Financial accelerator effects in UK business cycles

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I am indebted to Mark Gertler and Pau Rabenal for advice on the BGG model and for providing access to its coding. I would also like to thank colleagues in Monetary Assessment and Strategy Division, and elsewhere in the Bank, for their helpful comments. In particular, this paper has benefited substantially from comments and suggestions by Shamik Dhar, and two anonymous referees. Any errors are my own. The views expressed in this paper are those of the author and do not necessarily reflect those of the Bank of England.

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The Bank of England's working paper series is externally refereed.

ISSN 1368-5562

Contents

Abstract

The paper uses a dynamic general equilibrium model incorporating financial accelerator effects to examine interactions between corporate investment and financial conditions in recent UK business cycles. The paper notes correspondences in recent recessions between the behaviour of business investment, the financial health of the corporate sector and some indicators of the availability of finance. It then investigates whether a financial accelerator model, developed by Bernanke, Gertler and Gilchrist (1999), can shed light on key features of recent recessions. The model is calibrated to broadly match UK financial conditions prevailing at the start of recent recessions, and is simulated with and without its financial accelerator mechanism. Simulations of the model incorporating financial accelerator effects seem consistent with some of the observed features of corporate real and financial behaviour in previous downturns.

Summary

The depth and persistence of the UK recession of the early 1990s came as a surprise to many forecasters, particularly the prolonged weakness of corporate investment growth. Views on the causes of sluggish investment growth in this period vary. However, a number of subsequent analyses have suggested a potential role for financial factors, noting the coincidence of weak corporate investment with a marked financial retrenchment by the sector.

The non-financial corporate sector was far more dependent on external borrowing entering the 1990s recession than at the start of the previous downturn in the early 1980s: the financial deficit was around 4% of GDP in 1989 compared with a surplus of about 1% of GDP in 1979. The unexpected deterioration in economic prospects in the late 1980s may have led to a sharp downward revision to companies' desired levels of capital and debt. Marked rises in survey measures of demand uncertainty at this time suggest that demand-side factors were probably important determinants of weaker investment and borrowing. It is also possible that poor corporate financial health may have led to a general rise in lenders' perceptions of the expected risks of lending, reducing the supply of finance. Evidence for this is less clear. In the early 1990s the proportion of respondents to the CBI Industrial Trends survey citing the cost of finance as a constraint on investment increased and corporate bond yields rose relative to default risk-free rates on government debt. These movements were more pronounced than in the early 1980s recession when corporate financial conditions were (arguably) more favourable. It may be that these shifts simply reflected a substantial shift in the riskiness of corporate lending in the early 1990s. However, it is also consistent with a tightening in the terms of finance for borrowers of equivalent risk. This supply-side influence might have added to the demand-side factors weakening corporate investment at this time.

This paper does not attempt to settle this debate, but instead uses a theoretical model to consider the potential for corporate financial conditions and investment to interact. Many macroeconomic models assume perfect capital markets with the implication that financing decisions have no impact on real economic behaviour. In reality of course capital markets are not perfect and in recent years economists have developed models to show that in practice the way that companies fund their investment is likely to affect finance costs and investment activity. For example 'balance sheet models' suggest that companies will often prefer to use internal funds (such as retained profits) rather than external borrowing to finance investment. In other words, external borrowing is more costly than internal finance with the difference termed 'the external finance premium'. This premium may arise because external lenders cannot perfectly observe and/or control the risks involved in supplying funds to borrowers and require compensation for expected losses. Borrowers using internal funds do not face this problem. These models also suggest that the risks to lending may rise as companies' own stake in investment finance falls relative to that of external lenders. As a result, the external finance premium may well vary with borrowers' financial health. The resulting interaction between corporate financial positions and borrowing costs can lead to

amplification and propagation of shocks, termed ‘financial accelerator effects’ in the academic literature.

The paper considers the potential role of corporate financial health in recent recessions using a macroeconomic model explicitly designed to allow for these sorts of real-financial interactions. The financial accelerator model developed by Bernanke, Gertler and Gilchrist (1999) introduces a wedge between the cost of internal funds and external finance that responds endogenously to borrower financial health, measured by the share of investment that can be self-financed. When firms can finance most of their investment using retained internal funds, borrowing costs are relatively low. But when firms rely heavily on external finance, borrowing costs rise. The model is calibrated to broadly match UK financial conditions prevailing at the start of recent recessions, and is simulated with and without its financial accelerator mechanism. The simulations highlight the potential episodic nature of financial effects. In particular, the model indicates that financial factors are unlikely to have had much incremental impact on real activity in the early 1980s recession when corporate external borrowing was relatively low. By contrast the model suggests that the heavy dependence of the corporate sector on external borrowing at the start of the 1990s recession might have been a contributory factor to persistent weakness of investment growth over this period.

These results are at best indicative and certainly do not suggest that financial accelerator effects were the single, or even the most important, determinant of corporate investment behaviour in the early 1990s’ recession. The relatively simple theoretical modelling framework adopted excludes several potentially important features of reality and can only offer a very stylised representation of the actual experience of the UK corporate sector in recent recessions. However the exercise does illustrate the potential use of balance sheet models as an analytical tool for examining relationships between financial and real factors in the transmission mechanism, interactions absent in many standard macroeconomic models. Further work could usefully explore the robustness of the results by considering alternative calibrations of the specific model employed and/or different theoretical specifications of real-financial interactions. But perhaps the most important development would be an extension to the household sector, where financial factors may if anything play a more pervasive role in determining spending behaviour.

1 Introduction

Standard macroeconomic theory provides no role for financial factors in business cycle fluctuations. Macroeconomic models often assume perfect capital markets, isolating real economic variables from financial factors. These same models typically have problems in explaining the size and persistence of the effects of shocks to the economy. A case in point is the behaviour of the UK economy in the late 1980s and early 1990s. Following the monetary policy tightening of 1988, the economy swung from a position of exuberant growth to prolonged recession. Forecasters were surprised not only by this rapid turnaround but also by the persistence of the slump in activity relative to previous downturns.

A number of *ex post* explanations for the sluggish growth of the early 1990s have suggested a potential role for corporate and household indebtedness, noting the coincidence of weak real activity and a marked financial retrenchment by both sectors in the early 1990s.(1) This paper explores the role of corporate financial health at this time by considering a macroeconomic model explicitly designed to allow for interactions between real and financial factors. This financial accelerator model, developed by Bernanke, Gertler and Gilchrist (henceforth BGG) (1999), is calibrated to match UK corporate financial conditions entering the early 1980s and 1990s downturns and is used to examine whether endogenous fluctuations in the cost of finance might have helped to propagate or amplify shocks to the macroeconomy. The model is simulated with and without its financial accelerator mechanisms operating. The results suggest that the version including financial accelerator effects matches key features of the early 1990s recession better than the model excluding credit channel effects.

The paper is organised as follows. Section 1 reviews corporate sector real behaviour and financial conditions in recent recessions. Section 2 outlines the rationale for models incorporating financial accelerator effects, in particular the BGG model.(2) Section 3 considers whether a version of this model, calibrated to approximate the financial condition of the corporate sector entering recent recessions, can help to explain associations between real and financial developments. Section 4 draws conclusions and suggests avenues for potential future research.

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(1) For example, see Young (1993), Sterne (1993), Smith *et al* (1994) and Whitaker (1998).
(2) Annex 1 discusses the microeconomic underpinnings for financial accelerator models. Annex 2 reports log-linearised equations from the BGG model.

2 Recessions past

The depth and length of the UK recession of the early 1990s surprised many forecasters. Of particular note was the sharp fall in corporate fixed investment. In the search for explanations, several commentators have suggested that corporate indebtedness may have played a role, noting the coincidence of weak real activity and a marked financial retrenchment by the sector in the early 1990s. This section considers this possibility by reviewing historical evidence on real activity and corporate financial conditions in recent recessions—with a particular focus on comparing the early 1990s downturn with the recession of the early 1980s.(3)

2.1 Real activity compared

Table A reports changes in key components of gross domestic expenditure in the recent major UK economic downturns.(4) The table shows that GDP fell by comparable magnitudes in the downswing phases of the 1980s and 1990s recessions. But the contributions to each downturn varied markedly. Most notably, consumption fell as the economy entered the 1990s recession but supported the economy in the downswing phase of the early 1980s recession.

Table A
Real GDP components in previous recessions
Percentage change over nine quarters up to trough[(a)]

Trough	Total GDP	Consumption	Government consumption	Gross domestic fixed capital formation	*of which: business investment*	Exports	Imports
1975 Q3	-3.1%	-1.6%	7.7%	-3.1%	*9.9%*	2.7%	-2.9%
1981 Q1	-2.6%	3.7%	2.3%	-10.0%	*-6.7%*	-3.2%	-2.0%
1992 Q2	-2.2%	-1.4%	4.6%	-10.8%	*-12.3%*	7.8%	4.4%

(a) The average interval between peaks and troughs in coincident indicators in the three most recent major recessions.

Source: Office for National Statistics (ONS).

