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Household debt, monetary policy and financial stability: still searching for a unifying model

by

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I. Introduction

Household debt has been on a secular rise across a wide range of economies. In many cases, this reflects the deepening of financial markets and, in particular, the ability of households to tap human and non-human wealth in ways that had not previously been available. A key policy question is whether there is a downside to such developments, ie do they represent key sources of risk to the macroeconomy and how best can these issues be modeled?

An optimistic view is that the trend is generally good for households, reflecting a sounder economic and financial environment. A less optimistic view is that the debt trends indicate an increased vulnerability for household balance sheets, as households leveraged up against high and rising asset prices (eg real estate and stock markets). If asset prices prove to be largely unsustainable, households could find themselves saddled with debt overhangs and heavy debt servicing costs.

At the aggregate level, such household vulnerabilities raise the risks of triggering an economic slowdown or, even worse, amplifying an initial economic slowdown into a disorderly downward slide. In the worst case, downside pressures could mount as property foreclosures and personal bankruptcies multiply in a systemic way with serious macroeconomic consequences, not least being a vicious recession, a financial spiral and deflation. Arguably, the unfolding financial strains in global markets since last summer underscore the seriousness of such possibilities.

Natural questions arise for central banks. What is the appropriate policy regime to address the new environment? And, in particular, how should central banks react as vulnerabilities rise and as worst case scenarios materialize? At their heart, these questions raise complex issues associated with the nexus between monetary and financial stability.

To shed some light on the current debate, this paper offers a monetary policy perspective on these issues. Section II presents a pedagogical monetary policy model that features fundamental and non-fundamental asset prices and household debt with which to illustrate some of the potential tradeoffs that central banks face. Section III discusses how to extend the model to incorporate financial stability issues. Section IV concludes that central banks can, and in many cases should, incorporate the information about household debt in setting policy rates and in assessing the policy risks.

II. Adding household debt into a benchmark monetary policy model: in search of a special role

To explore how household debt might influence policy tradeoffs from a modeling perspective, it is important to consider the various ways in which household debt affects the components of aggregate demand. The microeconomics literature suggests that household debt can affect consumption decisions via various channels, not least being via debt servicing costs as interest rates change, borrowing constraints imposed by financial institutions and the influence on consumers' perceptions about how the debt may impinge upon their ability to achieve lifetime consumption goals.

Despite the micro evidence, household debt typically has played a minor, if any, role in benchmark monetary policy models. In part, the reason arises from the tendency of macroeconomic modelers to see household debt as not only an endogenous variable reflecting intertemporal consumption and saving decisions but also a passive one. Addressing this shortcoming, this section first sketches out a simple benchmark monetary policy model with a passive role for household debt before considering various ways in which household debt may play a more active role, as a driver of the aggregate demand and then as an indicator of boom-bust cycles.

A benchmark monetary policy model

This section begins by extending the optimal monetary policy model of Filardo (2007) to include consideration of household debt. At its heart, the model comprises several interrelated blocks of equations which provide a means to explore some of the theoretical tradeoffs of a central bank in an economy subject to typical cyclical fluctuations as well as boom-bust asset price dynamics. In particular, there is a macroeconomic block, an asset price block, a debt block and a monetary policy block, which are all discussed in turn.

Macroeconomic block. The macroeconomic block is an extension of the Rudebusch and Svensson (1997) model incorporating a vector of asset prices. The demand side of the model is assumed to have a standard *IS* curve specification. Inflation fluctuations are modeled as a standard backward-looking Phillips curve with an additional source of inflation coming from asset prices. As specified, it is only the non-fundamental, or bubble, component of asset prices that contributes to inflation, above and beyond what is already captured in the output gap or past inflation rate.

The specification is adopted to capture the stylized fact that in many past asset price booms were often associated with fairly benign inflation behavior. Algebraically, the first block of the system is represented compactly as follows:

Macro block

$$(IS) \quad y_t = -\gamma r_{t-1} + \theta y_{t-1} + \boldsymbol{\varphi}\left(\boldsymbol{\pi}_{AP,t-1} - \boldsymbol{\pi}_{t-1}\right) + \boldsymbol{\psi}_y \mathbf{Z}_{t-1} + \varepsilon_t \tag{2.1}$$

$$(PC) \quad \pi_t = \pi_{t-1} + \alpha y_{t-1} + \boldsymbol{\beta}\boldsymbol{\pi}_{NF,t-1} + \boldsymbol{\psi}_\pi \mathbf{Z}_{t-1} + \eta_t$$

where $\boldsymbol{\varphi} = (\phi_e, \phi_h)$ and $\boldsymbol{\beta} = (\beta_e, \beta_h)$; *y* is the output gap, *r* is the interest rate controlled by the monetary authority, π is the inflation rate, $\boldsymbol{\pi}_{AP}$ is a vector of the rates of asset price appreciation, which in turn is a function of $\boldsymbol{\pi}_F$ (the rate of change in asset prices attributable to fundamentals) and $\boldsymbol{\pi}_{NF}$ (the rate of change in asset prices attributable to the bubble component of asset prices). **Z** is a set of exogenous variables that may be useful to predict output and inflation.

To be more specific, the real return on asset prices in the IS equation captures the potential channels of asset prices, eg equity and housing price inflation, on consumption (via a real or perceived wealth effect), investment (via a cost of capital effect) and government spending (via a tax revenue effect). The linkages are kept fairly simple and linear in order to keep this block of equations relatively easy to manipulate and interpret. The error terms in the *IS* and *PC* equations are assumed to be normally distributed with a zero mean and a fixed variance.

Asset price block. The simplicity of the first two equations stands in contrast to the asset price specification. As is evident from cross-country experiences with boom-bust type asset price behavior, the associated dynamics can have a big and non-linear impact. Incorporating such dynamics enriches the range of monetary policy reactions that can be explored. This also allows us to consider various channels through which household debt can interact with asset price and macroeconomic dynamics.

Without loss of generality, we assume a bivariate asset price specification; clearly this can be easily extended to a greater number of asset prices. In light of recent history, it is natural to think in terms of equity price and housing price developments. The components of the asset price block have the following specification:

(2.2) *Asset price block*

$$(AP)\ \boldsymbol{\pi}_{AP,t} = \boldsymbol{\pi}_{F,t} + \boldsymbol{\pi}_{NF,t}$$

where

(2.3)
$$(F)\quad \boldsymbol{\pi}_{F,t} = \begin{pmatrix} \pi^e_{F,t} \\ \pi^h_{F,t} \end{pmatrix} = i\pi_{t-1} + \begin{pmatrix} \lambda^e \\ \lambda^h \end{pmatrix} y_{t-1} + \begin{pmatrix} \nu^e_t \\ \nu^h_t \end{pmatrix}$$

(2.4)
$$(B)\quad \boldsymbol{\pi}_{NF,t} = \begin{pmatrix} \pi^e_{NF,t} \\ \pi^h_{NF,t} \end{pmatrix} = \zeta_t(y_{t-1}, r_{t-1})$$

where i is a unit vector, (λ^e, λ^h) are coefficients and $(\nu^e, \nu^h) \sim N(0, \sigma^2_j),\ j = \{e, h\}$.

