time t to time $t+k$, $r_{t,t+k}$ is the ex ante real lending (borrowing) rate from time t to time $t+k$ and $E_t[\Pi_{t,t+k}]$ refers to the expected rate at time t of inflation between time t and $t+k$.⁴

An increase in short-term nominal interest rates will lead to higher short-term ex ante real rates if inflation expectations do not adjust upwards by the full increase in short-term interest rates and will result in higher short-term ex post real rates if there is price stickiness.⁵ Inflation inertia and price stickiness can arise from slow adjustment of expectations, the existence of explicit or implicit contracts that are not indexed to the rate of inflation, menu costs of adjusting prices, real rigidities, and price and wage staggering.

Higher real rates directly reduce the profitability of investment projects because of higher financing costs, and indirectly because of the prospect of a slowdown in consumption. A rise in interest rates tends to encourage households to reduce current consumption because the return on saving and the cost of borrowing to finance consumption both increase. Monetary policy may have an additional effect on current consumption by lowering the disposable income of households who are borrowers. A portion of households' spending is on servicing debt interest. Increases (decreases) in interest rates will raise (lower) the amount of debt servicing required and lower (increase) disposable income. The opposite holds true for households who are savers and the overall net effect on consumption will depend on how much the change in consumption of borrowers is offset by that of savers.⁶

In an open economy, monetary policy also affects output and inflation through the influence that interest rates have on the exchange rate. Interest parity arguments imply that movements in domestic interest rates will induce movements in the exchange rate. Uncovered interest parity, for example, states that the expected return on a bond

³ Uncertainty regarding future short-term interest rates coupled with risk aversion may cause the term structure to deviate from the shape implied by the risk-neutral expectations hypothesis. This deviation is captured by a term premium.

⁴ This formulation of the Fisher equation abstracts from taxes and, as Svensson (1985) notes, the simple Fisher relation does not hold under uncertainty.

⁵ It is not frequently recognised that an increase in short-term nominal interest rates will, ceteris paribus, have a neutral effect on the real economy only if prices adjust downwards in a stepwise manner, enabling subsequent price inflation to occur over the period relevant to that interest rate.

⁶ In the case of fixed term interest rates, changes in interest rates will affect consumption if households believe that they eventually will have to face the new interest rate and alter their consumption behaviour in anticipation.

denominated in a foreign currency should be the same as the expected return from holding an otherwise identical domestic currency bond. A differential between domestic and foreign interest rates reflects expected movements in the exchange rate. A change in monetary policy that leads to movements in the differential between domestic and foreign interest rates therefore implies (assuming uncovered interest rate parity) that either the exchange rate or the expected exchange rate or both must change.

Exchange rate movements have a *direct* impact on the cost of imports and domestic inflation.⁷ Exchange rate movements also have an *indirect* impact on inflation through their impact on the demand and supply of tradeable and non-tradeable goods and services. An appreciation of the exchange rate, for example, will lower the rate of growth of the domestic price level, which is a weighted average of tradeables and non-tradeables prices. This is because an appreciation of the exchange rate decreases the domestic price of tradeables (if tradeables prices are determined in foreign currency units by world markets). A decrease in the price of tradeables relative to non-tradeables increases the domestic demand for tradeables (and lowers the domestic supply of tradeable goods and services).⁸ Moreover, an appreciation of the exchange rate (or decline in the relative price of tradeables to non-tradeables) reduces the domestic demand for non-tradeables and increases the domestic supply of non-tradeables, causing excess supply of non-tradeables and a reduction in the price of non-tradeables.

Monetary policy affects asset prices more generally. For example, monetary policy directly affects the market value of future cash flows through its effect on the discount factor. The relationship between the market price of a unit future cash flow and interest rates is

$$PV_{t,t+k} = \exp(-i_t \cdot k_t) \quad (2)$$

where $PV_{t,t+k}$ is the present value at time t of a cash flow that matures at time $t+k$, i_t denotes the continuously compounding interest rate at annual rates at time t and k_t is the number of years to maturity at time t . The present value (or market price) of the cash flow is inversely related to the yield, i.e. a rise in i_t lowers the present value of the cash flow and a decline in i_t raises it. This result generalises to all assets (bonds, equities, property, etc.) because the value of all assets can be defined as a combination of expected future cash flows.

Tobin's q theory provides a mechanism through which monetary policy affects the economy through its effects on the valuation of equities. Tobin (1969) defines q as the market value of firms divided by the replacement cost of capital. The market price of firms will increase with an easing in monetary policy. Tobin's q rises if this market price of firms increases relative to the replacement cost of capital, i.e. if the cost of new plant and equipment capital declines relative to the market value of firms. Investment spending will rise because firms can purchase new investment goods, which will be valued in the equity market at greater than their purchase cost.⁹

On the other hand, when q is low, firms will not purchase new investment goods because the market value of firms is low relative to the cost of capital. If companies want to acquire capital when q is low, they can buy another firm cheaply and acquire old capital instead. As a result, investment spending will be low.

⁷ See, for example, Adolfson (2002) and Smets and Wouters (2002).

⁸ The increase in demand for tradeables is reflected in a deterioration in the current account deficit of the balance of payments (matched by a rise in the net foreign demand for domestic assets).

⁹ Here we are referring to marginal q rather than average q since it is the valuation of the marginal investment project which is relevant (Hayashi, 1982).

Consumption spending will also be affected by changes in the market value of equities. This is because equities are typically a component of households' financial wealth. When equities and stock prices fall, because of a tightening in monetary policy, the value of financial wealth decreases, leading to a decline in household consumption. This is because households' consumption spending is determined by their lifetime resources, which consist of current and future human capital, real capital and financial wealth. A tightening in monetary policy that leads to a decline in land and property values or structures and residential housing values also causes households' wealth to decline, while lower interest rates cause an increase in financial wealth.

Interest and exchange rates and asset prices are important channels through which monetary policy affects economic activity and inflation. All, or most of these channels are typically incorporated in macroeconomic models and can operate in conjunction with various degrees of price stickiness. However, in the presence of imperfect information, financial prices are unlikely to be a complete description of the monetary transmission mechanism for the reasons outlined in the introduction. Macroeconomic models that rely solely on the traditional price channels as conduits of monetary policy are likely to omit key channels through which monetary policy can affect activity and inflation. The remainder of this paper examines the role of financial intermediaries and credit in establishing additional channels of monetary policy influence on the real and nominal economy.

