10TH JACQUES POLAK ANNUAL RESEARCH CONFERENCE
NOVEMBER 5-6, 2009

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Paper presented at the 10th Jacques Polak Annual Research Conference
Hosted by the International Monetary Fund
Washington, DC─November 5–6, 2009

Macro Risk Premium and Intermediary Balance Sheet Quantities[1]

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October 15, 2009

Abstract: The macro risk premium measures the threshold return for real activity that receives funding from savers. Financial intermediaries' balance sheet conditions provide a window on the macro risk premium. The tightness of intermediaries' balance sheet constraints determines their "risk appetite". Risk appetite, in turn, determines the set of real projects that receive funding, and hence determine the supply of credit. Monetary policy affects the risk appetite of intermediaries in two ways: via interest rate policy, and via quantity policies. We estimate time varying risk appetite of financial intermediaries for the U.S., Germany, the U.K., and Japan, and study the joint dynamics of risk appetite with macroeconomic aggregates and monetary policy instruments for the U.S. We argue that risk appetite is an important indicator for monetary conditions.

[1] Paper prepared for the 10th Jacques Polak annual IMF research conference, November 5-6, 2009. The views expressed in this paper are those of the authors and do not necessarily represent those of the Federal Reserve Bank of New York or the Federal Reserve System.

1. Introduction

Financial intermediaries often take the back seat in aggregate macro models that focus on inflation and output. The main objective of this paper is to focus attention more squarely on the financial intermediary sector, and explore the extent to which banks and other intermediaries play the role of the engine of macroeconomic fluctuations through the determination of the price of risk. Our hope is to shed light on the mechanisms that drive financial booms and busts that have wider economic impact.

Our argument rests on the relationship between the macro risk premium and the growth of financial intermediary balance sheets. Financial intermediaries who aim to manage their balance sheets actively in response to changing economic conditions will tailor their credit supply decisions on the spare capacity of their balance sheets, as measured by the availability of equity capital and the measured risks associated with new lending. In this way, the tightness of balance sheet constraints of financial intermediaries determine the intermediaries' risk appetite, and hence the supply of credit. The greater is the risk taking capacity of the intermediary sector, the greater is the range of real activity that receives funding. Thus, we may expect a close relationship between three things.

- Rapid growth of intermediary balance sheets
- Lower risk premiums
- Higher real activity

We show that such relationships do indeed exist, and explore their empirical magnitudes as well as their dynamic properties. We measure higher real activity by GDP growth. Once the criterion for real activity is set in this way, we turn to the appropriate measures of intermediary risk appetite and risk premiums.

We start by making the second bullet point above empirically operational – the notion of a risk premium that is relevant for GDP growth. We estimate a "macro risk premium" r, by selecting a combination of financial market spreads from fixed income securities that perform well in tracking GDP growth. We document that our measure of the macro risk premium is closely related to the term spread of interest rates and to credit spreads, but that it only has a loose, negative relationship to the *level* of interest rates.

We then make operational the first bullet point above – the notion of financial intermediary risk appetite, by means of measures of the growth of balance sheet quantities. We identify the set of financial intermediaries for which their balance sheet growth best predict changes in the macro risk premium. We show that for the US, the market-based financial intermediaries such as the broker dealers and the "shadow banks" fit this role. In this way, market-based intermediaries play an important role in the empirical exercise of finding the summary measure of balance sheet growth that best captures the fluctuations in the macro risk premium.

Having taken the first two bullet points in the three-part relationship described above, we close the circle by showing that our summary measure of risk appetite, in turn, does a good job of explaining GDP growth directly. We document the relationship between risk appetite, GDP growth, and the level of the short rate. Finally, we document that the setting of short rates by central banks has been determined not only by GDP growth and inflation, but also by the degree of risk appetite.

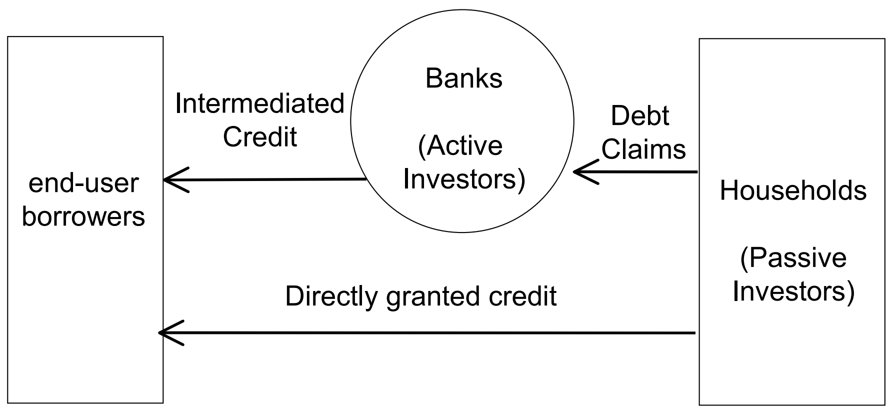
Our approach suggests that a fruitful extension of the standard New Keynesian macro model would be to incorporate balance sheet variables and measures of the macro risk premium. In this way, the role of financial intermediaries may be better captured within macro models that build on those already in use at central banks and other policy organizations. Our finding that spreads matter more than the level of interest rates ties in well with the nature of financial intermediation, which is to borrow in order to lend. As such, we may expect the yield difference on the two sides of the intermediary balance sheet to influence their willingness to lend.

The remainder of the paper is organized as follows. In Section 2, we present a brief overview of the rationale for examining the relationship between intermediary balance sheet growth and the macro risk premium. In Section 3, we implement the first step in our empirical exercise by estimating the macro risk premium that best captures fluctuations in GDP growth. We follow in Section 4 with the estimation of the risk appetite variable, discuss its microeconomic foundations, and show the empirical link to real economic variables. In Section 5, we present the vector autoregression (VAR) analysis of the macro-finance dynamics of our model, and discuss implications for monetary and financial stability policy. In section 6, we present the international comparison of the results. Section 7 concludes.

2. The Macro Risk Premium and Intermediary Balance Sheets

We begin with a brief overview of the rationale for why the macro risk premium will be related to the size of financial intermediary balance sheets. Figure 1 depicts a stylized financial system that we will use to explain the main ideas. We focus on the credit market, which channels savings from *ultimate creditors* – the household sector and financial institutions such as mutual funds and pension funds that lend on behalf of the households – to the *ultimate borrowers*, such as non-financial firms or young households who wish to borrow to buy a house.

Figure 1: Stylized Financial System



The lending can be channeled through two routes. Credit could be granted directly. For example, households buy corporate bonds and equity issued by non-financial firms directly. Alternatively, the credit can be granted indirectly through the financial intermediary sector, which borrows from the household sector in order to lend to the ultimate borrowers.

We can think of the two alternative ways of provision of credit in terms of the actions of two groups of investors---passive investors and active investors. The passive investors can be thought of as non-leveraged investors such as households, pension funds and mutual funds, while the active investors can be interpreted as leveraged institutions such as banks and securities firms who manage their balance sheets actively. The risky securities can be interpreted as loans granted to ultimate borrowers or securities issued by the borrowers, but where there is a risk that the borrowers do not fully repay the loan.

Under this interpretation, the market value of the risky securities can be thought of as the marked-to-market value of the loans granted to the ultimate borrowers. The passive investors' holding of the risky security can then be interpreted as the credit that is granted directly by the household sector (through the holding of corporate bonds, for example), while the holding of the risky securities by the active investors can be given the interpretation of intermediated finance where the active investors are banks that borrow from the households in order to lend to the ultimate borrowers.

The main distinguishing feature of banks and other financial intermediaries is that they manage their balance sheets actively in response to changes in capital market conditions and the size of equity capital. One way to formalize the active management is in terms of banks keeping enough capital to meet their Value-at-Risk, although other formalizations would yield similar conclusions. As shown in Adrian and Shin (2009a) and Shin (2009b), such management of balance sheets by active investors leads to portfolio choices that induce fluctuations in the risk premium for risky assets, and thereby influence the price of risk in the economy.

Figure 2: Increased Credit Supply from Intermediary Balance Sheet Management

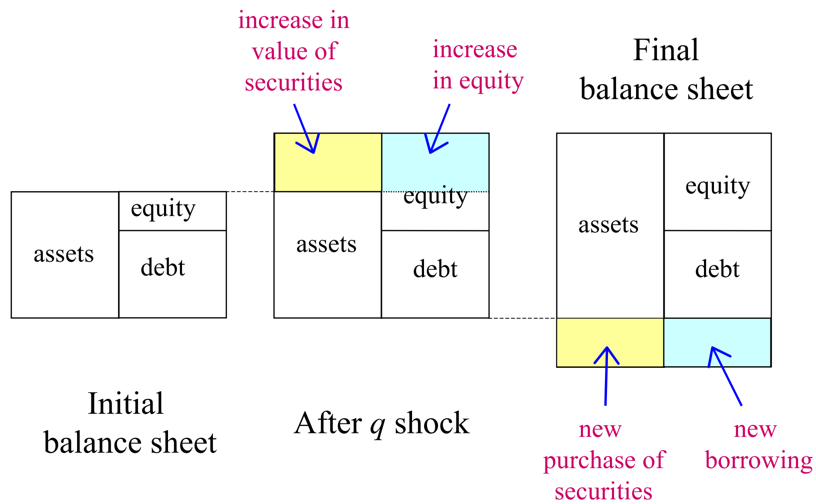


Figure 2 illustrates the effect of a positive shock to the price of assets already held by the banking sector. Suppose that the initial balance sheet of the banking sector is on the left. Now, suppose that there is a positive shock to the price of the assets already held by the banking sector. We envisage an increase in the expected return from the assets, denoted by q. Since the banks are leveraged, there is a mark-to-market increase in the capital position of the banking sector.

