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Journal of Banking & Finance 26 (2002) 2131–2154

Journal of BANKING & FINANCE

www.elsevier.com/locate/econbase

Modelling credit in the transmission mechanism of the United Kingdom ☆

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Abstract

Studies have focused heavily on money in the transmission mechanism of monetary policy. In this article we explore the empirical importance of credit. The paper provides a framework in which to analyse the balance sheets of, and financial flows between, different sectors of the UK economy, and an econometric model of the interactions between non-financial firms, households and credit offered by banks and non-bank financial intermediaries. The paper also provides a dynamic structural model of bank and building society credit, money and decisions to consume and invest and then adds credit from non-bank financial intermediaries. Our bottom line is that credit is an important part of the transmission process of UK monetary policy.

JEL classification: E41; E51
Keywords: Money; Credit; Consumer spending; Investment

1. Introduction

The traditional approach to modelling monetary conditions in the UK economy has been to focus on the demand for money, i.e. *banks' liabilities*. In practice, monetary policy is implemented via changes in short-term interest rates (the repo rate), however, and this influences the supply of and demand for loans i.e. *banks' assets*. It is through the loan market that aggregate spending and ultimately inflation is

☆ This paper was written while the second author was an Adjunct Professor at the University of South Australia. Any remaining errors are our responsibility.

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0378-4266/02/$ - see front matter
PII: S0378-4266(02)00203-0

affected, at least to some degree (see Bank of England, 1999a). This issue has been addressed in theoretic terms in the 'credit channel' literature (cf. Bernanke and Gertler, 1995) and two variations on the credit channel story have been identified: a *balance sheet channel* and a *bank lending channel*. The first has linked the determinants of lending to observable characteristics of the financial health of the borrowing firms, while the second has suggested influences on lending flows originate within the banking system.

Banks have reasons to develop close relationships with the households and corporations to whom they lend resources: the information about a company's financial position that can be gained through this banking relationship can be used to determine the loan facility they will offer. In this way the bank can overcome the information asymmetry problem by combining its deposit taking function with it role as a provider of loans. Factors that are easily monitored, such as cash flow, financial wealth, previous loan payments history and outstanding debt, will therefore affect the ability of a company to obtain loans. Households too will find that the availability of loans is based on measurable indicators of their ability to repay, such as disposable income, liquid savings, previous loans history and outstanding debts.

Large firms can often borrow on better terms through securities markets than they can through banks, so the bank lending effect is primarily a small–medium sized firm and households issue. Prudent banks will limit their exposure to any specific firm or household, so there will not generally be unlimited access to bank lending; hence the available supply of bank loans will be an important influence on real expenditure, in addition to any effect from market interest rates. The extent to which there is dependence on banks for finance, rather than on retained profits (internal sources) or securities markets (other external sources) is an empirical issue. This channel refers to the extent to which factors internal to the banking industry influence the willingness of banks to lend; for example, capital losses in overseas lending or changes to the amount of regulatory capital required. These types of shift in loan supply, via the bank lending channel, may lead directly to changes in aggregate spending.

Firms and banks have incentives to form special relationships, but we cannot deal with the specialness of the bank–firm relationships directly. We must acknowledge that demand-side influences over bank borrowing exist as well as those on the supply side. Financial wealth may have an effect on the available supply of loans (through its influence over perception of creditworthiness) and on the demand for credit by firms (as wealth improves with the cycle). Likewise, the relative price of credit may be an indicator of the desire to tighten the credit market on the supply side but it will also reflect the inducement to substitute on the demand side. Our results will indicate the combined importance of supply and demand effects in credit markets rather than direct evidence for a credit channel. [1]

[1] Even if the evidence is consistent with a credit channel view, through the significance of a credit aggregate, real financial wealth effects, or credit spreads, these could arise from demand side or the traditional monetary channel of the transmission mechanism. Since it is not our purpose in this paper to detect a credit channel we can afford to be modest in this respect, allowing others to attempt more discriminating tests to identify supply-side effects.

The paper addresses the question 'what additional influence does bank credit have on the transmission mechanism over and above that of money?'. To answer it we build a model of the balance sheets and flows between sectors based on Friedman and Kuttner (1993). Using this as a structure, we build an empirical model of the demand for credit, money and for expenditure by each of the sectors – firms, households and financial firms. This leads us to ask a further question: 'what role do non-banks play in offering external credit to firms and households?'. There are a range of non-bank financial intermediaries such as pension funds, life assurance companies, factoring companies and loan guarantors, securities and derivatives dealers, and leasing corporations that also take 'deposits' from the private sector. We may find that these financial intermediaries recycle the long-term savings of the household sector (through pension fund and insurance contributions and the like) towards the non-financial corporate sector by offering loans as well as by purchasing corporate securities. They may operate as wholesalers of bank loans by unbundling or they may secure loans on different collateral to that which banks require e.g. invoices receivable. [2]

The paper is structured as follows: Section 2 builds a theoretical framework within which financial flows can be analysed; then Section 3 offers an econometric methodology to test the model. Section 4 reports the findings for firm and household sectors, and the influence of lending by financial firms. We show that it is possible to model successfully the interaction between M4 lending to firms, their money holdings, and investment spending. We also report estimates of the interactions between *unsecured* M4 lending to households, and their money holdings and consumption spending. The conclusion we draw is that credit has an important influence on real expenditure by firms and households and ultimately on inflation, therefore, central banks should take careful note of credit data in order to gather timely information on spending and inflationary pressure.

2. A framework for modelling credit markets

In order to work through the effects of credit on real expenditures we use an extended version of the Friedman and Kuttner (1993) model. Our model begins by analysing the balance sheets, sources and uses of funds, and the demands for assets and liabilities of three sectors of a stylised economy: private non-financial corporations (PNFCs), banks, and households. This allows us to consider the lines of transmission from bank credit to real expenditures via the two other sectors. There are two fully specified alternatives to bank finance for investment/consumption arising

[2] Note that the purpose of this paper is to draw together the informational benefits derived from augmenting a model of investment/consumption with money and credit. We do not propose to explore the detailed questions thrown up by the credit channel literature, nor to dwell on the methodological issues surrounding the identification of dynamic econometric systems. For these details the reader is directed to three Bank of England Working Papers: Brigden and Mizen (1999), and Chrystal and Mizen (2001a,b) that deal with these matters.

from internally generated retained earnings/net saving and externally generated sources in the form of new issues of corporate bonds and commercial paper. A third source can be considered by introducing a fourth sector, comprising the non-bank financial intermediaries that we refer to collectively as 'other financial corporations' (OFCs). We assume that they can offer loans to firms/households by acting as wholesalers of bank loans or by redirecting the household sector's long-term saving (pension funds) towards firms. For simplicity we abstract from any role for 'government', other than as the regulator of the banking system and the controller of the money stock, and the overseas sector, but these could be added without altering the results. We will discuss each sector in turn.

2.1. Private non-financial corporations

We assume that all individual firms, indexed f, are identical in financial structure and in the physical output they produce. They have a balance sheet that represents their assets and liabilities as follows:

$$\mathrm{PE}_f + D_f = L_f + P_f + E_f. \tag{1}$$

PE_f represents an individual firm's stock of physical capital and D_f are its deposits. These are the only assets held in the absence of a government sector. The liabilities are represented by L_f (loans), P_f (commercial paper and corporate bonds) and E_f (net worth of the firm, owing to the household sector as equity).