The fundamental components of asset prices (F) are assumed to have a simple structure. The real growth rate of housing and equity prices is proportional to output, y. More complicated functions can be constructed but this is suppressed for simplicity. The nonfundamental, or bubble, components are modeled as endogenous, nonlinear random functions of output and interest rates.

One important feature of this bubble specification is that monetary policy can directly and indirectly influence the (transition) probability of bubbles. Higher interest rates would directly lower the probability that a bubble would continue and would indirectly lower it by slowing down economic growth. One interpretation of this endogenous behavior is that central banks via its policy rates can prick asset price bubbles.[1] More details about $\zeta(y_{t-1}, r_{t-1})$ are described below. As will be seen, the nonlinearity implied by this assumption introduce interesting nonlinear dynamics and enrich the types of trade-offs that the hypothetical monetary authority faces in such an environment.

Household debt block. The simplest assumption to address household debt issues is to append the macro block with an equation for the law of motion of debt. Without loss of generality, we can assume that household debt evolves as a function of output, inflation and interest rates:

(2.5)
$$D_t = \kappa_0 + \kappa_y y_{t-1} + \kappa_\pi \pi_{t-1} + \kappa_r r_{t-1} + \xi_t$$

[1] It might be more accurate to say that central banks can "stochastically" prick asset price bubbles in this model. In particular, central banks in this model cannot control the exact level of the bubble, but can alter the conditions that foster bubbles. For example, higher policy interest rates raise the probability that a bubble will collapse. In expectation terms, higher interest rates lower the expected duration of bubbles, and hence lower the expected size of them.

It is useful to note that debt plays a passive role in this simple extension of the benchmark model; while household debt may vary with the state of the economy it does not feedback into the macro block or the asset price block. In a sense, this assumption would be valid if debt levels were not considered important drivers of macroeconomic behavior. This is consistent with standard consumption theory. In theory, debt is not a driving variable unless it is so large that the transversality condition for the consumer's intertemporal budget constraint becomes an issue.[2] Subsequent sections examine the policy implications of debt playing an active role.

Monetary policy block. Given this structure of the macroeconomy and asset price and debt dynamics, the monetary authority's challenge is to choose a policy interest rate that minimizes the weighted average of the variance of output, inflation and the change in interest rates, that is, the monetary authority's loss function,[3]

(2.6) $$L = \text{var}(y) + \mu_\pi \,\text{var}(\pi) + \mu_r \,\text{var}(r - r_{-1}) \,.$$

For this specification of the household debt dynamics in equations (2.1), (2.2) and (2.5), the optimal policy rule would have the form of

(2.7) $$r_t = a_y y_t + a_\pi \pi_t + \mathbf{a}_F \boldsymbol{\pi}_{F,t} + \mathbf{a}_{NF} \boldsymbol{\pi}_{NF,t} \,.$$

where the parameters of the policy rule would solve the following optimization problem[4]:

(2.8) $$\underset{\{a_y, a_\pi, \mathbf{a}_F, \mathbf{a}_{NF}\}}{\text{argmin}} L \text{ subject to equations (2.1), (2.2) and (2.5).}$$

The policy implications for household debt are rather stark. In the benchmark model, the optimal interest rate rule does not include household debt. This is because

[2] Moreover, in aggregate consumer versions of closed-economy macroeconomic models, (net) debt is typically assume to be zero.

[3] The variance of the change in the interest rate is included to reflect the general desire of central banks to smooth interest rate fluctuations. Part of this desire might reflect financial stability concerns.

[4] See, eg, Chow (1978).

household debt plays no role in driving output and inflation dynamics. The basic message from this simple model is that household debt will only matter to the extent that it affects the dynamics of inflation, output and asset prices. If we were to extend the model to make it forward-looking, ie build in expectations, the same type of intuition would result: household debt would only matter to the extent that it predicts inflation, output and asset prices.[5]

Two extensions of the benchmark model

Various extensions of the benchmark model to include household debt can be motivated by empirical observations. Two stem from household debt's role in household liquidity constraints and as an indicator of boom-bust dynamics.

Household debt and liquidity constraints. Household debt may play a significant role in the propagation of macroeconomic shocks via borrowing constraints in the lending channel. Higher debt levels, all else the same, would lower net worth and therefore raise the cost of borrowing.[6] Debt levels can also increase the incidence of credit rationing. In these ways, household debt levels can affect aggregate consumption and therefore impact business cycle dynamics.[7]

This consideration suggests that economies facing significant liquidity constraints might be better represented by an IS curve (equation (2.1)) that includes a household debt (here thought of as a deviation of the household debt-to-income from its steady state ratio) variable:

$$(IS) \quad y_t = -\gamma r_{t-1} + \theta y_{t-1} + \boldsymbol{\varphi}\left(\boldsymbol{\pi}_{AP,t-1} - \boldsymbol{\pi}_{t-1}\right) + \beta D_{t-1} + \boldsymbol{\psi}_y \mathbf{Z}_{t-1} + \varepsilon_t \,.$$

[5] See Disyatat (2005) for such a derivation and discussion.

[6] See Bernanke, Gertler and Gilchrist (1999). Debelle (2004) notes that lower interest rates and less binding liquidity constraints have helped to boost household debt levels worldwide. Higher household debt levels, especially in economies dominated by variable rate loans, have increased the macroeconomic sensitivity to changes in interest rates, income and asset prices. In a fully articulated DSGE model, this is analogous to the "collateral constraint effect" in Monacelli (2006). Bordo and Jeanne (2002) argue in a somewhat different equilibrium model that the non-linearity implied by collateral constraints suggests a more complicated class of optimal policy rules.

[7] Assenmacher-Wesche and Gerlach (2008) could be interpreted to raise empirical doubts about the significance about such a channel. Using cross-country data, they find little difference in the response of output to monetary policy shocks in low versus high mortgage debt-to-GDP ratio economies.

