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## How We Might Model a Credit Squeeze, and Draw Some Policy Implications for Responding to It

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## How We Might Model a Credit Squeeze, and Draw Some Policy Implications for Responding to It

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### Abstract

This paper endeavours to illustrate the consequences of a credit squeeze by inserting a standard model of retail banks into some familiar macroeconomic models. Some possible policy conclusions are drawn about the benefits of incentives to increase lending at these times, and to reduce it in much better times.

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## 1 Introduction

The financial crisis of 2008 provokes three kinds of questions. First, how and why did it start? Second, how is it best fought now? And third, how are repetitions best prevented? Answers to these three questions are interwoven in many different ways. The main focus of this paper is on the second and the third questions. But to explore how best to combat it and to stop any recurrences, we must start by deciding how best to analyse it.

At the heart of the crisis lies a breakdown of trust. Trust lies at the heart of the financial system; when it snaps, grave effects must ensue. First, some banks began to distrust some of their debtors whose loans had previously seemed relatively sound, and packaged in bundles certified as such by credit rating agencies. Next came the fall of the second domino. Some banks got wind of this. So they started to lose trust in some of the other banks, in particular those thought to be over-exposed to these newly suspect loans. The third stage was a cascade of scepticism about almost *any* bank that sought to borrow from another. What had been a quite regular, if intermittent, business practice, was now taken as a signal of possible impending insolvency. The interbank loan markets seized up; perceived counterparty risks rose sharply; and an immense shadow fell upon credit default swaps and various other financial derivatives.

## 2 Background

A year after the “repricing” of risk had begun in the wholesale markets, the collapse of Lehman Brothers in September 2008 marked the onset of a grim struggle for survival on the part of thousands of financial institutions across the world. The stage was now set for distrust to spread to the general public. We now witnessed distrust of many of the retail banks. What had been presaged in October 2007 in the United Kingdom’s first bank run for over 150 years, by depositors in Northern Rock, turned

into a hasty rearrangement of customers' accounts across banks to maximize shelter under deposit insurance ceilings, and, in some cases, it led to a flight to cash.

Many banks now faced three simultaneous threats. One was deposit withdrawal. The second was the unavailability of (or at best sharply increased interest rates on) any interbank borrowings they had made. And the third was the rapid deterioration of loan income, net of provisioning. So they attempted to pay back their most short term debt as a matter of desperate urgency. And when loans exceeded deposits, as it did for many banks, narrowing the gap for which financing had suddenly become so expensive meant trimming the loan portfolio as rapidly as possible. Credit rationing afflicted weaker banks, and they in turn transmitted it to their retail borrowers. Where contracts allowed, retail loan rates were already swollen by augmented risk premia, and to allow for increased default probabilities and losses given default, and deteriorating collateral values following the principles of the Bernanke-Gertler financial accelerator. Now they jumped further, as the lender encouraged borrowers to switch suppliers. Overdraft ceilings were sometimes reduced unilaterally without discussion.

Thus corporate borrowers facing imminent rollover of their debts faced the prospect of sharply increased interest rates, at best. At worst, they could receive demand for repayment in full. Some would find they could not find another source for loans. When this happened, bankruptcy would often follow. Although central banks were to cut policy rates sharply, variable rate loan rates would tend to fall by less, and a large gap opened up between the marginal costs of external finance to those who could still borrow (or had yet to face roll over) on the one side, and those denied credit on the other. For those in the latter group, external finance became prohibitively expensive.

Keynes's "unsatisfied borrowers" would morph, therefore, from fringe to dense throng. And those corporate borrowers still lucky enough to be outside it, would wait anxiously, to see if their short term loans would be renewed, and began to disengage quickly from planned spending on projects or staff, in case they were not. Many households would then anticipate that their future labour income was

vulnerable, and cut back on various discretionary expenditures. These developments marked the start of the transformation from financial crisis to economic recession.