The use of funds imposes a financial constraint on the PNFCs by restricting current investment, I_f, to equal the retained profits of the firm, RP_f, and the flows arising from deposits, loans and commercial paper/corporate bonds:

$$I_f = \mathrm{RP}_f - \Delta D_f + \Delta L_f + \Delta P_f. \tag{2}$$

In aggregate, summing over all firms, this is written as

$$\sum I_f = \sum \mathrm{RP}_f - \sum \Delta D_f + \sum \Delta L_f + \sum \Delta P_f. \tag{3}$$

Assuming that firms adopt the usual risk-averse behaviour in selecting their portfolios we can write the flow demands for assets and liabilities as

$$\sum \Delta D_f = f_D\Big(\sum \Delta D_f - \sum \mathrm{RD}_f, r_D, r_L, r_P, \theta_L, \theta_P\Big), \tag{4a}$$

$$\sum \Delta L_f = f_L\Big(\sum I_f + \sum \Delta D_f - \sum \mathrm{RD}_f, r_D, r_L, r_P, \theta_L, \theta_P\Big), \tag{4b}$$

$$\sum \Delta P_f = f_P\Big(\sum \Delta D_f - \sum \mathrm{RD}_f, r_D, r_L, r_P, \theta_L, \theta_P\Big), \tag{4c}$$

where $\sum I_f + \sum \Delta D_f - \sum \mathrm{RD}_f$ is the finance required from external sources for the purposes of investment, r_D, r_L, r_P are the short-term rates of interest on deposits, loans and commercial paper/corporate bonds respectively. The variables θ_L and θ_P capture the non-price elements to borrowing and issuing that are central to a credit

channel view, these will be defined later. We can think of these as representing the charges and conditions that are imposed on borrowers in the form of fees or obligations to undertake certain services. The expected signs of the partial derivatives are

$$f_{D1} < 0, \quad f_{D2} > 0, \quad f_{D3} < 0, \quad f_{D4} < 0, \quad f_{D5} < 0, \quad f_{D6} < 0;$$

$$f_{L1} > 0, \quad f_{L2} < 0, \quad f_{L3} < 0, \quad f_{L4} > 0, \quad f_{L5} < 0, \quad f_{L6} > 0;$$

$$f_{P1} > 0, \quad f_{P2} < 0, \quad f_{P3} > 0, \quad f_{P4} < 0, \quad f_{P5} > 0, \quad f_{P6} < 0.$$

2.2. Banks

Banks act as financial corporations that take deposits and offer loans from the PNFC and household sectors subject to certain regulatory requirements. The banks are indexed b and their balance sheets are represented individually by Eq. (5):

$$L_b + R_b = D_b + \mathrm{CD}_b + K_b \tag{5}$$

where we take R_b as reserves, CD_b as certificates of deposit and K_b as bank capital. The banks are required to ensure that individually they meet the regulations over capital and reserves such that $R_b \geqslant \kappa_1 D_b + \kappa_2 \mathrm{CD}_b$ and $K_b \geqslant \kappa_3 L_b$, where κ_1, κ_2, κ_3 are set by the prudential authorities and are arbitrary constants.

The banks choose to offer loans and accept deposits and certificates of deposits as part of their portfolio considerations, resulting in the following equations for loan provision and deposit taking:

$$\sum L_b = b_L\left(r_D, r_L, r_P, \sigma^2, \theta_L, \sum R_b, \sum K_b\right), \tag{6a}$$

$$\sum D_b = b_D\left(r_D, r_L, r_P, \sigma^2, \theta_L, \sum R_b, \sum K_b\right), \tag{6b}$$

$$\sum \mathrm{CD}_b = b_{\mathrm{CD}}\left(r_D, r_L, r_P, \sigma^2, \theta_L, \sum R_b, \sum K_b\right), \tag{6c}$$

where σ^2 is the risk of default on the loans outstanding. Expected signs on the partial derivatives are:

$$b_{L1} < 0, \quad b_{L2} > 0, \quad b_{L3} < 0, \quad b_{L4} < 0, \quad b_{L5} > 0, \quad b_{L6} > 0, \quad b_{L7} > 0;$$

$$b_{D1} < 0, \quad b_{D2} > 0, \quad b_{D3} > 0, \quad b_{D4} < 0, \quad b_{D5} > 0, \quad b_{D6} > 0, \quad b_{D7} > 0;$$

$$b_{\mathrm{CD}1} > 0, \quad b_{\mathrm{CD}2} > 0, \quad b_{\mathrm{CD}3} < 0, \quad b_{\mathrm{CD}4} < 0, \quad b_{\mathrm{CD}5} > 0, \quad b_{\mathrm{CD}6}?, \quad b_{\mathrm{CD}7} > 0.$$

2.3. Households

The households, indexed h, are assumed to be the owners of the equity of the firms. They hold financial assets in the form of deposits, CDs and corporate bonds/commercial paper, and by subtracting their loans from the banking sector

we determine their total net worth, NW_h. Individually, their balance sheets can be written as

$$\mathrm{NA}_h + D_h + P_h + \mathrm{CD}_h - L_h = \mathrm{NW}_h \tag{7}$$

where NA_h represents the net assets of the household sector comprising equities and physical wealth (loaned to firms as physical capital). The financial constraints on the households imply that the flows into financial variables must be equal to their net saving plus any additional bank loans (assuming that there are no capital gains):

$$\Delta D_h + \Delta P_h + \Delta \mathrm{CD}_h = \mathrm{NS}_h + \Delta L_h \tag{8}$$

where net saving, $\mathrm{NS}_h = \Delta \mathrm{NA}_h = (Y_h - C_h)$. In aggregate

$$\sum \Delta D_h + \sum \Delta P_h + \sum \Delta \mathrm{CD}_h = \sum \mathrm{NS}_h + \sum L_h. \tag{9}$$

Finally, the portfolio choice under standard assumptions about risk-averse behaviour yields demand functions for deposits, loans and commercial paper/corporate bonds: [3]

$$\sum \Delta D_h = h_D\Big(\sum \mathrm{NS}_h, r_D, r_L, r_P, \sigma^2, \theta_L, \theta_P, \sum Y_h\Big), \tag{10a}$$

$$\sum \Delta L_h = h_L\Big(\sum \mathrm{NS}_h, r_D, r_L, r_P, , \sigma^2, \theta_L, \theta_P, \sum Y_h\Big), \tag{10b}$$

$$\Big(\sum \Delta \mathrm{CD}_h + \sum \Delta P_h\Big) = h_{\mathrm{CD}}\Big(\sum \mathrm{NS}_h, r_D, r_L, r_P, \sigma^2, \theta_L, \theta_P, \sum Y_h\Big). \tag{10c}$$

The signs of the partial derivatives are expected to be:

$$h_{D1} > 0, \quad h_{D2} > 0, \quad h_{D3} < 0, \quad h_{D4} < 0, \quad h_{D5} > 0, \quad h_{D6} < 0, \quad h_{D7} > 0, \quad h_{D8} > 0;$$

$$h_{L1} > 0, \quad h_{L2} < 0, \quad h_{L3} > 0, \quad h_{L4} < 0, \quad h_{L5} > 0, \quad h_{L6} < 0, \quad h_{L7} > 0, \quad h_{L8} > 0;$$

$$h_{\mathrm{CD}1} > 0, \quad h_{\mathrm{CD}2} < 0, \quad h_{\mathrm{CD}3} > 0, \quad h_{\mathrm{CD}4} < 0, \quad h_{\mathrm{CD}5} < 0, \quad h_{\mathrm{CD}6} > 0, \quad h_{\mathrm{CD}7} < 0, \quad h_{\mathrm{CD}8} > 0.$$

2.4. Financial market clearing

In order for the financial market to clear the following conditions must hold:

$$\sum \Delta D_b = \sum \Delta D_h + \sum \Delta D_f,$$

[3] Note that the market for CDs and commercial paper/corporate bonds is assumed to be arbitraged by the householders to ensure that the returns are identical. Since the two types of asset are perfectly substitutable we record the demand for the composite.

