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Are the Real Effects of Monetary Policy Currently Smaller than Usual?

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Introduction

The Federal Reserve has provided an unprecedented amount of monetary stimulus over the past several years. The FOMC reduced the federal funds rate to near zero in late 2008, and signaled its willingness to keep the funds rate low for an extended period. The Federal Reserve also expanded its balance sheet with more than $2 trillion in longer-term Treasury and agency securities, and engaged in a number of targeted programs to improve credit market functioning. Nevertheless, real activity has recovered much more slowly than in previous business cycles (and much more slowly than Board staff expected as of the early stages of the episode), leading some to question whether the effectiveness of monetary policy—in both its conventional and unconventional forms—is currently less than it would be under more normal circumstances.

Logically, there are two ways in which the effects of monetary policy on aggregate spending could be attenuated relative to historical norms. First, the effects of policy actions on loan rates, private security yields, corporate equity prices, or other asset prices that are relevant for aggregate demand could be smaller than usual (or smaller than expected). Second, even if policy actions *have* influenced these interest rates and asset prices to the degree that might have been anticipated based on historical experience, the sensitivity of aggregate demand to changes in these financial variables could itself be smaller than usual. For example, heightened uncertainty about the economic outlook could be reducing the sensitivity of capital spending to changes in interest rates, while tighter credit standards and reduced creditworthiness may have left many households and firms unable to take advantage of low borrowing rates.

In practice, it can often be difficult to disentangle "true" forms of policy attenuation from other types of adverse shocks. Indeed, while a number of factors are likely acting to offset the stimulative effects of accommodative monetary policy, not all of them necessarily imply a reduction in the *sensitivity* of real activity to additional policy easing—that is, policy attenuation. For example, while fiscal retrenchment by state and local governments is clearly restraining the pace of the recovery, it has probably had little or no direct influence on how private spending responds to changes in interest rates. Of course, some shocks can have both sorts of effects: For instance, tighter credit conditions in the housing market have depressed the demand for new houses at any given level of mortgage rates (thus offsetting the effects of lower rates), but have also probably reduced relative to past norms the number of new buyers that would be attracted into the housing market following a decline in mortgage rates (thus damping the response of housing demand to changes in rates).

In this note, we muster several pieces of macro- and micro-based evidence regarding the degree to which the effects of recent monetary policy actions might have been smaller than usual. On the macro side, we assess whether the estimated parameters from econometric spending

equations have recently shifted in a manner that would make aggregate demand less sensitive to changes in monetary policy. We find some evidence of such instability in the equations for consumer durables and residential investment, but little evidence of other meaningful parameter shifts associated with the financial crisis and recession. Taken as a whole, these estimation results provide modest evidence that the response of aggregate demand to conventional monetary policy shocks was somewhat smaller than normal at the peak of the crisis, although this difference is not large relative to the uncertainty associated with these estimates. In more recent periods, this attenuated response appears to have moved part of the way back to its pre-crisis average.

On the micro side, we consider two sets of questions. First, we attempt to quantify the effects that tight credit conditions are currently having on household spending. For example, although accommodative monetary policy has kept mortgage rates at historic lows, many households are unable to actually obtain credit on these terms. As a result, low borrowing rates might currently be providing a smaller spur to household spending than is typical. While we do uncover some evidence that this factor might be present—the volume of mortgage refinancing activity, for example, currently appears low relative to historical norms—the sizes of the effects that we find would not at present imply an especially large drag on household spending. Moreover, as our analysis does not distinguish between factors reducing the sensitivity of spending to interest rates and the effects of adverse shocks more generally, the implications of these results for changes in the effectiveness of monetary policy would presumably be even more modest.

Second, we ask whether developments in the banking sector could be curtailing the supply of bank credit. If banks still expect significant future loan losses, or if bank profitability has been reduced by the low level of longer-term interest rates, then the availability of cheap funding could be resulting in atypically small increases in lending. Relatedly, regulatory changes that are currently in train—specifically, the new capital levels required under Basel III regulations—could be restraining bank lending. We attempt to quantify the potential effects of these developments, again abstracting from the issue of whether these effects reflect actual attenuation in the effectiveness of monetary policy (as opposed to an adverse shock that reduces aggregate spending for any given level of interest rates).[1] While we find little evidence that bank lending has become more sensitive to changes in banks' capital positions, there is some evidence that banks may have reduced their lending in anticipation of Basel III, as the announced Basel III standards imply that many banks currently have weaker capital positions than they typically had prior to the crisis. However, the magnitude of the effect is imprecisely estimated. In addition, we find little to suggest that bank lending has been reduced in recent quarters by either higher loan losses or the state of the yield curve.