### 3 Banks

The very simplest model of a retail bank, a starting point for analysing the macroeconomic effects of the financial crisis, can be adapted from Klein's (1971) portrayal of a banking monopoly<sup>3</sup>. Suppose there are  $n$  independent banks, each of them choosing its own levels of loans and deposits to maximize its profits, taking its rivals' quantity decisions as given. This is therefore a Cournot model of simultaneous oligopsony for deposits and oligopoly in loans. For simplicity, loans are homogeneous, and deposits are homogeneous; there is no discrimination in either of these markets; there are uniform and constant marginal costs of managing loans of  $C$ , and of managing deposits of  $c$ ; and  $B$  represents an official interest rate set by the monetary authorities, which every bank takes as given - and treats as a single number. Banks' liabilities consist solely of the deposits they attract, and their loans and their holdings of short term claims against the monetary authority, all bearing the interest rate  $B$ , are strictly positive. The (industry-wide) demand for loans decreases smoothly as the market-determined rate of interest on them,  $R$ , rises; the supply of deposits rises smoothly with the market-determined deposit rate,  $r$ . I assume for convenience at this point that there are no defaults on loans, or no limits on the values  $B$  can take, that deposits will exceed loans, and that all banks will behave alike.

With the banks behaving in an identical fashion, resulting outcomes will be symmetric. There are three types of outcome. One is the Cournot equilibrium. This will give us an almost<sup>4</sup> analytical solution for the pair of retail rates: the deposit rate

will equal  $r = \frac{B - c}{1 + \frac{1}{\varepsilon n}}$ , and the loan rate will be  $R = \frac{B + C}{1 - \frac{1}{\eta n}}$ , where  $\varepsilon$  is the

elasticity of industry wide deposits to  $r$ , and  $\eta$  (defined as a positive number) is the

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<sup>3</sup> Another paper on this subject, written almost at the same time and with a very similar approach, is by Monti (1972). Both models build on Edgeworth's original insight (1886) that certain aspects of banking gave rise to increasing returns, thus making room for an imperfectly competitive industrial structure.

<sup>4</sup> An exact solution is available when the two elasticities in the formulae are constants.

elasticity of industry wide loans to  $R$ <sup>5</sup>. If all the banks collude, however, and new entrants that might otherwise be tempted in are kept out of the picture, then the effective number of independent banks is unity. In that case, a collusive equilibrium will generate the largest equilibrium spread between the two retail rates, and the lowest volume of industry loans and deposits. The formulae continue to hold, with this restriction. The loan rate is clearly much higher than in the Cournot equilibrium, and the deposit rate much lower, especially when the number of banks is large. The largest volumes, and the smallest spread,  $c+C$ , would be observed in the opposite extreme. This covers the cases of textbook perfect competition (where  $n$  is effectively infinite, and the formula still holds) and also in Bertrand competition between two or more banks (when banks set their two rates independently, taking each others' rates as given, and here the formulae do not hold). This would happen, too, even in monopoly-monopsony under the conditions of perfect contestability (no sunk costs, parity of technology and factor prices between an incumbent and a novice, and consumers able to switch banks faster than incumbents can reprice products; and again the formulae fail here). This spread would go to vanishing point if marginal administrative costs are negligible. In the Cournot or collusion cases, industry-level loan demand and deposit supply will need to be sufficiently well behaved – linearity or log linearity would of course suffice but nothing so restrictive is necessary - to rule out any possible instances of multiple equilibrium that might otherwise arise.

The retail rate spread between loan and deposit rates increases with the two marginal cost terms, and decreases as the number of independent banks rises, or as loan demand or deposit supply becomes more elastic to its particular interest rate. As a first step, we might model the consequences of the credit crunch as triggered by a spontaneous, exogenous jump in the loan rate-deposit rate spread, traceable in turn to a sudden, exogenous change in the required direction by any one or more of these relevant parameters. Within the confines of our assumptions, perhaps the most appropriate way of modelling the crunch would be by supposing that  $C$ , the marginal cost associated with managing loans, had jumped sharply. Loan rates would rise by the full extent of the marginal cost jump in the third case of perfect competition (or

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<sup>5</sup> These results come from assuming that, under conditions stated above, bank  $i$  sets its quantities of loans ( $\ell_i$ ) and deposits  $d_i$  to maximize  $(R - C)\ell_i + B(d_i - \ell_i) - (c + r)d_i$ .

Bertrand equilibrium or perfect contestability), or in the other cases, if industry loan demand happened to be semi-logarithmic<sup>6</sup> (more generally, the loan rate could go up by more or less than one for one with  $C$ ).