The profile of aggregate investment was broadly similar in the 1980s and 1990s downturns, and considerably weaker than in the 1970s recession. However these aggregate data hide sharp discrepancies in the behaviour of public and private investment in the two most recent recessions. Public sector investment was relatively weak during the 1980s downturn, particularly following the 1981 Budget. By contrast, Budgets in the early 1990s tended to raise public sector investment spending. But business investment growth was considerably weaker in the early 1990s than in the

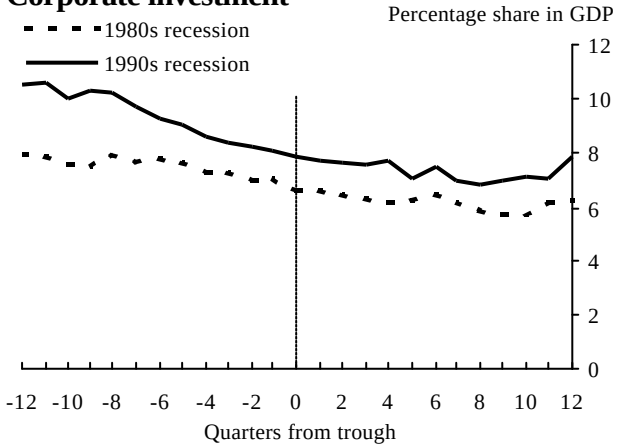
(3) This paper focuses specifically on developments in the private non-financial corporate sector. But interactions between household sector financial conditions and real activity may have been at least as important in the early 1990s. For example, Chrystal and Mizen (2001) report evidence of a relationship between household credit flows and consumption over this period.
(4) We use ONS coincident indicators to identify these episodes (see Moore (1993)). We do not consider behaviour in the minor cyclical turning point of 1985 Q4.

1970s and 1980s recessions: from a relatively high level entering the downturn, business investment fell by 12.3% in the period leading up to the output trough in 1992 Q2 and continued to fall until late 1993. In the equivalent period of the 1980s downswing, business investment fell by 6.7%, about half as much. Put another way, a fall in business investment accounted for about two-thirds of the GDP downturn in the 1990s recession compared with only about a quarter in the 1980s slowdown.

One possibility is that the sharp fall in investment in the early 1990s reflected particularly weak output growth or a high cost of capital—standard explanatory factors used in investment equations. But as noted above, the change in GDP was broadly similar across the 1980s and 1990s recessions. Chart 1 shows that although corporate investment was higher as a share of output entering the early 1990s downturn, it fell more sharply relative to GDP than in the equivalent period of the previous recession.(5) It is difficult to measure the real cost of finance precisely. Chart 2 presents a simple proxy measure based on the ratio of companies' current earnings relative to the market value of their net financial liabilities.(6) This measure suggests that the cost of finance was lower in the early 1990s recession than in the 1980s recession. As such, finance costs do not appear to help explain weaker investment in the most recent recession.

Chart 1

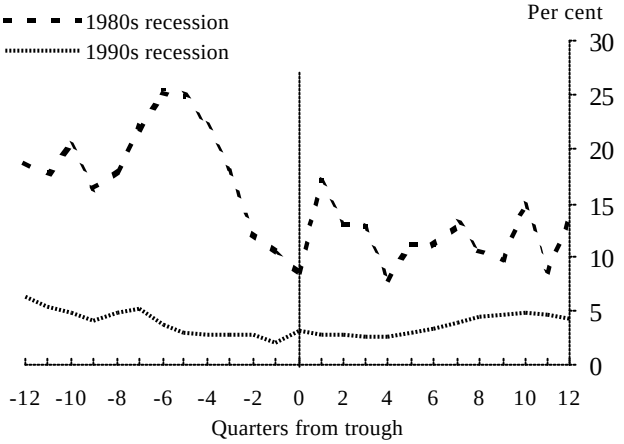
Corporate investment[(a)]



(a) Industrial and commercial companies (ICCs).

Chart 2

Cost of finance[(a)]



(a) Defined as ICCs' post-tax profits divided by the market value of their net financial liabilities.

Sources: ONS and Bank of England.

Given the apparent inability of GDP and the cost of finance to account fully for differences in investment behaviour in the early 1990s, we might expect models based largely on these explanatory variables to overpredict investment at that time. Table B suggests that, on average, medium-term projections for aggregate investment made in January 1990 by HM Treasury's Panel

(5) References to the 'corporate sector' relate to non-financial companies only. Note that fully consistent data for the financial position of the non-financial corporate sector are not available for the full period considered in this study.
(6) This measure is discussed in Fleming *et al* (1976).

of Independent Forecasters substantially overstated subsequent investment growth in the early 1990s. And total investment as a share of GDP fell more sharply over this period than the ratio implied by forecasts of investment and GDP, suggesting this did not simply reflect errors in GDP forecasts.

Table B
Forecasts and outturns for gross fixed investment
Average of forecasts made in January 1990

	Average forecast		Outturns	
	Annual growth in investment	Implied investment/GDP ratio	Annual growth in investment	Actual investment/GDP ratio
1989	5.7%	18.6%	5.9%	18.6%
1990	0.7%	18.5%	-2.3%	18.1%
1991	1.2%	18.3%	-8.7%	16.8%
1992	3.5%	18.4%	-0.7%	16.6%
1993	3.3%	18.5%	0.8%	16.4%

Source: HM Treasury (1990).

2.2 Financial conditions compared

If these standard determinants of investment cannot fully explain behaviour over this period, can financial factors account for the unusual weakness of investment in the early 1990s compared with the early 1980s?

The initial financial position of the corporate sector was considerably less favourable at the start of the 1990s recession than prior to the previous downturn. Several indicators suggest that corporate cash flow was weaker:

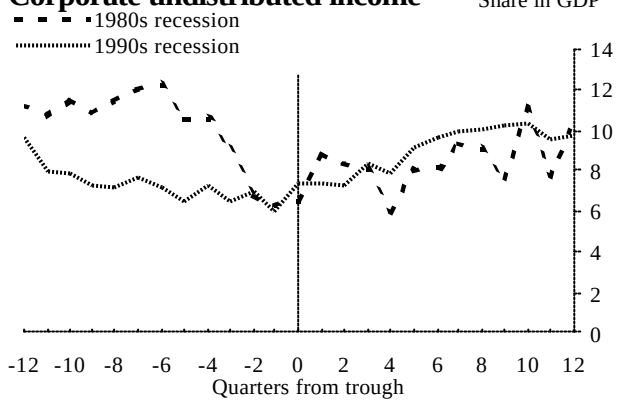
- Despite higher corporate profitability, large dividend payments in the late 1980s and early 1990s meant that companies' undistributed corporate income as a share of GDP was relatively lower (see Chart 3).

- Interest payments were a greater burden on corporate income entering the 1990s recession. Income gearing (interest payments as a share of post tax income) was almost twice as high at the onset of the 1990s recession as at the previous downturn (see Chart 4), reflecting both weaker income and greater indebtedness (see Chart 5).

- As a result, companies were far more dependent on externally supplied finance in the 1990s recession. The financial deficit was around 4% of GDP entering the 1990s downturn compared with a *surplus* of about 1% at the start of the 1980s recession (see Chart 6).

Chart 3

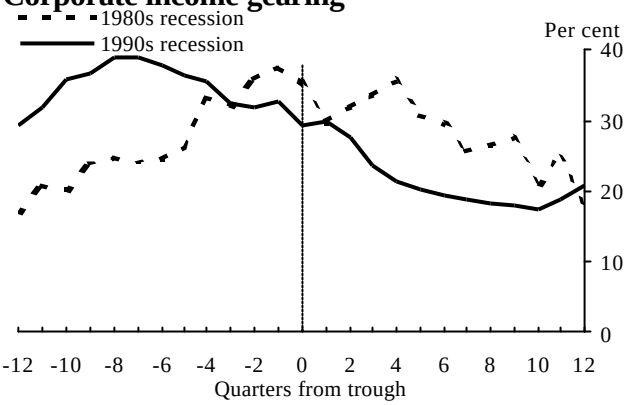
Corporate undistributed income[(a)]



(a) ICCs.

Chart 4

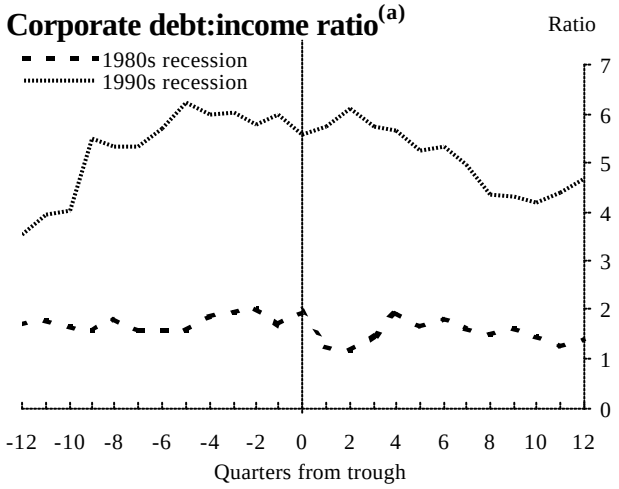
Corporate income gearing[(a)]



(a) ICCs pre-1987; private non-financial corporations (PNFCs) post-1987.