On balance, therefore, the evidence that we consider does not strongly point to a persistent sharp reduction in the efficacy of monetary policy of late. We would add two caveats to this conclusion, however. First, we have only examined a relatively small set of possible ways in which the monetary transmission mechanism might have been weakened, and we have assessed the few possibilities we do consider using a limited number of empirical approaches. (In

[1] Strictly speaking, these developments have probably not reduced the *sensitivity* of bank lending to changes in monetary policy—and so do not represent sources of "true" policy attenuation—but are rather things that have *offset* the effects of monetary policy actions on lending.

particular, we have generally not attempted to determine whether policy actions have been less successful than usual in affecting the longer-term interest rates and asset prices that influence real activity; this topic is the focus of ongoing staff research.) Second, our ability to detect whether policy attenuation has truly been present—or absent—in recent years is almost certainly extremely limited given the relatively small span of data that we have at our disposal and the abnormal character of recent events. For both of these reasons, our work by no means represents the definitive or final word on this issue. In addition, we should stress that our analysis is focused on the implications of post-crisis developments for *aggregate* outcomes and the overall effectiveness of monetary policy, and not on their consequences for the welfare or profitability of particular subgroups of households or firms, which could be severe.

Evidence on the attenuation of monetary policy from aggregate models

In theoretical terms, there are various ways in which the sensitivity of aggregate demand to monetary policy could have been reduced by the financial crisis and recession. For instance, as Bloom, *et al.* (2007) demonstrate, an increase in uncertainty can cause capital spending decisions to be less responsive to changes in monetary policy (and demand changes more generally): Intuitively, the presence of increased uncertainty makes agents more cautious—and therefore more willing to wait and see what direction the economy is moving—before committing to a capital purchase that cannot easily be reversed, even if interest rates and other financing costs for the project are low. (This sort of mechanism could also adversely affect household demand for housing or consumer durable goods.) Alternatively, reduced credit availability can also cause demand to be less sensitive to a decline in interest rates, as fewer agents will actually be able to take advantage of a reduction in borrowing costs.

It is also true that some of the ways in which monetary policy influences aggregate demand could have been largely unaffected by the financial crisis and recession. In addition to the effects on spending that obtain from interest rates, monetary policy also affects stock prices (which influence consumption) and exchange rates (which affect net exports). It is not immediately apparent why changes in stock prices or exchange rates would currently be having smaller effects on spending.

In any case, the quantitative significance of these various channels cannot be decided on purely theoretical grounds; moreover, some of the key drivers of the mechanisms that are involved are imperfectly observable at best. In the absence of strong theoretical guidance, we focus on modeling approaches that are relatively agnostic about the fundamental or systematic sources of any possible attenuation, but that should allow us to gauge their macroeconomic effects. Specifically, to explore whether the effects of monetary policy on aggregate demand are currently smaller than usual, we allow the coefficients in a set of econometric spending equations to vary over time and then compare the average implied effect of a monetary policy shock on real activity in history to its current effect.

The spending equations that we use for this exercise are taken from the FRB/US model. For our purposes, FRB/US strikes a useful balance between structural modeling, which is intended to permit identification of the types of counterfactual responses that we are interested in, and

reduced-form approaches, which seek to exploit a wide range of information for forecasting and current analysis. To permit the coefficients of the equations to change while maintaining as many of the model's structural features as possible (such as forward-looking behavior), we apply a variant of the procedure described in Müller and Petalas (2010), which provides an approximate but robust framework for inferring drift in the parameters of a model. Once time-varying paths for the parameters of the various spending equations are in hand, we can then compute impulse response functions that give the response of real activity (or any other model variable) to a monetary policy shock at various points in time. In addition, the Müller-Petalas framework implies distributions for the parameter paths, which can in turn be used to construct confidence intervals for the impulse responses.[2]

Using this framework, the resulting estimates of parameter drift in a subset of the equations in the FRB/US model typically imply only low-frequency movement, with little indication that special conditions have emerged over the past three years. One important exception is household spending—specifically, the equations for consumer durables and residential investment—where we find a meaningful reduction in the sensitivity of spending to changes in interest rates over the past few years.[3] (Note, however, that this decline in estimated sensitivity could also reflect a reduction in the degree to which the various interest rates and asset prices used in FRB/US provide a good proxy for overall financial conditions, given that the model's equations do not take account of underwriting standards and other credit supply factors that may also influence household spending.)