A few points about generalizations could be made at this point. First, defaults. Let  $\psi$  and  $\lambda$  respectively be the default rate, and the rate of loss given default (LGD), with  $\psi\lambda = a\phi(R)$ , say. Presumably  $\phi(R)$  increases with the loan rate  $R$  for reasons explained by Stiglitz and Weiss (1981): a higher loan rate deters better risks more than riskier lenders, and induces remaining borrowers to take more risk in ways that the bank cannot directly observe or prevent. With  $\xi$  the elasticity of  $\phi$  to  $R$ , the loan rate solution will now satisfy  $R = (B - C) / [(1 - a\phi)(1 - \frac{1}{\eta n}) - \frac{a\phi\xi}{\eta n}]$ . Here, the loan rate rises in response to an exogenous rise in the default or LGD rates (as reflected in parameter  $a$ ) or if their product becomes more elastic in  $R$ . Had individual banks been price setters rather than quantity setters, on the other hand, loan rates may be tempered, rather than augmented, by their perceptions of how higher interest can trigger these moral hazard and adverse selection effects – and in such circumstances credit rationing might result. But within the setup above, it is straightforward to see how an exogenous deterioration in expected defaults (and/or in losses given default) must, all else equal, boost loan rates.

Second, banks may not behave symmetrically. The monopoly – collusion solution is threatened by the incentive it provides for an individual cartel member to break ranks, and increase lending and deposit taking if he thinks he can get away with it. If one bank defects, and the others stick together, we move straight to Cournot duopoly / duopsony, with the formulae registering a rise in  $n$  from 1 to 2. If  $m$  banks defect, we see the interest rate spread shrinking further, with the formulae amending  $n$  to  $m+1$ . And complete fragmentation of the cartel takes us further, all the way to Cournot with  $n$  banks. Defection may be deterred if the cartel can credibly threaten, not just to identify the defector, but also to punish him, by flooding the market. Further, the cartel may be sustained if the rate of discount a potential defector applies to

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<sup>6</sup> That is, if the logarithm of industry loan demand were linear in the loan rate. In this special case, the loan rate will exceed  $B+C$  by a constant that is inversely proportional to  $n$ .

subsequent profits (which will be squeezed by such punishment) is sufficiently low. One strategy for a bank facing possible extinction (and thus exhibiting a high discount rate) may therefore be to attempt to expand its loans (and / or its deposits) rapidly. And if it is unsure about how and when its rivals will react to such moves, and the payoff to its decision takers is bounded below, this form of aggression could take on the character of a highly appealing “gamble for resurrection”. Regulators may of course intervene to try to prevent this, not least because such action could imperil the financial stability of other financial institutions. But this issue reminds us that financial crises could be attended, at least initially or temporarily, by credit feasts and not just credit famines, and by moves towards lower rather than higher loan rates. A recent instance of an interesting, but rather different kind of financial crisis model exhibiting loan rate reductions, and the breakdown of a cartel, is provided by Gorton and He (2008).

Cournot equilibrium may itself also be infected by asymmetric behaviour. In a Stackelberg leadership equilibrium, one bank, the “leader”, has learnt that its rivals’ loan and deposit quantities are not given, but tend to fall when the leader takes on new business. The leader exploits this information, and now produces more than his rivals, in the belief that they will respond by yielding some profitable business to him. When industry loan demand and deposit supply are (approximately) linear, the leader’s quantities resemble those of a pair of the other, “follower” banks, and the retail rate spread inches down a bit, in the direction of greater competition. If two or more try to “lead”, the spread may collapse to the perfect competition level, or conceivably (for a while, out of equilibrium) below it. Asymmetry in market shares will also arise when behaviour is symmetric but costs are not. Smaller banks will be smaller because they suffer from higher costs.

A third concern relates to the fact that the range of values that the retail rates may take may be bounded. There is presumably a zero lower bound to the monetary authorities’ nominal policy rate. Our formulae should be unproblematic when expected inflation is zero, because nominal and real interest rates converge. If not, one will wish to restrict their definition to *real* interest rates ruling in the retail markets. If so, this is how  $B$  will be defined. The zero lower bound to the nominal policy rate implies a lower bound to the real policy rate, too. Furthermore, because



currency offers a zero nominal return by definition, and because currency and bank deposits will generally be rather good substitutes, it is difficult to imagine that banks could pay a negative nominal rate on deposits for more than a brief period in unconventional circumstances (such as was seen in Switzerland on deposits of foreign origin for a brief spell in 1978). Extending their earlier paper (2005), He, Huang and Wright (2008) propose a theoretical model of bank deposits motivated by the (higher) risk of theft of cash in which negative nominal rates on deposits could happen, and might indeed be optimal. But evidence of Japanese money market and bank deposit interest rates in the periodic zero bound episodes earlier this century (e.g. Baba et al, 2006) testifies to a concertina effect where the gap between  $r$  and  $B$  gets very severely squashed.