$$\sum \Delta L_b = \sum \Delta L_h + \sum \Delta L_f,$$

$$\sum \Delta P_h = \sum \Delta P_f,$$

$$\sum \Delta \mathrm{CD}_b = \sum \Delta \mathrm{CD}_h,$$

$$\sum R_b = -\text{change in central bank liabilities (exogenous)}.$$

Finally, we must define the conditions that determine the non-interest costs of borrowing or issuing, θ_L and θ_P. These variables enter the equation because loans are provided under conditions of informational asymmetry and providers resort to non-price means to screen applicants. Consider firms seeking to borrow. A typical basis for evaluating applicants is the financial health of the firm (RP_f), the previous loan history and the current stock of loans outstanding (L_f), the current loan rate (r_L) and default risk (σ^2). Hence a suitable definition for the non-price cost of a loan would be given by Eq. (11):

$$\theta_L = \theta_L(\mathrm{RP}_f, L_f, r_L, \sigma^2). \tag{11}$$

The equation for θ_P would not depend on the same set of variables because market purchasers of bonds/paper do not have access to information about the firm, such as financial health and default risk, from ongoing relationships as banks do. Hence, the charges depend only on the volume of bonds/paper in the market and the flow:

$$\theta_P = \theta_P(P_f, \Delta P_f). \tag{12}$$

2.5. Real expenditure

Last of all we can explicitly define the real expenditure variables of the PNFC and household sectors. These are

$$\sum I_f = I\Big(\sum \Delta D_f + \sum \mathrm{RP}_f, r_D, r_L, \theta_L, \sigma^2\Big), \tag{13}$$

$$\sum C_h = C\Big(\sum \Delta D_h + \sum \mathrm{NS}_h, \sum \mathrm{NW}_h r_D, r_L, \theta_L, \sigma^2\Big). \tag{14}$$

Clearly, if 'credit matters' then it should influence Eqs. (13) and (14) through, r_L and θ_L. Our approach to modelling credit in Section 4 involves the estimation of two systems of equations: for the PNFCs, we estimate Eqs. (4a), (4b) and (13); whilst for households we estimate Eqs. (10a), (10b) and (14).

2.6. Other financial corporations

We have developed a system of equations in which to determine whether banks matter, that is, whether the loans that banks offer and the conditions attached to them have an influence over real expenditures. But why should banks be different from other loan providers such as pension funds, life assurance companies and other

financial firms? Banks may have some 'special' features, but other financial firms may also offer credit in the form of loans even though they are not banks. We extend our original model by supposing that the typical OFC is a pension fund or life assurance company that is collecting contributions from the household sector and investing them in the commercial paper/corporate bonds issued by firms (we have ignored the government sectors otherwise we might also add government bonds in their portfolio). We also suppose that they borrow from banks and unbundle or re-bundle these funds for the PNFCs. The balance sheet of the sector as a whole, indexing each OFC using o, gives the following:

$$\left(\sum L_o\right)_f + \sum P_o + \sum D_o = \left(\sum L_o\right)_b + \sum \mathrm{PF}_o \tag{15}$$

where the outer subscript refers to the destination/source of loans, so that $(\sum L_o)_f$ represents loans to PNFCs from the OFCs, and $(\sum L_o)_b$ represents loans from banks to OFCs. $\sum \mathrm{PF}_o$ refers to claims of the household sector on the pension fund. The aggregate flows between sources and uses of funds can be written as

$$\left(\sum \Delta L_o\right)_f + \sum \Delta P_o + \sum \Delta D_o = \left(\sum \Delta L_o\right)_b + \sum \mathrm{NC}_o. \tag{16}$$

Here $\sum \mathrm{NC}_o$ represents the aggregated net contributions from the household sector to the OFCs. We can think of the OFC operating as investors of the longer term savings of the household sector and, therefore, we might expect their demand for assets to mimic that of the households (cf. Eqs. (10a)–(10c)). In regard to its loan behaviour, we might expect them to borrow from banks in much the same way as a non-financial firms (cf. Eq. (4b)), and to re-bundle them and loan out to the PNFCs on the same basis as the banks (cf. Eq. (6a)). One difference between banks and non-banks may emerge through the non-price cost of borrowing: non-banks do not benefit from the close relationships that banks can foster as deposit takers, and they may accept different types of collatoral and therefore monitor different measures of creditworthiness. OFCs may also be subject to regulatory requirements that give them certain advantages or disadvantages relative to banks.

To make the model consistent, we must modify Eq. (4b) to allow firms to borrow from banks and non-banks. If we assume that the loan rate is arbitraged to a single rate, r_L, then the only difference will appear through $(\theta_L)_b$ offered by banks and $(\theta_L)_o$ offered by non-banks.

$$\sum \Delta L_f = f_L\left(\sum I_f - \sum \Delta D_f - \sum \mathrm{RD}_f, r_D, r_L, r_P, (\theta_L)_b, (\theta_L)_o, \theta_P\right) \tag{4b′}$$

where $\sum \Delta L_f = \sum \Delta L_b + \sum \Delta L_o$ refers to *total* loans from bank and non-bank sources.

We must also modify Eq. (9) to include the net contributions to the OFCs by the household sector, noting that $\sum \mathrm{NC}_o = \sum \mathrm{NC}_h$ (by definition for a fully funded pension fund):

$$\sum \mathrm{NC}_h + \sum \Delta D_h + \sum \Delta P_h + \sum \Delta \mathrm{CD}_h = \sum \mathrm{NS}_h + \sum \Delta L_h. \tag{9′}$$

It is possible, but less likely, that the OFCs may offer loans to the household sector in which case the loan Eq. (10b) would alter in exactly the same way as discussed above for the PNFCs.

3. Econometric methodology

The econometric methodology used in this paper is described by Hendry and Mizon (1993), Hendry (1995) and Hoffman and Rasche (1996). We begin by modelling the PNFC and household sectors separately as two systems of three equation including real expenditure, money and credit. This involves estimates of Eqs. (4a), (4b) and (13) for the PNFCs, and (10a), (10b) and (14) for households. We then go on to consider whether credit offered by OFCs influences the expenditure of these sectors.

3.1. A dynamic model for the private non-financial corporations and household sectors

The first step involves the estimation of an unconditional qth order VAR over a sample $t = 1, 2, \ldots, T$, where the model is estimated for sector i:

$$\Pi(L)z_{it} = \varepsilon_{it} \tag{17}$$

where z_{it} is a vector of p variables, $\Pi(L) = I - \sum_{j=1}^{q} \Pi_j(L^j)$ is a qth order lag polynomial and ε_{it} is a p-dimensional random vector of serially uncorrelated error terms. Eq. (1) can be re-written as a linear dynamic system as follows:

$$\Delta z_{it} = \Pi_i z_{it-1} + \sum_{j=1}^{q-1} \Gamma_{ij} \Delta z_{it-j} + \varepsilon_{it} \tag{18}$$

where Γ_{ij} are matrices of short-term parameters and Π_i is a matrix of long-run coefficients (cf. Johansen and Juselius, 1994).

The variables are all non-stationary variables with an order of integration equal to one. We test for the existence of rank reducing cointegrating relationships between these variables using the maximum likelihood based approach of Johansen (1996), which entails examining the canonical correlations between Δz_{it} and z_{it-1}. [4] Translating this into a problem in terms of eigenvalues, ranked from largest to smallest as $\lambda_1, \lambda_2, \ldots, \lambda_p$, a likelihood ratio $\mathrm{LR}(r) = -T\log(1-\lambda_r)$ where $H(r-1) = K - (T/2)\sum_{j=1}^{r-1} \log(1-\lambda_j)$, $H(r) = K - (T/2)\sum_{j=1}^{r} \log(1-\lambda_j)$ tests whether rank $(\Pi_1) \leqslant r$ by determining if λ_r is statistically different from zero (which it would be for a non-cointegrating combination). A trace test $\mathrm{Tr}(r) = -T\sum_{j=1}^{r} \log(1-\lambda_j)$ is a joint

[4] The appropriate lag length is chosen by adding the longest feasible lags given degrees of freedom requirements and comparing the likelihood as lags are deleted. We do not find that the results are particularly sensitive to lag length, although we are aware that the theoretical literature has established that taking a lag length can affect the dimensions of the cointegrating space. Overfitting leads to a loss of power, but underfitting leads to potential spurious cointegration (Urbain, 1995, p. 189).

test of whether all λ_j for $j = r, r+1, \ldots, p$ are insignificantly different from zero. The distributions are non-standard but are given in Osterwald-Lenum (1992), Johansen (1996). The reduction in the rank, r, allows us to write the long-run equilibrium relationships of the system given by the $p \times p$ dimensional matrix Π_i in the familiar form of the product of two $p \times r$ matrices α_i and β_i. The matrix β_i defines the cointegration space and the matrix α_i defines the error correction space.