The middle balance sheet in Figure 2 shows the effect of an improvement in fundamentals that comes from an increase in asset values, but before any adjustment in the portfolio by the banking sector.

Although the liabilities of the banks will also change in value due to marked-to-market effects of debt, they will be small, and so we approximate the effect by assuming that there is no change in the debt value. So, the increase in asset value flows through entirely to an increase in equity. Moreover, since the bank is leveraged, the percentage increase in the value of equity is much larger than the percentage increase in the value of assets.

The increase in equity relaxes the Value-at-Risk constraint, and the leveraged sector can increase its holding of risky securities, or alternatively, increase its supply of loans to the ultimate borrowers. The new holding of risky securities is larger, and is enough to make the VaR constraint bind at the higher equity level, with a higher fundamental value.

In other words, after the positive shock to asset values, banks' balance sheets have strengthened, in that capital has increased. There is an erosion of leverage, leading to spare capacity on the balance sheet in the sense that equity is now larger than is necessary to meet the Value-at-Risk. In order to utilize the slack in balance sheet capacity, the banks take on additional debt to purchase additional risky securities. The demand response is upward-sloping. The right hand side balance sheet in Figure 2 illustrates the expansion of lending that comes from the increased capacity on banking sector balance sheets.

It is important to distinguish the increase in the balance size between the middle balance sheet in Figure 2 and the balance sheet on the right in Figure 2. In the middle balance sheet, the assets increase in value due to the increase in the price of the risky asset. It is a pure valuation effect. However, the right-side increase in the balance sheets is due to the increase in quantity of risky asset holdings. For a bank, such an increase will come through new lending or through the purchase of new securities.

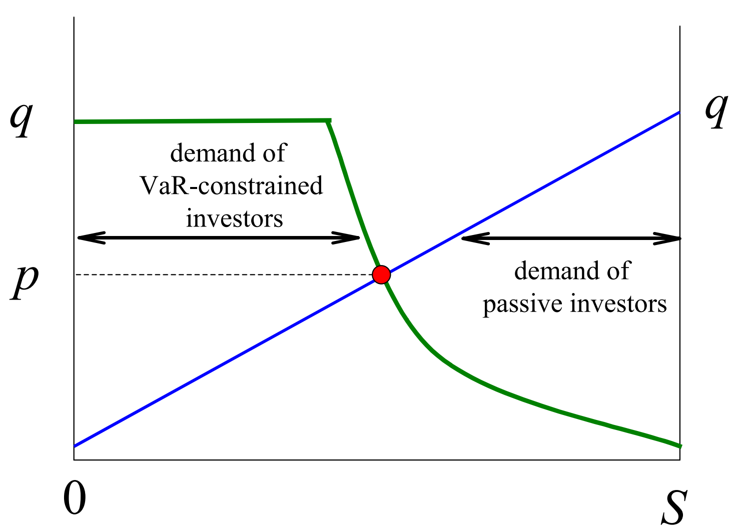
Without the quantity response from the banking sector, the increase in the balance sheet size of the banking sector would purely mirror the asset prices in the economy – say, due to the prospect of greater real activity in the future. It is the additional quantity adjustment that sets in motion the amplifying effect of financial intermediaries. It is in this sense that banks and other financial intermediaries are the engine that drives the boom-bust cycle. They are the primary channel for the amplification of real shocks. In this respect, our argument should be distinguished from New Keynesian DSGE models such as Curdia and Woodford (2009) which introduce a credit spread into a macro model, but where the intermediaries remain passive entities that provide a risk sharing service to households with differing shocks to wealth.

The consequences of the increased lending for risk premiums can be illustrated in Figures 3 and 4. Suppose to begin with that the supply of risky securities is fixed at S. The demand for the risky security (the supply of lending) by the passive sector is measured from right to left, and is illustrated as a linear demand curve. The intercept is at q, which we assume is the expected value of the risky security.

The demand curve for the risky security by the banking sector is illustrated by the kinked curve that measures the demand for risky securities from the banking sector. A bank's objective is to maximize the expected return to its portfolio subject to a Value-at-Risk constraint, in the sense that the bank must keep enough capital to meet its worst-case loss. Its demand for the risky security (its supply of lending) is then fully determined by its capital position, since as long as the expected return from the portfolio is strictly positive, it will expand its lending until its VaR constraint binds.

Figure 3 illustrates the determination of the equilibrium price of the risky security, which is denoted by p. Since q is our notation for the expected payoff from the risky security, the expected return from the risky security (expected return from lending) is given by $r = (q/p) - 1$.

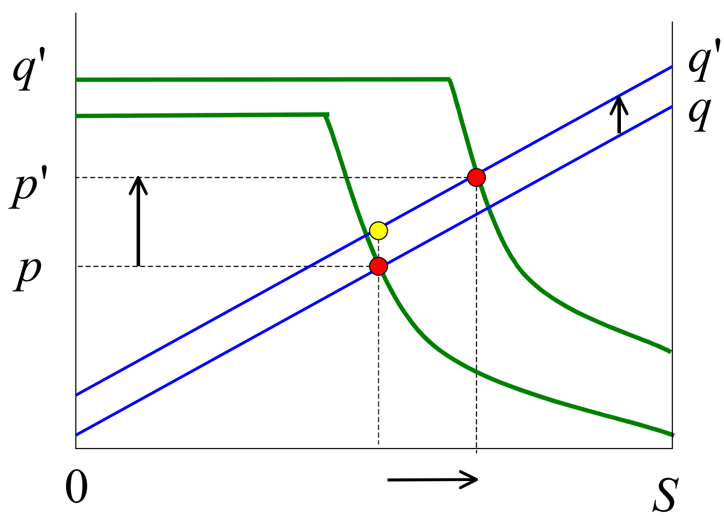
Figure 3: Determination of Risk Premium



Now consider a possible scenario involving an improvement in the fundamentals of the risky security where the expected payoff of the risky securities rises from q to q'. In our banking interpretation of the model, an improvement in the expected payoff should be seen as an increase in the marked-to-market value of bank assets. Although the scenario sketched here is a static one, we could motivate the increase in the expected payoff in terms of the anticipation of greater real activity in the future. We mention later the role of monetary policy in affecting q. Figure 4 illustrates the scenario. The improvement in the fundamentals of the risky security pushes up the demand curves for both the passive and active investors, as illustrated in Figure 4. However, there is an amplified response from the leveraged institutions as a result of marked-to-market gains on their balance sheets and (crucially) the balance sheet quantity adjustments entailed by it.

In such a setting, it is possible to show that the risk spread, as given by the excess expected return $r = (q/p) - 1$ is decreasing in the size of the banking sector's holding of the risky security (see Adrian and Shin (2009a)). One immediate consequence is that risk premiums are low when the size of the leveraged sector is large relative to the passive, non-leveraged sector.

Figure 4: Compression of Risk Premium From Increase in Intermediary Balance Sheets



The amplifying mechanism works exactly in reverse on the way down. A negative shock to the fundamentals of the risky security drives down its price, which erodes the marked-to-market capital of the leveraged sector. The erosion of capital induces the sector to shed assets so as to reduce leverage down to a level that is consistent with the VaR constraint. Consequently, the risk premium increases when the leveraged sector suffers losses, since $r = (q/p) - 1$ increases.

Up to this point, we have treated the total endowment of the risky securities S as being fixed. However, as the risk spread on lending becomes compressed, the leveraged investors (the banks) will be tempted to search for new borrowers they can lend to. In terms of our scenario, if we allow S to be endogenously determined, we can expect credit supply to be increasing when the risk premium falls. To explore this idea further, suppose there is a large pool of potential borrowers who wish to borrow to fund a project, from either the active investors (the banks) or the passive investors (the households). Assume for the moment that potential borrowers are identical, and each has identical projects relative to those which are already being financed by the banks and households. In other words, the potential projects that are waiting to be financed are perfect substitutes with the projects already being funded. Denote the profitability associated with the pool of potential projects by r^*. If the market risk premium were ever to fall below r^*, the investors in the existing projects would be better off selling the existing projects to fund the projects that are sitting on the sidelines.