#### **4 Modelling the Credit Squeeze – The Short Run, and a Possible Policy Response**

Suppose, for simplicity, that final expenditure by firms and households is partly paid for out of current income, and partly out of loans from banks, at a real rate  $R$ . Assume no foreign trade or fiscal activity, and let expectations of inflation be zero, so that nominal and real interest rates are equal. This will give us a very simple IS curve. Suppose that the monetary authorities set the policy rate at  $B$ , a “neutral” rate, supplying base money to meet demand for which the relevant opportunity cost is the rate on deposits,  $r$ . That will imply a simple LM curve. We might write these down in linear form as

$$y = \alpha + \beta y - \gamma(B + w_1) \quad (1)$$

$$m/p = \delta + \varepsilon y - \zeta(B - w_2) \quad (2)$$

where  $y$ , and  $m/p$  denote real income and real balances of base money, all Greek parameters are positive (with  $\beta < 1$ ) and  $w_1$  and  $w_2$  denote mark-up and mark-down from the central bank’s policy rate,  $B$ . If retail banking had been costless, perfectly competitive and completely devoid of risk, the two retail rates would lie at  $B$ . This is a basic textbook ISLM system, with the LM curve horizontal.

Financial market frictions, whether in the form of marginal costs of managing deposits or loans, mark-ups due to imperfect competition, and risk premia, would all drive a wedge between the two retail rates. That would have to lower the level of real income implied by money market equilibrium and aggregate demand consistency. How much aggregate demand would have to fall would be proportional to the size of the loan market wedge,  $w_1$ , and to the solved-out gradient of the IS curve,  $\frac{\gamma}{1-\beta}$ .

The damage wreaked by a financial crisis is the greater, the flatter the IS curve. As the crisis could be interpreted as the amplification of a capital market distortion, we would expect the parameter  $\beta$  to increase, reflecting the enlarged gap between borrowing and lending rates of interest, as argued first by Flemming (1973); and the parameter  $\alpha$  would be correspondingly reduced. An increased value of  $\beta$  would flatten the IS curve directly. The financial friction in the deposit market, however, plays no explicit role here: only  $w_1$  matters for  $y$ . (If the monetary authorities attempt to target the money base, on the other hand, and allow  $B$  (which one might now reinterpret as a treasury bill rate) to float, both wedges affect real income. The loss in real aggregate demand due to the two wedges combined will equal their sum, multiplied by  $\frac{\gamma}{1-\beta+\gamma\varepsilon/\zeta}$ . Which monetary regime sees a greater reduction in aggregate demand is ambiguous, and depends on the sign of  $(w_1\gamma\varepsilon/\zeta - w_2(1-\beta))$ ).

One course of action that suggests itself at once would be for the monetary authorities to lower the policy rate,  $B$ . If the loan rate wedge and inflation expectations are unaltered, an increase in  $w_1$  brought about by a financial crisis could, it seems, be neutralized at once. There are a number of concerns, however. One is the zero lower bound restriction on the nominal value of the policy rate. This will place a floor on how far the policy rate can be cut. A large reduction, to something close to the floor, will surrender the option of cutting further later on, should that appear necessary. Then there is the possibility of sluggish or incomplete pass through from  $B$  to  $R$ ; while  $R$  does react to  $B$  in practice, the long run reaction in most countries is typically less than one for one<sup>7</sup>, and the response is often gradual, too. This would limit the

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<sup>7</sup> Mahadeva and Sinclair (2005) conduct a study of over 130 countries' data (as published in *International Financial Statistics*) examine the dynamics of loan rates to policy rates, and find the long

benefits of relief from the sudden appearance of excessive risk premia in loan markets. A third issue is the fact that a policy rate cut would lower the deposit rate,  $r$ . That must serve to reduce the banks' deposit base, in the context of the Klein model at least, as agents are stimulated to substitute into currency (and possibly other assets with now relatively higher yield); and a fall in banks' deposit base can only expose banks to greater financial stress. A fourth possible problem is that the policy rate cut will tend, if sustained, to lead to greater actual and anticipated inflation, and hence, in due course, a reversal in direction. That will have certain advantages (prominent among them, the reduced risk of hitting the zero bound, and fact that elevated expectations of inflation, once generated, act as a kind of "subsidy" in the ISLM system, since the IS curve is a real rate of interest relationship, and the LM curve, in general, primarily a nominal one). But it poses a challenge, too. The bloated risk premium element in the wedge  $w_1$ , the key source of the problem, might well persist, continuing to keep the loan rate excessive in real terms.