Taking into account the estimated drift in the model's main spending, inflation, and labor market equations, the implied response of overall real activity to a monetary policy shock is somewhat smaller in recent periods, with the most important source of attenuation coming from the reduced sensitivity of household spending (as well as the reduced importance of consumer durables and residential investment in overall aggregate demand). Figure 1 plots the impulse response function for real GDP following a three-year 25 basis point federal funds rate reduction under the parameter estimates that prevailed in 2009:Q1 (the quarter immediately following the intensification of the financial crisis) and in the most recent period (2012:Q1); the figure also shows the average historical response over the 1989-2004 period together with its 68 percent and 90 percent confidence intervals.[4] As is apparent from the figure, at the height of the financial

[2] We use the version of the FRB/US model with VAR-based expectations. To make the Müller-Petalas procedure more sensitive to changes near the endpoints of the sample, we allow the variance of the parameter drift processes to break in 2008:Q3; we also use maximum likelihood to estimate the variance of the drift rather than the weighted average risk minimizing estimator suggested by Müller and Petalas. Without these modifications, our estimates would show low-frequency parameter drift in some equations, but would not identify the last three years as being especially noteworthy in this regard.

[3] Our finding that significant parameter instability is confined to the household spending block of the model is confirmed by a set of breakpoint tests we performed that are designed to capture structural breaks near the endpoint of a sample period (Andrews, 2003).

[4] The 2009:Q1 and 2012:Q1 impulse response functions are median values based on 1,000 Monte Carlo draws. Our method for computing impulse responses does not account for the fact that a monetary policy shock could itself influence the parameters of the spending equations. For example, if the sensitivity of spending to interest rates were altered by financial conditions or uncertainty, a contractionary monetary policy shock could indirectly affect this sensitivity by causing financial conditions to deteriorate or by contributing to uncertainty about the economic outlook (and conversely). The results in Figure 1 are therefore best interpreted as providing a convenient way of

crisis the peak increase in output following a conventional expansionary monetary shock of this size was modestly lower than its average historical value, though the 2009:Q1 response is still inside the historical response's 90 percent confidence interval. In the most recent period, the peak output response has moved part of the way back to its historical average.

We would note one other relevant piece of macro-based evidence on monetary policy attenuation. Using a threshold VAR (TVAR) estimated over the period 1968-2007, Berrospide and Edge (2008) find that the effects of a temporary federal funds rate shock on the unemployment rate in a "tight-credit" regime are reduced by roughly a third relative to the responses that obtain when credit conditions are normal. Their model uses either the spread between the BAA bond yield and the 10-year Treasury yield or the reported willingness to make consumer installment loans from the Senior Loan Officer Opinion Survey (SLOOS) to identify tight-credit periods; they find that the results regarding policy attenuation are similar in either case. However, these two variables are currently sending different signals as to whether the economy is in a tight-credit regime: According to the model, the SLOOS-based measure implies that credit conditions returned to normal around the end of 2009, while the BAA-Treasury spread still exceeds the threshold that signals the presence of tight credit conditions.[5]

Household finance and consumer spending

The financial crisis and its aftermath resulted in a significant tightening of credit to households, both relative to the loose credit conditions that preceded the crisis, as well as relative to historical norms. In addition, the creditworthiness of many households was severely damaged. As a result, many consumers have been unable to take advantage of the lower interest rates that have resulted from monetary policy actions; moreover, to the extent that monetary policy operates by affecting willingness to lend, a tightening of lending standards will undermine the effects of policy easing. In this section, we examine two key components of household borrowing—mortgage debt and revolving credit—to attempt to gauge the likely effect that tighter credit conditions are having on household spending. Because our analysis does not distinguish between effects arising from the reduced effectiveness of monetary policy and those arising from adverse shocks more generally, the results we find represent an upper bound on the degree to which these household finance channels of the monetary transmission mechanism may have been weakened.