The vector of variables z_{it} can be decomposed into endogenous variables v_{it} and exogenous variables x_{it} so that we can write (18) as a conditional system as (19) where

$$\begin{pmatrix} \Delta v_{it} \\ \Delta x_{it} \end{pmatrix} = \sum_{j=1}^{q-1} \begin{pmatrix} \Gamma_{ijv} \\ \Gamma_{ijx} \end{pmatrix} \Delta z_{it-j} - \begin{pmatrix} \alpha_{iv} \\ \alpha_{ix} \end{pmatrix} \beta_i' z_{it-1} + \begin{pmatrix} \varepsilon_{ivt} \\ \varepsilon_{ixt} \end{pmatrix}. \tag{19}$$

Endogenous variables are defined by the conditional system (20), but exogenous variables are defined by a marginal process that excludes the long-run relationship $\beta_i' z_{it-1}$. Effectively the part of the error correction space that determines the feedback of the long-run cointegrating relationships on the dynamics of the exogenous variables, x_t, is composed of zeros. A test of this weak exogeneity proposition can confirm the validity of the partition between endogenous variables, v_{it}, and the exogenous variables, x_{it}. [5] Only the endogenous variables, v_{it}, are conditionally dependent on the long-run cointegrating relationships $\beta_i' z_{it-1}$:

$$\Delta v_{it} = \omega_i \Delta x_{it} + \sum_{j=1}^{q-1} \Gamma_{ij} \Delta z_{it-j} - \alpha_i \beta_i' z_{it-1} + \varepsilon_{it}. \tag{20}$$

[5] Weak exogeniety is sufficient for the methodology we employ. When the vector z_{it} is partitioned into a vector of variables, v_{it} and x_{it}, we can write the general model as a conditional model for v_{it}:

$$\Delta v_{it} = \omega_i \Delta x_{it} + \sum_{j=1}^{q-1} \Gamma_{ij} \Delta z_{it-j} - \alpha_{1i} \beta_{1i}' z_{it-1} + \varepsilon_{1it}$$

and a marginal system for x_t:

$$\Delta x_{it} = \sum_{j=1}^{q-1} \Gamma_i \Delta z_{it-j} - \alpha_{2i} \beta_{2i}' z_{it-1} + \varepsilon_{2it}.$$

The maximum likelihood estimate of β is the same whether we estimate the full system or the conditional and marginal systems separately (cf. Boswijk, 1995; Ericsson, 1995). If the parameters of the conditional and marginal models are variation free and the parameters of interest are only a function of conditional model, then estimation of the conditional model will be sufficient to recover all the necessary information about β. When variables are weak exogenous, the neglect of the marginal model does not result in the loss of information. Weak exogeneity of x_t ensures that the part of the error correction space that determines the feedback of the long-run cointegrating relationships on the dynamics of the exogenous variables is composed of zeros ($\alpha_2 = 0$). Since the exogenous variables are defined by a marginal process that excludes the long-run relationship Πz_{t-1}, the conditional model is sufficient to recover the parameter information about β. We use two tests proposed by Urbain (1992, 1995) to confirm the validity of the partition between endogenous variables, y_t, and the exogenous variables, x_t.

The conditional model is just identified but to ensure that the model is exactly identified in a structural sense we must impose a minimum of a further $s(s-1)$ additional restrictions, where $s = p - r$. We also introduce contemporaneous changes in exogenous variables on the right-hand side of the equation. Other additional overidentifying restrictions may be imposed and tested based on economic considerations. Exact and overidentifying restrictions are imposed jointly by premultiplying by a contemporaneous coefficient matrix, A_i, and are tested by a likelihood ratio test.

$$A_i \Delta v_{it} = A_i \omega_i \Delta x_{it} + A_i \sum_{j=1}^{q-1} \Gamma_{ij} \Delta z_{it-j} - A_i \alpha_i \beta_i' z_{it-1} + A_i \varepsilon_{it}. \tag{21}$$

Once we have fully identified the system for the PNFC and household sectors we can determine whether there is evidence consistent with a balance sheet channel and a bank lending channel for each sector.

3.2. Introducing the other financial corporation sector

To deal with OFCs' lending to PNFCs and households, consider that there are now two sectors i.e $i = 1, 2$, assuming the same notation and lag length the combined conditional model we could write out the combined system as if the two models were stacked one on top of the other:

$$\begin{pmatrix} \Delta v_{1t} \\ \Delta v_{2t} \end{pmatrix} = \begin{pmatrix} \alpha_{11} & \alpha_{12} \\ \alpha_{21} & \alpha_{22} \end{pmatrix} \begin{pmatrix} \beta_1 z_{1t-1} \\ \beta_2 z_{2t-1} \end{pmatrix} + \sum_{j=1}^{q-1} G_j \begin{pmatrix} \Delta z_{1t-i} \\ \Delta z_{2t-i} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix} \tag{22}$$

where G_j are matrices of short-run coefficients. However, it is possible that there are interactions in the long-run relationships that imply that further long-run equilbiria can be discovered. Taking $Z_{t-1} = (z_{1t-1}, z_{2t-1})'$ where further cointegrating relations are represented as $\beta_3' Z_{t-1}$ we would write the model as

$$\begin{pmatrix} \Delta v_{1t} \\ \Delta v_{2t} \end{pmatrix} = \begin{pmatrix} \alpha_{11} & \alpha_{12} & \alpha_{13} \\ \alpha_{21} & \alpha_{22} & \alpha_{23} \end{pmatrix} \begin{pmatrix} \beta_1 z_{1t-1} \\ \beta_2 z_{2t-1} \\ \beta_3 Z_{t-1} \end{pmatrix} + \sum_{j=1}^{q-1} G_j \begin{pmatrix} \Delta z_{1t-j} \\ \Delta z_{2t-j} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix}. \tag{23}$$

The existence of further equilibria involving PNFC or household expenditure and lending by OFCs provides evidence for the importance of OFC credit as well as bank credit. Moreover, the financial linkages between OFCs and other sectors can be evaluated weak exogeneity tests, by restrictions to the error correction space. Effectively we are testing the exogeneity of the sector 1 (sector 2) to sector 2 (sector 1) by a test of the restriction $\alpha_{21} = 0$ ($\alpha_{12} = 0$), this implies that a departure from the long-run cointegrating relationship in sector 1 (sector 2) does not have an impact on the dynamic behaviour of sector 2 (sector 1).

In the next section, we will report results for two separate systems of equations representing PNFCs and households. We will then consider the OFC sector and

the potential importance of OFC credit to PNFCs and households alongside that of bank credit.

4. Empirical results

4.1. Private non-financial corporations

We simultaneously estimate the Eqs. (4a), (4b) and (13) using real gross domestic fixed capital formation (i_t), [6] real money holding (M4) of PNFCs (m_t), and real M4 lending to PNFCs (l_t) as endogenous variables. The explanatory variables used are: real GDP at market prices (y_t); a measure of the proportion of firms reporting more than adequate stocks of finished goods, taken from the CBI monthly survey (s_{ut}); [7] PNFCs' real financial wealth (w_t); PNFCs real retained earnings (π_t); the real user cost of capital (c_{kt}); the spread of the M4 deposit rate over three-month sterling LIBOR (r_{dt}), referred to as the 'deposit spread'; the spread of the interest rate on bank lending to companies over LIBOR (r_{lt}), referred to as the 'lending spread'; and the real value of mergers and acquisitions (lrma_t). All except interest rates are converted to natural logarithms, and estimates apply to the sample period 1977 Q4–1998 Q1.

Real GDP measures the general level of economic activity, and this is likely to influence the demand for investment goods and the demand for bank borrowings. The CBI survey question on stocks can be thought of as a barometer of confidence about future demand prospects and is indicative of outturns in the recent past relative to expectations. If firms consider themselves 'overstocked', they are likely to be relatively pessimistic about demand prospects and may be less willing to undertake further investment in fixed capital. They may also need to undertake distress borrowing. Total financial assets measure the liquidity of the sector, which will be related to money holdings and bank borrowing. Undistributed earnings are a measure of the supply of internal finance, which is an alternative to bank finance. The real user cost of capital is an indicator of the cost per period of raising capital in the financial markets. The deposit spread and the lending spread are, respectively, the return on retail deposits relative to wholesale money market rates and the cost of bank borrowing relative to money market rates.