Beyond these points, we should accept the force of two other observations. One is that a standard relaxation of monetary policy in the form of a policy rate cut, despite the critically valuable role it can play in fighting the *symptoms* of the financial crisis, is not an attack on its *source*. It is indirect. It is not aimed squarely at the root of the problem. The other is this. There are many candidates for sharing the blame for the 2008 crisis. These include: mistakes and possibly mixed motives on the part of the credit rating agencies; the inherent procyclicality of national and international regulations on banks; doubtfully wise early responses by regulatory or monetary authorities (Buiter, 2008; Goodhart, 2008); mark-to-market accounting, as well as other sinister balance sheet effects explored recently by Shin (2008); the meretricious effects of bonuses to staff in financial firms that reflect performance over very short periods, and the myopia and tendency to bubbles this induces, examined by Sinclair et al (2009); the egregious econometric error of confusing *number* of observations (for asset prices) with the *span* of history from which the data are drawn, and the consequent failure of risk management models employed by financial firms; the herding typical of markets with incomplete and disparate information sets; political pressures to widen house ownership quickly among the poor, sacrificing standard risk

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run pass through coefficient averages at about 0.7. For a recent study on UK disaggregated data, see Heffernan, Fuertes and Kaloychou (2008).

appraisal procedures; and the neglect by many market participants, and devotees of vector autoregressive models, of equilibrium correction mechanisms that will eventually force asset prices back to fundamentals. But there is another possible culprit, too. This is the very low policy rate, negative in real terms, set by the FOMC for some three years or more in the wake of the 9/11 outrage and the dot.com crash. It therefore seems rather ironic that the illness appears to call for homeopathic treatment.

## 5 Modelling the Longer Run

In a basic Ramsey setup, agents with an infinite horizon choose paths for their consumption and capital, and perhaps other variables such as labour, real money holdings, bonds and human capital, to maximize an exponentially discounted felicity integral, subject to budget constraints that keep repeating that income equals consumption plus investment. Given some starting value of capital for each, and given (suitably restricted and well-behaved) functions for production and utility, optimization leads both to a steady state, and to a unique saddle path, a transition path towards it. With perfect competition, foresight and a government that is either absent or beneficently correcting any distortions, both steady state and the saddle path are well pinned down and clear. Technically the problem can be expressed as each individual choosing the sequence of capital per person,  $k(t)$ , from a given initial value  $k(0)$ , to maximize

$$\phi = \int_0^{\infty} \{e^{-\beta t} u(f(k(t)) - \dot{k}(t))\} dt \quad (3)$$

(where the overdot denotes time derivative) or some more complex variant of this problem. The steady state is characterized here by  $f'(k^*) = \beta, c^* = f(k^*)$  and the saddle path shows consumption,  $c$ , and  $k$  rising or falling towards it along a path which is linear (concave, convex) if the (modulus of the) elasticity of  $u'$  equals (exceeds, lies below) the elasticity of  $f(k)$ . The framework lends itself relatively easily to various extensions<sup>8</sup>. One of these is taxation by government. Another is to certain kinds of capital market imperfection that may resemble some of the features of Klein's models of banks.

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<sup>8</sup> Stokey and Lucas with Prescott (1989) is a particularly useful reference here.

One wrinkle that is particularly easy to introduce is a quadratic cost of adjusting capital. This can capture the idea that those who wish to build their capital will find it increasingly expensive to build it up, or dispose of it, in large amounts or at great speed. It resembles the impact of a financial market friction that penalizes both savers and borrowers, with a penalty proportional to the size of the modulus of the change in wealth. If saving and dissaving has to be channelled through a financial market that acts like this, the key conclusions are that the steady state is unaffected, but the time taken to get arbitrarily close to it (in an asymptotic convergence) is greatly prolonged, with a saddle path that is twisted away from its normal shape, biased in favour of an especially gradual trajectory for wealth. The greater time taken to approach the steady state must take its toll on the agents' felicities.