In this equation, the coefficient on household debt would generally have a negative sign, reflecting the influence of borrowing costs and credit rationing on output. In this case, the resulting policy rule would change to include a reaction to household debt:

$$r_t = a_y y_t + a_\pi \pi_t + \mathbf{a}_F \boldsymbol{\pi}_{F,t} + \mathbf{a}_{NF} \boldsymbol{\pi}_{NF,t} + \mathbf{a}_{D,L} D_t .$$

In general, the policy rule coefficient on household debt is negative, suggesting that as household debt rises, monetary policy should optimally be eased, all else the same.[8]

This should be contrasted with the benchmark model. In the benchmark model, debt is modeled as being passive, ie debt is correlated with the state of the economy but does not influence the dynamics. In such a setting, a monetary authority can simply respond to the output, inflation and asset price dynamics, but ignore household debt levels. In other words, household debt in the benchmark model does not contain marginally useful information above and beyond that already contained in output, inflation and asset prices. But in this extension of the model, household debt does provide useful information for policy. The key question is how best to evaluate and respond to the marginal value – which ultimately is an empirical question.

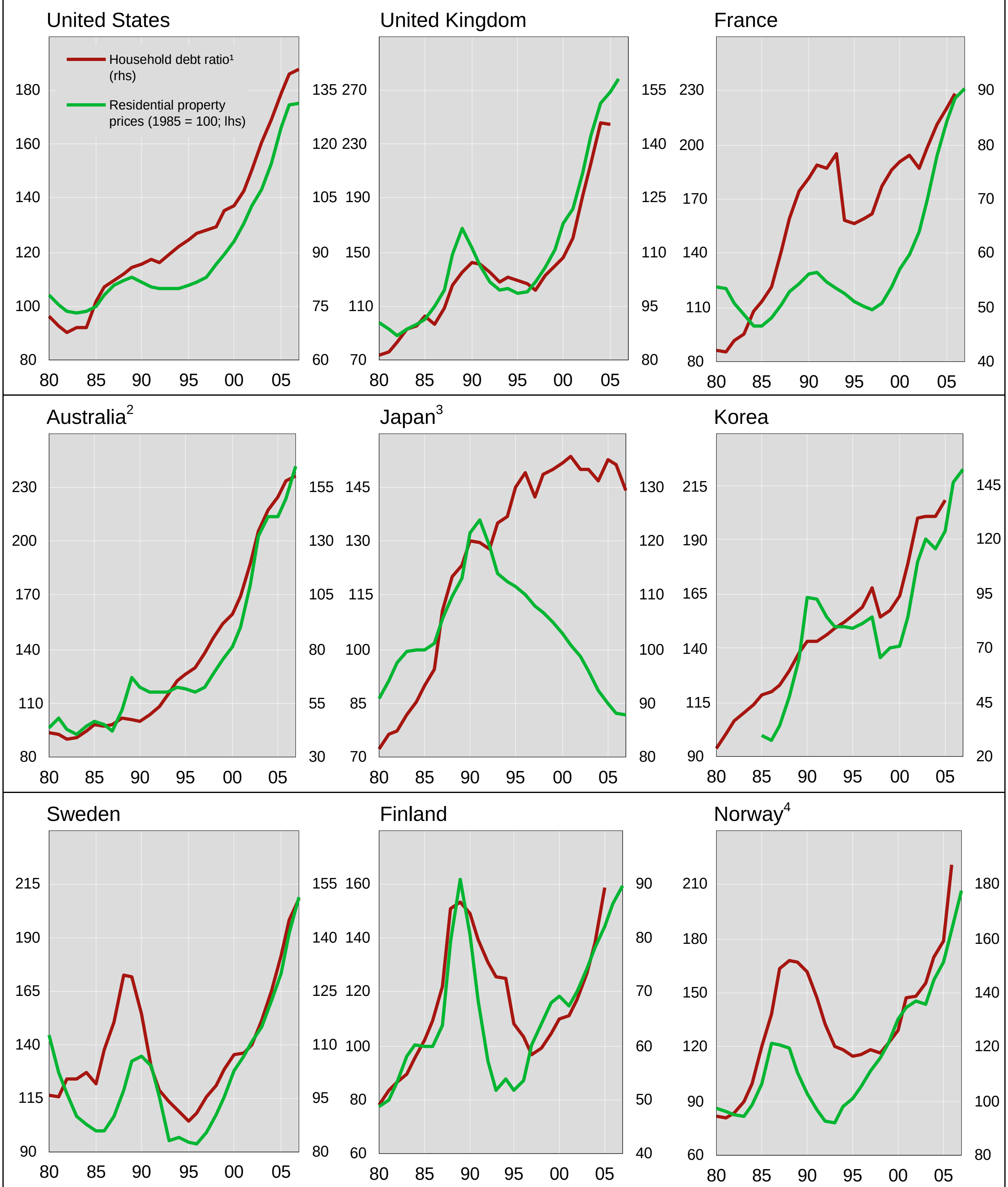
Household debt as an indicator of boom-bust behavior. Alternatively, household debt can be seen as a potential indicator of boom-bust behavior. As an indicator, it would not necessarily be a direct driver of inflation and output but rather act as an indicator of the conditions that foster frothy asset price valuations, ie asset price bubbles.[9] Graph 3.1 illustrates for data going back a few decades that there is a strong correlation during boom periods.

To capture the basic characteristics of such a link to boom-bust dynamics, one can augment the asset price block to incorporate household debt. Ideally, it would not be household debt per se that would be added to equation (2.4), but rather some

[8] It is important to note that the rise in household debt in this comparative static exercise should be interpreted carefully. The thought experiment is one where a household wakes up and finds that its debt obligations rose in a way largely independent of the economy. Such an exogenous shock would lower net worth and would set in motion economic weakness, both through a traditional wealth effect channel and because of tighter liquidity constraints that would further depress output, inflation and asset prices. In such a situation of an exogenous increase in debt, the monetary authority would ease monetary policy to cushion the blow to the macroeconomy. Also see Akram and Eitrheim (2006) for an alternative specification for debt in the macroeconomic block.

[9] It is also possible that a debt-asset price self-reinforcing process, on the way up as well as on the way down, could be part of the story.

Graph 3.1 Residential property prices and household indebtedness



[1] Total financial liabilities of personal sector and non-profit institutions serving households as a percentage of household disposable income. [2] Total household debt as a percentage of household disposable income. [3] Structural break in 1996. [4] Household domestic debt as a percentage of household disposable income.