The assumption that the pool of potential borrowers have projects that are perfect substitutes for the existing projects being funded is a strong one, and unlikely to hold in practice. Instead, it would be reasonable to suppose that the project quality varies within the pool of potential borrowers, and that the good projects are funded first. For instance, the pool of borrowers would consist of households that do not yet own a house, but would like to buy a house with a mortgage. Among the potential borrowers would be good borrowers with secure and verifiable income.

However, as the good borrowers obtain funding and leave the pool of potential borrowers, the remaining potential borrowers will be less good credits. If the banks' balance sheets show substantial slack, they will search for borrowers to lend to. As balance sheets continue to expand, more borrowers will receive funding. When all the good borrowers already have a mortgage, then the banks must lower their lending standards in order to generate the assets they can put on their balance sheets. In the sub-prime mortgage market in the United States in the years running up to the financial crisis of 2007, we saw that when balance sheets are expanding fast enough, even borrowers that do not have the means to repay are granted credit – so intense is the urge to employ surplus capital. The seeds of the subsequent downturn in the credit cycle are thus sown.

The discussion so far on the relationship between risk premiums and balance sheet size of the intermediary sector suggests a way to modify the monetary models of the New Keynesian tradition that is in wide use in central banks and other policy organizations. Let us first review the basics of the standard New Keynesian model (NK model).

The reduced form of the NK model consists of three equations that determine three macro state variables *i* (short term interest rate), *y* (real GDP growth), and *π* (PCE inflation):

IS curve: $$y = a_y + b_y\left(i - \pi\right) \qquad (1a)$$

Phillips curve: $$\pi = a_\pi + b_y y \qquad (1b)$$

Taylor Rule: $$i = a_i + b_i y + c_i \pi \qquad (1c)$$

In this set-up, output *y* is determined by the real short term interest rate $i - \pi$ (the IS curve in equation 1a). The short rate *i* is set by the central bank, which follows a Taylor (1993) rule (equation 1c). Inflation is determined by the Phillips curve (1b). Financial intermediaries play no role in the NK model. The level of the real interest rate $i - \pi$ pins down consumption and investment, independently of any financial intermediary balance sheet, risk, or net worth considerations.

The model described in our earlier discussion suggests augmenting the standard New Keynesian model by two endogenous variables and two further equations. First, we include the feature that asset prices are influenced by the tightness of balance sheet constraints of financial intermediaries. We label such looseness of balance sheet constraints "risk appetite". Formally, risk appetite could be defined by reference to the Lagrange multiplier associated with the capital constraint of the banking sector. The Lagrange multiplier would indicate the additional profit that the banking sector may earn by having one dollar of extra bank capital. The looser is the capital constraint, the lower is the Lagrange multiplier, and hence the higher is the risk appetite.

The terminology of "risk appetite" is intended to highlight the apparent change in preferences of the banking sector. We say "apparent" change in preferences, since the fluctuations in risk appetite are due to the constraints faced by the banks rather than their preferences as such. However, to an outside observer, the fluctuations in risk appetite would have the outward signs of fluctuations in risk preferences of the investor. These issues are discussed more formally in Danielsson, Shin and Zigrand (2009).

Risk appetite is a determinant of expected returns and of the availability of credit to the real economy, which we denote by the "macro risk premium" r. Our reduced form augmented macro model can be summarized by means of the following four equations:

IS curve:	$y = a_y + b_y (i - \pi) + c_y r$	(2a)
Macro risk premium:	$-\Delta r = a_r + b_r y_{lag} + c_r i_{lag} + d_r \lambda_{lag}$	(2b)
Phillips curve:	$\pi = a_\pi + b_y y$	(2c)
Target rate rule:	$i = a_i + b_i y + c_i \pi + d_i r + e_i \lambda$	(2d)

Relative to the standard NK model, there are two new variables: the macro risk premium r, and risk appetite λ. There is also an additional equation which links the return to the macro risk premium to risk appetite (equation 2b). Whereas only the real short rate (i-π) is determining real activity in the standard NK model, we assume that GDP is additionally pinned down by the macro risk premium r. Expected returns to the macro risk premium (the negative of the changes in the macro risk premium, -Δr) are in turn determined by the lagged macro variables y_{lag} and i_{lag}; as well as the financial intermediary risk appetite variable λ_{lag}. The Taylor rule is augmented by the macro risk premium r, and the risk appetite variable λ.[2] Although the dynamics of the risk appetite variable should also be considered in a fully closed system, we consider it as being exogenous for our exercise here, possibly influenced by monetary policy. This is so as to relate our discussion to the existing macro literature in the most economical way without bringing too many complicating features. Note that our approach differs from the literature on financial frictions that have focused on the demand for credit, arising from fluctuations in the strength of the borrower's balance sheet (see Bernanke and Gertler (1989) and Kiyotaki and Moore (1997)). Instead, the effects described here rely on the supply of credit that is driven by fluctuations in the strength of the lender's balance sheet.

[2] Curdia and Woodford (2009) present a model that is giving rise to a reduced form very similar to equations (2a)-(2d). However, as mentioned already, the type of financial intermediary frictions which is giving rise to their reduced form differ from the model that we described earlier.

3. Measuring the Macro Risk Premium

We now turn to the task of operationalizing our notion of the macro risk premium. The macro risk premium is the analogue of the expected excess yield $r = (q/p) - 1$ in the discussion of the simplified financial system in Section 2. The risk premium measures the hurdle rate of return for new projects that are financed in the economy, and hence reflects the ease of credit conditions. It is therefore natural to measure the risk premium from yields of fixed income securities.

We give empirical meaning to the macro risk premium by estimating a linear combination of spreads that is tracking GDP growth most closely. In doing so, we allow both term spreads of the Treasury yield curve and credit spreads to enter. Both term spreads and credit spreads are measures of hurdle rates – the additional yields on longer-dated or riskier bonds that induce market investors to fund additional investment or consumption. By allowing the data to speak in determining our summary measure of risk premium, we do not prejudge whether levels or slopes are most closely associated with aggregate real activity.

Much of the macro literature focuses on the relationship between the *level* of interest rates and measures of real activity such as GDP growth. For example, Bernanke and Blinder (1992) argue for a model of monetary policy transmission where expansion and contraction of the balance sheets of commercial banks are determined by the level of interest rates. The level of the nominal federal funds rate as a measure of monetary policy stance is investigated in Bernanke and Mihov (1998) in an identified VAR framework. Laubach and Williams (2003) propose the gap between the current real interest rate and the natural rate of interest as measure of monetary tightness. In the current benchmark NK models, the level of interest rates is often the only relevant financial state variable (see Woodford 2003).

However, the economics of financial intermediation suggest that it is both the level of interest rates and the various spreads that determine the profitability of lending, and hence the willingness of the bank to supply the marginal new loan. The relevant spreads are the rates of return on the two sides of the bank's balance sheet. Since banks borrow short term and lend long term, term spreads are likely to be relevant. Consistent with this observation, Estrella and Hardouvelis (1991) show that the term spread of interest rates forecasts recessions, while the levels of nominal or real interest rates do not. Moreover, Adrian and Estrella (2008) show that the gap between the real rate of interest and the "equilibrium real rate of interest" is not a predictor for recessions, but the term spread is.[3] In addition, the loans granted by the bank will be subject to credit risk. Measures of excess credit spreads (in excess of expected losses) will determine the expected payoff of the loan. Hence, credit spreads can also be expected to enter in the loan supply decision of the bank.

In standard macroeconomic models, the IS curve is derived from an Euler equation that describes the behavior of households or firms. In these models, consumption growth is tied to the level of real interest rates. In reality, firms and households face a variety of interest rates for their lending and borrowing decisions. Borrowing households and firms have different risk characteristics, different maturities of investment, and more or less liquid collateral. In addition, the NPV of a marginal investment or consumption project might well vary over the business cycle. As a result, the real overnight interest rate that is often used as a proxy for the marginal interest rate in simple macroeconomic models might not be the best proxy for the marginal cost of additional investment projects. Moreover, some important interest rates --- for example on corporate loans --- might not be directly observable.

We turn now to the empirical task. We estimate the macro risk premium by contemporaneously regressing GDP growth on the real Fed Funds target, as well as a wide variety of Treasury and credit spreads. We use the seven constant maturity yields published in the H.15 release of the Federal Reserve Board and compute spreads relative to the Fed Funds target. We also use a wide cross section of credit spreads which cover AAA, AA, A, BBB, BB, and B spreads from Standard & Poors. Our empirical analysis starts in the first quarter of 1986, and ends in the second quarter of 2009. We start the analysis in 1986 as the nature of financial intermediation changed dramatically in the early 1980s. We define the macro risk premium as the component of GDP that is correlated with the various Treasury term spreads and credit spreads, after controlling for the real Fed Funds target. We rotate the macro risk premium using an affine transformation to make it most highly correlated with the AA credit spread.