Continuing to assume that asset accumulation and decumulation has always to be conducted through banks, but assuming now that there is – as in the simple Klein model with no discrimination – a pair of constant wedges that punish both lending and borrowing in a linear fashion, we arrive at a different result. This is that there is no longer a unique steady state, but rather a zone within which long run capital per head may settle. If you start off with a capital stock within this zone, you stay there. You obey Polonius' advice to Laertes, on his way to study at the University of Paris: "Neither a borrower nor a lender be". If you start below it, you will eventually converge on its lower boundary; if above, on its upper one. Capital is misallocated in the long run, because marginal products do not get equalized. Those who begin rich end up with too much capital, and poor beginners with too little. Adjustment patterns along the saddle paths also change, and differ between the two groups. The steady state zone for capital is patently inefficient. To maximize the aggregate output from a set of homogeneous capital stocks, you should equalize their marginal products, given that these are positive and decreasing; the zone frustrates this. The asset accumulator builds up capital until  $f'(k) \rightarrow R$ . The asset decumulator lets it slide until  $f'(k) \rightarrow r$ , the rate for lenders. The width of the steady state zone for capital is  $f'^{-1}(r) - f'^{-1}(R)$ .

There is another way of introducing financial markets. Let us now assume that agents have two choices. One gives them the opportunity, if they wish to take it, of adding to their capital gradually, on their own, out of their income, or, if they start off with “too much”, of slowly running it down by converting bits of it into extra consumption. This option bypasses the financial markets. It is a “Do It Yourself” technology for changing capital. The other choice is for capital accumulators to borrow straight away, raising their capital quickly but at the cost of a lower level of consumption later on (there will be a stream of interest on their debt that they have to service, or of dividends on the shares they sell). Capital decumulators can sell what they don’t need straight away, too, and boost their long run consumption with the interest on the sale proceeds. If capital markets are perfect, with no wedges, everyone should opt for the second strategy. Do it yourself must give a lower felicity integral. But bring in the wedges, and this result may get reversed, and is almost bound to, if the wedges are really large. In that case it will pay people to avoid financial intermediators, and stick with a non-horizontal consumption time-stream during the slow transition towards the steady state. The prize for DIY accumulators is a larger level of consumption in the steady state; its price, a slow, arduous slog of sacrifice in at least the earlier stages of the process, which would have seemed prohibitive if financial markets had been undistorted, but is worth paying if these wedges are sufficiently excessive. Again, however, the financial imperfections generate inefficiency, because perfect capital markets, in the absence of any adjustment costs, would have equalized capital’s marginal products across agents *at once*, and DIY processes will leave them disparate outside the steady state.

The Ramsey approach has much more to tell us. Abstract now from all financial market imperfections, and consider the fiscal legacy of a financial crisis. Suppose that the government finances its costs of servicing the national debt, along with all its other outgoings, from a tax on all incomes at a single, proportional rate, call it  $\tau$ . Consider the consequences of a financial crisis. Tax proceeds fall. Transfer payments increase. A period of large budget deficits is likely to ensue. In addition, the government’s finances may suffer the costs of a spell of losses from deposit insurance by a public agency and / or of guaranteeing deposits in failing banks. And the government may attempt to raise spending or cut taxes in an effort to prop up the nation’s real income. The eventual flow cost of these developments will be registered

in the form of additional debt interest. If the steady state income tax rate has to rise, from  $\tau(0)$  to  $\tau(1)$ , say, steady state capital will fall – in the simplest case – from  $f'^{-1}(\frac{\beta}{1-\tau(0)})$  to  $f'^{-1}(\frac{\beta}{1-\tau(1)})$ . Steady state output and consumption will fall.

After an initial jump, consumption will drop back, along with capital, towards its new long run values. The fact that financial crises leave such a long shadow of gravely weakened investment and depressed output<sup>9</sup> may be partly attributable to this phenomenon. Fortunately, however, there is a way of escaping it. This is to adopt Kaldor's (1956) proposal for an expenditure tax. This taxes  $f(k(t)) - \dot{k}(t)$ , income minus net accumulation, rather than income,  $f(k(t))$ . Another device that insulates long run capital from the ravaging effect of taxation on compound income is Lucas's (1990) proposal for exempting capital income from income tax entirely. A third will be to restrict revenue raising to taxes on consumption, such as VAT. Of these three, Kaldor's device achieves a similar end result for aggregate capital, with perhaps less cost in terms of labour market distortions (income streams on preexisting capital still get taxed) and inequality within and between generations. Switching from income taxation to an expenditure tax is not free of practical difficulties, but it is a change that merits close scrutiny in all circumstances, and especially so when government borrowing is going to be exceptionally heavy.