Sources: national data, OECD Economic Outlook, CEIC unobserved variable $\tilde{D}_{t-1}$ that reflects the portion of household debt that is out of line with fundamentals[10]:

$$(2.9) \qquad (B') \quad \boldsymbol{\pi}_{NF,t} = \begin{pmatrix} \pi^{e}_{NF,t} \\ \pi^{h}_{NF,t} \end{pmatrix} = \zeta_t(y_{t-1}, r_{t-1}, \tilde{D}_{t-1}(D_{t-1})).$$

In this case, the resulting optimal policy rule would include a reaction to household debt:

$$r_t = a_y y_t + a_\pi \pi_t + \mathbf{a}_F \boldsymbol{\pi}_{F,t} + \mathbf{a}_{NF} \boldsymbol{\pi}_{NF,t} + \mathbf{a}_{D,NF} \tilde{D}_t(D_t).$$

In general, the coefficient on excessive household debt would be positive, indicating that as excessive household debt rises monetary policy should be tightened. This stands in contrast to the incentives to ease as liquidity constraints tighten.

The implications for policy reactions to debt would be somewhat complicated and depends on the assumed drivers of debt, ie the nature of the shocks hitting the economy. Two examples illustrate the difficulties.

In the case of a house price-debt spiral, ie the mutually reinforcing dynamic owing to the role of housing prices as collateral and of easier access to credit as a driver of housing prices, central banks should respond to higher debt with higher policy rates in this model. Rising stock market valuations would also feed this process. In a nutshell, higher debt adds to the frothiness of asset price bubbles and, in turn, signals the rise in the unobserved measure of excess debt $\tilde{D}_{t-1}$. This is a traditional channel that can lead to strong boom-bust cycles.

Alternatively, higher household debt might be seen as largely reflecting, rather than driving, unsustainable asset prices. However, higher household debt levels could still contribute to the fragility of the economic and financial environment if asset prices were to suddenly collapse. A bursting bubble would likely lead to recession and hence increasing difficulties in servicing the debt. Such adverse outcomes would still indicate that a bubble was growing and excessive debt $\tilde{D}_{t-1}$ accumulating. This,

[10] The unobserved variable, $\tilde{D}_{t-1}$, could in principle be estimated using a probit model, using methods advocated in Filardo and Gordon (1999).

according to the model, would call for a tighter policy response during the buildup phase because of the increased vulnerabilities. The absence of the asset price-debt amplification mechanism indicates a boom-bust dynamic, but of a less virulent nature than the previous example.

Of course, one could not rule out *a priori* that soaring asset prices reflected fundamentals and household debt rose in response. This could occur in the case of improved productivity. In such a situation, no policy reaction to debt movements is called for because the higher household debt would not necessarily raise $\tilde{D}_{t-1}$.[11] This possibility underlines the practical difficulties for central banks in diagnosing rising asset prices and debt as representing fundamentals or non-fundamentals. While diagnosing imbalances at central banks has benefited from research efforts over the past decade, it still remains a daunting task and further efforts are called for.

Several key policy implications, deriving in part from the multiple bubble aspect of model, are worthy of note.

First, this model indicates that monetary policy should be tightened during periods of rising household debt. Higher debt increases the probability of asset price bubbles, which tend to lead to economic overheating. As a consequence, higher interest rates are called for not only to cool down aggregate demand via the interest rate channel but also to raise the chances of pricking the asset price bubbles. In terms of expectations of the asset price bubbles, higher interest rates reduce the expected speed and ultimate size of the correction.

Second, this model underscores the possibility that price stability might not be enough to ensure macroeconomic stability. As has been seen in various economies around the globe at different times, the co-movement of asset prices and strong economic growth need not result in higher inflation or inflation expectations during the build-up phase.[12] As a consequence, a natural feedback from inflation to tighter monetary policy appears to be broken. This possibility could lead to particular difficulties, especially with respect to communication, for central banks following an explicit inflation targeting framework and facing sharply rising household debt and asset prices.

[11] It should be noted, however, that if trend productivity steepened, the natural rate of interest would tend to rise, thereby calling for a higher policy rate, all else the same.

[12] For a more detailed analysis of this perspective, see White (2006).

Third, the collapse of an asset price bubble would generally call for a sharp easing of monetary policy. If a household debt overhang ensues, a stronger policy reaction would be called for, in part because an overhang might lead to rounds of fire sales of assets. Note that the apparent asymmetry of the monetary policy reaction – slowly tightened during the build up and rapidly eased after the bust – does not reflect the time-varying preferences of the central bank but rather the fact that asset price movements are slow to rise but quick to decline. Paraphrasing Greenspan (1999), monetary policy is not asymmetric, asset prices are.

Fourth, while a sharp easing of monetary policy is important, it is crucial the reaction not be too sharp. In a world of multiple bubbles, policy actions that are too aggressive with respect to one bubble collapsing may unwittingly sustain another bubble, and even stoke the pressures for still loftier prices. One could argue that the low interest rate environment in the early part of the decade – when policy interest rates were too low for too long – contributed to the unsustainably high real estate prices and abetted the self-reinforcing debt-asset price cycle.[13] Policy efforts focused too sharply on easing the strains in one sector of the economy may lead to a buildup of vulnerabilities in another. The moral here is that policymakers need to be always mindful of the unintended consequences of their actions.

A couple caveats are worth mentioning. First, the modeling approach abstracts from the ultimate source of the drivers of the boom-bust behavior. History suggests that there are several possible sources such as the central bank, the banking sector, prudential regulators and borrowers themselves. For example, overly expansive monetary policy may create excess liquidity. The banking sector might systematically underestimate the risks and extend credit on too lenient a basis. Financial liberalizations might lead to excessive credit creation especially if prudential norms prove to be obsolete after financial liberalizations. And, last but not least, borrowers may overestimate their capacity to repay loans and become over-leveraged, only to find out later that it just wasn't the case.

These various sources suggest that there could be gains from monitoring each as a means to better understand the nature of the frothiness in asset markets, rather than relying solely on aggregate household debt statistics or some other quantitative

[13] A detailed analysis of the multiple bubble model without household debt is found in Filardo (2007).

measure of unsustainable lending. Progress at central banks with respect to financial stability monitoring is moving in a positive direction.

Second, the modeling approach above emphasizes quantitative measures of financial vulnerabilities but this should not be seen as discounting the potential role of price measures. In some instances, price measures might be even more reliable. Indeed, the availability of a wide range of interest rate and swap spreads (eg CDS premia, TED spreads, Libor-OIS spreads) at the touch of a computer screen suggest price measures may be essential in real-time crisis management. That said, it is not clear that such spreads are always reliable at signaling a low-frequency building of financial imbalances. This would be particularly true if asset price frothiness were due to unsustainably high risk appetites, which arguably has been an important part of story behind the turmoil in financial markets in 2007-08. Overall, both quantitative and price measures of financial market stress are likely to be important, if only as cross-checks on the more disaggregated evidence. The key challenge is to model these financial conditions indexes in a reliable manner.[14]

III. Factoring in financial stability concerns

The current policy debate in many central banks goes beyond consideration of the narrow macroeconomic stabilization issues. Since the start of the financial turmoil of 2007, central banks have had to look to all the tools at their disposal to address the various risks that have flared up. The old adage that necessity is the mother of invention comes to mind. Indeed, central banks have been facing daunting challenges in part because financial innovations over the past decade have so altered the monetary transmission mechanism that new tools, or at least new practices, have been called for. New auction facilities have been created. Eligible collateral standards have been relaxed. New coordinated central bank swap lines have been adopted by major central banks.