3 Traditional literature on financial intermediation

The credit creation process is “the process by which, in exchange for paper claims, the savings of specific individuals or firms are made available for the use of other individuals or firms” (Bernanke, 1992-93, p. 50). The idea that the credit creation process can have real economic effects is not new. The role of bank lending in the propagation of cyclical fluctuations has been examined since at least Wicksell's early writings on monetary dynamics and Fisher's “debt-deflation theory of great depressions”.

Wicksell's theory focuses on the tendency for bank lending and the money supply to expand during periods of boom and strong demand for loanable funds. To explain these credit expansions during booms, Wicksell introduces the concept of the “natural rate of interest”. The natural rate is defined as the “rate of interest at which the demand for loan capital and the supply of savings exactly agree” (Wicksell, 1906, p. 193). It is determined by the demand for loans, which depends on the expected profitability of investment.

The trouble as Wicksell saw it was that the market rate of interest tends to be sticky, responding only slowly and with a delay to changes in the demand for funds. Because of this stickiness, if the natural rate rises, because of changes in domestic or foreign demand, the market interest rate will be below the natural rate for some time, increasing the demand for loans (and lowering the supply of saving).¹⁰ The increase in borrowing and investment in turn raises spending and prices, leading to higher expected profitability of investment, further investment, spending and increased prices. This “cumulative” process continues until banks raise market interest rates (when running out of excess reserves).

¹⁰ Investment, which equaled saving before the opening of the gap between the natural and market rates, now exceeds saving.

Fisher (1933), who examined the Great Depression, argues that economic crises result from “over-indebtedness” and can be exacerbated by falling prices. The “great cause of over-borrowing” is “easy money” (Fisher, 1933, p. 348).

During the 1920s, households and unincorporated businesses had greatly increased their levels of debt and, in Fisher’s view, the high leverage of borrowers was the prime cause of over-indebtedness. Over-indebtedness in turn led to “over-production” (or excess supply) and prices fell to restore equilibrium – a period of over-production (excess supply) was followed by a period of under-production (excess demand), causing large cyclical fluctuations in output.

The *direct* effect of the business downturn that led to the Great Depression was an increase in bankruptcies, which still further contributed to the slowing of the economy. The *indirect* impact, and possibly the more important channel in the propagation mechanism, was the price deflation caused by the downturn. Given that debt contracts were written in nominal terms, the protracted fall in prices and money incomes greatly increased real debt burdens. The deterioration in borrowers’ net worth due to higher debt induced borrowers to reduce spending, sending the economy into further decline, and thus continuing the spiral of falling output and deflation.¹¹

In Wicksell’s and Fisher’s view, business cycles are caused by the expansion and contraction of credit. In Keynes’ (1936) *General Theory of Employment, Interest and Money*, the financial variable most relevant to aggregate economic activity is money rather than credit. The financial system plays a less explicit role in Keynes’ theory of output determination, although credit market conditions are important for investment behaviour. A key factor in the determination of investment is the “state of confidence” and Keynes (1936) distinguishes two basic determinants of this state. The first is the borrowers’ beliefs about “prospective yields” from investment projects. The second is the “state of credit”, which is determined by the confidence lenders have in financing borrowers. A collapse in confidence of either borrowers or lenders is sufficient to induce a downturn.

The macroeconomics literature following the *General Theory* largely ignored any links between movements in output and credit market conditions (Gertler, 1988). Some attention was redirected toward the interaction between financial structure and real activity with Gurley and Shaw (1955), who emphasised the role of financial intermediaries in improving the efficiency of intertemporal trade and economic growth. Their argument is based on an observed correlation between economic development and the system of financial intermediation.¹² In developed countries there generally exists a highly organised and broad system of financial intermediation to facilitate the flow of loanable funds between borrowers and lenders, while in developing countries the financial system is much less evolved.

According to Gurley and Shaw (1955), the economy’s overall “financial capacity” is more relevant to macroeconomic behaviour than money. Financial capacity is the borrowers’ ability to absorb debt, without having to reduce spending in order to avoid default. Financial capacity is an important determinant of aggregate demand, and balance sheets (a key determinant of financial capacity) can enhance the movements in spending and magnify business cycles. Financial intermediaries are important because they extend borrowers’ financial capacity.

¹¹ Fisher (1933) calculates that by March 1933, “debt as measured in terms of commodities”, i.e. real debt, had increased by about 40 percent from its previous peak reached in 1929 (p. 346).

¹² The link between the financial system and economic growth has also been investigated more recently. See, for example, King and Levine (1993) and Khan and Senhadji (2000).

However, any potential momentum provided by Gurley and Shaw was soon deflected by Modigliani and Miller's (1958) derivation of the formal proposition that real economic decisions are independent of financial structure in the general equilibrium framework of Arrow and Debreu. Modigliani and Miller (1958) showed that, when capital markets are perfectly competitive and information and transactions are costless, the value of a firm and its investment decisions are independent of the source of finance, i.e. it is irrelevant whether a firm finances its investment decisions through debt or equity.

The Modigliani-Miller theorem allowed economists to abstract from consideration of credit market conditions. In part, credit markets fell by the theoretical wayside because they lacked microfoundations, in contrast to the Modigliani-Miller theorem. It was not until the 1970s with the rise of the economics of imperfect information that foundations began to be developed that posit an important role for credit markets (discussed in the next section). Until that time, the emphasis was on the role of money in the monetary transmission mechanism.

Keynes' (1936) discussion of "liquidity preference" had shifted the focus to the interaction of money supply and money demand as the determinants of the real interest rate. The study by Friedman and Schwartz (1963) of the historical relationship between money and output became the cornerstone for the monetarist theory, which opposes activist government policy intervention aimed at stabilising aggregate demand. "Monetarists" were given their name to reflect the emphasis they place on steady growth in the money supply as the basic tenet of stabilisation policy. Friedman and Schwartz's (1963) work was an alternative explanation of the role of financial markets in the Great Depression, with the emphasis on the central importance of money.