The estimated long-run relationships for the PNFC sector are reported in Table 1(a). The first equation shows that investment is proportional to real GDP in the long-run, and is negatively related to the survey measure of more than adequate

[6] The results reported here use whole-economy gross domestic fixed capital formation, but similar results can be obtained using business investment.

[7] This variable is a measure of the proportion of firms recording more than adequate levels of finished goods (stocks), which is taken from the Confederation of British Industry's monthly survey of business conditions. The CBI survey is treated as a 'barometer' of confidence in prevailing economic conditions relating to the cycle, since it records the extent to which firms consider themselves overstocked and therefore less likely to wish to undertake further investment in fixed capital.

stocks, and to the cost of capital. [8] The former captures the effects of excess capacity [9] and lack of business confidence about planned investment, while the latter captures the normal inverse relationship between quantity demanded and price. Equations two and three explain long-run investment, money demand and demand for bank lending, but they both contain investment as one of the explanatory variables, which itself depends on other variables.

To obtain expressions for money and bank lending that do not rely on investment, we substitute out investment using the first equation to obtain: [10]

$$m_t = 0.5y_t - 0.5s_{ut} - 1.407c_{kt} + 0.5w_t + 11.204r_{dt} + 0.107\text{lrma}_t,$$

$$l_t = 0.5y_t - 1.407c_{kt} + w_t - 0.5\pi_t + 4.432r_{dt} + 0.107\text{lrma}_t.$$

The first equation can be thought of as PNFCs' long-run money demand function. The stock of PNFCs' M4 deposits varies positively with GDP, financial wealth, the bank deposit rate, and mergers and acquisitions activity. It is negatively related to the cost of capital and the measure of firms reporting more than adequate stocks. The latter effect suggests that money is itself a 'buffer stock', such that money holding is reduced partly to finance unexpectedly high inventories of goods. The second equation shows the long-run determinants of the stock of bank lending to PNFCs. This varies in proportion to financial wealth, and is also positively related to GDP, the deposit spread, and mergers and acquisitions activity. Lending is negatively related to the cost of capital and to retained earnings. The latter indicates that bank lending to PNFCs falls as the alternative, and preferred, internal source of funds expands. [11]

The estimated dynamic equations appear in Table 1(b), and the actual and fitted values for each of these equations are shown in Fig. 1 [12,13]. The coefficient on the

[8] Note that all round number coefficients are restricted. Some restrictions are necessary to achieve identification. The over-identifying restrictions are not rejected by the data. See Brigden and Mizen (1999) for further details.

[9] It could be questioned whether a cyclical variable such as excess stocks should appear in the long-run relationships; however, this series is non-stationary in our sample. This may be because the sample period is shorter than ideal, but it may also reflect the big changes in inventory behaviour since the early 1980s. The particular problem with the stockbuilding data is that it has a cycle around a pronounced downward trend. A separate paper Mizen (2000) has attempted to model this series in conjunction with net corporate borrowing. It has shown that a simple model of the long-run stock-to-output ratio is a function of PNFC's gross financial wealth and an HM. Treasury measure of stockholding costs. Allowing for the downward trend using six different measures of structural change did not improve upon the likelihood versus no trend, and the correlations of the residuals from the seven equations (no trend and six different models with a trend) were never below 0.98, suggesting that the other variables were able to capture the downward trend component without resorting to a specific trend variable.

[10] These can be thought of as 'reduced forms' which relate endogenous variable to exogenous variables only.

[11] Note that borrowing from securities markets is also available to firms. This is excluded from the present study but could also be included to provide a more complete picture.

[12] Here we use the general notation x^* to denote the estimated long-run equilibrium of variable x. $(x - x^*)$ then denotes the disequilibrium in variable x (relative to the long-run).

[13] Full reports of the diagnostic tests and further discussions of the estimated specifications are available in Brigden and Mizen (1999).

Table 1

(a) Long-run estimates

$$i_t = y_t - s_{ut} - 2.813c_{kt}$$

$$m_t = 0.5i_t + 0.5w_t + 0.5s_{ut} + 11.204r_{dt} + 0.107\text{lrma}_t$$

$$l_t = 0.5i_t + w_t + 0.5s_{ut} - 0.5\pi_t + 4.432r_{dt} + 0.107\text{lrma}_t$$

(b) Estimates of the dynamic structural model for PNFCs (standard errors are in brackets)

$$\Delta i_t = \underset{(0.0266)}{-0.1565}(i - i^*)_{t-1} - \underset{(0.0261)}{0.0923}(l - l^*)_{t-1} + \underset{(0.0297)}{0.0839}(m - m^*)_{t-1} + \underset{(0.2545)}{0.5430}\Delta y_t - \underset{(0.2175)}{0.4815}\Delta c_{kt-1} - \underset{(0.7154)}{0.7779}\Delta r_{lt}$$
$$- \underset{(0.5666)}{0.9988}\Delta r_{lt-1} + \underset{(0.1021)}{0.2580}$$

$$\Delta l_t = \underset{(0.0503)}{0.1631}\Delta i_{t-1} + \underset{(0.0685)}{0.4107}\Delta l_{t-1} - \underset{(0.0212)}{0.1246}(l - l^*)_{t-1} + \underset{(0.0196)}{0.0734}(m - m^*)_{t-1} + \underset{(0.1674)}{0.3466}\Delta y_t - \underset{(0.1556)}{0.2516}\Delta y_{t-1}$$
$$- \underset{(0.0104)}{0.0418}\Delta\pi_t + \underset{(0.0102)}{0.0216}\Delta\pi_{t-1} + \underset{(0.0453)}{0.1796}\Delta s_{ut} - \underset{(0.4218)}{0.7787}\Delta r_{dt} - \underset{(0.4323)}{1.307}\Delta r_{dt-1} - \underset{(0.3730)}{0.7539}\Delta r_{lt}$$
$$+ \underset{(0.0017)}{0.0072}\Delta\text{lrma}_{t-1} - \underset{(0.0598)}{0.3172}$$

$$\Delta m_t = \underset{(0.0928)}{-0.1233}\Delta i_{t-1} - \underset{(0.1084)}{0.1863}\Delta l_{t-1} + \underset{(0.0881)}{0.2812}\Delta m_{t-1} - \underset{(0.0334)}{0.0350}(l - l^*)_{t-1} - \underset{(0.0316)}{0.0632}(m - m^*)_{t_1} + \underset{(0.2778)}{0.8271}\Delta y_t$$
$$+ \underset{(0.0837)}{0.1708}\Delta w_t + \underset{(0.2455)}{0.5427}\Delta c_{kt} + \underset{(0.2423)}{0.5527}\Delta c_{kt-1} + \underset{(0.7383)}{3.1371}\Delta r_{dt} + \underset{(0.8026)}{1.4435}\Delta r_{dt-1} - \underset{(0.6413)}{1.0273}\Delta r_{lt-1}$$
$$+ \underset{(0.0031)}{0.0084}\Delta\text{lrma}_t$$

Data period 1978 Q1–1998 Q1.

Portmanteau 9 lags = 100.32; AR 1-5 $F(45, 146) = 1.13$ [0.28]; normally $\text{Chi}^2(6) = 2.86$ [0.83]; log likelihood = 961.76; $T = 75$; LR test of over-identifying restrictions: $\text{Chi}^2(46) = 46.02$ [0.47].

deviation term in the investment equation indicates that investment adjusts by about 16% per quarter towards its long-run equilibrium. In the same equation, the coefficients on both $(l - l^*)$ and $(m - m^*)$ are significant at the 5% level. [14] The negative coefficient on the lending deviation term indicates that when lending is above its long-run equilibrium, investment tends subsequently to fall, while the positive coefficient on the money deviation term indicates that excess money holding by firms is associated with higher investment. Lending adjusts by about 12% per quarter towards its long-run equilibrium, while money adjusts more slowly at 6% a quarter.