While it is still too early to evaluate fully the actions taken to date, it is nonetheless clear that central banks have the ability, the authority and the willingness to take strong actions in pursuit of financial stability. These actions, however, have not been done without some trepidation of mission creep – that is, taking actions that go well beyond the key mandate of price stability. Could such actions by central

[14] See, for example, Goodhart and Hofmann (2001). For an alternative method that focuses on financial market stress, see Illing and Liu (2006).

banks raise credibility issues? Could such actions be taken by some other, perhaps more appropriate, regulatory agency or government body? These questions raise deep and difficult issues, especially those associated with moral hazard, the consequences for the resilience of financial markets and the appropriate use of lender of last resort powers.

While debates of these issues will likely go on well after the current financial turmoil subsides, a more immediate concern arises from consideration of the appropriate use of policy interest rates as yet another tool to help fix the financial problems. Lower policy rates and the associated boost in liquidity could help to cushion financial markets, ease debt financing burdens and facilitate the cleanup process. While such actions could also help to boost the macroeconomy by strengthening economic and financial fundamentals and by bolstering confidence, easier monetary policy could increase the risk of weakening its commitment, actual or perceived, to price stability.[15]

The paper now turns to modeling financial stability concerns in order to analyze some, but certainly not all, of the tradeoffs facing central bankers. To preview the findings, the model will provide rather stark implications about the potential benefits of expanding central bank mandates beyond price stability and will offer a rationale for such actions.

Three extensions of the benchmark model.

This section focuses on three different extensions of the benchmark model to highlight some insights about the tradeoffs central banks' face, particularly when addressing concerns about financial stability via the setting of policy interest rates. The first addresses how a central bank might explicitly factor in central bank concerns/mandates about financial stability. The second sheds some light on the quandary in which central banks might find themselves when authorities other than the central bank cannot or will not react to financial stability concerns in a timely fashion. The third speaks to the special complications arising from high impact, low probability risks (ie tail risks).

[15] See Borio and Lowe (2004), Borio and White (2003) and Roubini (2006) for a further discussion of these issues. See Gertler (2003) for a more skeptical view.

Factoring in general concerns about financial stability. A way to conceptualize the central bank concerns about financial stability is to alter its preferences with respect to output, inflation and interest rate volatilities. In terms of the model above, this would translate into a modification of equation (2.6). The simplest case to consider would be to merge the preferences for both monetary stability (MS) and financial stability (FS) in an additive fashion:

$$
\begin{aligned}
&L_{MS} = \text{var}(y) + \mu_\pi^{MS}\,\text{var}(\pi) + \mu_r^{MS}\,\text{var}(r - r_{-1}) \\
(3.1)\quad &L_{FS} = \mu_y^{FS}\,\text{var}(y) + \mu_\pi^{FS}\,\text{var}(\pi) + \mu_r^{FS}\,\text{var}(r - r_{-1}) \\
&L = L_{MS} + L_{FS} = (1 + \mu_y^{FS})\,\text{var}(y) + (\mu_\pi^{MS} + \mu_\pi^{FS})\,\text{var}(\pi) + (\mu_r^{MS} + \mu_r^{FS})\,\text{var}(r - r_{-1})
\end{aligned}
$$

In this case, the qualitative results of Filardo (2007) would still hold in the sense that the functional form of the central bank's loss function is the same up to the particular values of the weights on inflation, output and interest rate volatility.[16] In light of the typical concerns associated with financial stability, measures of financial vulnerabilities such as household debt burdens would naturally show up prominently in the modeling efforts, especially when thinking about medium-term risks.[17]

Quantitatively, however, financial stability concerns would likely entail the placing of greater relative weight on economic stability versus inflation stability. This would naturally suggest more aggressive actions to smooth output, especially when boom-bust dynamics were particularly worrisome.

This shift is not be a unique implication of this model but would generally be the case when one instrument (ie the policy rate) is used to tradeoff multiple goals. Greater emphasis on financial stability would imply a tilting of central bank actions

[16] That is, the qualitative results are preserved under affine transformations of the loss function.

[17] This assumes that the underlying structure of the macroeconomic, asset price and debt blocks of the model outlined in section II is appropriate. For a pedagogical discussion of alternative central bank preferences for financial stability, this might be fine. But it skirts the deeper issues of how best to add a financial sector into the model and how best to define financial stability. A full treatment of the issues would include microeconomic justification of the underlying theories that lead to financial instability (see, for example, Allen and Gale (2007) and Gai et al (2008)) and the nature of the externalities that call for government regulation in general and actions from the central bank in particular. Goodhart and Tsomocos (2007) in a special journal issue on the theory and applications of financial stability highlight various current approaches to provide a more rigorous definition of policy-relevant financial stability. There are additional issues about how to translate financial stability in a meaningful macroeconomic way (see for example, Haldane et al (2004)).

away from a narrow mandate of inflation stability.[18] From theory, it may be inadvisable to design frameworks which suffer from this policy assignment dilemma. Arguably though, putting weight on financial stability concerns alongside those of price stability is already business as usual at most central banks. What this model does is provide a more explicit framework with which to explore the possible tradeoffs.

Compounding this assignment problem is the associated practical communication issues. Explaining the subtleties of policy decisions arising from the nexus between monetary and financial stability raises the level of complexity of public discourse and hence increases the risk of miscommunication.

It is important to note, however, that the analysis based on equation (3.1) is simplified greatly by assuming that central bank preferences can be adequately "mapped" in an additive fashion into variances of output, inflation and interest rates.[19] Much can be gained from analyzing the monetary policy tradeoffs under this assumption, but there are important limitations implied by this assumption about the nature of financial vulnerabilities. In particular, the setup of the model implies that the optimal policy should focus on changes in the expected values of the targeted variables. While this might prove to be sufficient in some situations, it is also possible, if not more likely, that major concerns about financial stability arise from tail-risk, ie low probability but high impact outcomes. Tail risks do not fit well into the benchmark model, and the implications are discussed in greater detail below.