Mortgage markets

Several policy actions taken by the Federal Reserve, including large-scale purchases of agency debt and agency mortgage-backed securities (MBS), have sought to increase the supply and reduce the cost of home mortgage credit. However, the aftereffects of the financial crisis left

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summarizing the effect that estimated parameter instability has had on the sensitivity of aggregate demand to changes in monetary policy.

[5] Berrospide and Edge's results concerning attenuation contrast with those found by Balke (2000) using a similar TVAR-based technique (Balke's sample covers the period 1960-1997, and his main indicator of credit tightness is the spread of commercial paper rates over Treasury bill rates). Balke finds that federal funds rate shocks have *larger* effects on output in tight-credit regimes, with the difference especially pronounced for large contractionary funds rate shocks (note that Berrospide and Edge find no evidence of this type of asymmetry).

many homeowners with high loan-to-value ratios, damaged credit records, or both, thereby reducing their ability to lower the rate on their mortgages through refinancing. Indeed, despite mortgage rates that have remained near historic low levels, the volume of refinancing activity seen over the past year has fallen far short of its 2003 peak and is also below its level in early 2009 (see the black line in Figure 2). To provide a rough estimate of the extent to which the current volume of refinancing is atypically low, we fit a regression model over the period 1992 to 2007 that relates quarterly refinancing activity to the current value and two lags of the gap between the prevailing mortgage rate and an estimate of the average interest rate on existing mortgage debt.[6] We then use this model to predict refinancing volumes in 2011 given the actual values of the mortgage rate gap, and find that the projected volume is 13 percent higher (a difference of $130 billion), on average, for 2011 as a whole. Assuming an average mortgage rate reduction of 120 basis points (the 2011:Q4 value of the mortgage rate gap), this additional quantity of refinancing would imply a reduction in household interest outlays of less than $2 billion per year.[7] (Of course, this calculation ignores any other potential positive effects from increased access to mortgage refinancing, such as lower mortgage delinquency rates and thereby perhaps increased house prices.)

Purchases of MBS will reduce mortgage costs to the extent that the resulting reduction in MBS yields passes through to mortgage borrowers. However, some observers have claimed that the widening of the spread between conforming mortgage rates and agency MBS yields seen over the past year is evidence that the effectiveness of monetary policy has been reduced by other developments in mortgage markets. While this spread tends to rise when refinancing activity picks up—compare the black and red lines in Figure 2—its current value is in fact quite high by historical standards even given the current volume of refinancing, and is close to the level seen at the height of the financial crisis.[8] However, the effects of this elevated spread on household spending are unlikely to be large. Returning the spread to its 2007 average would imply a decline in mortgage rates of around 50 basis points. Using the refinancing model discussed above, this decline in rates would yield interest savings to households of at most about

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[6] The mortgage rate gap is statistically and economically significant, and the adjusted R-squared for the model is 21 percent. Note that our results were robust to the inclusion of additional variables, including lags of the dependent variable and changes in house prices.

[7] Not all of this interest saving would show up as higher disposable personal income: To the extent that the refinanced mortgages are held by U.S. investors, the net interest component of personal income would be reduced accordingly. (See Remy, *et al.*, 2011, and Tracy and Wright, 2012, for a discussion of the potential magnitudes involved.) In addition, if points are charged when the mortgages are refinanced, this would initially show up as a reduction in the rental income component of personal income.

It is also instructive to consider what a more ambitious increase in refinancing activity would imply. For example, a proposal by Boyce, *et al.* (2012) calls for all mortgages in GSE pools that are current to be allowed to refinance at a 4 percent rate or lower. It is estimated that this would reduce annual mortgage payments by $36 billion, which is equivalent to 0.3 percent of disposable personal income (again, the actual effect on disposable personal income would be subject to the preceding caveat).

[8] See Dawsey and Molloy (2012) for a discussion of several possible explanations for why the spread could be unusually high, including reduced competition, lower capacity, and higher costs in the mortgage origination sector. To some degree, policy-induced reductions in the overall level of long-term interest rates may not have passed through completely to mortgage rates given the constraints on the ability of originators to meet increased demand for refinancing. Nevertheless, event-study evidence suggests that past policy actions—notably, the first round of large-scale asset purchases—were effective in bringing down MBS yields and mortgage rates, possibly because these actions improved market functioning along other dimensions (for instance, by reducing uncertainty about future MBS demand).