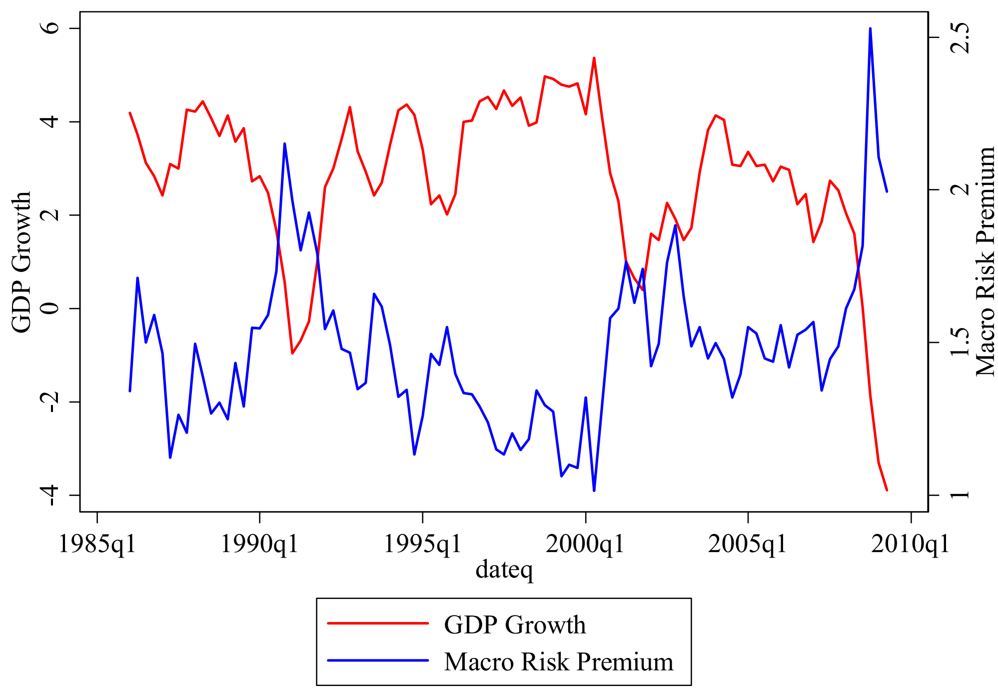
From the regressions of GDP growth on measures of term spreads and credit spreads, we obtain a list of spreads that do a good job of explaining GDP growth. The weighted average of the spreads, with the regression coefficients as the weights, can then serve as the summary

[3] Adrian, Estrella, and Shin (2009) investigate the relationship between the level of short term interest rates, the slope of the yield curve, financial intermediary profitability, and real activity in more detail.

measure of the macro risk premium. The macro risk premium would then give the analogue of the risk premium term $r = (q/p) - 1$ discussed in Section 2.

Our measure of the macro risk premium together with GDP growth, are plotted in Figure 5. The macro risk premium is rotated using an affine transformation so as to match the average level and the volatility of the AA credit spread. We can see that the macro risk premium is strongly negatively correlated with GDP growth.

Figure 5: GDP Growth and the Macro Risk Premium



Sources: Bureau of Economic Analysis, Standard & Poors, Federal Reserve Board of Governors

In Table 1, we show results of regressing the macro risk premium on the level and slope factors obtained from the principal components of the cross section of Treasury yields, and the level and slope factors from the principal components of credit spreads (column 1). The coefficients that we obtain in the regression can be interpreted as portfolio weights of a financial intermediary balance sheet. We can see that these four factors explain 86% of the times series variation of the macro risk premium.

Table 1: Determinants of the Macro Risk Premium

	(1)	(2)	(3)
Yield Level Factor	-0.09***		
Yield Slope Factor	0.04***		
Credit Spread Level Factor	0.22***		
Credit Spread Slope Factor	0.30***		
Real Fed Funds Target		-0.06***	
PCE Inflation			0.07**
Constant	0.84***	1.59***	1.27***
Observations	90	90	90
Adjusted R-squared	0.680	0.222	0.095

P-values are computed from robust standard errors. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

As predicted, the macro risk premium loads positively on the credit spread and credit slope factors. It also loads positively on the interest rate slope factor, but negatively on the interest rate level factor. These loadings look just like sensitivities of financial intermediary balance sheets, who typically have positive exposures to spreads and a negative exposures to the level of interest rates. The second column of Table 1 shows that the macro risk premium is not just negatively related to the nominal level of interest rates, but also to the real level of interest rates. The third column of Table 1 shows that the macro risk premium is uncorrelated with inflation.

4. Intermediary Risk Appetite Factor

We now turn to our measure of the looseness of financial intermediary capital constraints, which we have called "risk appetite" as a shorthand. As sketched in Section 2, the willingness of banks to lend will be positively associated with the size of intermediary balance sheets. The scenario outlined in Section 2 is that financial intermediaries manage their balance sheets actively by employing a Value-at-Risk constraint when choosing the size and composition of their portfolio. The fluctuations in the willingness to lend have been examined theoretically in Adrian and Shin

(2009b) and Danielsson, Shin, and Zigrand (2009); and empirically in Adrian, Moench, and Shin (2009), Adrian, Etula, and Shin (2009), and Etula (2009).

When financial intermediaries easily obtain funding, their balance sheet constraints are loose, risk premia are compressed (the risk appetite equation 2b), the supply of credit is plentiful, which in turn leads to higher GDP growth (equation 2a). Effective risk aversion is low, and real growth is high. In reverse, when financial intermediary funding conditions worsen, their risk appetite declines, leading to lower real growth.

Although the typical financial intermediary is considered to be a bank, a variety of institutions provide credit to the real economy. For example, over the past 30 years, the market based financial system has gained more and more importance, particularly in the U.S. The market based financial system has a number of distinctive features relative to traditional banking. First, it is primarily funded in wholesale money markets, by issuing securities such as repurchase agreements (repo) or commercial paper (CP). Second, it is typically using fair value accounting for the majority of their balance sheets. Important financial institutions of the market based financial system include security broker-dealers, finance companies, as well as asset backed security (ABS) issuers.

A priori, it is not clear which institutions are the most important ones in determining risk premia for the economy as a whole. In the spirit of letting the data speak, we run forecasting regressions for the negative changes of the macro risk premium on a variety of balance sheet measures from different classes of financial institution. For each type of institution, we include asset growth and the growth of net worth as potential variables. We also include the growth rates of assets and net worth weighted by the relative size of total assets of each intermediary in order to capture the trends of assets under management across different institutions.

We note that the financial sectors that do best in predicting the change in the macro risk premium are sectors consisting of market-based intermediaries such as the broker-dealer sector, the shadow banks and commercial banks. However, we note that the sign on the commercial bank balance sheet variable is negative, whereas the signs of the broker dealer sector or the shadow banking sector institutions are positive. This finding echoes earlier studies which have shown that commercial banks play the role of a buffer that shields borrowers from fluctuations in the credit conditions ruling in the economy (see Adrian and Shin, 2008b and 2009b).

Table 2: The Intermediary Risk Appetite Factor

	Negative of Annual Change of the Macro Risk Premium		
	(1)	(2)	(3)
Broker-Dealer Asset Growth (year lag)	0.00*		0.00
Broker-Dealer Equity Growth (year lag)	0.03**		-0.02
Shadow Bank* Asset Growth (year lag)	0.01**		0.01
Shadow Bank* Equity Growth (year lag)	-0.02		-0.42
Commercial Bank Asset Growth (year lag)	-0.05***		-0.03
Commercial Bank Equity Growth (year lag)	-0.04		-0.31
Broker-Dealer Asset Growth (year lag, weighted)		0.07	0.02
Broker-Dealer Equity Growth (year lag, weighted)		1.17**	2.01*
Shadow Bank Asset Growth (year lag, weighted)		-0.03	-0.04
Shadow Bank Equity Growth (year lag, weighted)		-0.25	2.54
Commercial Bank Asset Growth (year lag, weighted)		-0.04	-0.05
Commercial Bank Equity Growth (year lag, weighted)		-0.08	0.91
Constant	0.12	0.11	0.17
Observations	90	90	90
R-squared	0.214	0.032	0.280

Shadow banks are ABS issuers, finance companies, and funding corporations.