Central banks going it alone. The model above might be interpreted as suggesting that central banks "go it alone" in dealing with financial stability issues. Such an interpretation would not be completely off the mark. There is a sense in which governmental authorities other than the central bank are not fully addressing

[18] Also see Mussa (2003) on this point. Ideally, this issue of the number of policy instruments and goals (the assignment problem) would call for a unique instrument for each goal. In practice, this ideal might not be achieved. Even in the case where a central bank may have additional instruments in its policy bag (such as policy rates, quantitative measures such as lender of last resort or lender of collateral, and moral suasion), these instruments might prove to be too blunt to address the policy concern in a precise manner. See Fisher and Gai (2005) for a discussion of a range of financial stability instruments that may either support or complicate the ability of central banks to pursue monetary stability. In the situation where other authorities are unwilling or unable to respond with the most appropriate policy instruments, a central bank might be the only feasible option given the constraints on others.

[19] It is important to note that the inclusion of the variance of interest rate changes in conventional specifications of central bank preferences also can reflect concerns about the impact of policy rate volatility on financial markets. In this sense, financial stability issues of this type are already incorporated in standard monetary policy models.

the financial stability issues. In such a vacuum, central banks may find themselves obliged to help.

This might motivate an extension to the preferences in (3.1). Rather than always weighing the implications of financial stability in terms of variances of output, inflation and interest rates in policy decisions at all times, it might be more appropriate to model central bank behavior in a particular state-dependent way. During normal times, central banks would largely rely on other governmental authorities to attend to financial stability issues. Regulators and prudential authorities would address soundness and safety concerns in the bank and non-bank financial sector. The central bank would focus on price stability. However, during periods of imminent financial instabilities, the central bank would place weight on financial stabilities and hence adopt different preferences. These state-dependent preferences might be appropriately modeled in the following way:

$$\begin{aligned} L &= L_{MS} + I(s_t)L_{FS} \\ &= (1 + I(s_t)\mu_y^{FS})\,\mathrm{var}(y) + (\mu_\pi^{MS} + I(s_t)\mu_\pi^{FS})\,\mathrm{var}(\pi) + (\mu_r^{MS} + I(s_t)\mu_r^{FS})\,\mathrm{var}(r - r_{-1}) \end{aligned} \tag{3.2}$$

where $I(s_t) = \begin{cases} 0, & \text{if normal times} \\ 1, & \text{if imminent financial instabilities} \end{cases}$.

The implications for policy responses flow directly from equation (3.2). In the normal times when financial instabilities are minimal or when other governmental authorities are adequately attending to the concerns, the central bank would respond in a way consistent with the models in section II. Otherwise, the central bank would alter its reaction function (ie the weights in the Taylor-type rule) in the manner suggested by equation (3.1).

Beyond the specification of the weights in the Taylor-type rules, the state-dependent preferences raise some important policy considerations about the appropriate role of central banks. On the one hand, some would likely raise objections to central banks diverting their eyes from the main goal of price stability. Such actions could adversely affect credibility and all that entails. On the other hand, as the current market turmoil has illustrated, central banks might be, at times, the only institutions that have the resources and ability to move flexibly enough in an emergency.

For instance, the recent policy response to financial troubles at Bears Sterns and the setting up of the Primary Dealer Credit Facility at the Federal Reserve Bank of New York required a nimble institution with considerable credibility. The actions appeared to boost confidence that financial markets were fundamentally sound. The aggressive cut in US policy rates, especially in contrast to the actions of other central banks, also appears to be part the Federal Reserve's approach to the current situation. Despite putative success so far, questions remain. Could other bodies have dealt with the concerns? What would have been the risks? What risks has the Federal Reserve taken both, directly, in terms of the quasi-fiscal action of writing a free option and, indirectly, in terms of possibly distorting the incentives of market-based financial intermediation and the central bank's credibility as an inflation fighter?

All this goes to the point that central banks may find themselves in difficult situations where, as a representative of the government, they are the only feasible option, however undesirable from the perspective of the mandate of price stability. The bigger question is not whether or not to act in an emergency but whether, in a risk management approach to monetary policy, central banks should take such actions into account.

In terms of the tradeoffs associated with using policy rates in 'going it alone', the benchmark model can be informative. Underlying the law of motion of the asset price bubbles described in equation (2.4) is a set of relationships between the economic environment and the endogenous behavior of the bubbles. For example, the transition probability of an asset price bubble, be it a housing price bubble or a stock market bubble, is modeled as having the following functional form in Filardo (2007):

$$(3.3)\ P(\text{bubble at t} \mid \text{bubble at t-1}, y_{t-1}, r_{t-1}, \tau_{t-1}) = \frac{\exp(2.5 + 1.1 y_{t-1} - 0.4 r_{t-1} - 0.1 \tau_{t-1})}{1 + \exp(2.5 + 1.1 y_{t-1} - 0.4 r_{t-1} - 0.1 \tau_{t-1})}.$$

This indicates that the probability of an asset price bubble at time *t* is a function of whether the economy was already in a bubble state at time *t-1*, as well as the state of the economy. If in an expansion, the probability of a bubble continuing is higher than otherwise and, if the central bank is easing monetary policy, the bubble is more likely to continue. To some extent, the bubble longevity variable, τ , can be interpreted as a measure of regulatory forbearance[20], and it can provide a means with which to get a sense of the tradeoffs that central banks face if other governmental bodies are reluctant or unable to respond to bubbly conditions. For example, if bank regulators failed to react to a lowering of mortgage lending standards to highly leveraged households, one could reasonably argue that excessive lending would boost the longevity of a housing bubble. In this framework, greater forbearance can be modeled as a larger (negative) impact coefficient on τ.[21]

Simulations of this possibility confirm one's intuition that the greater the forbearance by other government bodies, the greater the incentive for the central bank to step in and react more aggressively to bubbly asset prices. In a sense, as the liquidity in the proverbial punchbowl flows in faster, the central bank should work harder to siphon the excess liquidity by tightening monetary policy.

The transition probability for the bubble (equation (3.3)) in this benchmark model also captures endogenous feedback from economic and financial developments to the behavior of the asset price bubble. Accordingly, actions by the central bank would affect the expected duration and size of bubbles, through the (lagged) impact of interest rates directly and on output (y_t) indirectly. In the case of higher policy interest rates, the expected duration of the bubble and the expected peak size would tend to decline. In the extended version of the model based on equation (2.9), the endogenous interactions of monetary policy actions and household debt (D_t) would also factor in. Higher interest rates would tend to impede the growth in debt due to exuberance and reinforce the downward pressure on the expected duration and expected peak size.[22]

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[20] Technically, it is a measure of duration dependence, ie the tendency that asset price bubbles can collapse eventually under their own weight.