$13 billion per year, which is 0.1 percent of disposable personal income. (This estimate is probably an upper bound, as it implies a volume of refinancing activity that—while not unprecedented—would be very large.) In addition, conventional models of residential investment suggest that a 50 basis point reduction in mortgage rates would boost that component of spending by about 3½ percent after one year, which would add less than 0.1 percentage point to annual GDP growth.

Revolving consumer credit

In the aggregate, credit limits for existing credit card accounts fell sharply after the financial crisis for both prime and nonprime consumers (see Figure 3). For prime consumers, these limits stabilized after the middle of 2010 before rising about 6 percent through the end of 2011; by contrast, aggregate credit limits for nonprime consumers continued to decline. If we assume that nonprime credit limits had instead risen at the same rate as for prime borrowers, they would have been $31 billion higher at the end of 2011. Given that nonprime consumers borrowed 77 percent of their credit limit on average over this period, a partial-equilibrium calculation suggests that the resulting increase in spending that would have been supported by additional credit extension to nonprime households would have added a little over 0.1 percentage point to consumption growth at an annual rate (this excludes the effect of higher interest payments). Even if nonprime credit limits had completely returned to their pre-crisis level over the past six quarters—which would leave their end-of-2011 level $94 billion higher—the resulting one-time increment to spending growth over this period would have averaged about ½ percentage point at an annual rate under our assumptions (again, this excludes any effect of higher interest payments). It seems unlikely, then, that reduced access to revolving credit by nonprime households has been a major impediment to overall consumer spending.[9]

Banking-sector developments and bank lending

The bank-lending channel provides another potentially important way in which changes in monetary policy are transmitted to the real economy. We focus on three developments in the banking sector that could have plausibly resulted in a smaller-than-usual increase in bank lending in the current recovery. First, banks might desire to move toward the new, higher capital-asset ratios required under the Basel III framework. Second, banks could still perceive a need to build up reserves for expected future losses on existing loans. Finally, the behavior of the yield curve in recent years could be limiting the scope for financial institutions to "earn their way" to higher capital. If some or all of these factors have been in play over the past several years, they could be partly or wholly offsetting the effect that access to low-cost funding (itself the result of substantial monetary accommodation) has had on bank lending. As a result, real activity could have been weaker than it otherwise would have been. That said, these developments are

[9] As noted, credit limits for prime borrowers have also declined on net since the crisis. Nevertheless, barring strong compositional effects, it appears unlikely that this reduction had a material effect on consumer spending: On average, prime consumers tend to borrow only about 20 percent of their credit limit.

Revolving credit accounts for about a third of consumer credit. While we have less information about nonrevolving credit, about 40 percent of nonrevolving consumer credit is accounted for by auto loans. The share of nonprime loans in total auto financing has risen sharply since 2009, from 36.4 percent to 41.5 percent (though it remains below the 44.6 percent share posted in 2007).

probably better thought of as mainly representing adverse shocks that have *offset* the effects of monetary policy actions on lending, rather than as factors that have reduced the *sensitivity* of bank lending to monetary policy. For that reason, any effects that we find should again be viewed as an upper bound on the extent to which this component of the monetary transmission mechanism has been attenuated.

We analyze the potential effects of these banking-sector developments on lending using regression models that explain loan growth as a function of capital surpluses, other bank-specific variables, and various macroeconomic controls.[10] The capital surplus for bank i in period t, $S_{i,t}$, is defined as

$$S_{i,t} = \frac{K_{i,t}}{\rho_t \cdot A_{i,t}} - 1,$$

where $K_{i,t}$ denotes bank capital, ρ_t denotes a target capital-asset ratio, and $A_{i,t}$ is bank assets. The target capital-asset ratio equals a specified regulatory capital ratio plus an assumed buffer of 2 percentage points (a buffer of this magnitude is in line with historical experience). We consider four separate definitions of the regulatory capital ratio (the common equity, Tier 1 capital, total risk-based capital, and leverage ratios), and assume that the Basel III values of the ratios became relevant to banks after the second quarter of 2010 (even though these new standards will not be fully phased in until 2019).[11]