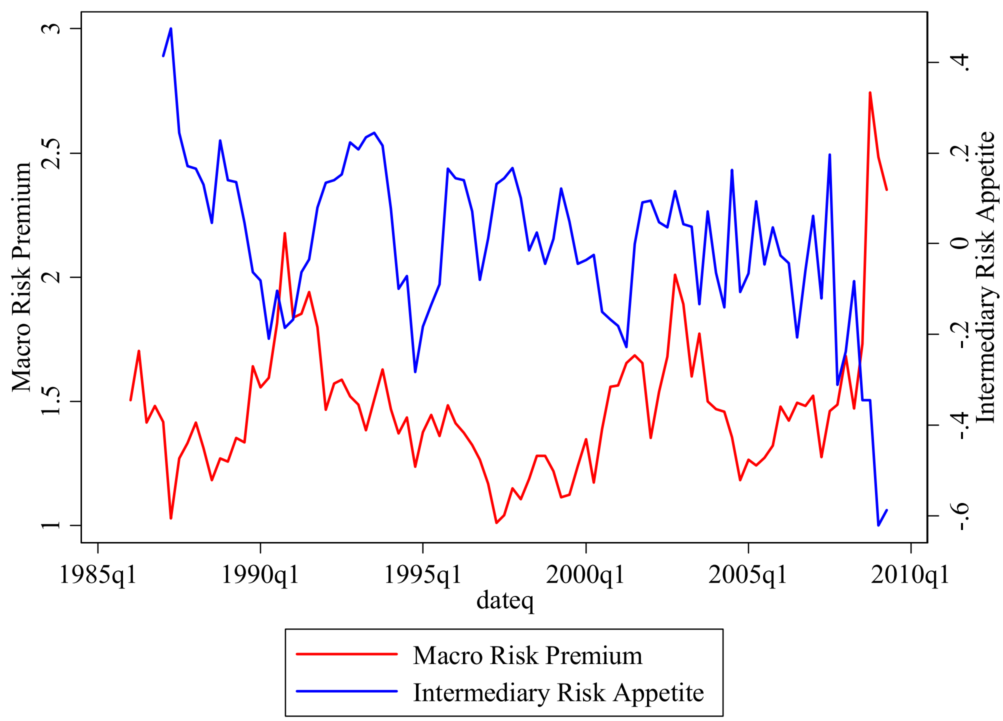
From these regressions we conclude that broker-dealer and shadow bank balance sheets capture potentially useful information on underlying financial conditions. At the margin, all financial intermediaries (including commercial banks) have to borrow in markets (for instance via commercial paper or repos) in order to lend. This is because commercial bank deposit liabilities are insufficiently flexible to fund expanding balance sheets.

For a commercial bank, even though only a small fraction of its total liabilities are market based, at the margin, it has to tap the capital markets. But for commercial banks, their large balance sheets mask the effects operating at the margin. Broker-dealers or shadow banks, in contrast, give a purer signal of marginal funding conditions, as their liabilities are short term, and their balance sheets are closer to being fully marked to market.

In addition, broker-dealers originate and make markets for securitized products, whose availability determines the credit supply for consumers and non-financial firms (e.g. for mortgages, car loans, student loans, etc.). So broker-dealers are important variables for two reasons. First, they are the marginal suppliers of credit. Second, their balance sheets reflect the financing constraints of the market-based financial system.

To the extent that balance sheet dynamics affect the supply of credit, they would have the potential to affect real economic variables. Adrian and Shin (2008) exhibit some evidence that broker dealer asset growth is a good predictor of future real activity, especially in sectors such as housing investment and durable consumption that are sensitive to financial market conditions.

Figure 6: Intermediary Risk Appetite and the Macro Risk Premium



We plot the indicator of risk appetite, as given by our summary measure of risk appetite obtained from balance sheet changes, together with the macro risk premium, in Figure 6. Our measure of risk appetite is the predicted value of the regression reported in column (3) of Table 2. The plot shows that risk appetite is highly negatively correlated with changes to the macro risk premium. Higher risk appetite leads to balance sheet expansions, which are associated with increases in asset prices and hence declines in spreads. Movements in risk appetite are thus strongly negatively correlated with the macro risk premium, which we saw earlier is closely associated with interest rate spreads.

In Table 3 (column 1), we report the results of regressing GDP growth on standard macro variables, as well as the intermediary risk appetite factor. The results in the table demonstrate that risk appetite forecasts GDP growth. Interestingly, innovations in GDP growth are unrelated to PCE inflation, or the level of the Fed Funds rate, once we control for the risk appetite variable.

Table 3: GDP Growth and Intermediary Risk Appetite

	(1)	(2)	(3)
GDP Growth (lag)	0.87***	0.76***	0.90***
PCE Inflation (lag)	-0.14	-0.24*	-0.10
Fed Funds Target (lag)	0.01	0.00	-0.05
Intermediary Risk Appetite (lag)	2.42***	1.94***	1.48***
VIX (lag)		0.02	
Moody's BAA / 10-Year Treasury Spread (lag)		-0.63***	
10-year / 3-month Treasury spread (lag)		0.12	
Broker-Dealer Total Asset Growth (lag)			0.01***
ABS Issuer Total Asset Growth (lag)			0.01**
Constant	0.56**	1.97***	0.26
Observations	89	89	89
R-squared	0.858	0.875	0.869

P-values are computed from robust standard errors. *** p<0.01, ** p<0.05, * p<0.1

In column (2) of Table 3, we add standard asset pricing controls to the regression: the level of the VIX, the credit spread, and the term spread. While the inclusion of the term spread and the credit spread do reduce the significance of the risk appetite variable somewhat (from the 1% level to the 5% level), they again only marginally raise the R^2 of the regression. In Table 3, column (3), we report results of regressing GDP growth directly on some balance sheet measures. While both security broker-dealer total asset growth and ABS issuer asset growth appear significant, these variables only increase the R^2 of the regression marginally, from 86% to 87%. We thus conclude that our formalization of risk appetite in terms of balance sheet growth has some support in the empirical results.

5. Macro Dynamics

So far, we have shown a connection between three concepts.

- Rapid growth of intermediary balance sheets
- Lower risk premiums
- Higher real activity

The first bullet point (rapid growth of intermediary balance sheets) carries information on the risk appetite of the financial intermediation sector, which includes traditional commercial banks as well as market based intermediaries such as security broker dealers and institutions from the shadow banking sector. The second bullet point has been addressed by examining various Treasury term spreads and credit spreads. We now turn to examine the dynamic properties of the three notions, and the time signature of their relationships.

5.1. Vector Autoregressions

Table 4 reports coefficients of a non-structural VAR with GDP growth, PCE inflation, the Fed Fund Target, the GDP yield factor, and the risk appetite factor. Table 5 reports the results for the standard model with GDP growth, PCE inflation, and the Fed Funds target as endogenous variables. Each of the VARs is estimated using data from 1986Q1 through 2008Q2.

We acknowledge from the outset that inferences concerning causality by means of non-structural vector autoregression analyses is difficult without further identifying restrictions. Although we have sketched a scenario where the fluctuations in risk appetite is the driving force of the macro fluctuations, we have not shown conclusively that our preferred hypothesis is backed up by the empirical evidence to the exclusion of other possible hypotheses.

The more ambitious task (not attempted in this paper) is to test the hypothesis that it is the fluctuations in the ***supply of credit*** emanating from the banking sector that drives the macro business cycle. One possibility would be to run an instrumental variables of GDP growth on credit availability as an endogenous variable, with a first stage linking credit conditions to balance sheet variables.[4] One would have to justify, and then test, the exclusion restrictions. We fully acknowledge that we have not done this in the current exercise, and so the interpretation of our results is still less than fully conclusive. However, our desired interpretation of the results is that stronger balance sheet growth of financial intermediaries is associated with more ready supply of credit, which leads to lower spreads and higher real activity. The sense of causality that can be applied to our analysis is that of "Granger Causality". We constructed the risk appetite variable via forecasting regressions of balance sheet variables on future returns to the macro risk premium. The risk appetite variable thus captures a temporal causation from the intermediary balance sheets to future asset price movements.

Table 4: Risk Appetite Vector Autoregression

	(1) GDP Growth	(2) PCE Inflation	(3) Fed Fund	(4) Risk Premium	(5) Risk Appetite
GDP Growth (lag)	0.77***	0.01	0.13**	-0.03*	-0.02
PCE Inflation (lag)	-0.05	0.95***	0.20***	0.02	0.04**
Fed Funds Target (lag)	-0.05	0.00	0.88***	0.00	-0.02**
Macro risk premium (lag)	-0.60	-0.04	-0.84**	0.57***	-0.18**
Risk Appetite Factor (lag)	1.74***	-0.08	0.46	-0.26**	0.52***
Constant	1.85**	0.10	0.82	0.65***	0.30*
Observations	85	85	85	85	85

*** p<0.01, ** p<0.05, * p<0.1, estimates are from 1986Q1 to 2008Q2

[4] We are grateful to a referee for this suggestion.

As we can see in the first column of Table 4, the risk appetite factor forecasts GDP growth with significance at the 1% level. This result is to be expected: as the risk appetite factor is constructed by forecasting changes in the GDP yield factor, and the GDP yield factor tracks GDP growth, we would expect the risk appetite factor to forecast GDP growth.

None of the other variables forecasts GDP growth; particularly not the level of the Fed Funds target. The finding that none of the other variables forecasts changes in GDP growth also holds in the smaller VAR of Table 5. While PCE inflation is strongly autocorrelated, it is not forecasted by any of the other state variables in both the small VAR and the VAR with risk appetite (column 2 of Tables 4 and 5).