[21] This interpretation of τ might be viewed as being too narrow. It can also be viewed as a measure of asset price momentum. It might be reasonable to assume that, from the perspective of the central bank, asset price bubbles tend to have a momentum that prevents 'acceptable' movements in the policy rate to reverse their trajectory. This underlying momentum could be captured by constant term and τ. Intuitively, it provides a way to weaken the link between asset price dynamics and the actions of the monetary authority.

[22] For example, growing financial imbalances in the form of unsustainable debt levels, $\tilde{D}_{t-1}$, might be modeled as having a negative impact on the bubble's transition probability; greater debt imbalances raise the risk of a asset price bubble collapse in the sense that the financial imbalances are more likely to unwind under their own weight. However, if $\tilde{D}_{t-1}$ primarily acts as a signal of underlying bubble conditions, then the modeling of role of $\tilde{D}_{t-1}$ might be more complicated but nonetheless generate similar policy tradeoffs. For example, the financial imbalances' influence might be best captured in the

Given this linkage between monetary policy and bubbles, two types of policy strategies are suggested. The first are called *defensive strategies*. They are the ones aimed at pricking asset price bubbles as a means to cushion the economy from a larger and more painful correction in the future. In this model, significantly higher policy interest rates would tend to dash the irrational exuberance that was driving asset prices. In practice, higher interest rates directly drive up the discount on future payouts from assets and would lower the prospects for economic activity. Together, these would tend to reduce the incentives to borrow, to raise the cost of existing debt servicing and, ultimately, to take the wind out of the sails of asset prices. In this scenario, household debt might be a good indicator of the effectiveness of monetary policy.[23]

The model also suggests other, more controversial, strategies – the *opportunistic strategies*. Strictly speaking, such strategies suggest that central banks might want to foster favorably conditions for positive bubbles when the economy is weak and for negative bubbles when the economy is strong.[24] To many this may sound odd. But a more compelling interpretation is based on confidence building. To the extent that the economy is weak or suffering a crisis, the central bank might like to talk up the economy, ie cheerleading, in order to engender confidence. Conversely, if the economy is strong, the central bank would like to rein in the exuberance, possibly by reiterating the downside risks to the forecast owing for example to overleveraging of household balance sheets and the possible nonlinear and outsized possible reactions to a slowdown. Taking this perspective, opportunistic strategies do not seem to be wildly at odds with what central banks actually do.

Both types of strategies – defensive and opportunistic – in theory are suggested by the model. But, their practical importance is likely to be greater when considering the nexus of financial and monetary stability. The additional concern

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updating equations of a nonlinear Kalman filtering algorithm of the type in time-varying Markov switching models. In either case, tighter monetary policy would tend to lower the probability of the continuation of a bubble.

[23] Some commentators argue that such defensive strategies are too risky, in part because of the difficulty in identifying bubbles. Another part of the argument appears to rest on the assumption that pricking bubbles is too hard to calibrate with any sense of confidence; there is a sense of resignation that markets are likely to be better at defusing bubbles than central banks. Both arguments are empirical in nature. The recent financial turmoil may be seen as undercutting the strength of both arguments.

[24] Also see Blanchard (2000) on this point.

about financial stability naturally provides greater ammunition for those advocating a more pro-active approach to conditions characterized by bubbles rather than to macroeconomic stabilization alone. This would apply to central bank efforts both during the build-up phase of the bubble and the collapse. In either case, though, central banks might find it very difficult to calibrate the policy responses with a sense of confidence.

Arguably, recent events underscore the possibility that central banks (and other governmental bodies) were behind the curve during the build-up phase of the financial vulnerabilities. And, by all accounts, central banks are now facing very serious financial sector problems that may spillover to the global economy. One silver lining to the current crisis is that banks were generally well capitalized going into the turmoil. If they had not been, the depth and duration of the crisis could have been much worse. Higher household debt levels, on the other hand, have been a contributing factor to the cause and the propagation of the shocks to the system. More research into the current situation to understand the various causes, consequences and implications for the future is called for.

Dealing with high impact, low probability risks. As noted above, the mapping of financial stability concerns into variances of output, inflation and interest rates might not be a good characterization of the policy environments that most concern central banks. Indeed, some have argued that financial instabilities are best thought of as low probability, high impact events that might justify time-varying policy rules.

Two different assumptions have been put forth in recent years to justify time-varying policy rules. The first models the central bank as having state dependent preferences. The second models tail-risk, which implies very nonlinear central bank reactions during periods of relative turbulence compared with periods of relative quiescence.

A state-dependent preferences approach to financial stability concerns was proposed by Svensson (2003) and explored by Disyatat (2005). This amendment to the benchmark monetary policy model reflects the fact that central banks, from time to time, will be expected to step in to help preserve the stability of the financial system or they may have to contribute to a financial sector clean up. Given these events are sufficiently rare, the central bank can typically focus on conventional monetary stability issues with little prejudice towards financial stability most of the time. At other times, when financial instabilities arise, however, central banks may need to switch to alternative policy rules that better address the needs of the public welfare.

This might suggest transforming standard central bank preferences by adding a more complicated state-dependent measure of financial imbalances. Following Disyatat (2005), we could re-write equation (3.1)

(3.4)
$$L = \text{var}(y) + \mu_\pi \text{ var}(\pi) + \mu_r \text{ var}(r - r_{-1}) + \Gamma(\widetilde{D})^2, \quad \text{where } \Gamma = \begin{cases} = 0, if\ \widetilde{D} \leq \overline{D} \\ > 0, otherwise \end{cases}.$$

The optimal monetary policy rule implied by these preferences would be similar to that of the benchmark model in Section 2. During periods of imminent financial instability, the policy rule would switch to one with more weight on measures of debt. It is important to note here that the mandate of price stability is not abandoned but rather weighed along with the competing goal of financial stability.

Three practical implications flow from this extension. First, inflation problems that might arise during a period of imminent financial crisis are likely to be dealt with less aggressively, and hence deviations of inflation from implicit or explicit targets are likely to be larger and to be brought back to target more slowly. Second, these preferences also suggest that if financial stability concerns were being appropriately addressed by other governmental bodies, the central bank would generally keep a closer focus on price stability. Third, at the tipping point for a switch between policy rules, policy interest rates could swing abruptly, in contrast to the general implications in more conventional models that central banks should react gradually to changing economic conditions.

While these three implications are hardly novel, the modeling exercise here illustrates that modeling options do exist to address this nexus of monetary and financial stability. More research into understanding the factors driving financial instabilities can, in principle, help to illuminate some of the trade-offs that central banks face in practice.