For PNFCs, the long-run level of lending is found to be heavily dependent on balance sheet items, such as real financial wealth and retained earnings, rather than on factors operating through the bank lending channel, such as the lending spread, which appears only in the short-run dynamics. A direct credit effect operates through 'excess' lending, which is associated with an decrease in investment, but the influence of the company balance sheet on banks' willingness to lend and firms' readiness to borrow supports both a supply-side 'balance sheet channel' and a demand-side interpretation. [15]

[14] Not all deviation terms appear in all equations. Some are excluded to satisfy the requirements of econometric identification, while others may be eliminated as they are insignificant. See Thomas (1997a,b) on this issue.

[15] This is consistent with a credit channel, although we recognise that the limitations of using sectoral time-series data mean that the evidence may be consistent with alternative interpretations.

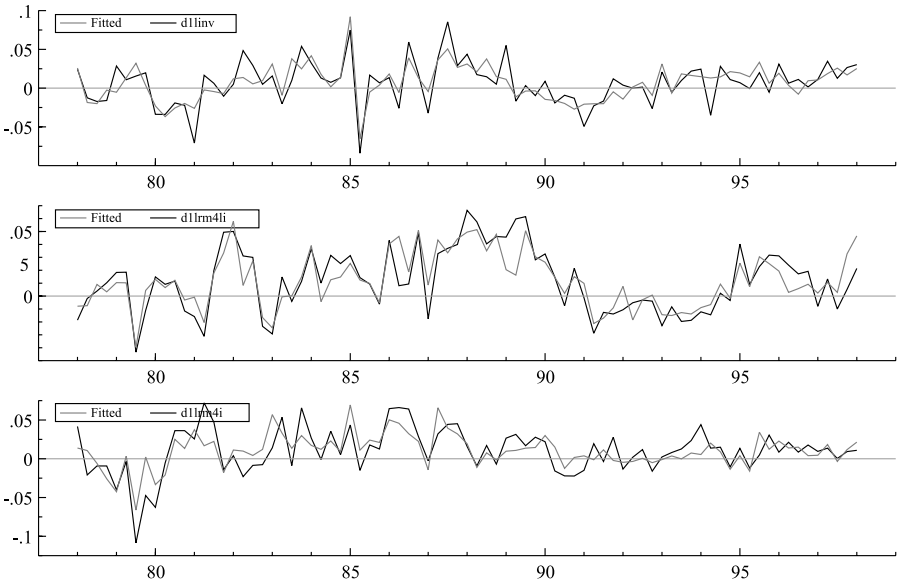

Fig. 1. Actual and fitted values for the PNFC structural model.

Lending adds significantly to our explanation of corporate spending partly because the decision to invest and the decision to borrow are made simultaneously. The point is that 'excess' borrowing in one quarter helps to explain investment in the subsequent quarter. In addition to this direct evidence, the lending deviation term is significantly linked to money, and money in turn has significant explanatory power in the investment equation. Therefore we conclude that credit contains useful supplementary information to that found in the money data when explaining real corporate expenditure.

4.2. Households

The variables used in our model for the household sector are: real consumer expenditure by households (c_t); the stock of real M4 balances held by households (m_t); the stock of real unsecured M4 lending to households by banks and building societies (l_t). These correspond to Eqs. (10a), (10b) and (14). We include as explanatory variables: real net labour income (y_t); household real net total wealth (w_t), defined as housing wealth plus financial assets minus total debt; inflation ($\Delta^4 p_t$), measured as the annual rate of change of the consumer expenditure deflator; a deposit spread, measured by the difference between the retail deposit rate and base rate (r_{dt}); and a credit spread of the credit card rate over base rate (r_{ct}). Two additional stationary variables used are an aggregate measure of consumer confidence (conf_t), and the percentage change in unemployment (Δu_t), measured by the claimant count. All data except the inflation rate, interest rate spreads, and the change in the

Table 2

(a) Long-run estimated equations

$$c_t = -0.2m_t - 0.12l_t + 1.0y_t + 0.32w_t - 0.7\Delta^4 p_t$$

$$m_t = 0.32l_t + 0.81y_t + 0.75r_{dt}$$

$$l_t = 0.85y_t + 0.77w_t - 1.5r_{ct} - 2.9\Delta^4 p_t$$

(b) Estimates of dynamic structural model for households (standard errors are in brackets)

$$\begin{aligned}\Delta c_t = {} & \underset{(0.10039)}{-0.47840}\Delta c_{t-1} + \underset{(0.17877)}{1.0720}\Delta m_t + \underset{(0.13024)}{0.21298}\Delta m_{t-1} - \underset{(0.15033)}{0.42172}\Delta l_t + \underset{(0.11404)}{0.16647}\Delta l_{t-1} - \underset{(0.04461)}{0.19998}(c-c^*)_{t-1} \\ & + \underset{(0.078614)}{0.14894}\Delta y_{t-1} - \underset{(0.18126)}{0.21103}\Delta r_{dt-1} - \underset{(0.06852)}{0.18266}\Delta r_{ct-1} - \underset{(0.004937)}{0.00922}\Delta u_t + \underset{(0.00499)}{0.00947}\Delta u_{t-1} + \underset{(0.00020)}{0.00058}\mathrm{conf}_t \\ & - \underset{(0.00018)}{0.00032}\mathrm{conf}_{t-1} - \underset{(0.026576)}{0.15265}\end{aligned}$$

$$\begin{aligned}\Delta m_t = {} & \underset{(0.07729)}{-0.13773}\Delta m_{t-1} + \underset{(0.04384)}{0.19201}\Delta l_t + \underset{(0.02143)}{0.07308}(c-c^*)_{t-1} - \underset{(0.02248)}{0.1378}(m-m^*)_{t-1} + \underset{(0.04118)}{0.21249}\Delta y_t \\ & + \underset{(0.04356)}{0.03227}\Delta y_{t-1} + \underset{(0.01504)}{0.03701}\Delta w_t + \underset{(0.01989)}{0.03879}\Delta w_{t-1} - \underset{(0.10317)}{0.35582}\Delta r_{dt} + \underset{(0.10146)}{0.11334}\Delta r_{dt-1} - \underset{(0.04521)}{0.19330}\Delta r_{ct} \\ & - \underset{(0.05263)}{0.31999}\Delta^4 p_t - \underset{(0.06116)}{0.12454}\Delta^4 p_{t-1} - \underset{(0.001702)}{0.009379}\Delta u_{t-1} - \underset{(0.000007)}{0.000295}\mathrm{conf}_t + \underset{(0.012100)}{0.045911}\end{aligned}$$

$$\begin{aligned}\Delta l_t = {} & \underset{(0.09673)}{-0.45759}\Delta c_{t-1} + \underset{(0.08441)}{0.32978}\Delta l_{t-1} + \underset{(0.09312)}{0.31556}(c-c^*)_{t-1} - \underset{(0.07401)}{0.50685}(m-m^*)_{t-1} - \underset{(0.03225)}{0.17603}(l-l^*)_{t-1} \\ & - \underset{(0.17818)}{0.48094}\Delta r_{dt-1} - \underset{(0.09175)}{0.38030}\Delta r_{ct} - \underset{(0.10147)}{0.52959}\Delta^4 p_t - \underset{(0.12426)}{0.32658}\Delta^4 p_{t-1} + \underset{(0.00366)}{0.00691}\Delta u_{t-1} + \underset{(0.00019)}{0.00058}\mathrm{conf}_t \\ & - \underset{(0.00019)}{0.00054}\mathrm{conf}_{t-1} - \underset{(0.26598)}{1.5292}\end{aligned}$$

Data period 1978 Q1–1998 Q4.
Portmanteau 9 lags = 86.98; AR 1-5 $F(90,96) = 1.02$ [0.46]; normally $\mathrm{Chi}^2(6) = 3.68$ [0.72] LR; log likelihood = 1107.8; $T = 72$; LR test of over-identifying restrictions: $\mathrm{Chi}^2(38) = 21.42$ [0.99].

percentage unemployed are converted to natural logarithms. The sample period is 1978 Q1–1998 Q4.