Table 5: Baseline Vector Autoregression

	(1)	(2)	(3)
	GDP Growth	PCE Inflation	FedFunds
GDP Growth (lag)	0.89***	0.02	0.23***
PCE Inflation (lag)	0.00	0.95***	0.15**
Fed Funds Target (lag)	-0.06	0.01	0.90***
Constant	0.61**	0.03	-0.64***
Observations	89	89	89

*** p<0.01, ** p<0.05, * p<0.1

Column (3) of Tables 4 and 5 can be interpreted as Taylor rules. As expected, we find that the Fed Funds target loads positively on GDP growth and on inflation. In addition, Column (3) of Table 4 shows that the macro risk premium has a weak forecasting power for the Fed Funds target: the target tends to be cut when interest rate spreads increase. The macro risk premium is negatively associated with GDP growth (interest rate spreads increase when real growth slows), positively with inflation, and negatively with the Fed Funds target (which is the result we documented earlier, i.e. that the GDP yield factor relates negatively to the level of interest rates). The significant predictive power of the risk appetite factor for the macro risk premium is again by construction, as risk appetite has been obtained by regressing changes in the risk premium on lagged balance sheet variables (column 4 of Table 4).

The most interesting findings of Table 4 concern the determination of financial intermediary risk appetite (column (5)). A lower Fed funds target precedes higher risk appetite. This can be interpreted as evidence in favor of the risk taking channel of monetary policy. As described earlier, lower short term rates lower the cost of funding of financial intermediaries, thus relax their funding constraints, and increase their effective risk taking. Column (5) also shows that a higher macro risk premium tends to lower intermediary risk appetite, which is likely due to the fact that the credit spreads that intermediaries' have to pay are correlated with the macroeconomic credit spreads.

5.2. Impulse Response Functions

Impulse response functions to risk appetite shocks that correspond to the VAR from Table 4 are plotted in Figure 8. Impulse response functions are computed from a Cholesky decomposition, where the ordering corresponds to the ordering of the variables in Table 4. Figure 8 plots the impulse response of the macro risk premium to a risk appetite shock. Per construction, the response is negative: larger risk appetite leads to an expansion of intermediary balance sheets, and a compression of credit spreads. The response of the macro risk premium peaks at four quarters, and then subsequently reverts slowly towards zero. However, the significance of the risk appetite shock on the macro premium is fairly persistent, and only becomes insignificant after about six quarters.

Figure 9 plots the response of GDP to a risk appetite shock. Higher risk appetite is followed by stronger GDP growth. The response of GDP is again persistent, and significant for up to six quarters. As explained in earlier sections, higher risk appetite tends to lead to an increase in the suplly of credit, which in turn fuels economic growth. The channel for this finding is that higher risk appetite is associated with lower spreads, which in turn leads to higher credit supply and higher GDP growth.

Figure 8: Impulse Responses
of Macro Risk Premium to Risk Appetite Shock

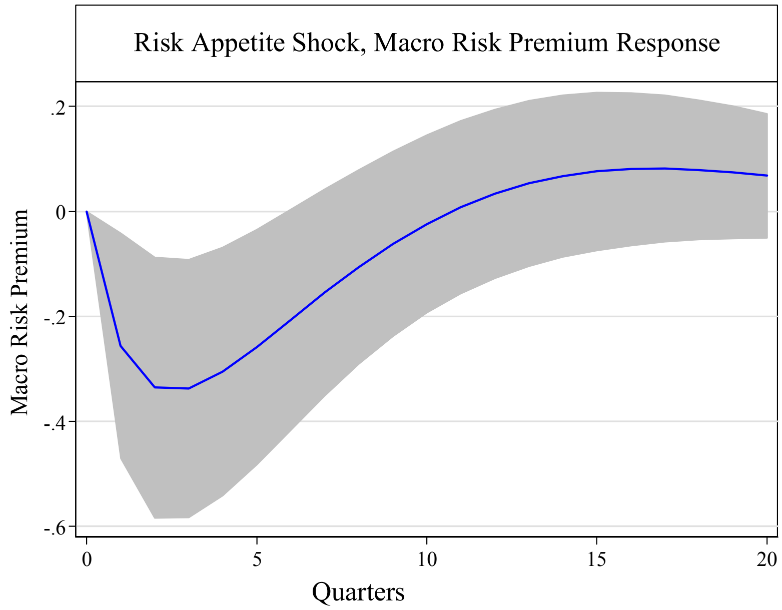


Figure 9: Impulse Responses
of GDP Growth to Risk Appetite Shock

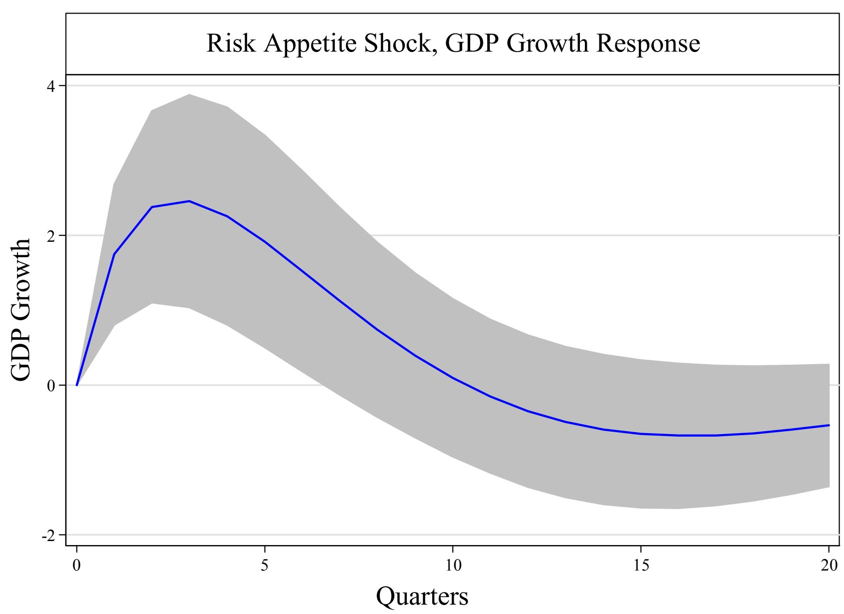


Figure 10 traces out the response of the Fed Funds target to a risk appetite shock, while Figure 11 traces the reverse, i.e. the response of risk appetite to a Fed Funds shock. Figure 10 shows that higher risk appetite tends to be followed by monetary tightening. This finding can be viewed as countercyclical monetary policy. As stronger risk appetite is associated with stronger balance sheet growth, lower credit spreads, and faster GDP growth, the Fed Funds target is eventually tightened to slow the resulting upward pressure on inflation. Interestingly, the causality goes the other way when considering the response of risk appetite to a Fed Funds target shock. A lower target loosens the funding constraint of intermediaries, thus increasing their effective risk appetite, which in turn leads to an amplification of monetary policy. The effect of the Fed Funds target on risk appetite appears to be highly persistent, lasting for more than four quarters.

Figure 10: Impulse Responses of Fed Funds Target to Risk Appetite Shock

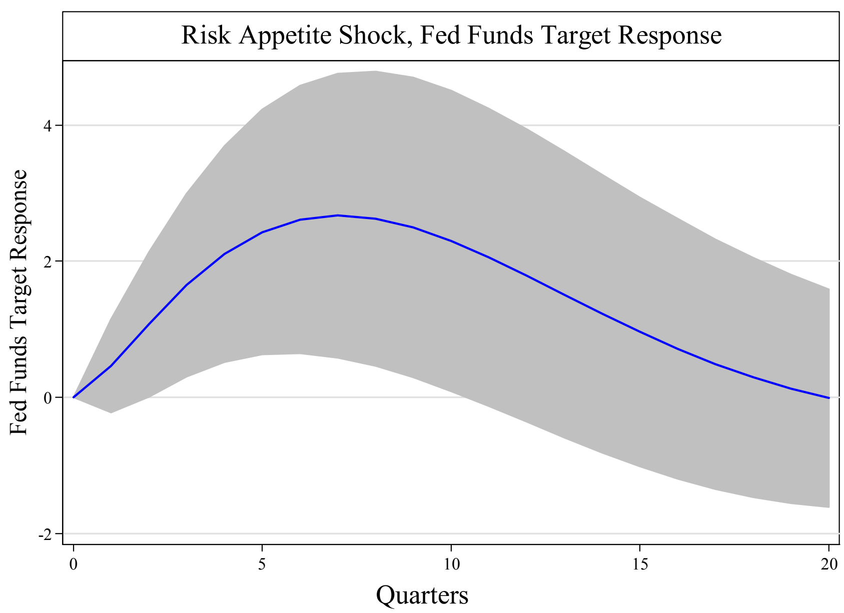
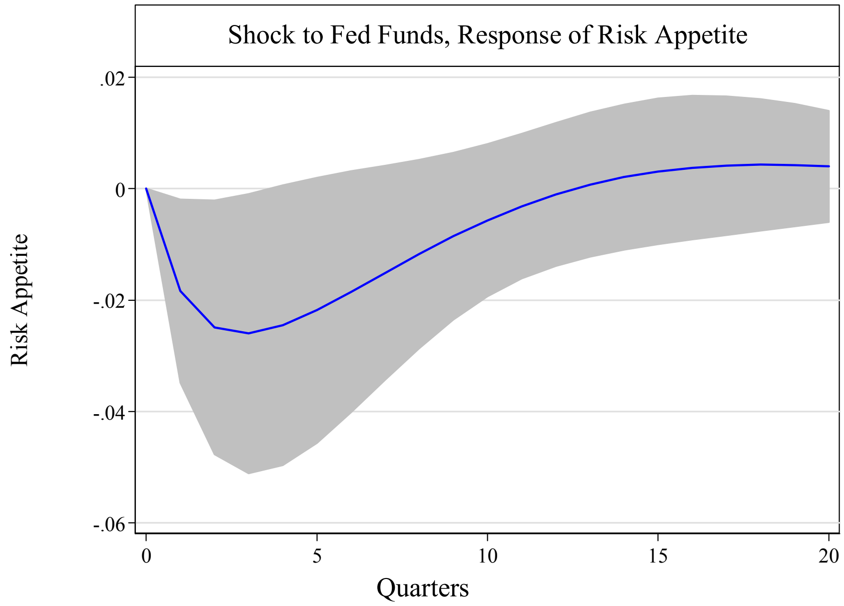