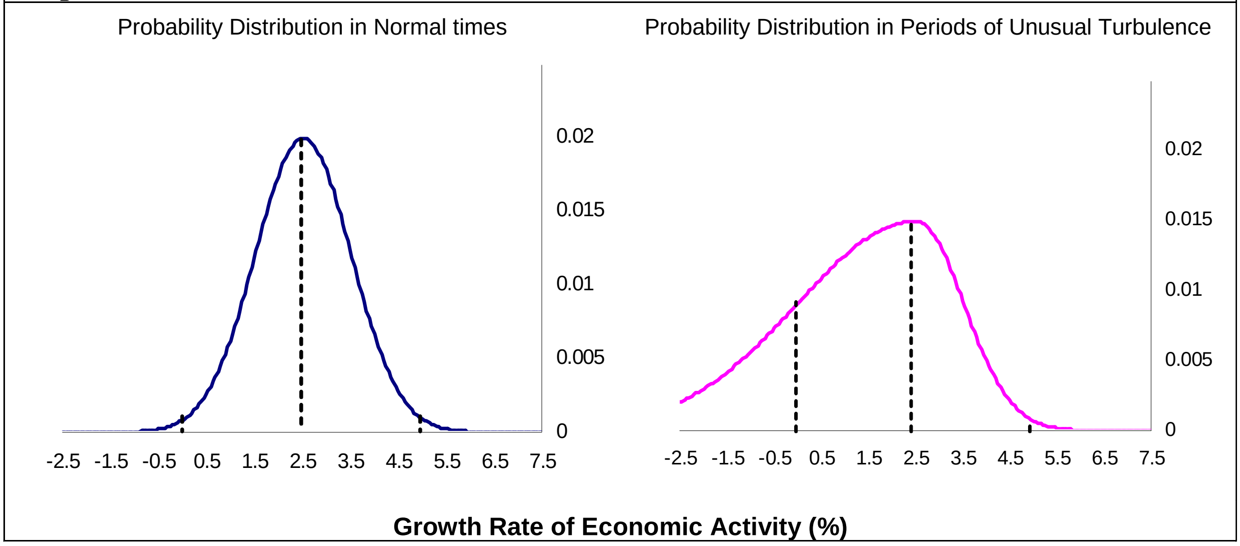
One drawback of the state-dependent preference approach implied by equation (3.4) is that it might not depart too far from the certainty-equivalence modeling world where expected values of the targeted variables are sufficient to characterize the policy reaction function. To be sure, central bank behavior would be non-linear at the tipping point. But on either side of the tipping point, the reaction function would be linear in the measure of household debt. Another way to make this point is that even though the preferences switch, the shocks in the other blocks of the model are normally distributed.

An alternative approach would be to emphasize the possibility that very nonlinear monetary policy rules could arise from tail risks, ie non-normal shocks.[25] While a detailed discussion of the robust control in the presence of tail-risk goes beyond the scope of this paper, there are some conceptual issues worth mentioning. Three practical implications of tail risks for monetary policy were recently summarized by Mishkin (2008):

First, strong policy actions are called for. It is well known that additive uncertainty (eg assuming normally distributed errors) of the Brainard (1967) type calls for policy gradualism. Tail risks, however, call for more significant actions to insure against very bad outcomes. Arguably, such tail risks would rise with the level of household leverage. Second, central banks should move promptly as significant tail risks are realized. In the benchmark model case, by way of contrast, policy rules tend to suggest that central banks smooth policy responses over time. Third, policy actions should be decisive and the reasoning behind the actions should be transparent. In this case, actions are equivalent to taking out insurance against the low probability events (ie the tail risk events) that may have very dire consequences. It is important to make clear that the insurance motive arises from the tails of the distribution of likely outcomes rather than from a shift in the mode of the distribution (ie the most likely outcome). Graph 3.2 illustrates this difference.

[25] See Cecchetti (2006) and Gochoco-Bautista (2008) on the empirical relevance of such concerns.

Graph 3.2: An illustration of tail risk



Conclusions

This paper began with the observation that credit growth, especially to households, has been a defining feature of economic environments that appear to have been correlated with past and current financial turmoil, and ended with a discussion of how central banks might want to respond to low probability, high impact risks that can be associated with such developments. To be sure, current attempts to model such issues are a work in progress. And the current financial market turmoil illustrates just how hard it is to tailor responses to problems that arise in real-time and, in some sense, are problems because they often include new dimensions with no historical precedent.

This paper highlights the fact that a rise in household debt, in and by itself, is not a sufficient reason to call for a monetary policy response. Rather, the impact on monetary policy decisions should depend on the particular role that household debt plays in an economy. The various extensions developed in the paper underscore the possibility that an economy subject to significant liquidity constraints would call for a very different policy response from one where household debt played a role in boom-bust dynamics. Further complicating the policy tradeoffs is the likelihood that most economies could be subject to both roles at the same time. Calibrating the policy implications in such a setting would require a clear understanding of the relative importance of the roles and the likely outcomes, including the possibility of significant tail risks arising from financial instabilities and, in the extreme, full blown credit crunches.

More research is called for. First, and foremost, better measures of financial instability are needed. Empirical work to date has provided some leads worth pursuing. At the aggregate level, credit aggregates stand out in this respect. Increasingly, though, more efforts to bridge the gap between the detailed micro data and aggregate measures of instability are needed. Given the various ways in which financial instability can arise, a suite of models is likely to be the way forward.[26] Naturally, different types of financial instability will likely call for different types of measures.

The more difficult angles to grapple with, however, are the interactions amongst the various players at the centre of financial instabilities. On the one hand, financial market participants are human and do not always act as the sophisticated mathematical financial models suggest. In extreme conditions, participants may simply stop trading in the face of Knightian risks. The recent turmoil has illustrated just how serious a risk this is. In such circumstances, it may be difficult to know, with even a moderate degree of confidence, the combination of policy efforts that are necessary to restore confidence and accelerate a return to normalcy.

On the other hand, the behavior of governmental bodies also affects the options facing central banks. Forging common diagnoses, prescriptions and coordinated actions across regulatory, prudential, fiscal and monetary authorities appears to remain a significant challenge. Moreover, globalization raises additional dimensions of interactions related to cross-border spillovers and policy jurisdictions.

Whether simple models can be written down to capture all these issues in an adequate and insightful way is an open question. In the meanwhile, though, central bankers nonetheless will have to confront reality. In this sense, modest quantitative steps, while surely leaving much to be explained, might offer useful ways to think about the complex issues.

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[26] A range of historical financial crises is studied in recent research by Reinhart and Rogoff (2008).

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