As with the PNFC model, we estimate three long-run relationships between the variables—one for each of the endogenous variables c_t, m_t and l_t in Table 2(a). There are interactions between consumption, money and lending. [16] The levels of real money and credit appear in the equation for household's real consumption. The inclusion of money in the consumption equation can be interpreted as indicating that liquid assets have a different impact on consumption in the long-run than do other components of financial wealth. A higher stock of lending lowers consumption in the long-run (for given wealth and labour income) as the debt has to be serviced.

Rewriting to ensure that only exogenous variables on the right-hand side gives:

$$c_t = 0.69y_t + 0.18w_t - 0.17\Delta^4 p_t - 0.15r_{dt} + 0.28r_{ct},$$

$$m_t = 1.08y_t + 0.25w_t - 0.9\Delta^4 p_t + 0.75r_{dt} + 0.48r_{ct},$$

$$l_t = 0.85y_t + 0.77w_t - 2.9\Delta^4 p_t - 1.5r_{ct}.$$

[16] Again some of these coefficients are restricted. Details can be found in Chrystal and Mizen (2001a,b).

Lending to households is positively related to income and wealth, although it is less responsive to labour income and more responsive to net wealth than is money demand. As the credit spread increases the stock of bank lending falls. The credit channel suggests that these effects could represent the influence of the balance sheet (i.e. the importance of net wealth for credit provision) and bank lending channels (i.e. the dependence of households on banks and the stock of credit on the price of credit set by banks). Although the results could equally represent demand factors – since the negative effect of the credit spread is also consistent with households undertaking less unsecured borrowing when interest rates on credit rise relative to savings rates or rates on secured borrowing.

Real consumption has a believable marginal propensity to consume out of real labour income of 0.69, and co-moves with real net wealth. In theory, the sign of the impact of inflation on consumer expenditure is ambiguous, however, most previous studies have found that inflation reduces real consumption. This could be because inflation increases uncertainty or because households expect a tightening of future monetary policy with rising inflation. A further reason could be that households attempt to restore the real value of their savings balances after erosion by inflation.

The deposit spread has a negative effect on consumption, but surprisingly the credit spread has a small positive effect. This effect comes from the fact that lending appears in this equation with a negative sign and the credit spread appears in the lending equation with a negative sign. Both of these effects are highly plausible – borrowing is reduced by a widening in the credit spread, and consumption is reduced (in the long-run) if debt is higher (because interest on the debt has to be paid out of disposable income, so sustainable consumption will be lower). So the positive effect of the credit spread on consumption arises because the higher is this spread the lower is the stock of debt in the long run. The money demand function is nearly homogenous in labour income, and has a smaller positive coefficient on net financial wealth. As deposit spreads increase, households add to their deposits; the effects of the credit spread and inflation reduce money demand by households.

The dynamic structural models are reported in Table 2, and the actual and fitted values are shown in Fig. 2. Taking the equations in reverse order is helpful, given that deviations of money and consumption from their long-run fitted values influence the dynamics of lending, and the deviation of consumption from its long-run value affects the dynamics of money. The adjustment speed of lending towards its long-run value is 18% per quarter. Excess money and consumption have a very strong influence on lending, with estimated adjustment speeds per quarter of 31% and 50% respectively. Excess money balances are associated with reduced lending, suggesting that excess money balances are used to pay off borrowing. Excess consumption leads to increases in lending, suggesting plausibly that a build-up of unsecured borrowing results from periods of abnormally high consumer spending. Past changes in lending have a positive influence on the contemporaneous change in lending, and increases in the cost of credit and the return on deposits (relative to the base rate) reduce the growth rate of unsecured lending.

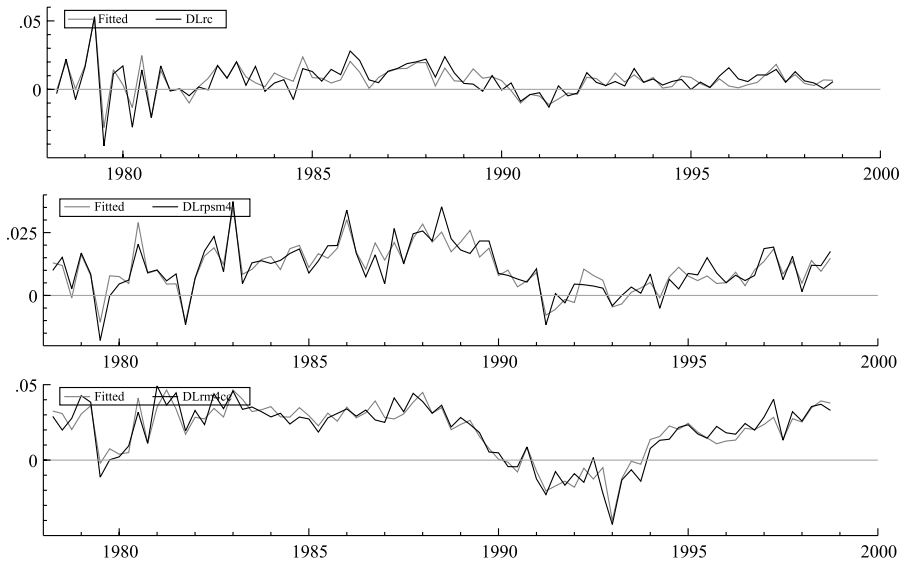

Fig. 2. Actual and fitted values for the household structural model.

In the dynamic equation for money, the adjustment speed to excess money balances is 14%, consistent with the view that money is used as an inventory or buffer stock to 'mop up' shocks to financial resources coming from either unexpected income or unplanned spending. Contemporaneous adjustments to lending have a positive effect on current changes to money balances in these results, suggesting that when households borrow to spend they also run up money balances, reversing the effect in subsequent quarters.

Lastly, the consumption equation implies that 20% of the difference between actual consumption and its long-run fitted value is eliminated in each quarter. Consumption growth is negatively related to its own lagged value, which appears contrary to the idea of consumption smoothing, but this result may simply be an offset to the strong autocorrelation coming through money growth. There is a very strong positive relation between consumption growth and contemporaneous and lagged changes in money balances. Consumption is also negatively related to lending growth but this is unwound the following quarter.

The key feature of these results is that the addition of lending does appear to add significant explanatory power. Although the lending deviation term does not appear in the consumption equation in this case, lending growth is significant in the consumption equation. Lending growth is also a significant determinant of money growth, which itself is a significant determinant of consumption growth. In addition to these dynamic effects, lending is significant in the long-run equation for consumption and there is evidence consistent with a balance sheet effect in the long-run equilibrium for credit. The combined impact of all these effects gives an indication that lending data do influence the path of household consumption, but the effect may not be as influential as for PNFCs.

4.3. Credit from other financial corporations

We are interested in the impact of the OFC sector on the spending decisions of PNFCs and households. Our approach towards this issue is to consider how disequilibria estimated separately for OFCs' money and lending might influence the system of equations for the two other sectors reported above. The OFC equilibria are:

$$l_t = 5.81 + 0.5m_t + y_t + 0.254w_t + 0.004r_{st},$$

$$m_t = 10.86 + 0.5l_t + 0.254w_t + 1.413\tau_t - 0.037r_{st} + 0.063(rl - dy)_t,$$

where the variables are: real M4 balances held by OFCs (m), real M4 lending to OFCs by banks and building societies (l), real gross domestic product (y), OFCs' real gross financial wealth (w), the real transfer earnings of the financial sector as a whole (including banks) from intermediation services (τ), [17] a maturity spread measured by the difference between the long gilt rate and the three month Treasury bill rate (r_s), and the spread of the long gilt rate over the Financial Times-30 dividend yield ($rl - dy$).

The argument we have proposed in the theoretical section is that OFCs may operate as quasi-bank recycling 'deposits' into loans. The OFCs themselves borrow from banks and this may influence the PNFC sector as OFCs offer quasi-bank intermediation services, dealing facilities and purchase the capital equipment that they subsequently lease to PNFCs. We might expect that lending to OFCs would be influential over PNFC investment if OFCs lending is a substitute for bank lending. This would weaken the 'specialness' of banks, and the lessen the significance of the bank lending channel (especially if OFCs operate under different rules to banks) by widening the definition of credit through which the credit channel operates. OFCs' borrowing is shown to matter for real activity: increased OFC borrowing is associated with higher levels of real investment. This would weaken the bank lending channel but would broaden the credit channel.