We then model loan growth at bank i in period t, $\Delta L_{i,t}$, as

$$\begin{aligned}\Delta L_{i,t} = {} & \alpha_0 + \alpha_1 Crisis_t + \alpha_2 Basel_t + \beta_1 S_{i,t-1} + \beta_2 Crisis_t \cdot S_{i,t-1} + \beta_3 Basel_t \cdot S_{i,t-1} \\ & + B(L)\Delta L_{i,t-1} + \gamma_1 Macro_t + \gamma_2 Controls_{i,t-1} + f_i + \varepsilon_{i,t},\end{aligned}$$

where $Crisis_t$ is an indicator variable for the 2008:Q1 to 2010:Q2 period; $Basel_t$ is an indicator variable to capture the Basel III transition period (which we assume begins after 2010:Q2); $Macro_t$ is a set of macroeconomic variables; $Controls_{i,t}$ is a set of bank-specific variables; and f_i denotes bank-specific fixed effects.[12] (Note that the model allows the effects of the capital surpluses to differ over both the crisis and Basel III transition periods.) Our full sample period runs from 1998:Q2 to 2011:Q4, and the sample is restricted to include bank holding companies with at least $3 billion in assets in the third quarter of 2008 (a total of 146 bank holding companies is used in the baseline analysis).[13]

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[10] Berrospide and Edge (2010) use a similar specification to analyze the effect of bank capital on lending.

[11] Not all measures of bank assets and capital affected by the Basel III framework are available in the data that we use for our analysis. Where necessary, we therefore employ a set of regression models based on the relationship between the share of assets excluded from risk weighting and the Basel I to Basel III risk-weighted asset conversion factors (which are taken from the Quantitative Impact Studies) to impute risk-weighted assets under Basel III.

[12] The macro variables we use are four lags of real GDP growth, the federal funds rate, and GDP price inflation, along with the current value and two lags of lending standards for large commercial loans from the SLOOS. The bank-specific variables we use are the ratio of securities to assets, controls for mergers and TARP receipt, the shares of loans 30 and 90 days late, the share of non-accrual loans, and the ratio of net charge-offs to assets. We also include a set of seasonal dummies, and allow four lags of loan growth to enter the model.

[13] This criterion for asset size follows Berrospide and Edge (2010). The data are taken from the consolidated bank holding company reports (the Y9-C data). We correct for mergers and acquisitions and drop observations that

To aid in interpretation (and for comparison with related studies), we use average lending, capital, and asset levels to express the effects of capital surpluses as the dollar increase in lending that results from a one-dollar surplus (or, equivalently, the dollar reduction in lending that results from a one-dollar shortfall). The first two columns of figures in Table 1 summarize our results; for each of the four regulatory ratio concepts that we consider, the estimated effects of surpluses on lending appear to have been smaller in the most recent period—what we call the Basel III transition period—than they were in the pre-2008 period. This difference is only statistically significant for the leverage ratio, however (and is generally imprecisely estimated, possibly because of the small number of observations we have for the transition period).[14]

To further explore these results, we also estimated a variant of the baseline regression that allows for capital surpluses and shortfalls to have different effects; these estimates are summarized in the remaining columns of Table 1. Comparing the two sets of results indicates that the decline in the effects of capitalization levels on lending in the transition period appears to be largely driven by a smaller effect of positive capital surpluses (once again, the reduction in the effect of capital surpluses is only statistically significant for the leverage ratio). The evidence that capital *shortfalls* have had a larger effect on lending in the Basel III transition period—which would be expected if banks had begun aggressively moving toward the new Basel III standards—is somewhat mixed. Although the reduction in lending that obtains from a capital shortfall is in fact larger in the most recent period for the measures based on Tier 1 and total risk-based capital, the difference is only statistically significant for the former measure (because we need to impute a number of components of total risk-based capital, the risk-based capital estimates likely suffer from some degree of measurement error). In addition, the results based on the common equity measure imply a *smaller* effect on lending most recently, though the difference is not statistically significant in this case.

Over the Basel III transition period, total capital surpluses have been smaller and more banks have faced capital shortfalls. If we take the point estimates from our regression estimates at face value and average across the four variants of our loan growth model, the implied effect of this deterioration in banks' capital positions would have been to depress lending growth by about 7 percentage points per year since the middle of 2010. We assume that this reduction in lending growth is representative of the commercial banking sector as a whole, and feed it into a small VAR model in order to compute the potential effect on real activity. This calculation implies that the reduction in bank lending implied by our panel regression models would have reduced average real GDP growth over this period by about ½ to 1 percentage point per year depending on the VAR model's specification.[15] Of course, this estimate is subject to numerous caveats—

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exhibit increases or decreases in total assets in excess of 50 percent in a single quarter; in addition two other firms (Taunus Corp. and State Street) were excluded from the sample because they do not engage in commercial bank activities.