Considerable debate arose over the empirical significance of the mechanism linking money and economic activity. One of the earliest empirical studies to try to assess the impact of money on economic activity was Friedman and Meiselman (1963). Friedman and Meiselman, who tested whether monetary or fiscal policy was more important in the determination of *nominal* income, using single-equation estimation, find a much more stable and statistically significant relationship between output and money than between output and their measure of government expenditure. Andersen and Jordon (1968) also reported a strong empirical relationship between money and nominal income.¹³

One important problem with these single-equation regressions is that they are mis-specified if money is endogenous, i.e. if the central bank adjusts monetary policy in response to shocks to output.¹⁴ To overcome this endogeneity problem, subsequent empirical studies of the link between monetary policy and (real) economic activity adopt a vector autoregression (VAR) framework, pioneered by Sims' (1984) reduced-form bivariate model of money and output. The common result, Sims and others find, is that lagged values of money can help explain variations in output. This general statistical pattern provided the motivation for developing more structural models of movements in the money supply and output fluctuations.¹⁵

Two key assumptions underlay the emphasis on money (and neglect of credit). First, the central role of bank deposits (and currency) as transactions media led to the assumption that money performs a special service to businesses and consumers not performed by other assets, so that other assets are not close substitutes for money. Second, with well-

¹³ Similar single-equation regressions were estimated to investigate the link between money and *real* output.

¹⁴ The first study to formally model the idea that a positive correlation between money and output may not indicate the true causal role of money was Tobin (1970).

¹⁵ For a summary of the literature see Leeper, Sims and Zha (1996).

functioning capital markets, bank credit is simply one alternative source of investment finance for businesses. The assumption is that if the supply of bank credit is reduced, firms seeking to fund working capital or an investment project can always issue tradable bonds or equity shares in the capital market at no extra cost. Given this assumption that other sources of finance are perfect substitutes for bank credit, any disturbance to the quantity or price of liquidity impacts on the wider economy only through the demand and supply of money (see Bernanke, 1992-93; Garretsen and Swank, 1998). From the policy makers' perspective this meant that attempts to control credit would be negated by changes in the supply of substitutes, but attempts to control money would be effective given the absence of substitutes. This argument provided the rationale for using monetary targets in many countries during the 1970s and 1980s to conduct monetary policy.

However, with the advent of financial deregulation during the 1980s, the validity of the focus on money only and the effectiveness of monetary targets to implement policy were called into question. Widespread financial innovation, especially the increased use of credit cards and electronic banking, contributed to disrupt what was previously observed as a stable medium- to long-run relation between the stock of money and aggregate nominal income. The instability between the money stock and nominal income eventually led countries to abandon monetary targeting.

New empirical work and developments in theory (discussed in the next section) rekindled interest in the role of credit in the business cycle. The empirical work, beginning with Mishkin (1978), involves a reconsideration of an earlier issue – the role of financial factors in the Great Depression. Analysing data from the Great Depression to determine whether financial factors affected consumer spending, Mishkin finds that the behaviour of households' net financial positions had a significant influence on consumer demand. These results provide evidence that financial market conditions played an important role in the business cycle propagation mechanism, reminiscent of the one in Fisher's (1933) debt-deflation theory. The rise in consumer real indebtedness resulting from declining incomes and deflation induced consumers to lower spending on durables and housing, which in turn magnified the decline, contributing yet further to the economic downturn.

Analysing the relative importance of monetary versus financial factors in the Great Depression, Bernanke (1983) concludes that the collapse of the financial system was an important determinant of the depression's depth and persistence. The basic premise in Bernanke's (1983) analysis is that, because markets for financial claims are incomplete, intermediation between borrowers and lenders requires nontrivial market-making and information-gathering services. The disruptions of 1930-33 reduced the effectiveness of the financial sector in performing these services. As the real costs of intermediation increased, some borrowers found credit to be expensive and difficult to obtain. The effects of this credit squeeze on aggregate demand contributed to turn the severe but not unprecedented downturn of 1929-30 into a protracted depression. The two major components of the financial collapse were the loss of confidence in financial institutions, primarily commercial banks, and the widespread insolvency of debtors.

The alternative explanation of the correlation between the conditions of the financial sector and the general economy is that due to Friedman and Schwartz (1963), who stress the effects of the banking crises on the supply of money. To test these two competing propositions, Bernanke's (1983) empirical approach is to estimate output equations using monetary variables, and then to evaluate whether or not adding (non-monetary) proxies for the financial crisis improves the performance of these equations. He finds that adding proxies for the financial crisis, such as suspended bank deposits, failing business liabilities, differentials between BAA corporate bond yields and yields on U.S. government

bonds, generally improves the purely monetary explanation of short-run output movements.

4 Current theories of financial intermediation

Current theories of the economic role of financial intermediaries build on the economics of imperfect information that began to emerge during the 1970s with the seminal contributions of Akerlof (1970), Spence (1973) and Rothschild and Stiglitz (1976). Financial intermediaries exist because they can reduce information and transaction costs that arise from an information asymmetry between borrowers and lenders.¹⁶ Financial intermediaries thus assist the efficient functioning of markets, and any factors that affect the amount of credit channelled through financial intermediaries can have significant macroeconomic effects.

There are two strands in the literature that formally explain the existence of financial intermediaries. The first strand emphasises financial intermediaries' provision of liquidity. The second strand focuses on financial intermediaries' ability to transform the risk characteristics of assets. In both cases, financial intermediation can reduce the cost of channelling funds between borrowers and lenders, leading to a more efficient allocation of resources.

Diamond and Dybvig (1983) analyse the provision of liquidity (the transformation of illiquid assets into liquid liabilities) by banks. In Diamond and Dybvig's model, *ex ante* identical investors (depositors) are risk averse and uncertain about the timing of their future consumption needs. Without an intermediary, all investors are locked into illiquid long-term investments that yield high payoffs only to those who consume late. Those who must consume early receive low payoffs because early consumption requires premature liquidation of long-term investments. Banks can improve on a competitive market by providing better risk sharing among agents who need to consume at different (random) times. An intermediary promising investors a higher payoff for early consumption and a lower payoff for late consumption relative to the non-intermediated case enhances risk sharing and welfare.

The optimal insurance contract in Diamond and Dybvig's model is a demand deposit contract, but it has an undesirable equilibrium (bank run), in which all depositors panic and withdraw immediately, including even those who would prefer to leave their deposits in the bank if they were not concerned about the bank failing. Bank runs cause real economic problems because even "healthy" banks can fail, leading to a recall of loans and the termination of productive investment.