Chart 5

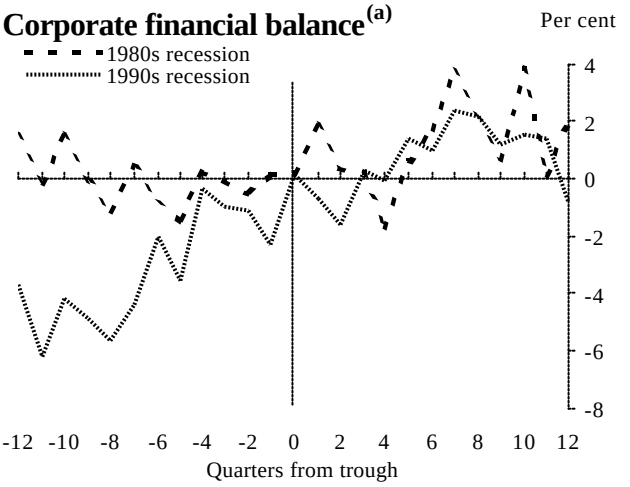
Corporate debt:income ratio[(a)]



(a) ICCs.

Chart 6

Corporate financial balance[(a)]



(a) ICCs.

Sources: ONS and Bank of England.

Corporate balance sheet positions were also less favourable entering the 1990s downturn and weakened substantially as capital markets revised their expectations about future profitability:

- Confidence about future profitability and greater credit availability due to financial liberalisation contributed to a substantial build-up in corporate debt during the 1980s, heightening the sensitivity of the sector to interest rate changes (see Chart 5 above).

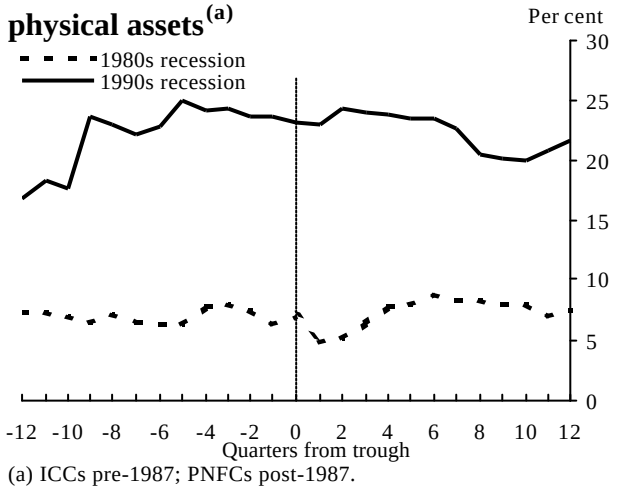
- Capital gearing, as measured by debt relative to physical capital, rose in the downswing of the 1990s recession to about four times its level in the 1980s downturn (see Chart 7).

- Capital gearing, as measured by debt relative to financial market valuations of corporate assets (including non-physical assets), started the 1990s downswing at similar levels to the equivalent

period of the previous downturn but rose sharply as markets revised their valuations of corporate assets (see Chart 8).

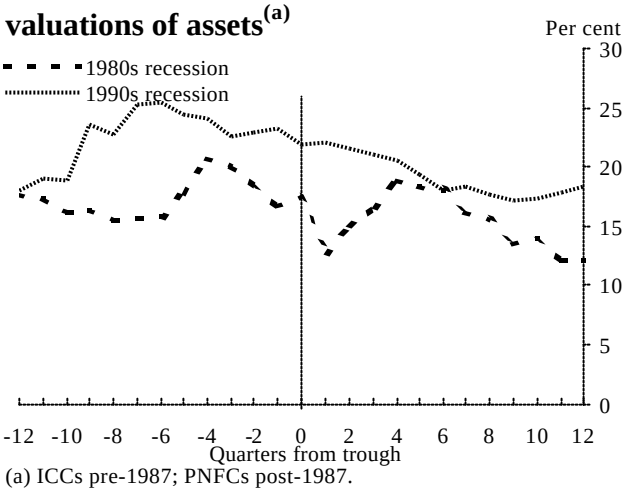
- The persistent weakness of asset prices was an important distinguishing feature of the 1990s recession. Chart 9 shows the sustained weakness in real equity prices and falls in real house and commercial property prices in the early 1990s. As well as indicating marked revaluations of the present value of future asset returns, these asset price reductions lowered collateral available to back corporate borrowing.

Chart 7
Corporate debt as a share of physical assets[(a)]



(a) ICCs pre-1987; PNFCs post-1987.

Chart 8
Corporate debt as a share of financial valuations of assets[(a)]



(a) ICCs pre-1987; PNFCs post-1987.

Chart 9
Real asset prices

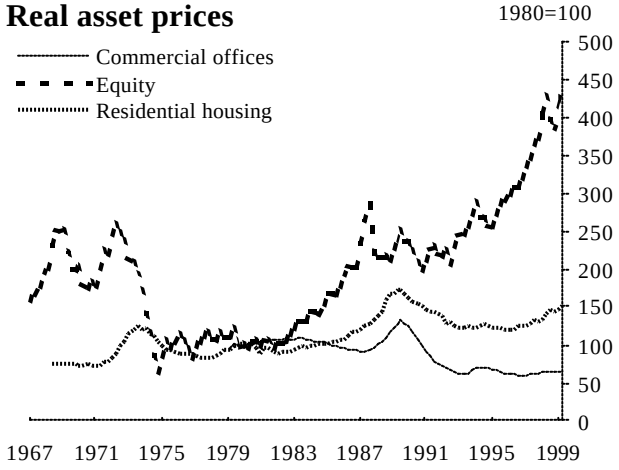
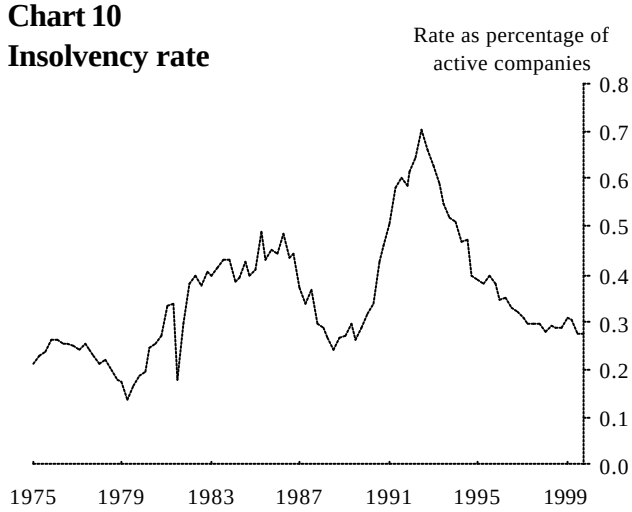


Chart 10
Insolvency rate



Sources: ONS and Bank of England.

In summary, these *ex ante* indicators suggest considerably higher corporate financial fragility at the onset of the 1990s recession than at the start of the previous downturn. *Ex post* evidence subsequently pointed to greater corporate distress in the 1990s recession in response to the unanticipated weakening in economic prospects at that time. For example, default rates reached unprecedented levels, evident in sharp rises in the rate of corporate insolvencies (see Chart 10).

2.3 Finance demand and supply

One interpretation of the sustained weakness of investment in the early 1990s is that the unexpected deterioration in economic prospects led to a sharp fall in companies' desired levels of capital and indebtedness.(7) Rather than invest, companies may have used internal funds to repay debt and reduce their potential sensitivity to future shocks. On their own, changed expectations about the returns from existing capital and a desire to strengthen their balance sheet positions should not have inhibited companies from borrowing to fund profitable new investment opportunities. But greater uncertainty about future demand (see Chart 12 below) may have raised risk premia embedded in corporate hurdle rates for investment. This demand-side and/or voluntary balance sheet restructuring interpretation would be consistent with the sustained weakness in investment through the early 1990s, despite falling costs of finance.

It is also possible that the weakness of investment in the early 1990s might have partly reflected a tightening in the supply of finance. The willingness of lenders to satisfy corporate finance demand will depend on their assessment of the likely returns from lending. In general, lenders will supply funds if loan rates at the margin exceed the cost of providing funds (including expected default costs). Lenders may assess default probabilities using *ex ante* indicators of borrower financial risk and/or *ex post* evidence on default. As noted above, these indicators of credit risk were less favourable in the early 1990s downturn than in the previous recession and lenders may have adjusted rates on new loans accordingly. By itself, rising loan rates relative to risk-free rates in response to greater risk in lending does not represent a tightening in supply for equivalent-risk companies. But is there any evidence that loan rates or other terms of provision of funds rose by more than needed to offset higher credit risk? Did lenders stop offering funds to certain classes of borrower altogether? And did this inhibit new investment?

Over the course of the early 1990s recession, there was certainly a substantial weakening in flows of external finance to the corporate sector. The corporate financial balance, which measures total net flows of finance into the sector, moved from a large deficit to surplus (Chart 5 above). And within total financial flows, bank lending growth fell sharply, with firms on average repaying debt in the early years of the recovery (see Chart 11).(8)

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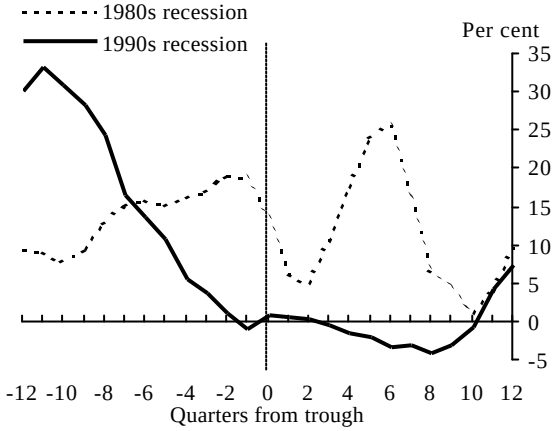
(7) Whitaker (1998) provides an assessment of factors affecting investment growth in the early 1990s.
(8) Espezel and Mizen (2000) note that corporate non-bank external finance liabilities increased over this period. Kohler *et al* (2000) point out that higher non-bank finance might be consistent with a trade credit channel interpretation, with quoted firms 'helping out' those firms without direct access to capital markets.