Figure 11: Impulse Responses of Risk Appetite to Fed Funds Target Shock



6. International Comparison: Germany, Japan, and the UK

6.1. The Macro Risk Premium and Risk Appetite Across Countries

We now broaden our discussion to examine the same exercise we have conducted above generalized to three further countries–Germany, the United Kingdom and Japan. The results for Germany are reported first.

In the case of Germany, we see that the recent increase in the macro risk premium is closely mirrored in the decline in GDP growth. The magnitudes are comparable to the United States, although compared to the past fluctuations in the macro risk premium, the current episode is not such a glaring outlier.

One hypothesis we can entertain is that for a bank-dominated financial system such as Germany, the fluctuations in the intermediary risk appetite should be less pronounced, compared to the large fluctuations we saw for the United States. Indeed, this is what we see reflected in the data. Compared to the large fall in the GDP growth rate, the fluctuations in the intermediary risk appetite is comparatively small. This finding would be consistent with the result we observed earlier that the fluctuations in the commercial bank assets in the United States has the opposite sign to the fluctuations in the assets of market-based intermediaries. The role of banks as a buffer against shocks is evident here.

Figure 12: GDP Growth and Macro Risk Premium for Germany

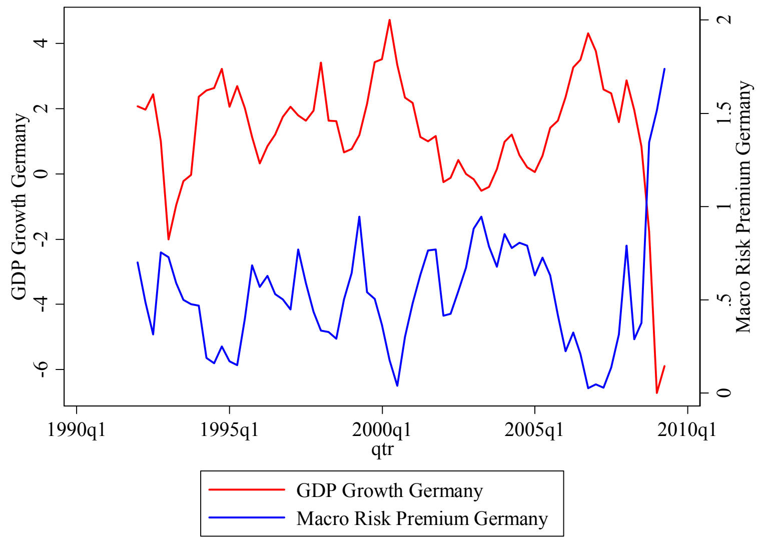
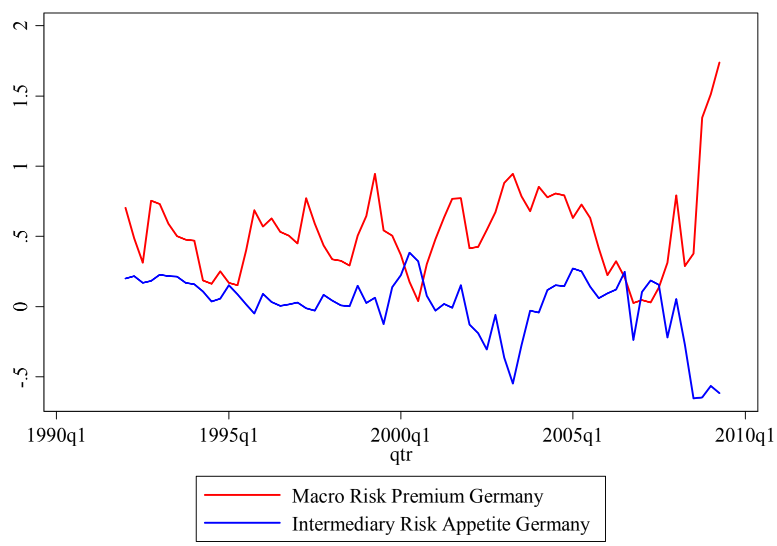


Figure 13: Macro Risk Premium and Intermediary Risk Appetite for Germany



Similar results can be seen for Japan. The financial crisis of 2008 is clearly evident in the rise in macro risk premium and the fall in the GDP growth rate, but the main characteristic of Japan is that the recent increase in macro risk premium is not so large compared to the higher frequency fluctuations seen since 1997. The fact that Japan was emerging from a long banking crisis where the banks were nursed back to health through publicly funded recapitalizations may be put forward as a possible explanation.

Figure 14: GDP Growth and Macro Risk Premium for Japan

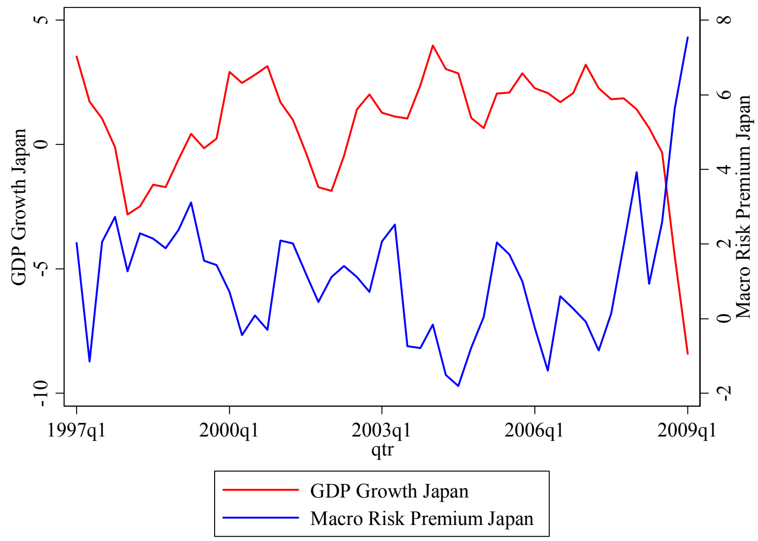
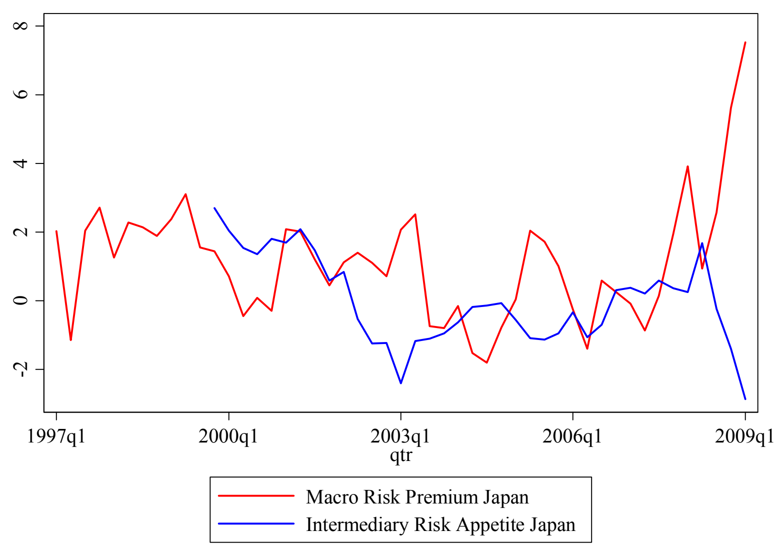


Figure 15: Macro Risk Premium and Intermediary Risk Appetite for Japan



The most dramatic evidence comes from the United Kingdom. The increase in the macro risk premium associated with the current crisis is very sharply higher compared to the higher frequency movements in risk premiums before the crisis. The fall in GDP growth is similarly much sharper than the higher frequency movements before the crisis.