The link between OFCs and households is likely to be through the long-term management of savings by institutional investors such as pension funds and life assurance companies, as well as through unit and investment trusts. These funds are liable to be 'locked in' for a considerable period of time, but the perceived wealth effects of these funds may influence the sustainable consumption that households believe they can maintain. The link between the wealth that is held and managed by OFCs and household wealth is very strong, and gross wealth has been shown to be influential over money and lending by OFCs. But it is not immediately clear that the levels of money or lending and hence disequilibria in these variables will affect the consumption of households, on whose behalf the wealth is invested.

[17] The variable used is 'financial intermediation services indirectly measured' (FISIM) which measures interest payments to the financial sector that are considered a transfer from other sectors and not considered part of the economy's gross value added (at basic prices). This used to be called 'adjustment for financial services'.

Our method is to ask how (a) how OFC lending affects other sectors' spending in the long-run; and (b) how short-run disequilibria in OFCs lending might affect PNFCs and households. We ascertain whether these variables and those used to determine their equilibria 'explain' expenditure of the PNFCs and households. This involves a search for further long-run relationships between the variables explaining equilibrium money and credit held by the OFC sector and those used to augment the models of the other sectors. If there are new cointegrating relationships then we must allow for their influence over the dynamic behaviour of the other two sectors.

In the case of the PNFCs, a new cointegrating relation is found, where the OFC lending variable, $l(\text{ofc})_t$ influences firm's real investment in an otherwise similar long-run equation:

$$i_t = y_t - 0.494c_{kt} - s_{ut} + 0.054l(\text{ofc})_t.$$

The discovery of the new relation is an interesting result because it shows that even if OFCs expand and contract the asset and liability sides of their balance sheet proportionally, and have no direct spending component that feeds into aggregate demand, they do influence real investment by firms. In our model we replace the original investment equation with this new equilibrium.

Table 3 reports the results of disequilibria on the PNFC sector. There are two potential effects. The first comes through the new equilibrium investment equation, where the results show that, compared to the original PNFC model, there is stronger feedback to the new investment disequilibrium. This implies that the OFC lending does have an impact on whole economy investment growth through their loans to firms who undertake investment or through their own borrowing activity to finance the purchase of capital equipment that they subsequently lease. The second effect operates through the direct influence of money and lending disequilibria on spending, but in this model there is no detectable influence on PNFCs investment (see terms four and five, top row).

The search for additional cointegrating relations between variables in the OFC and household models concluded that there were no new long-run relationships of the kind that we discovered in between OFCs and the PNFC sector. This eliminates the possibility that OFCs lending influences the long-run behaviour of households. The test of the significance of the OFC disequilibria on household spending is reported in Table 3 (see terms four and five, bottom row). There is only one feedback coefficient that is significant, and this corresponds to the influence of the disequilbrium in OFC money on consumption growth. Excess OFCs' money balances are associated with lower consumers' expenditure growth, which may arise if OFCs hold more money than they desire at times when other assets are perceived as overvalued and consumer expenditure declines as perceived wealth of households is revised.

The conclusion we draw is that OFC lending positively influences whole economy investment. It may do so through the PNFC sector, supplementing bank lending as a complement or a substitute, or it may reflect investments undertaken by OFCs them-

Table 3
Financial linkages between sectors

	PNFC's response to disequilibria in:				
	PNFC investment	PNFC lending	PNFC money	OFC money	OFC lending
Coefficients	−0.2352	−0.041	0.0189	−0.0157	0.0111
Standard errors	(0.0345)	(0.032)	(0.0300)	(0.0469)	(0.0523)
	Household's response to disequilibria in:				
	Household consumption	Household lending	Household money	OFC money	OFC lending
Coefficients	−0.2213	0*	0*	−0.0051	−0.051
Standard errors	(0.0583)			(0.0189)	(0.0255)

Notes: * restricted to equal zero in structural model.

selves as they purchase capital equipment for leasing. There is no detectable effect of OFCs lending on households.

5. Conclusions

The purpose of this paper is to investigate the empirical evidence for credit effects in the transmission mechanism in the UK. There are two main channels by which credit supply can influence expenditure: the balance sheet channel and the bank lending channel, although our paper is broader than a supply-side analysis since it also includes demand effects. Our paper sought to discover whether there is evidence consistent with these effects and to determine whether non-banks as well as banks have an influence over PNFC and household spending.

Our results are clear cut. There is support for the view that credit matters and that financial wealth is an important criterion determining the level of equilibrium credit employed by households and firms. The feedback from credit disequilibria to investment and consumption implies that variations above or below the desired level of borrowing have real effects. The results are generally less supportive for households than for firms and there is no feedback from credit disequilibrium on spending.

The question of how important non-bank credit might be for expenditure is also answered. Extending the range of organisations offering credit facilities beyond banks to include non-banks in the non-bank financial sector reveals that non-bank credit also matters. The lending by these other financial institutions (OFCs) has a direct effect on total economy investment and including OFC credit as a determinant of the long-run equilibrium increases the strength of the feedback coefficient to firm's real expenditure. There are no effects through the household sector, however.

In summary, the results are supportive of credit effects in the monetary transmission mechanism of the UK and these effects extend beyond those of bank credit. The principal channel appears through lending to firms, which influences whole economy investment.

Acknowledgements

We wish to thank Robert Lensink, an anonymous referee and former colleagues from the Bank of England too numerous to mention, for helpful comments and suggestions.

Appendix A. Data appendix

The data we use conform to the new European System of Regional and National Accounts (ESA95) provided by the Office for National Statistics (ONS) and the Bank of England.

Private non-financial corporations data sources

- Real gross domestic fixed capital formation: ONS.
- Real M4 held by PNFCs: Bank of England break adjusted series deflated by the GDP deflator.
- Real M4 lending to PNFCs by banks and building societies: Bank of England break adjusted series deflated by the GDP deflator.
- Real gross domestic product at market prices: ONS.
- PNFCs' real gross financial wealth: ONS.
- The proportion of firms reporting more than adequate stocks of finished goods, taken from the CBI monthly survey (see footnote 7).
- PNFCs real retained earnings: ONS.
- The real user cost of capital: ONS.
- Deposit spread: M4 deposit rate minus the three-month sterling LIBOR rate: Bank of England.
- Lending spread: M4 bank lending minus LIBOR: Bank of England.
- Real value of mergers and acquisitions: ONS.

Households data sources

- Real consumer expenditure by households: ONS.
- The stock of real M4 balances held by households: Bank of England break adjusted series deflated by the consumer expenditure deflator.
- The stock of real unsecured M4 lending to households by banks and building societies: Bank of England break adjusted series deflated by the consumer expenditure deflator.
- Real net labour income: ONS.
- Household real net total wealth: defined as housing wealth plus financial assets minus total debt: ONS.
- Inflation: the annual rate of change of the consumer expenditure deflator: ONS.
- A deposit spread: M4 retail deposit rate minus the base rate: Bank of England.
- A credit spread: credit card rate minus the base rate: Bank of England.

- Consumer confidence: GfK series on consumer confidence.
- The percentage change in unemployment: the claimant count: ONS.

Other financial corporation data sources

- Real M4 held by OFCs: Bank of England break adjusted series deflated by the GDP deflator.
- Real M4 lending to OFCs by banks and building societies: Bank of England break adjusted series deflated by the GDP deflator.
- Real gross domestic product at market prices: ONS.
- OFCs' real gross financial wealth: ONS.
- FISIM: interest payments to the financial sector that are considered a transfer from other sectors and not considered part of the economy's gross value added (at basic prices). This used to be called 'adjustment for financial services': ONS.
- Long–short differential: the long gilt rate minus the three month Treasury bill rate: Bank of England.
- Bond–equity spread: long gilt rate minus the Financial Times-30 dividend yield: Bank of England.

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