Chart 11

Corporate bank lending growth[(a)]



(a) ICCs.

Source: Bank of England.

In practice, however, it is extremely hard to judge whether lower volumes of finance reflected weaker corporate demand for funds or tighter finance supply. We have little direct evidence on the actual loan rates and risk characteristics of lending to the corporate sector during the 1990s recession. A potential indicator is the CBI Industrial Trends survey, which showed a much sharper rise in the proportion of manufacturing respondents citing the cost of finance as a constraint on capital expenditure in the early 1990s than in the early 1980s (see Chart 12). And importantly, this rise was greater than can be explained by the normal relationship between base rates and responses to this question, although this might just reflect deteriorating credit quality (evident in higher insolvencies in the early 1990s) rather than a tightening in credit supply for equivalent-risk loans.[(9)]

Corporate bonds offer an alternative source of finance for large borrowers. To the extent that prices of credit-rated corporate bonds reflect an assessment of average default risk over the duration of the bond, short-term shifts in bond spreads might help to identify whether finance costs shifted because of changing risk or due to tighter credit supply. Chart 13 shows the spread between bond rates for A-rated corporates and default-risk-free yields on government debt of comparable maturity. These spreads widened significantly more at the start of the 1990s recession than in the early 1980s downturn. It may well be that this widening in spreads simply reflected an equal shift in the risk of A-rated companies from the perspective of both borrowers and lenders in the recession (ie there was no change in the external finance premium). However, it is also consistent with a tightening in the terms of finance supply in traded debt markets for borrowers of equivalent risk, and a rise in the external finance premium. That might have added to the demand-side factors weakening corporate investment.

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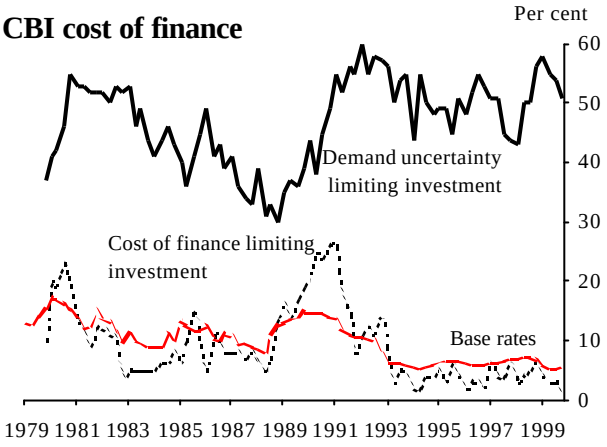
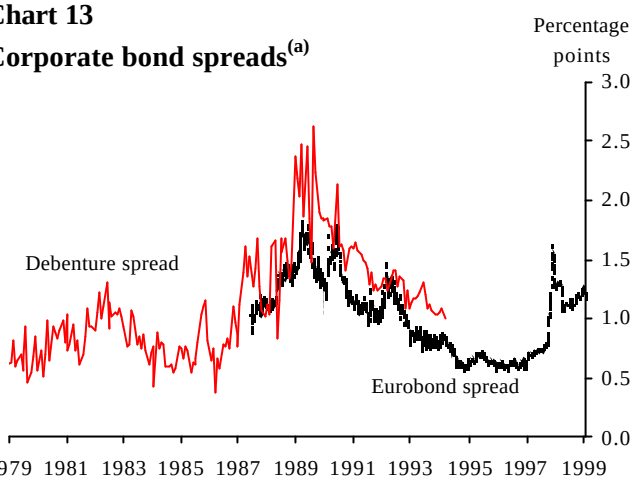
(9) Merton (1974) shows that credit spreads reflect expected losses on a corporate bond in the event of default.

Chart 12
CBI cost of finance



Sources: CBI and ONS.

Chart 13
Corporate bond spreads[(a)]



Sources: Bloomberg and Bank of England.

(a) Proxy measures defined as yields on debentures or corporate eurobonds minus approximate equivalent-maturity yield on risk-free government debt. Corporate bond yields are derived as a composite of investment-grade company debt.

2.4 Summary

Corporate investment fell unusually sharply in the 1990s downturn in relation both to previous recessions and to its standard explanatory factors. This weakness coincided with a period of substantial deterioration in corporate cash flow and balance sheet positions, reflecting weaker income, higher interest payments and sharp falls in corporate asset prices. It is possible that poor corporate financial health may have raised lenders' perceptions of the expected risks of lending, leading to a rise in the cost of corporate finance relative to risk-free rates and sharp reductions in external finance flows to the sector over this period. However, in practice it is hard to disentangle the contribution of demand and supply factors to the reduction in finance flows over this period and determine whether firms passed up opportunities to invest in profitable projects because of external financing constraints. Available evidence suggests that demand-side factors were important. The contribution of credit supply shifts is less clear.[(10)] The following sections do not settle the debate, but examine whether the predictions of theoretical credit channel models are consistent with observed data over this period.

(10) For example, evidence submitted by the Bank of England to a Treasury and Civil Service Committee in March 1991 concluded '*There is little evidence that (lenders) have tightened standards beyond what is required, given the change in their customers' position and prospects'*, Bank of England (1991). Hickok and Osler (1994) found that *'slowing credit demand due to cyclical factors appears to explain some but not all of the recent slowdown in British credit growth (in the early 1990s)'.*

3 A financial accelerator model of the UK economy

The previous section noted a correspondence in the 1990s recession between unusually subdued business investment, weak corporate financial conditions and tighter finance supply. In standard macroeconomic models, which embed Modigliani-Miller assumptions about perfect capital markets, there is no theoretical role for interactions between real and financial factors. But these factors are explicitly interconnected in credit channel models with imperfect capital markets.

A key result from the credit channel literature is that in markets with informational asymmetries, firms will prefer to finance investment projects using internally generated funds rather than external resources.(11) In other words, external finance is more costly than internal finance, with the difference termed the '*external finance premium*'. This premium may arise because external lenders cannot perfectly observe and/or control the risks involved in supplying funds to borrowers and require compensation for the expected agency costs. Borrowers using internal funds do not face this imperfect information problem. Agency costs, and the external finance premium, may well vary with borrowers' financial health. For example, the stake of a borrower in an investment project (measured by the degree to which it is able to finance a project using internal funds) may provide a signal of the unobserved risk of lending (the 'adverse selection' effect), may affect the borrower's likely incentive to act diligently (the 'moral hazard' effect) and the incentive to report project outcomes truthfully.(12) This relationship between corporate financial health and expected agency costs in lending can provide a direct link between corporate financial conditions and real activity.

Financial accelerator models embed this imperfect information problem in the supply of external finance in a standard macroeconomic framework. The key innovation in these models is the introduction of corporate net worth (or internal finance) as an additional state variable.(13) Shocks to net worth relative to total finance requirements (eg investment expenditure) generate endogenous changes in agency costs and in the premia charged above risk-free rates for external finance. In this way, monetary (and/or other) shocks to the financial health of borrowers can propagate and/or amplify the impact of shocks to real activity. The literature has focused on two key transmission mechanisms:

- One focuses on corporate cash flow.(14) An unexpected rise in interest rates (or a negative productivity shock) reduces current output, lowers cash flow and raises the proportion of a given investment project which must be financed from external funds. This increases expected

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(11) Annex 1 offers a fuller discussion of the microeconomic underpinnings of these credit models.
(12) James (1987) and Lumer and McCommel (1989) suggest that the presence of bank loans may act as a positive signal to other external lenders since banks tend to monitor more closely, and at lower cost, than other lenders.
(13) Credit models are often divided into financial accelerator and bank lending channel models. This distinction is in some ways artificial. In principle, the balance sheet channel can affect any recipient of external finance, be it final borrowers or banks. The distinguishing feature is the location of the shock to net worth.
(14) Bernanke and Gertler (1989) is an example of a model incorporating this mechanism.

agency (default) costs and the external finance premium, reducing investment and subsequent output, revenues and cash flow.

- A second operates through asset prices and the value of collateral.(15) Here, an unanticipated monetary tightening reduces the demand for capital and lowers asset prices. This lowers the value of corporate collateral available to back loans, raises the external finance premium and reduces current investment and subsequent output and cash flow. And expectations of future declines in cash flow and lower net worth might exacerbate the current movement in (forward-looking) asset prices.

The BGG (1999) model incorporates both these additional transmission mechanisms in an otherwise standard dynamic new Keynesian general equilbrium model. In their model, households work, consume and invest their savings in a financial intermediary. The financial intermediary pools savings and lends to companies. Companies produce in competitive markets using labour and capital, with capital financed from retained internal/collateralised funds (net worth) or external/uncollateralised borrowing. Production is bought by retailers who differentiate goods and sell in monopolistically competitive markets permitting price stickiness, as in Calvo (1983). In the base case, a monetary authority uses a simple forward-looking interest rate rule to stabilise inflation.