In Diamond and Dybvig (1983) the illiquidity of assets provides both the rationale for the existence of banks and for their vulnerability to runs.¹⁷ A bank run is caused by a shift in expectations. When normal volumes of withdrawals are known and not stochastic, suspension of convertibility of deposits will allow banks both to prevent bank runs and to provide optimal risk sharing by converting illiquid assets into liquid liabilities. In the more

¹⁶ When markets do not operate costlessly, firms arise if they can reduce market transaction costs by organising resources more cheaply within the firm (Coase, 1937).

¹⁷ The vulnerability to bank runs in the Diamond and Dybvig (1983) model has stimulated a lengthy debate in the literature on prudential regulation. See, for example, Bhattacharya, Boot and Thakor (1998), Dewatripont and Tirole (1994).

general case (with stochastic withdrawals), deposit insurance can rule out runs without reducing the ability of banks to transform assets.¹⁸

Financial intermediaries are able to transform the risk characteristics of assets because they can overcome a market failure and resolve an information asymmetry problem. Information asymmetry in credit markets arises because borrowers generally know more about their investment projects than lenders do. The information asymmetry can occur “ex ante” or “ex post”. An ex ante information asymmetry arises when lenders cannot differentiate between borrowers with different credit risks before providing loans and leads to an adverse selection problem. Adverse selection problems arise when an increase in interest rates leaves a more risky pool of borrowers in the market for funds. Financial intermediaries are then more likely to be lending to high-risk borrowers, because those who are willing to pay high interest rates will, on average, be worse risks.

The information asymmetry problem occurs ex post when only borrowers, but not lenders, can observe actual returns after project completion. This leads to a moral hazard problem. Moral hazard arises when a borrower engages in activities that reduce the likelihood of a loan being repaid. An example of moral hazard is when firms’ owners “siphon off” funds (legally or illegally) to themselves or to associates, for example, through loss-making contracts signed with associated firms.

The problem with imperfect information is that information is a “public good”. If costly privately-produced information can subsequently be used at less cost by other agents, there will be inadequate motivation to invest in the publicly optimal quantity of information (Hirschleifer and Riley, 1979). The implication for financial intermediaries is as follows. Once banks obtain information they must be able to signal their information advantage to lenders without giving away their information advantage. One reason, financial intermediaries can obtain information at a lower cost than individual lenders is that financial intermediation avoids duplication of the production of information. Moreover, there are increasing returns to scale to financial intermediation. Financial intermediaries develop special skills in evaluating prospective borrowers and investment projects. They can also exploit cross-sectional (across customers) information and re-use information over time.

Leland and Pyle (1977) formally show that a bank can communicate information to investors about potential borrowers at a lower cost than can individual borrowers. They focus on an ex ante information asymmetry, where entrepreneurs selling shares to the market know the expected returns of their own investment, but other agents find this information costly to observe. This results in a moral hazard problem since firms with low expected returns have an incentive to claim a high expected return so as to increase their market valuation. In Leland and Pyle’s model intermediaries can solve this moral hazard problem by monitoring the actions of firms.

Retained equity can serve as a costly signal of the entrepreneur’s information about a project.¹⁹ The value of the firm increases with the share of the firm held by the

¹⁸ Under the assumption that banks cannot select the risk of their loan portfolios, a central bank as a lender of last resort could provide a service similar to deposit insurance. However, when there is a trade-off between optimal risk and proper incentives for portfolio choice, the lender of last resort can no longer be as credible as deposit insurance. If the lender of last resort were always required to bail out banks with liquidity problems, there would be perverse incentives for banks to take on risk. Deposit insurance on the other hand is a binding commitment that, in theory, can be structured to retain punishment in the case of bank runs. See Demirgüç-Kunt and Kane (2002) for difficulties in implementing deposit insurance in practice.

¹⁹ Leland and Pyle (1977) assume that investors cannot infer intermediaries’ information by observing their portfolios.

entrepreneur, and in contrast to Modigliani and Miller (1958), the financial structure of a firm is therefore related to project or firm value.

One problem with the Leland and Pyle analysis is that it *assumes* the existence of an incentive signalling equilibrium. However, as Campbell and Kracaw (1980) note, if a signalling equilibrium exists, then firms will be properly valued with or without intermediaries or other information producers.

Diamond (1984) argues that diversification within the financial intermediary is the main reason financial intermediaries exist. He also develops a model in which the outcome from firms' investment project is not known *ex post* to external agents, unless information is gathered to assess the outcome, i.e. there is "costly state verification" (Townsend, 1979). This leads to a moral hazard problem because it provides an incentive for borrowers to default on a loan even when the project is successful.

In Diamond's model, intermediaries are delegated the costly task of monitoring loan contracts. A financial intermediary must choose an incentive contract such that it has incentives to monitor the information, make proper use of it, and make sufficient payments to depositors to attract deposits. Providing these incentives is costly and diversification can reduce these costs.

The optimal contract is a debt contract (an agreement by the borrower to pay the lender a fixed amount) with a non-pecuniary bankruptcy penalty. The intermediary need not be monitored because it bears all penalties for any shortfall of payments. This is because the diversification of the intermediary's portfolio makes the probability of incurring these penalties very small. The optimal size for a financial intermediary is infinite; costs are lowered indefinitely by diversification, as long as the returns to entrepreneurs are not perfectly correlated.²⁰

Adverse selection increases the likelihood that loans will be made to bad credit risks, while moral hazard lowers the probability that a loan will be repaid. As a result, lenders may decide in some circumstances that they would rather not make a loan and credit rationing may occur. There are two forms of credit rationing: (i) some loan applicants may receive a smaller loan than they applied for at the given interest rate, or (ii) they may not receive a loan at all, even if they offered to pay a higher interest rate.

Jaffee and Russell (1976) develop a theoretical model in which imperfect information and uncertainty can lead to rationing in loan markets, where some agents do not receive the loan they applied for. Their paper analyses the behaviour of a loan market in which borrowers have more information than lenders about the likelihood of default. The key feature in the model is the relationship between default proportions and contract sizes. There is some minimum loan size at which no default is observed, beyond that, the proportion of individuals who do not default is declining with the contract size.