Ramsey's framework can also be adapted to the context of endogenous growth, where it yields a key relationship linking the steady state growth rate to the real rate of interest. This relationship is positive. A higher real rate of interest generates a faster growth rate of consumption per head, and hence in aggregate income in the steady state if population is stationary. The relationship is linear when  $u'$  is isoelastic. Many endogenous growth models can be viewed as combining this with another growth-interest link, capturing such mechanisms as arbitrage between human capital and physical capital investment (as in Lucas (1988)) or the adverse impact of higher interest on the rewards from invention (as in Romer (1990)). This second link is typically a negative or at least non-positive one<sup>10</sup>. The endogenous growth rate is solved under first best conditions as the growth rate at which the two curves intersect

<sup>9</sup> See Hoggarth, Reidhill and Sinclair (2003) for some detailed evidence on this.

<sup>10</sup> With the real interest rate independent of the growth rate in an interior, steady state equilibrium.

(but it will be zero if they only cross at a negative rate of growth, an impossibility if it implies negative rates of training or invention). So it is now a simple matter to examine the consequences of capital market imperfections, if one assumes that the Ramsey, positive link refers to the behaviour of households who observe a (real) deposit rate  $r$ , with the other, non-positive link relating to the (real) borrowing rate,  $R$ . The implication is unmistakable: a bigger wedge between the two real rates can only reduce the growth rate. And if the wedge is permanent, so will be the reduction in the rate of growth. For a given  $R-r$  gap, growth is the more impaired, the flatter these two relationships (if the rate of growth is placed on the horizontal axis).

## 6 Concluding Remarks – Some Policy Implication for the Longer Run

If the key issue is one of a breakdown in trust of and by banks, this should ideally be addressed at source. Tinbergen's rule is that if you have two targets, you should have two instruments. It is surely asking too much of the monetary authorities' policy rate that it should be used for both macroeconomic stabilization and combatting fits of overoptimism or distrust on the part of participants in the financial markets. Just because distrust clogs up lending channels, and a credit famine may have very serious, though gradual, impact on inflation and real income, cannot imply that policy rate cuts – helpful, even invaluable as they may well be in such circumstances - are the ideal sole instrument for trying to deal with the source of the problem.

Pigou's solution to a problem of underprovision of a good or service from a social welfare standpoint<sup>11</sup> was to urge a subsidy; overprovision should, he thought, be restrained by a tax. What might a Pigouvian solution therefore look like? First one would need to determine what overprovision or underprovision might mean, and how they could be quantified. One measure would be deviation from a mean value of corporate bond (or "debenture") yields drawn from a wide index. One could construct an index of the prices (ideally adjusted to remove the influence of coupons) of (unindexed) corporate bonds, which were due to be redeemed within say 2 years, or approximately in one year's time, stretching back over a long period. The mean

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<sup>11</sup> See Pigou (1954) and references therein. What follows in the present paper is a specific suggestion that builds, on Pigouvian lines, upon the proposal by de Fiore and Tristani (2008) for careful monitoring of credit spreads.



annualized yield to maturity could then be readily calculated, and compared with annualized yields of (unindexed) government bonds at similar maturities. The historical mean difference in the means would be, let us say, 150 basis points. This could then be compared with the actual difference in yields on a quarterly, monthly or even daily basis. Where the difference was historically low, say below the 90% confidence interval around the mean, a tax could be imposed on the nominal quarterly *growth* of a licensed or chartered bank's lending, of perhaps £2 per £100 lent. This tax would become payable in conditions presumed to correspond to excessive optimism. It could be thought of as an advance charge that took the place of appropriate, forward looking provisioning. Where the difference was high, above the 90% confidence interval, the nominal growth in a bank's lending would attract a symmetric subsidy. The scheme should be self financing if the long run yield difference proved stationary, and any changes in tax treatment that might alter it could be allowed for by amending the trigger points for subsidy and tax. Basing the tax/subsidy regime on the corporate versus government yield difference would be much less liable to manipulation than say on the gap between the central bank's policy rate and a measure of interbank rates at a similar maturity. The costs of administering the scheme would be sharply lessened by the fact that it would only be expected to operate, by construction, one tenth of the time. The scheme could be enriched, if thought useful, by relating the size of the tax and the subsidy to the actual size of the difference, when this strayed outside the confidence interval, but care would be needed to correct for the skewness of the yield difference if long-run breakeven was to be achieved: the tax/subsidy schedules would need to be non-linear. If it were thought useful to narrow the confidence interval around the mean beyond which taxes or subsidies became payable, this could also be easily achieved, though at some extra administrative cost.