Given the standard nature of most of the BGG model, we focus here exclusively on the key innovation in the investment system.(16) In a standard model, without financial accelerator effects, firms would increase their capital stock until the expected return on capital (R^k_{t+1}) was equal to the opportunity cost of funds (R_{t+1}) (see equation **(1)**). However, in this model the cost of finance depends on the financial health of firms. Specifically it responds endogenously and negatively to the level of corporate internal funds (net worth, N_t) relative to total financing requirements (Q_tK_{t+1}), where Q and K are the price and quantity of capital respectively (see equation **(2)**). When a substantial portion of corporate investment is funded internally (ie borrowing and capital gearing is low), the external finance premium is small (tending to zero for investment which is fully internally funded or collateralised). When corporate investment is mainly funded through external borrowing (gearing is high), the premium is high. The intuition is that the intermediary's participation constraint in the optimal contract between lenders and borrowers requires a premium sufficient to offset the greater likelihood that the borrower will declare default (and the lender will incur default costs) when the borrower's stake in a project is low. This added element provides for greater amplitude and persistence in response to shocks, and for inter-relationships between real and financial variables unavailable in standard models.

$$E_t[R^k_{t+1}] = R_{t+1} \qquad \textbf{(1)}$$

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(15) Kiyotaki and Moore (1997) show how this mechanism can lead to credit cycles.
(16) Annex 2 reports the full model in log-linearised format as simulated using the Winsolve package. For further details, see Bernanke, Gertler and Gilchrist (1999).

$$\mathrm{E_t}[R^{k}_{t+1}] = v\left[\frac{N_t}{Q_t K_{t+1}}\right] R_{t+1} \qquad v'(\cdot) < 0 \qquad \textbf{(2)}$$

Moreover, the initial financial position of the corporate sector becomes critical in determining the responses of net worth, the cost of finance and investment to shocks. For a highly-geared firm, a shock to project returns will have a far more marked impact on internal funds (and finance premia) than for a firm that has low gearing. The model therefore provides theoretical grounding for the intuition that more heavily indebted economies tend to be more vulnerable to adverse shocks.

4 Results

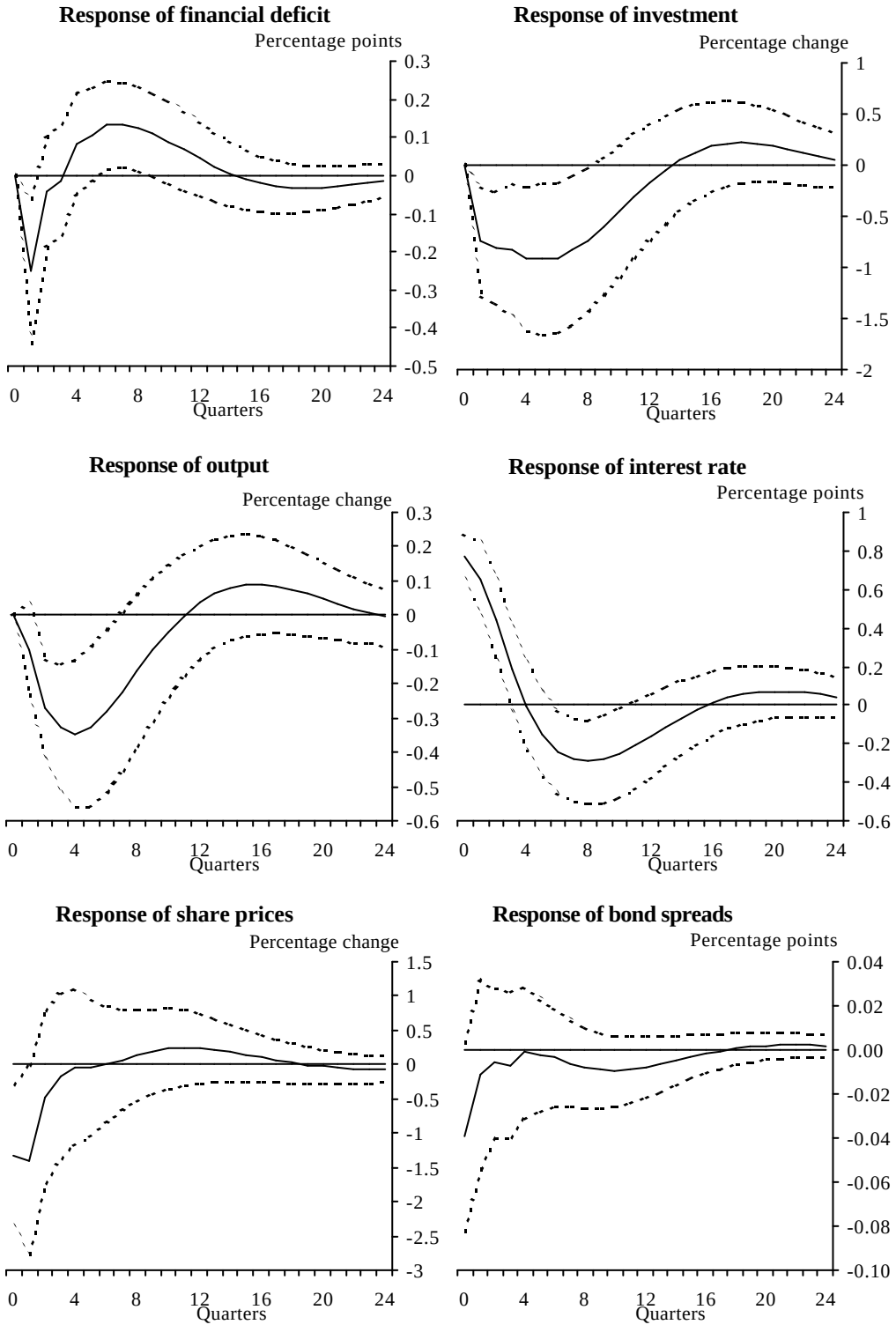
In this section we consider whether the behavioural implications of the BGG model are consistent with observed behaviour of corporate investment and financial conditions in the 1980s and 1990s recessions.(17) As a benchmark, we start by comparing average responses to a monetary shock in historical data estimated from a vector autoregression model with simulated responses in the model economy. We then consider whether simulations of the BGG model, specifically calibrated to reflect financial conditions of the UK corporate sector entering the 1980s and 1990s recessions, might shed light on the differential behaviour of investment in these periods.

4.1 Estimated real and financial interactions

Chart 14 reports historic average responses in the UK economy of the financial deficit, business investment, real GDP, nominal base interest rates, real equity prices and corporate bond spreads to an unanticipated rise in interest rates in a six-variable VAR model estimated over the period 1977 to 1998. The model follows the 'identified VAR' approach in which variable ordering is critical. Here real variables—the financial deficit ratio, business investment and output—appear at the top of the VAR. The policy instrument—official interest rates—appears next; and last of all come the so-called 'information' variables—equity prices and the bond spread. This ordering implies that real variables respond to policy changes with a lag and that policy can respond to changes in these variables within a quarter. Information variables respond to policy changes immediately under these identifying conditions. The interest rate equation can be interpreted as a monetary policy rule and the equation residuals as monetary policy 'shocks'. Chart 14 shows the responses of variables to these monetary policy 'shocks'.

(17) Specifically, we use a version of the model developed in the paper 'Monetary policy and asset price volatility', presented at the Federal Reserve Bank of Kansas City conference on 'New challenges for monetary policy", Jackson Hole, Wyoming, August 26-28, 1999. For details see Annex 2 below.

Chart 14
Estimated average responses to interest rate rises[(a)]



(a) Response to a one standard deviation (about 80 basis points) interest rate shock. Dashed lines mark bands of plus and minus two standard errors.

The VAR suggests that companies' total net flow of external funds, as measured by the financial deficit, falls after a monetary tightening, although our VAR cannot distinguish between a decline in

the demand for funds and a contraction in finance supply. As might be expected, output and, particularly, investment decline following an unexpected rise in interest rates. And, on average, equity prices have fallen in response to unexpected monetary tightenings, perhaps as the market has anticipated lower future yields.

At face value, the lack of a statistically significant response of bond spreads seems to suggest that demand effects have been more dominant than supply effects over time.[18] However, this does not necessarily mean that financial accelerator effects have not been a feature of past UK business cycles. For example, it may be that by using bond spreads (in the absence of suitable historical data on loan spreads), we fail to capture underlying changes in the cost (and/or availability) of finance for many firms in the UK economy over time—bond finance represented a relatively small proportion of total finance supplied in the economy over our period of estimation.[19]

However, the absence of a response of bond spreads also may illustrate a benefit of a model-based approach to the credit channel over econometric estimation techniques. The essence of the credit channel is that loan spreads are likely to move only if there is a marked change in lenders' assessment of the risks to lending, perhaps in response to substantial changes in financial conditions. As such, financial accelerator effects are likely to vary in strength over time. Models (at best) are only simplified representations of behaviour in the actual economy, and are critically dependent on specification and calibration. But they can potentially help us to examine variations in the strength of interactions between financial conditions, lending terms and real activity over time—for example, by investigating the response of the model to shocks when specified under different steady-state parameterisations for corporate financial health. By contrast, an estimation approach tends to average over time, capturing periods when financial accelerator effects may have mattered and periods when they probably did not. Chart 13 (above) may support this view. Bond spreads actually fell at the start of the early 1980s downturn but rose sharply in the early 1990s downturn. Our subsequent experiments, considering corporate sector activity in the early 1980s and early 1990s recessions, are explicitly designed to investigate this potential episodic nature of financial accelerator effects.