Since borrowers are identical *ex ante*, the market interest rate incorporates a premium to take account of the aggregate probability of default. Consequently, borrowers with low default probability pay a premium to support low quality borrowers and credit rationing in the form of the supply of smaller-sized loans than those demanded by the borrowers at a quoted rate may result. High quality borrowers will prefer some rationing if the smaller loan sizes lower the market average default probabilities, thus reducing the premium.

²⁰ When project returns are not independently distributed and instead depend on several common factors that are observable (such as economic conditions, interest rates, and input prices) the intermediary still monitors firm-specific information, but hedges out all systematic risks.

Stiglitz and Weiss (1981) develop a model of credit rationing, where some borrowers receive loans and others do not. They assume that the interest rate directly affects the quality of loans because of an adverse selection effect or moral hazard effect.²¹ Banks making loans are concerned about the interest rate they receive on a loan, and the riskiness of the loan. For a given loan rate, lenders earn a lower expected return on loans to borrowers with riskier projects than to good quality borrowers.²²

The interest rate a bank charges can affect the riskiness of the loans by either sorting prospective borrowers (the adverse selection effect), or by affecting the actions of borrowers (the moral hazard effect). When the price (interest rate) affects the transaction, it may not clear the market. The adverse selection effect of interest rates is a consequence of different borrowers having different probabilities of repaying their loans. The interest rate an individual is willing to pay may act as a screening device. Those who are willing to pay high interest rates may, on average, be worse risks. They are willing to borrow at high interest rates because they perceive their probability of repaying the loan to be low. As a result there exists an interest rate that maximises the expected return to the bank and beyond which the bank will be unwilling to supply funds, making the supply of loans curve bend backwards.

A change in interest rates can affect the bank's expected return from loans through the moral hazard effect by changing the behaviour of borrowers. Higher interest rates induce firms to undertake projects with lower probabilities of success but higher payoffs when successful. Increasing the rate of interest increases the relative attractiveness of riskier projects, for which the return to the bank may be lower. As the interest rate rises, the average riskiness of those who borrow increases and the moral hazard effect reinforces the adverse selection problem. Banks therefore have an incentive, in some circumstances, to ration credit rather than to raise interest rates when there is excess demand for loanable funds.

Williamson (1986) develops a model of credit rationing where borrowers are subject to a moral hazard problem. Borrowers are identical ex ante, but some receive loans and others do not. A borrower and lender are asymmetrically informed ex post about the return on the borrower's investment project, and the borrower will have an incentive to falsely default on the loan. Costly monitoring by lenders of borrowers together with large-scale investment projects imply that there exist increasing returns to scale in lending and borrowing which can be exploited by financial intermediaries. The optimal contract between a lender and a borrower is a debt contract and the lender only monitors in the event of default.²³

An increase in the loan interest rate raises the expected return to the lender, but also results in an increase in the probability that the borrower defaults, thus increasing the expected cost of monitoring to the lender. This, in turn, generates an asymmetry in the borrowers' and lenders' payoff functions, which can lead to credit rationing. Because of the asymmetry in the payoff functions it may not be possible for the loan interest rate to adjust to clear the market, so that some borrowers do not receive a loan in equilibrium.

In summary, financial intermediaries play an important role in credit markets because they reduce the cost of channelling funds between relatively uninformed depositors to uses that

²¹ Stiglitz and Weiss (1981) assume that heterogeneity among entrepreneurs arises from different probability distributions of returns to their projects.

²² This occurs because an unobserved mean-preserving spread in a borrower's project return distribution reduces the expected payment to lenders under default (Rothschild and Stiglitz, 1970).

²³ Unlike in Diamond (1984) monitoring decisions are made ex post and the probability that monitoring occurs is determined endogenously.

are information-intensive and difficult to evaluate, leading to a more efficient allocation of resources. Intermediaries specialise in collecting information, evaluating projects, monitoring borrowers' performance and risk sharing. Despite this specialisation, the existence of financial intermediaries does not replicate the credit market outcomes that would occur under a full information environment. The existence of imperfect, asymmetrically-held information causes frictions in the credit market. Changes to the information structure and to variables which may be used to overcome credit frictions (such as firm collateral and equity) will in turn cause the nature and degree of credit imperfections to alter.

Banks and other intermediaries are “special” where they provide credit to borrowers on terms which those borrowers would not otherwise be able to obtain. Because of the existence of economies of scale in loan markets, small firms in particular may have difficulties obtaining funding from non-bank sources and so are more reliant on bank lending than are other firms. Adverse shocks to the information structure, or to these firms' collateral or equity levels, or to banks' ability to lend, may all impact on firms' access to credit and hence to investment and output.

5 The credit channel

The credit channel literature examines the impact of asymmetric information and other credit market frictions on real spending and economic activity, with resulting implications for monetary policy.²⁴ The *bank lending* channel analyses the impact of monetary policy on the supply of loans by depository institutions, and the *balance sheet* (or *financial accelerator*) effect focuses on the potential impact of monetary policy on firms' balance sheets and their ability to borrow. The credit channel also operates when shifts in monetary policy alter either the efficiency of financial markets in matching borrowers and lenders or the extent to which borrowers face rationing in credit markets. With credit rationing, monetary policy may have real effects without changing interest rates in lending markets.

Monetary policy can have an impact on the supply of intermediated credit, which in most countries is predominantly provided by banks. A bank is a financial intermediary that participates in the payment system and finances entities in financial deficit, generally the public sector, firms and some households, using the funds of entities in financial surplus, typically households.

The reliance on bank credit is probably declining overall as corporations and, in particular, large businesses turn to the securities markets to meet their funding needs. However, an important fraction of firms, mainly small firms, are likely to remain bank-dependent at least in the near future (Trautwein, 2000). Moreover, banks are a critical source of liquidity even for large firms during times of economic stress (Saidenberg and Strahan, 1999).