The main aim of such a measure would be to redress the procyclical bias in existing regulatory arrangements, and, if possible, actually reverse it when certain thresholds were reached. But the system could be tailored to meet other needs. For example, if equilibrium correction econometric regressions<sup>12</sup> revealed that the price of houses was more than x% away from values implied by fundamentals, or more than some

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<sup>12</sup> Of the kind pioneered in the housing context by Hendry (1983).

unacceptable number of standard deviations from fundamentals, the tax / subsidy regime could apply to the growth of mortgages<sup>13</sup>. This would not necessarily be an alternative to other stabilization devices, such as varying rates of stamp duty for housing transactions, or setting regulations on maximum loan-to-value ratios; it could be complementary with them. And while it is surely true that a credit famine will be accompanied by the likelihood of an abnormally large volume of credit rationing (in housing markets and well beyond), a phenomenon that transcends the simple models studied in this paper, fighting the famine by inducements to lend offer at least some reasonable hope of alleviating it.

Alternatives to these proposals – or possibly complements - would be to focus on the growth of credit per se, or on the credit/GDP ratio. One could regress nominal credit aggregates on nominal GDP, over time, and perhaps a set of other variables. First one would need to see whether credit (or any of its aggregates) was cointegrated with GDP. Of course it should be, but this should be checked, and over short or atypical periods a negative answer is conceivable. Once cointegration was assured, the next task would be to pinpoint any trend in the ratio, and any other variables that theory would suggest, and evidence confirmed, entered a well identified cointegrating relationship. (There might well be none of these other variables). New cointegrating equations would be run, and, one would hope, just a single one would emerge. The next stage would involve stipulating a credit growth rule: This could be target annual credit growth = inflation target + GDP growth trend + any annual time trend. If actual credit growth overran the target for a sufficiently long interval or by a sufficiently large amount, penalties on banks raising credit growth at or above this overall rate would be imposed. And a long enough or large enough sequence of below-target credit growth would trigger subsidies on banks with lending growth at or above this rate. A second variant would be to penalize banks for rapid lending growth when the credit-GDP ratio was significantly above trend, and reward them when it was significantly below. Of these two, the first would probably be superior, for two reasons: first, a trigger that focussed on growth rates would lead to earlier

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<sup>13</sup> Goodhart and Hoffman (2008) provide a valuable review of the role of house prices in the money-credit-interest nexus, and policy implications that may follow, and Gorton (2008) gives an excellent account of the role of mortgages in sowing the seeds of the current crisis. For the general argument for monitoring credit and asset prices, and the need for policy to react to them from time to time, Borio and Lowe (2004) are magisterial and persuasive.

intervention, and second, innovation that took the form of non-transient intercept shifts on the ratio would be much less likely to set off destabilizing policy responses.

Perhaps it is also time, as suggested by Dodge (2008), to consider reviving reserve and/or liquidity ratios on banks in those jurisdictions where they had fallen been dropped or had fallen into desuetude. Much of the trouble in 2007 was characterized by banks (like Northern Rock, HBOS and Bradford and Bingley in the UK) that had gambled on an “external finance strategy” and borrowed heavily on money markets to supplement their deposit base.. A minimum liquidity ratio would simply prohibit such behaviour (a milder sanction would be to insist on evidence of well spread and lengthy maturity on these loans, or insurance against inter-bank markets drying up, on pain of threat of massive fines or to suspend a banking licence). And to prevent banks rushing like Gadarene swine to the opposite extreme of hoarding liquidity as many did in late 2008, one could envisage a maximum liquidity ratio, which might be reduced all the way to zero – or even below- in exceptional conditions.

Policy rate cuts may well form part of the optimum response to a credit famine. But they do not by themselves constitute more than one ingredient in it.

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