4.2 Model economy responses

Chart 15 considers the impact of a similar unanticipated rise in interest rates simulated on the model economy. In this baseline application of their model we set initial steady-state conditions to

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(18) This result contrasts with the finding by Bernanke, Gertler and Gilchrist (1999) in a VAR estimated for the United States that bank lending spreads rose in response to unexpected rises in interest rates.
(19) An alternative VAR was estimated using a proxy spread series based on the CBI Industrial Trends survey (see Chart 12 above). This spread rises following a monetary tightening, possibly consistent with financial accelerator effects, but is insignificantly different from zero.

broadly reflect the average financial position of the UK corporate sector over the past 20 years.[20] Strictly speaking, calibration of corporate financial conditions in the BGG model requires an estimate of the share of corporate sector net worth (or internal equity) in their overall balance sheet (ie a *stock* measure of financial health of the sector). In the United Kingdom, the share of debt on corporate balance sheets has been low historically (relative to, say, the United States) and the share of equity correspondingly high. However, the *internal* equity of the corporate sector—that is, the firm's own stake in its production activities on which lenders form their assessment of potential default risk—is likely to be overstated by the value of *issued* equity. As a result, in this (and subsequent) experiments we use a calibration of financial health based on historic shares of internally-generated finance (ie profits) in total financial *flows* in the sector (about 60% over the whole period since 1978), although we acknowledge that calibrations derived from issued equity data would substantially reduce financial accelerator effects.

As seen in the estimated VAR, investment and output fall in response to an unanticipated rise in interest rates, although the initial quantitative impact is much larger than in the data (see Chart 15).[21] The premium on external finance over risk-free rates rises very slightly, while estimated average actual responses show little change. The chart also shows simulated responses based on the same steady state as the BGG model but with financial accelerator effects 'switched off' (ie the cost of finance does not respond to shifts in the financial position of firms as in equation **(1)** above). These results illustrate that the financial accelerator mechanism adds to the amplitude and the persistence of responses of investment and output to interest rate rises.

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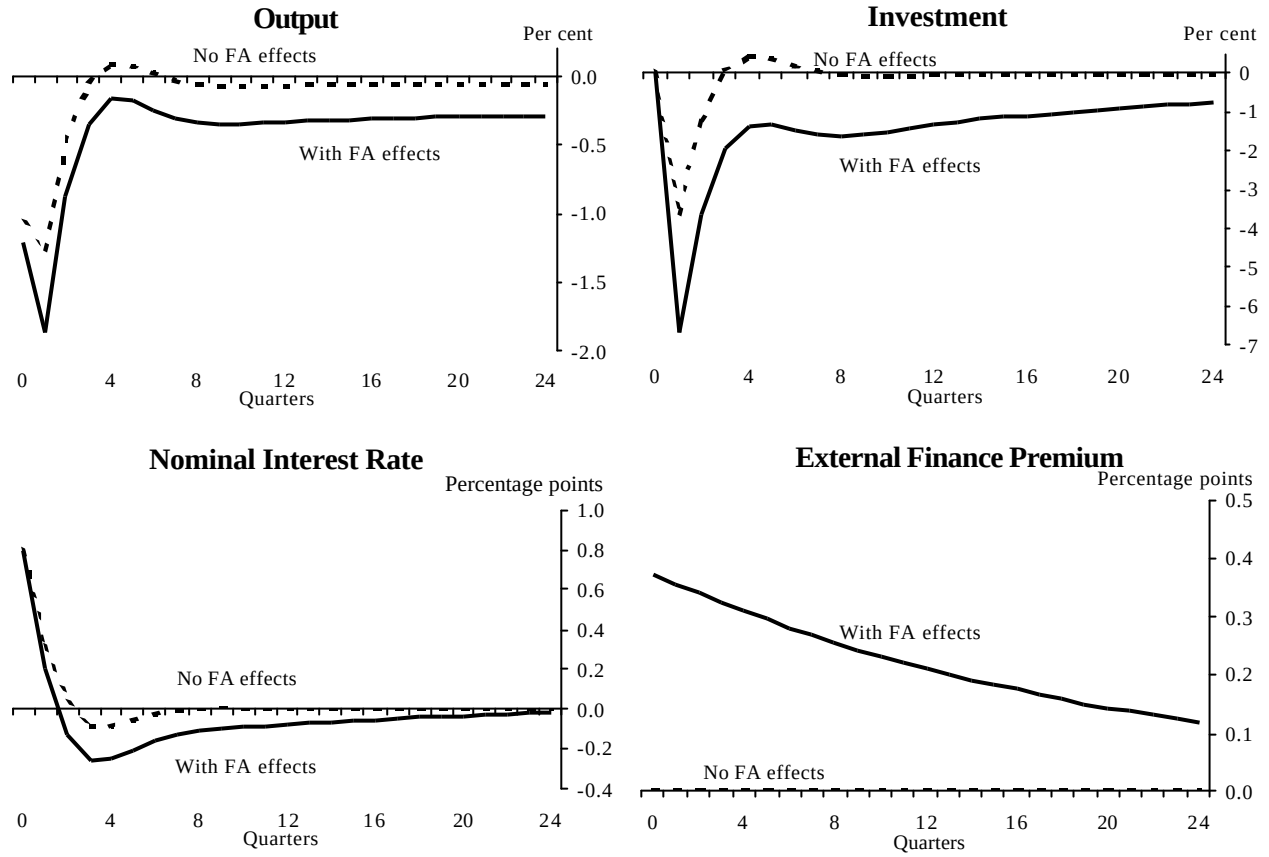
(20) Our model calibration broadly follows that adopted by BGG—full details are provided in Annex 2. As well as varying the calibration of financial leverage, we differ from BGG in our calibration of nominal price rigidity. We set nominal inertia to match historical estimates for the United Kingdom taken from Hall, Walsh and Yates (2000). As such, our model has somewhat more price flexibility than the BGG model.

(21) Potential ways of improving the correspondence between the model dynamics and data include the introduction of habit formation in consumption or longer planning lags in investment. For an extension including habit formation in consumption, see Bernanke, Gertler and Gilchrist (2000).

Chart 15
Model economy



4.3 Modelling corporate sector recessionary experiences

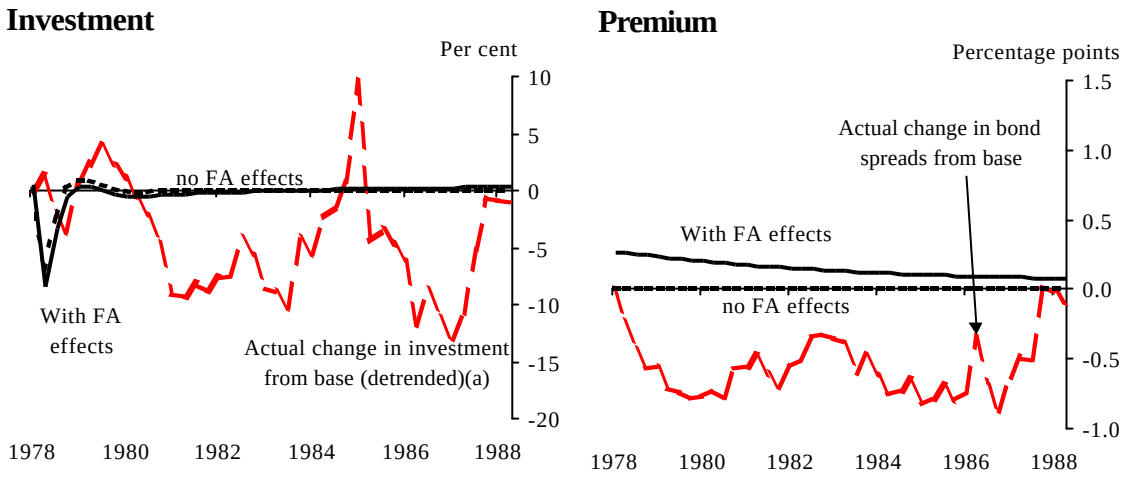
The previous subsection showed that the model economy offers a reasonable qualitative representation of average historic responses to monetary shocks in the UK economy. But as noted earlier, average responses can hide substantial variation over time, and obscure the potential episodic impact of financial accelerator effects.

Our hypothesis in Section 2 was that the less favourable initial financial condition of the UK corporate sector at the onset of the 1990s recession might have heightened the fragility and sensitivity of the sector to shocks. Following the policy rate rises in the late 1980s, this might have contributed to the persistent weakness of investment in the early 1990s. We conduct two experiments to investigate this hypothesis. For these experiments, we calibrate the steady-state initial financial position of the corporate sector in the model to match prevailing internal finance shares in the late 1970s and late 1980s respectively.[(22)] We then subject our model economy to unanticipated monetary shocks, assumed for simplicity to equal actual rises in policy rates in 1978

(22) In the BGG model, the steady-state leverage ratio is derived from the model's deep parameters, such as the assumed variance of uncertain investment returns. When changing steady-state leverage in our simulations we are assuming implicitly that these deep structural parameters are also changing.

and 1988 (noting that these rises may well considerably overstate actual monetary ‘shocks’ at these times). We also abstract from the many other shocks hitting the economy over these periods. Finally, we compare our simulations to actual changes in (detrended) investment and bond spreads from their starting levels in these periods.