The asset side of banks' balance sheets consists of loans to the public sector, firms and households. The liability side includes deposits by households and firms plus banks' equity. Banks' equity consists of stock issues and retained earnings. Banks typically “borrow short” and “lend long”: they take deposits that can be withdrawn on demand or in a matter of months and make loans that often are only re-paid over periods of years. As a result, banks' assets tend to have longer maturity than their liabilities. Monetary policy can have an impact on banks' balance sheets because of this maturity mismatch of assets

²⁴ See Bernanke and Gertler (1995), Mishkin (1995) and Trautwein (2000) among others.

and liabilities. In the absence of perfect interest rate hedging, a tightening in monetary policy, i.e. an increase in interest rates, tends to cause a larger decline in the present value of the assets with longer maturity than the liabilities with shorter maturity. Conversely, a decline in interest rates causes a larger gain in the present value of the assets than the liabilities. For example, the decline in the market price of a unit future cash flow (see equation 2) due to an increase in i_t is a function of k_t , the number of years to maturity

$$\frac{\partial PV_{t,t+k}}{\partial i_t} = -k_t \cdot \exp(-i_t \cdot k_t) \quad (3)$$

By construction, because the asset side of a balance sheet equals the liability side, a tightening in monetary policy that leads to a larger decline in the value of loans than the value of deposits, implies a contraction in banks' value of equity. If banks are required by regulators or depositors to retain some minimum capital ratio (defined as the value of banks' equity as a percent of the value of loans outstanding), they will have to either reduce their supply of loanable funds or raise new equity. However, because equity takes time to raise and also because the cost of new capital has increased due to higher interest rates and a lower market value of banks, the typical initial response is a contraction in lending.²⁵

A reduction in the supply of bank loans increases the financing cost, or reduces the financing, of firms that are dependent on banks for credit. Bank-dependent firms are typically smaller in size (Gertler and Gilchrist, 1994). These firms tend to be bank-dependent because their access to (non-bank) capital markets is poor, because of reduced economies of scale with respect to intermediaries acquiring information about small firms. Moreover, the spread between the interest rate on loans paid by bank-dependent (small) firms and the interest rate paid by (large) firms, who use public debt markets, tends to increase during monetary contractions (Kashyap, Stein and Wilcox, 1993).

A reduction in the supply of bank credit reduces real activity. During the Asian crisis in the second half of the 1990s, for example, the disruption in the supply of credit was a major factor in the recessions experienced by the affected countries. Banks in these countries were unable or unwilling to establish credit facilities required for importers to provide overseas suppliers assurance of payment. The duration of a credit squeeze depends on how long it takes to establish new or revive old channels of credit after a disruption. In Asia it lasted several months in some countries and over two years in the case of Indonesia (Grimes, 1998).

The bank lending channel is likely to be more important in small open economies than large closed countries. This is because the proportion of small, typically bank-dependent, firms tends to be higher than in larger economies. Financial innovations and deregulation are unlikely to have materially improved bank-dependent firms' ability to borrow from the capital markets. In the presence of open capital markets the information problem is augmented by additional informational asymmetries between foreign and domestic borrowers and lenders. Foreign investors may be less willing to lend to small firms than domestic lenders.

If banks are special in providing credit to a large fraction of firms in the economy, the amount of credit channelled through the banking system may have significant

²⁵ Sofianos, Wachtel and Melnik (1990) and Bernanke and Blinder (1992) provide empirical evidence of the response of bank loans to fluctuations in interest rates.

macroeconomic effects. Most macroeconomic models currently used by policy makers do not explicitly incorporate a banking sector and hence do not capture these bank lending effects of the monetary transmission mechanism.

Information asymmetries and the inability of lenders to monitor borrowers costlessly lead to “agency costs”, which create a wedge between the costs of internal and external financing for a firm (Bernanke and Gertler, 1989). Cash flow and net worth are important determinants of agency costs and hence the cost and availability of finance, and ultimately the level of investment (Walsh, 1998). For instance, a firm with high net worth (equity) thereby signals its credit-worthiness to banks which can in turn lend to the firm without having to incur the same expected monitoring costs, so lowering the cost of borrowing for the firm. If net worth is depleted, the result is a rise in the firm’s borrowing costs.

The second channel, the balance sheet or financial accelerator effect, focuses on the potential impact of monetary policy on firms’ financial positions and arises from the presence of agency costs. Agency costs in credit markets occur whenever lenders delegate control over resources to borrowers, leading to adverse selection, moral hazard and monitoring costs because of the inability to monitor borrowers or share in borrowers’ information costlessly.

As discussed in section 2, a tightening in monetary policy that raises real interest rates reduces the profitability of firms’ investment projects because of higher financing costs (and indirectly because of the prospect of a slowdown in consumption).²⁶ Higher interest expenses lower firms’ cash flow and internal funds, and could increase firms’ short-term borrowing (and interest expenses) if firms need to borrow to finance an inventory build-up as a result of slowing demand. Interest expenses may thus remain high for some time even after short-term interest rates have started coming down because of the rise in short-term debt outstanding.

The effects of a corporate cash squeeze on real activity depend largely on firms’ ability to smooth the decline in cash flows by borrowing. Gertler and Gilchrist (1994) find that larger firms, which are more likely to have recourse to commercial paper markets and other sources of short-term credit, typically respond to an unanticipated decline in cash flows by increasing their short-term borrowing. These firms are, at least temporarily, able to maintain their level of production and employment during periods of rising interest rate costs and declining revenues. As a result, inventories of large firms tend to grow following a tightening of monetary policy. In contrast, small firms, which in most cases have more limited access to short-term credit, respond to the cash squeeze by decumulating inventories and cutting work hours and production.

In the presence of agency costs, the effects of a monetary tightening will be amplified further via the balance sheet or financial accelerator effect. This is because the deterioration in firms’ balance sheets due to lower cash flow and internal funds worsens the agency problem and so increases the costs of external financing. Adding to the higher cost of external financing is the fact that higher interest rates lower the market value (or net worth) of firms and hence lower the value of assets that firms can use as collateral. As a result, banks may be less willing to lend to firms because the reduction in collateral increases banks’ potential losses from adverse selection: owners will have a lower equity stake in their firms, which gives them more incentive to engage in risky investment

²⁶ The rise in borrowers’ interest expenses is, of course, only a redistribution from borrowers to lenders. However, a redistribution between borrowers and lenders is not neutral if, for example, lenders and borrowers do not have access to the same investment and spending opportunities.

projects. In some cases, the decline in collateral may lead to loans not being extended upon maturity or even being recalled, i.e. forms of credit rationing.