The UK has suffered a much sharper property downturn, and has seen greater distress in the banking sector. Although the UK's financial system had not progressed as far as the US toward a fully market-based intermediary system, the experience with Northern Rock and HBOS has shown that the rapid accumulation of banking sector assets in the years leading up to the current crisis was funded mainly from the wholesale capital markets, rather than through domestic household deposits (Shin (2009c) is a study of Northern Rock, and its failure in 2007).

Nevertheless, we see from the chart on the risk appetite series for the UK that the time signature bears some similarities to that of Germany and Japan. The fact that banking sector assets have not declined very sharply in spite of the crisis can be put forward as a possible explanation for the comparatively mild fluctuations in risk appetite. The conjunction of (i) sharp increase in macro risk premium and (ii) the comparatively mild fluctuations in risk appetite reflects both the fact that the UK is still a bank-based financial intermediary system, but that the banking sector in the UK has suffered sharp setbacks from the decline in housing prices and real activity.

Figure 16: GDP Growth and Macro Risk Premium for the UK

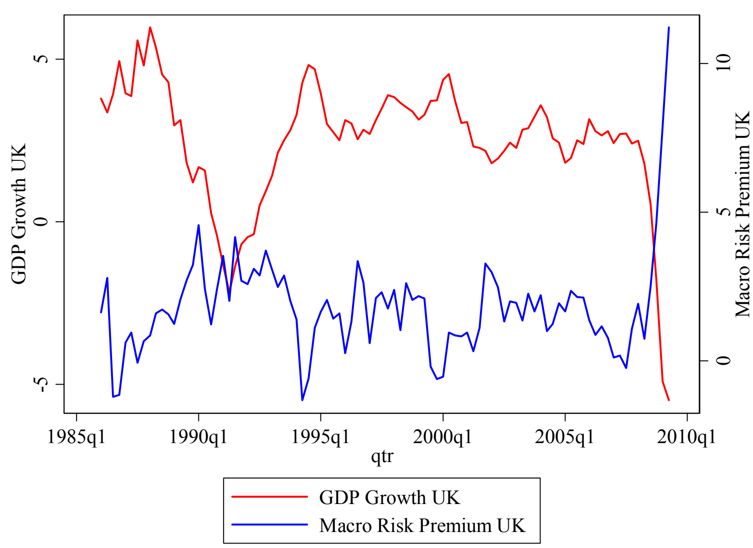
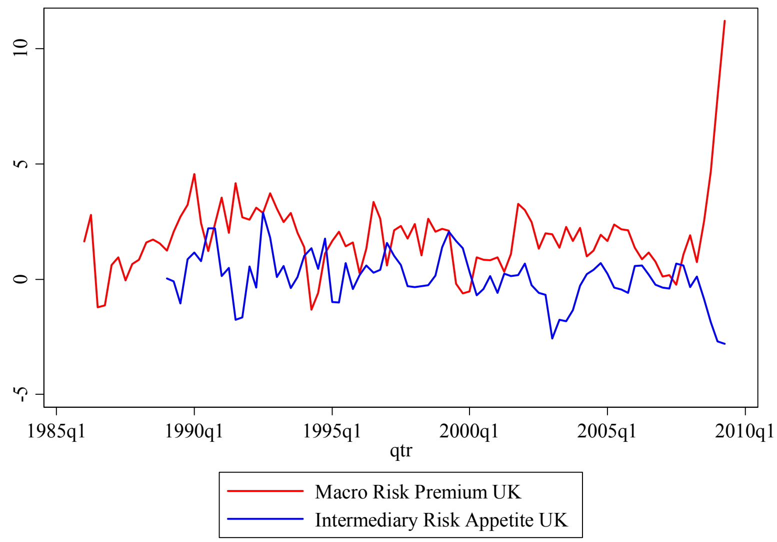


Figure 17: Macro Risk Premium and Intermediary Risk Appetite for the UK



6.2. VAR Analysis for Germany, Japan, and the UK

Tables 6-8 show the vector autoregressions for Germany, Japan, and the UK. Qualitatively, the VAR results for Germany, Japan and the UK are similar to those of the United States. However, there is a glaring difference with respect to the risk appetite factor. For both Germany and the UK, the risk appetite factor is insignificant in the VAR for GDP growth (see the respective column (1)) in Tables 6-8. More surprisingly, in Japan, the risk appetite factor enters with the "wrong sign" in that higher risk appetite apparently predicts subdued GDP growth. The correct way to interpret our results is to consider the role of commercial banks as a buffer in a downturn. As we have already commented, commercial bank asset growth is maintained in economic downturns even as market-based financial intermediaries curtail their credit. The apparent absence of an effect of risk appetite on GDP growth should be seen as the commercial banks playing this economic buffer role.

Table 6: Risk Appetite Vector Autoregression Germany

	(1) GDP Growth	(2) Core CPI Inflation	(3) Discount Rate	(4) Risk Premium	(5) Risk Appetite
GDP Growth (lag)	0.66***	0.09	0.17***	-0.08***	0.02
Core CPI Inflation (lag)	-0.04	0.87***	0.06	-0.03	0.01
Discount Rate (lag)	-0.08	0.07	0.87***	0.03	0.01
Macro risk premium (lag)	-0.92	0.44	0.63***	0.42***	0.02
Risk Appetite Factor (lag)	0.29	-0.14	-0.09	-0.21	0.49***
Constant	1.43**	-0.51*	-0.12	0.34***	-0.07
Observations	65	65	65	65	65

*** p<0.01, ** p<0.05, * p<0.1, estimates are from 1992Q1 to 2008Q2

Table 7: Risk Appetite Vector Autoregression Japan

	(1) GDP Growth	(2) Core CPI Inflation	(3) Discount Rate	(4) Risk Premium	(5) Risk Appetite
GDP Growth (lag)	0.65***	0.04	0.02	-0.26	0.12
Core CPI Inflation (lag)	-0.56	0.69***	0.01	0.08	0.29
Discount Rate (lag)	1.51**	0.64**	0.94***	0.65	0.50
Macro risk premium (lag)	0.03	0.07	0.04**	0.45***	0.16**
Risk Appetite Factor (lag)	-0.37**	-0.11*	-0.02	-0.06	0.80***
Constant	-1.00	-0.74**	0.00	0.15	-0.68
Observations	34	34	34	34	34

*** p<0.01, ** p<0.05, * p<0.1, estimates are from 1999Q4 to 2008Q2

Table 8: Risk Appetite Vector Autoregression the UK

	(1)	(2)	(3)	(4)	(5)
	GDP Growth	Core CPI Inflation	Discount Rate	Risk Premium	Risk Appetite
GDP Growth (lag)	0.79***	0.11	0.34***	-0.42***	-0.09
Core CPI Inflation (lag)	-0.11	0.94***	0.31***	-0.29*	-0.23
Discount Rate (lag)	-0.03	0.05	0.84***	0.22**	0.18**
Macro risk premium (lag)	-0.01	0.09	0.07	0.35***	0.03
Risk Appetite Factor (lag)	0.02	-0.04	-0.05	-0.04	0.43***
Constant	1.02***	-0.61*	-0.80**	1.50***	-0.35
Observations	77	77	77	77	77

*** p<0.01, ** p<0.05, * p<0.1, estimates are from 1989Q1 to 2008Q2

7. Concluding Remarks

According to the perspective outlined here, fluctuations in the supply of credit arise from how much slack there is in financial intermediary balance sheet capacity. The cost of leverage of market-based intermediaries is determined by two main variables – risk, and short term interest rates. The expected profitability of intermediaries is proxied by spreads such as term spreads and various credit spreads. Variations in the policy target determine short term interest rates, have a direct impact on interest rate spreads, and hence the profitability of intermediaries. Moreover, for financial intermediaries who tend to fund long-term assets with short-term liabilities, movements in the yield curve may also have valuation effects due to the fact that assets are more sensitive to discount rate changes than liabilities.

Monetary policy actions that affect the risk-taking capacity of the banks will lead to shifts in the supply of credit. Borio and Zhu (2008) have coined the term "risk-taking channel" of monetary policy to describe this set of effects working through the risk appetite of financial intermediaries.

In the run-up to the global financial crisis of 2007 to 2009, the financial system was said to "awash with liquidity", in the sense that credit was easy to obtain. In an earlier study (Adrian and Shin (2007)) the authors showed how liquidity in this sense is closely related to the growth of financial intermediary balance sheets. The estimates of a reduced form macroeconomic model presented here capture the notion that liquidity in the sense of the ease of credit conditions is tightly linked to real economic activity and monetary policy. When asset prices rise, financial intermediaries' balance sheets generally become stronger, and – without adjusting asset holdings – their leverage becomes eroded. The financial intermediaries then hold surplus capital, and they will attempt to find ways in which they can employ their surplus capital. Monetary policy can affect the balance sheet behavior of financial intermediaries, which in turn influence the supply of credit, risk premia, and ultimately the level of real activity.

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