Chart 16
1980s recession experiment

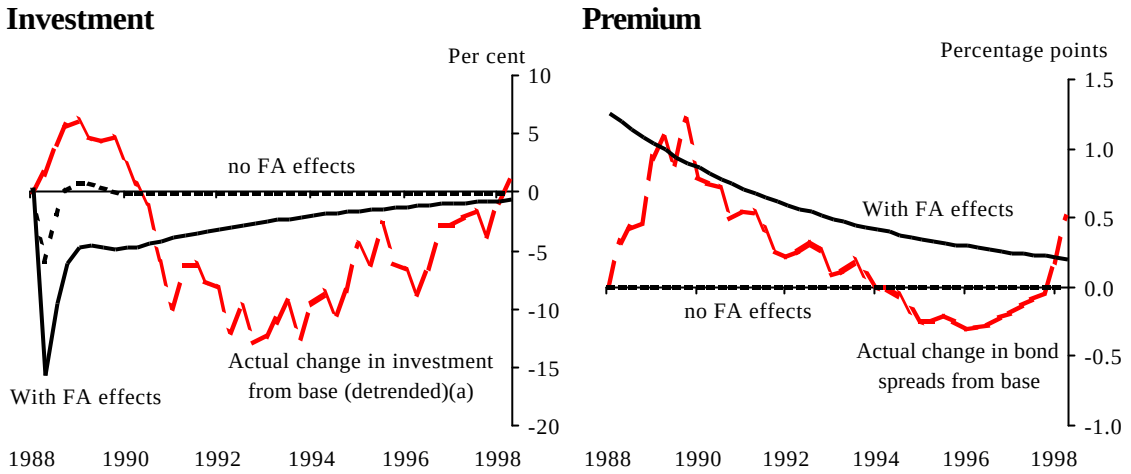


(a) Real business investment.

Chart 16 reports simulations of a monetary shock in our model economy, calibrated to the relatively favourable initial financial conditions holding in the early 1980s.[23] Comparison of responses in simulations with and without financial accelerator effects operating suggest that financial accelerator effects may not have added greatly to the impact on investment of the monetary tightening in this period—perhaps not surprising given the strong financial conditions at the time. The model also overstated the observed response of actual investment over this period, although the financial accelerator mechanism does appear to provide marginally more persistence to investment behaviour. The premium on external finance in our simulation rises slightly in response to the shock, contrasting with the actual falls observed in bond spreads at this time (although Chart 12 above suggests that spreads on other forms of finance may have risen at this time).[24]

(23) Specifically, the internal finance share is set to 75%. The economy is hit in 1978 Q1 with a monetary shock of 150 basis points (approximately equal to the overall change in base rates in the year from 1978 Q1 at an annual rate).
(24) The anomalous fall in bond spreads in the early 1980s might have been related to the thinness of the corporate bond market at that time. See Davis (1992) for a discussion of historic trends in the UK corporate bond market.

Chart 17
1990s recession experiment



(a) Real business investment.

Chart 17 reports results for the 1990s experiment. Here the financial accelerator mechanism is more potent reflecting the less favourable initial financial condition of the UK corporate sector.[25] After the initial rise in interest rates in 1988, actual investment continued to rise, but then fell sharply and remained below its starting-point for around seven years. As in the previous experiment, the model economy does not fully capture the short-run dynamics of investment and overstates the initial fall, but does provide a reasonable explanation of the persistent weakness of investment, in particular compared with the model economy absent financial accelerator effects. An important factor leading to persistent weak investment in the model is declining asset prices (which, as noted above, were an important distinguishing feature of this period). Lower asset prices in the model substantially reduce the net worth of a highly geared corporate sector, lowering collateral relative to external finance requirements, and leading to a rise in the external finance premium. As the charts show, the model economy broadly mirrors movements in corporate bond spreads over this period, with an initial rise and then gradual decline in the external finance premium charged over base rates.

4.4 Summary

The simulations of our model economy are clearly highly simplified and stylised representations of the actual experience of the UK corporate sector in recent recessions. The quantitative responses in our model economy are also sensitive to the calibration of the financial accelerator mechanism (and other parameters in our model) and to assumptions about the specific shocks hitting the economy in these periods. Extensive sensitivity analysis would be desirable to test the quantitative robustness

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(25) Here the internal finance share is low at 40%. A 125 basis points monetary shock hits the economy in 1988 Q2 (approximately equal to the change in rates over the year from 1988 Q2 at an annual rate).

of the effects identified. But the simulations do illustrate the potential importance of relationships between financial conditions and real behaviour, factors absent in standard explanations of business cycle real activity. In particular, the experiments illustrate the potential episodic nature of financial accelerator effects. In this way, the framework highlights the importance of monitoring interactions between corporate financial conditions and fragility, finance supply and real activity.

5 Conclusions

This paper has sought to investigate the potential role of financial factors in explaining unusually weak corporate real activity in the early 1990s recession relative to the previous downturn. Rather than adopting an econometric approach, the paper analyses interactions between financial factors and real activity using a standard dynamic general equilibrium model, augmented to include financial accelerator effects. An advantage of this approach is that financial effects are given explicit micro-foundations and respond endogenously to developments elsewhere in the economy, permitting richer analysis of the underlying mechanisms driving results. This approach helps us to identify conditions in which interactions between real and financial factors are likely to matter, something which econometric models, that average out responses over time, might obscure.

The paper noted a correspondence between unusually weak investment in the early 1990s, poor initial cash-flow and balance sheet financial conditions, substantial falls in asset prices and a possible tightening in finance supply. This observation motivated simulations of a version of the financial accelerator model developed by Bernanke, Gertler and Gilchrist (1999). The model was calibrated to broadly match the dependence of the UK corporate sector on external finance at the start of the 1980s and 1990s recessions. The model simulations illustrate how financial accelerator effects might help in understanding the behaviour of investment in previous downturns. In particular, the model calibrated to the relatively stretched financial condition of the corporate sector at the start of the 1990s recession suggested larger and more persistent falls in investment and a significant rise in bond spreads, broadly consistent with actual developments at that time.

This paper does not claim that financial accelerator effects were the single, or even the most important, determinant of corporate investment behaviour in the early 1990s recession. For one thing, the results are predicated on a number of strong assumptions about the financial position of companies at the start of the downturn and the response of borrowers and lenders to deteriorating economic prospects at this time. Moreover, several potentially important features of reality are excluded from the relatively simple theoretical modelling framework adopted. For example, the model assumes that policy-makers are responding to shifts in inflation in a closed economy, when the UK economy was clearly affected by movements in exchange rates over the period of consideration. In addition, it does not consider structural changes, such as financial liberalisation or changes in tax regimes, that undoubtedly impacted significantly on demand and supply conditions for corporate finance over the period of this study.

Notwithstanding these caveats, the BGG model is potentially a useful analytical tool for qualitatively examining interactions between financial and real factors in the transmission mechanism. Further sensitivity analysis, particularly on the interaction of corporate financial conditions and the finance supply decisions of lenders, would be required for it to be used as a robust quantitative tool. In this paper we have considered responses to monetary shocks only, but the model can also be used to analyse a range of other shocks, such as to productivity or the financial position of companies. But perhaps the most important development of the model would be an extension to the household sector, where financial factors may if anything play a more pervasive role in determining spending behaviour.

Annex 1: Theoretical foundations for financial accelerator models

The well-known Modigliani and Miller (1958) result that financial structure is irrelevant to real spending behaviour is a benchmark underpinning much of mainstream macroeconomic theory. Taken literally, the result implies that finance is simply a 'veil'. Deficit units will be indifferent between alternative sources or contractual forms of finance for current spending. For example, firms will face the same cost of financing investment regardless of whether they use retained internal funds, intermediated debt (by banks or non-banks), or equity. Essentially, real outcomes depend on real factors (such as tastes and technologies) and financial variables respond endogenously and passively.

The validity of the irrelevance result turns on the plausibility of its stringent assumptions. The approach assumes that markets are complete, all agents share the same (complete) information, there are no search costs in obtaining external funds, no transactions costs in writing contacts between deficit and surplus units, no issues of corporate control, and no discriminatory taxes favouring particular finance sources. Of course these assumptions are violated often in actual financial markets. Over the past 20 years a substantial research programme has investigated and formalised the implications of capital market imperfections for economic behaviour and institutions. A key result from this work is that in markets characterised by informational asymmetries, transactions and search costs, finance sources are imperfectly substitutable.

An important result is that firms often prefer internally generated funds to external resources for financing investment projects. In other words, external finance costs more than internal finance—with the difference termed the '*external finance premium*'. Transactions costs may explain this premium. It is less costly for a firm to use retained profits for investment than incur the search and contract-writing costs of external finance. And external finance may have managerial costs if it affects corporate control.[26] More commonly, the external finance premium is motivated by agency costs in the supply of intermediated finance. Agency costs may arise in a symmetric information environment if we introduce an imperfection into the resale market for corporate assets. Hart and Moore (1994) suggest that if entrepreneurial human capital is inalienable from physical capital, then the value of a project as an ongoing concern may exceed its recoverable value in default. Absent an effective commitment technology, producers can threaten to withdraw labour from projects before completion unless the terms of the loan are renegotiated in their favour. Lenders are aware of the possibility of *ex post* renegotiation and will structure financial contracts accordingly, limiting finance provision to the discounted present value of collateral. In other words, debt is fully secured and there is no default in equilibrium.