A tightening in monetary policy that increases the external financing premium (or wedge between the costs of internal and external funding) will have additional contractionary effects on investment, output and spending. Higher interest rates may have a much stronger contractionary impact on the economy if balance sheets are already weak, introducing the possibility that non-linearities in the impact of monetary policy may be important.²⁷

6 General equilibrium models of the credit channel

Financial intermediaries exist because of imperfect information between borrowers and lenders. Modelling asymmetric information is difficult and probably the main reason why macroeconomic models currently used by policy makers do not incorporate a fully developed credit channel.

Credit channel effects are not completely ignored by these models, but tend to be incorporated in an ad hoc manner as borrowing or cash flow constraints. For instance, in the Federal Reserve Board of Governors' FRB/US model constraints are imposed to try to mimic the behaviour of credit-constrained households and firms. Additionally, the investment equation in the FRB/US model is augmented with cash flow influences (Brayton and Tinsley, 1996). Credit constraints are also a feature of the Reserve Bank of New Zealand's macroeconomic model to some degree. In this model, the stock of household assets and the future path of labour income determine the sustainable, long-run flow of consumption. Some consumers, however, consume all their current period income and do not accumulate assets. This can be interpreted as a credit constraint where some individuals do not have access to credit markets and hence are unable to smooth consumption by borrowing against their future labour income (see Black, Cassino, Drew, Hansen, Hunt, Rose and Scott, 1997; Claus and Smith, 1999).

Dynamic general equilibrium models that formally account for an explicit role of credit market frictions in business cycle fluctuations have begun to be developed in the literature. In these models, monetary policy can have a significant impact on the real economy because of asymmetric information and agency costs. None of the models is complete. In particular, elements that are important in an open economy are still not being captured. Moreover, these models often do not explicitly account for the bank lending channel. Typically these models incorporate a financial accelerator mechanism.

Bernanke, Gertler and Gilchrist (1999) develop a dynamic general equilibrium model that incorporates a financial accelerator. The key mechanism in this model is the link between an external finance premium and the net worth of prospective borrowers. The external finance premium is the difference between the cost of funds raised externally and the

²⁷ Credit market frictions that affect firms should also be relevant to the borrowing and spending decisions made by households, particularly spending on costly durable items such as automobiles and houses. In Carroll's (1997) buffer stock model of consumption, for example, balance sheet effects impact on consumers' willingness to spend. If consumers expect a higher likelihood of finding themselves in financial distress, they would rather be holding fewer illiquid assets like consumer durables or housing and more liquid financial assets. As discussed by Bernanke and Gertler (1995), this channel is still comparatively under-developed in the literature.

opportunity costs of internal funds. An increase in entrepreneurs' wealth or net worth lowers the external finance premium. A decline in net worth raises it.

The basic structure of the model is as follows. There are three agents in the economy: households, entrepreneurs, and retailers. Households work, consume, and save. Entrepreneurs produce output by hiring labour and using capital, which they purchased in the previous period. Acquisitions of capital are financed out of entrepreneurs' net worth and by borrowing. Entrepreneurs' net worth arises from two sources: profits accumulated from previous capital investment and entrepreneurs' income from supplying labour. Entrepreneurs produce wholesale goods in competitive markets, and sell their output to retailers who are monopolistic competitors. Retailers buy goods from entrepreneurs, differentiate them (costlessly) and then re-sell these goods to households. The monopoly power of retailers allows modelling nominal rigidities in the economy; otherwise, retailers play no role.

Entrepreneurs' net worth is an important determinant of their cost of external finance. An increase in net worth lowers the external finance premium of entrepreneurs leading to increased borrowing, and thus higher investment, spending and production. A decline in net worth has the opposite effects. The main source of variation in net worth is entrepreneurs' equity, which in turn is sensitive to unexpected shifts in asset prices and unanticipated changes in the ex post return to capital.

The financial accelerator magnifies the impact of monetary policy on the real economy and smaller countercyclical movements in interest rates are therefore required to dampen output movements. The greater the extent to which monetary policy is able to stabilise output, the smaller is the effect of the financial accelerator in amplifying and propagating business cycle fluctuations.

Calibrated for the United States, the model is able to replicate observed cyclical movements in macroeconomic variables when allowing for price stickiness, decision lags in investment and limited access to credit for some entrepreneurs. Bernanke, Gertler and Gilchrist (1999) do not incorporate credit rationing in the sense of Stiglitz and Weiss (1981), where some borrowers simply do not receive loans, but assume that the price of capital can differ across entrepreneurs.

Kiyotaki and Moore (1997) develop a model with Stiglitz and Weiss type credit constraints. Credit constraints arise because lenders cannot force borrowers to repay their debts unless the debts are secured. Assets such as land, buildings and machinery serve as collateral for loans and borrowers' credit limits are affected by the value of collateralised assets. The basic structure of their model is as follows. There are two goods, a durable asset (land) and a nondurable commodity (fruit) and two types of agent: farmers and gatherers. Both farmers and gatherers produce and eat fruit. In each period, land is exchanged for fruit at a given price, and fruit is exchanged for a claim to some fruit in the next period.

Farmers' technology is idiosyncratic in the sense that, once their production has started at date t with some land, then only they possess the skill necessary to cultivate the land to bear fruit at date $t+1$. Moreover, it is assumed that farmers can always withdraw their labour. This implies that if farmers have a lot of debt, they may try to threaten their creditors by withdrawing their labour and repudiating their debt contract. Lenders protect themselves from the threat of repudiation by collateralising farmers' land; that is, farmers must make a down payment in order to purchase land. At date t farmers can borrow up to

an amount at which the repayment does not exceed the (expected) market value of their land at date $t + 1$.

Gatherers' production does not require any specific skills and gatherers, unlike farmers, are not credit constrained. Because gatherers are not credit constrained their demand for land is determined where the present value of the marginal product of land equals the opportunity cost of holding land. The amount of land is fixed, so if farmers' demand for land increases, then in order for the land market to clear, gatherers' demand has to decline.