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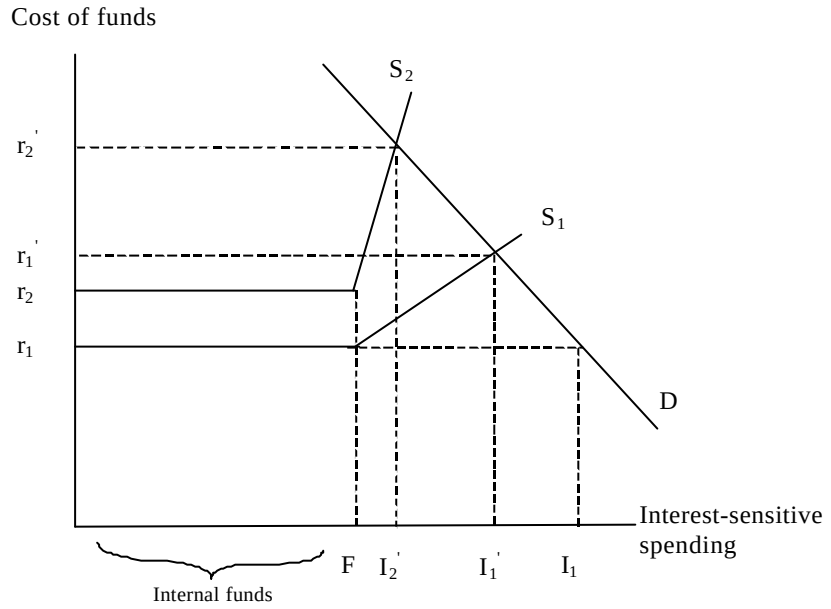
(26) Jensen and Meckling (1976) discuss the relationship between financial structure and corporate control. We do not consider these issues here.

Agency costs can also arise from *asymmetric* information about the riskiness of investment projects, the actions of investors and the outcome of projects. The advantage of this approach (over the Hart and Moore (1994) specification) is that it allows unsecured lending and default. In this case, the borrower's stake in the project (its cash flow relative to collateral) may signal the unobserved risk of lending (the adverse selection effect), the borrower's likely incentive to act diligently (the moral hazard effect) and his incentive to truthfully report project outcomes.(27)

Figure 1
Financial conditions and the marginal cost of finance



These effects are illustrated in Figure 1.(28) For financing requirements up to point *F*, a firm can use own cash flow at a rate r_1 (which can be thought of as the sum of the risk-free rate r_1^f, the monetary policy instrument, and a firm-specific risk factor q). Beyond *F*, the firm requires external finance charged at a premium above r_1. Asymmetric information means that this premium is increasing in the proportion of total finance raised externally since higher gearing linked with limited liability means greater incentives to take risks, higher expected default rates and so lenders require more compensation—so S_1 is upward sloping beyond *F*. Without informational problems, the firm would demand I_1-*F* of external funds at r_1. But the lender is not prepared to lend at this rate due to the expected impact of sorting and incentive effects on returns. The equilibrium level of external finance is I_1'-*F* charged at a spread of r_1'-r_1. In addition, the premium may also be increasing in the level of the interest rates since this may lower the present discounted value of collateral and/or

(27) Along the lines of the costly state-verification approach of Townsend (1979).
(28) This example is taken from Oliner and Rudebusch (1996).

reduce current cash flow and the chance of default—so if interest rates rise to r_2, the finance supply schedule becomes S_2, which is steeper than S_1.[29]

This simple example illustrates potential links between borrower financial conditions, agency costs and the external finance premium. It implies that firms who are prepared to post more 'collateral' per unit of external finance or to self-finance a greater proportion of an investment project from internal cash flow are likely to face a lower external finance premium. These credit mechanisms open up potential channels for the cost and/or availability of finance (corporate real spending behaviour) to depend on firm-specific financial conditions.

(29) The supply curve may eventually become vertical as incentive and sorting effects become unacceptable. This is the limit case of quantity rationing suggested by Stiglitz and Weiss (1981). In practice, it seems that lenders use a combination of devices to encourage firms to signal their risk type—collateral, loan covenants and maximum maturities, as well as price and quantity rationing.

Annex 2: The Bernanke, Gertler, Gilchrist model

Aggregate demand

Resource constraint

$$y_t = \frac{C}{Y} c_t + \frac{I}{Y} ina_{t-1} + \frac{G}{Y} g_t + \frac{C^e}{Y} c_t^e \quad \textbf{(A1)}$$

Euler relation for consumption

$$c_t = -s\, r_t + \mathrm{E}_t c_{t+1} \quad \textbf{(A2)}$$

Relation between price of external funds and interest rate

$$\mathrm{E}_t\, f_{t+1} = r_t - y\, [n_t - (q_t + k_t)] \quad \textbf{(A3)}$$

External finance premium

$$s_t = \mathrm{E}_t\, f_{t+1} - r_t \quad \textbf{(A4)}$$

Ex post price of external funds

$$f_t = (1-e)(x_t + y_t - k_{t-1}) + eq_t - q_{t-1} \quad \textbf{(A5)}$$

Relation between asset valuations and investment

$$\mathrm{E}_t q_{t+1} = j\, (ina_t - k_t) \quad \textbf{(A6)}$$

Aggregate supply

Production function

$$y_t = a_t + ak_{t-1} + (1-a)l_t \quad \textbf{(A7)}$$

Labour market equilibrium

$$y_t = g_l l_t - x_t + g_c c_t \quad \textbf{(A8)}$$

Phillips curve

$$\mathrm{E}_t p_{t+1} = l\, \mathrm{E}_t x_{t+1} + g_f\, \mathrm{E}_t p_{t+2} + g_b p_t \quad \textbf{(A9)}$$

Evolution of state variables

Capital accumulation

$$k_t = dinv_t + (1-d)k_{t-1} \quad \textbf{(A10)}$$

Investment delay

$$inv_t = ina_{t-1} \quad \textbf{(A11)}$$

Net worth accumulation process

$$n_t = cf_t - c(1-nk)r_{t-1} - c(1-nk)yk_{t-1} - c(1-nk)yq_{t-1} + c((1-nk)y + nk)n_{t-1} + \frac{(c(1-g.rk)nk)}{g}y_t \quad \textbf{(A12)}$$

Entrepreneurial consumption

$$c_t^e = knf_t - kn(1-nk)r_{t-1} - kn(1-nk)yk_{t-1} - kn(1-nk)yq_{t-1} + kn((1-nk)y + nk)n_{t-1} \quad \textbf{(A13)}$$

Monetary policy rule and shock processes

Real interest rate

$$r_t = r_t^n - \mathrm{E}_t p_{t+1} \quad \textbf{(A14)}$$

Monetary policy rule

$$r_t^n = rr_{t-1}^n + (1-r)g_p p_{t+1} + h_t^r \quad \textbf{(A15)}$$

Government spending process

$$g_t = r_g g_{t-1} + h_t^g \quad \textbf{(A16)}$$

Technology process

$$a_t = r_a a_{t-1} + h_t^a \quad \textbf{(A17)}$$

Variables

y	output	k	capital
c	consumption	x	marginal cost
ina	investment	l	labour
g	government spending	p	inflation
r	real interest rate	r^n	nominal interest rate
n	net worth	inv	investment delay variable
f	expected price of capital	a	technology
c^e	entrepreneurial consumption	q	Tobin's Q (price of capital)
s	external finance premium	h^r	Additive shock to r^n
h^g	additive shock to g	h^a	Additive shock to a

Selected parameter values and features of steady state (SS)

'Standard'

Parameter	**Description**	**Baseline value**
C/Y	SS consumption-output share	0.568
I/Y	SS investment-output share	0.1779
G/Y	SS government-output share	0.2
C^e/Y	SS entrepreneurs' consumption-output share	0.0541
s	Consumption elasticity of substitution	1
e	Parameter on marginal product in investment demand	0.95
φ	Elasticity of price of capital to investment/capital ratio	0.25
a	Capital share	0.35
$(1-a)$	Labour share	0.65
γ_l	Coefficient on labour (=1+1/labour supply elasticity)	1.33
γ_c	Coefficient on consumption in labour market equation (=1/ σ)	1
l	Parameter on marginal cost in Phillips curve	0.1
γ_f	Coefficient on *forward-looking* inflation in Phillips curve	0.5
γ_b	Coefficient on *backward-looking* inflation in Phillips curve	0.5
d	Quarterly depreciation rate	0.025
ρ	SC parameter for interest rate in policy rule	0.9
$(1-r)g_p$	Coefficient on inflation in policy rule	0.2
ρ_g	SC parameter for government spending shock	0.95
ρ_a	SC parameter for technology shock	1
ß	Quarterly discount factor	0.99
q	Probability of price change	0.5

'Non-standard'

Parameter	**Description**	**Baseline Value**	**Note**
R^k-R	SS risk spread	200 basis points	Annual basis
F(w)	SS business failure rate	0.03	
nk	SS leverage ratio	0.5	Varied in simulations
kn	1/nk	2	Varied in simulations
c	Parameter on net wealth accumulation	2.1	Varied in simulations
1-γ	Death rate of entrepreneurs	0.0272	
Log(w)	Productivity log normally distributed	Variance 0.28	
m	Share of payoffs lost in bankruptcy costs	0.12	
y	Elasticity of external finance premium to leverage	0.05	Varied in simulations

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