The dynamic interaction between credit limits and asset prices is an important transmission mechanism by which the effects of shocks persist, amplify and propagate business cycle fluctuations. For example, a temporary productivity shock that reduces the net worth of credit constrained farmers forces farmers to cut back their demand for land. For the land market to clear, the demand for land by the gatherers has to increase, which requires that their opportunity costs of holding land must fall. The land price drops by the same amount as the opportunity costs of holding land, which lowers the value of farmers' existing landholdings, and reduces their net worth still further. Small temporary productivity shocks thereby generate large and persistent fluctuations in output and asset prices. The fluctuations in output become even more persistent when capital (trees) is reproducible, i.e. investment is introduced, and when in each period only a fraction of the farmers are able to invest.

Carlstrom and Fuerst (1997) develop a general equilibrium model that explicitly incorporates financial intermediaries. There are three agents in this model: entrepreneurs, consumers and financial intermediaries (capital mutual funds). Entrepreneurs receive external financing from households through the capital mutual funds. The creation of new capital (including entrepreneurial capital) is subject to agency costs, which in turn are a function of entrepreneurs' net worth. An increase in net worth lowers agency costs and thus lowers the cost of new capital. A decline in net worth increases agency costs and the cost of capital.

Calibrated for the United States, the model is able to replicate observed movements in output. Following a temporary positive productivity shock, for example, output rises gradually. This is because the shock causes households to delay their investment decisions until agency costs are at their lowest level – several periods after the initial shock. Agency costs fall over time because the shock increases the return to internal funds and net worth.²⁸

Carlstrom and Fuerst show how agency costs arising from the difference between the costs of external and internal funds can alter business cycle dynamics following a supply-side shock. However, the model abstracts from demand-side shocks and does not explicitly model a monetary authority.

Edwards and Végh (1997) develop a theoretical model of a small open economy with privately-owned banks that allows for monetary policy shocks. They have four agents in the economy: households, entrepreneurs, banks and a government/monetary authority. Households are subject to a deposit-in-advance constraint and must use demand deposits to purchase consumption. Entrepreneurs produce output by hiring labour from households. They face a credit-in-advance constraint and must borrow from banks to pay households' wages. Banks lend to entrepreneurs and hold households' demand deposits.

²⁸ Carlstrom and Fuerst (1997) assume that entrepreneurs are long-lived. In Fuerst (1995) entrepreneurs only live for a single period and the model is unable to replicate the positive serial correlation observed in output.

Banks finance their lending to entrepreneurs through deposits and borrowing internationally. Banks' operations are costly, which introduces a wedge between the lending rate and the deposit rate, the interest spread. Changes in the interest spread and bank credit, resulting from shocks to the banking system and world business cycle, lead to fluctuations in output and employment.

Edwards and Végh (1997) explicitly model financial intermediaries and allow for a foreign sector. However, the theoretical model, which is not empirically tested, only incorporates the bank lending channel, although it appears that the bank lending channel *by itself* cannot explain the macroeconomic fluctuations that are observed following a monetary policy shock (Fisher, 1999). Moreover, the economy in the model does not operate under a flexible exchange rate and so does not provide information on interactions between financial intermediaries' actions and the exchange rate channel.

The models discussed in this section are important contributions to understanding the effects of imperfect information in credit markets. But each is incomplete and further work is needed. General equilibrium models of the credit channel, where agents' decisions are derived from optimising behaviour, have mainly focused on the closed economy. The credit channel has yet to be incorporated in a model of an open economy with a floating exchange rate. Moreover, models to date generally only allow for either the bank lending channel or the balance sheet channel, but not both.

7 Summary and conclusions

Macroeconomic models currently used by policy makers generally assume that the Modigliani and Miller (1958) theorem holds. The theorem implies that, under the assumptions of complete markets and the absence of information and transaction costs, the workings of financial markets can be fully summarised by financial prices and allows one to abstract from considerations of credit market conditions. However, imperfect information and theories of financial intermediation suggest that information and transactions costs *are* important and the assumptions upon which the Modigliani-Miller theorem is based, and thus macroeconomic models used by policy makers, do not hold in practice. These models hence disregard the importance of credit markets and financial intermediaries not only for individual depositors but the economy as a whole.

Financial intermediaries play an important role because they reduce the cost of channelling funds between relatively uninformed depositors to uses that are information-intensive and difficult to evaluate. If banks and other intermediaries provide credit to a large fraction of firms, who otherwise would not be able to borrow, the amount of credit channelled through the banking system can have significant macroeconomic effects, highlighting the importance of public policy in designing policies that ensure the soundness of the banking system.

These policies may include deposit insurance, a lender of last resort function and prudential regulation, including imposition of a minimum capital ratio. However, such policies may themselves contribute to the impact of the credit channel. For instance, consider a bank that is required by regulation to hold at least a 4 percent tier 1 equity to risk-adjusted assets ratio (as under the Basle regime) and which initially has a 5 percent equity ratio. The bank then experiences a shock to its capital base as a result of a negative economic shock that reduces its equity ratio to 3 percent. If it cannot access new equity immediately, it has no choice but to reduce the size of its loan portfolio by a combination of extending fewer new loans, reducing loan rollovers and calling in existing

(callable) loans. The initial negative economic shock thereby is magnified as the credit supply is diminished. By contrast, without the 4 percent minimum, the bank may be able to undertake less drastic short-term adjustment. In some circumstances, therefore, there may be a trade-off between soundness (minimum capital) and monetary policy (credit channel) concerns. Nevertheless, policies which promote bank soundness – for instance, through a requirement for directors' attestations regarding adequacy of risk management systems – in general, reduce the potential for shocks to impact on bank capital in the first place, so helping to mitigate both soundness concerns and credit market imperfections.

The credit channel literature has made great strides in recent years, but significant issues remain unresolved. Much of the literature to date has focused on the United States, which can be adequately modelled as a large closed economy. The credit channel has yet to be incorporated in a model of a small open economy with a floating exchange rate. Moreover, existing models generally only allow for either the bank lending channel or the balance sheet channel, but not both. To account for the bank lending channel, a model would need to explicitly incorporate financial intermediaries and bank lending, while balance sheet or financial accelerator effects could be captured by making firms' acquisitions of capital depend on their net worth. The foreign sector could be accounted for by allowing at least some agents in the model to borrow from abroad. The development of such a model based on an amalgam of recent advances of the literature presents an agenda for a programme of future work. This programme, by incorporating financial market interactions into macroeconomic models, will enhance the understanding of the transmission mechanism of monetary policy and other shocks to the economy.

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