[14] Our estimate of the effect of the leverage ratio on lending in the pre-2008 period is essentially identical to the value reported by Berrospide and Edge (2010).

[15] The VAR includes the unemployment rate, the rate of core PCE price inflation, the spread between BAA and 10-year Treasury yields, the 10-year term premium, the rate of growth of bank lending, and the federal funds rate; each variable enters with two lags. (We use a separate Okun's Law relation to obtain the estimated effect on real GDP; using the GDP gap or real GDP growth in the VAR instead of the unemployment rate yields smaller estimated effects of lending growth.) We measure bank lending as either commercial or industrial loans or total core lending

and considerable uncertainty—and so should be viewed as representing a potential order of magnitude only.[16]

We can use our basic model to examine two other questions related to the effect of recent developments in the banking sector on bank lending. First, bank lending could be restricted if banks anticipate future loan losses. The share of non-accrual loans in our sample rises sharply after 2007 (from an average of 0.6 percent in the pre-2008 period to 3.6 percent in the period after 2010:Q2).[17] However, the estimated effect of this share on lending (which is significant and negative in the pre-2008 period) also declines in the most recent sample period, yielding essentially no net effect of the higher share of non-accrual loans on bank lending.

Second, because banks derive part of their profits from maturity transformation, a low level or slope of the yield curve could be associated with reduced bank profitability. To assess the possible effect of recent yield curve movements on bank lending, we augment our basic model with a measure of the degree of maturity mismatch between bank assets and liabilities, the slope of the yield curve, and the interaction of the two variables. For our baseline sample, the degree of maturity mismatch has no effect on bank lending; moreover, our model suggests that a 100 basis point increase in the yield curve slope would be expected to *reduce* lending growth by 0.35 percentage point.[18]

On balance, then, the anticipation of higher capital standards may have reduced lending and thus held back real activity to some extent, though our results do not strongly suggest that other developments in the banking sector have led to reductions in lending that would act to significantly offset the greater access to cheap funding that has resulted from accommodative monetary policy.[19] Again, however, this situation is not likely to have contributed much to an actual *attenuation* in the effectiveness of monetary policy.

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for all commercial banks; the former measure yields the larger point estimate for GDP growth reported above. The VAR's estimation period runs from 1990 to 2007.

[16] The uncertainty around our estimated effect of lending growth on real GDP is mirrored in the extensive literature on this subject. To take two representative examples: The estimates in Bassett, *et al.* (2011) would imply a reduction in real GDP growth of about 1½ percentage points per year for the reduction in loan growth considered here (note that Bassett, *et al.* consider the effect of a shock to the SLOOS lending standards measure on bank loans and GDP, so their estimate will be boosted to the extent that standards have an independent effect on activity). By contrast, the estimates in Ashcraft (2006) would imply smaller reductions in GDP growth, ranging from zero to an upper bound of 0.7 percentage point per year.

[17] A non-accrual loan is a loan on which the bank is not receiving interest payments from the borrower. Typically, a nonperforming loan becomes a non-accrual loan when the bank has not received principal and interest payments on the loan for 90 days (unless the loan is fully collateralized).

[18] The maturity mismatch variable is taken from English, *et al.* (2012); the yield curve slope is derived from a principal component decomposition of a sample of six-month, one-year, three-year, five-year, and ten-year yields. (For this exercise, the sample is restricted to bank holding companies that have U.S. companies at the top of their ownership chain.) The finding of a negative relation between the yield curve slope and lending growth is consistent with English, *et al.*, who interpret it as reflecting a lower demand for loans when interest rates increase.

[19] We carried out two extensions to assess the robustness of these results. First, we repeated the analysis using capital surpluses that were computed with assumed buffers of zero, one, and three percentage points; the results were unchanged. Second, where applicable we repeated the analysis using two different samples: the 50 largest bank holding companies with U.S. companies at the top of the ownership chain, and a larger sample of 779 bank holding companies. In general, the results were quite similar; one exception is that the larger sample implied smaller effects of capital surpluses and shortfalls on lending, which could reflect the fact that the smaller bank

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holding companies in our sample have higher capital ratios and are less likely to come under regulatory pressure inasmuch as they are not viewed as systemically important.

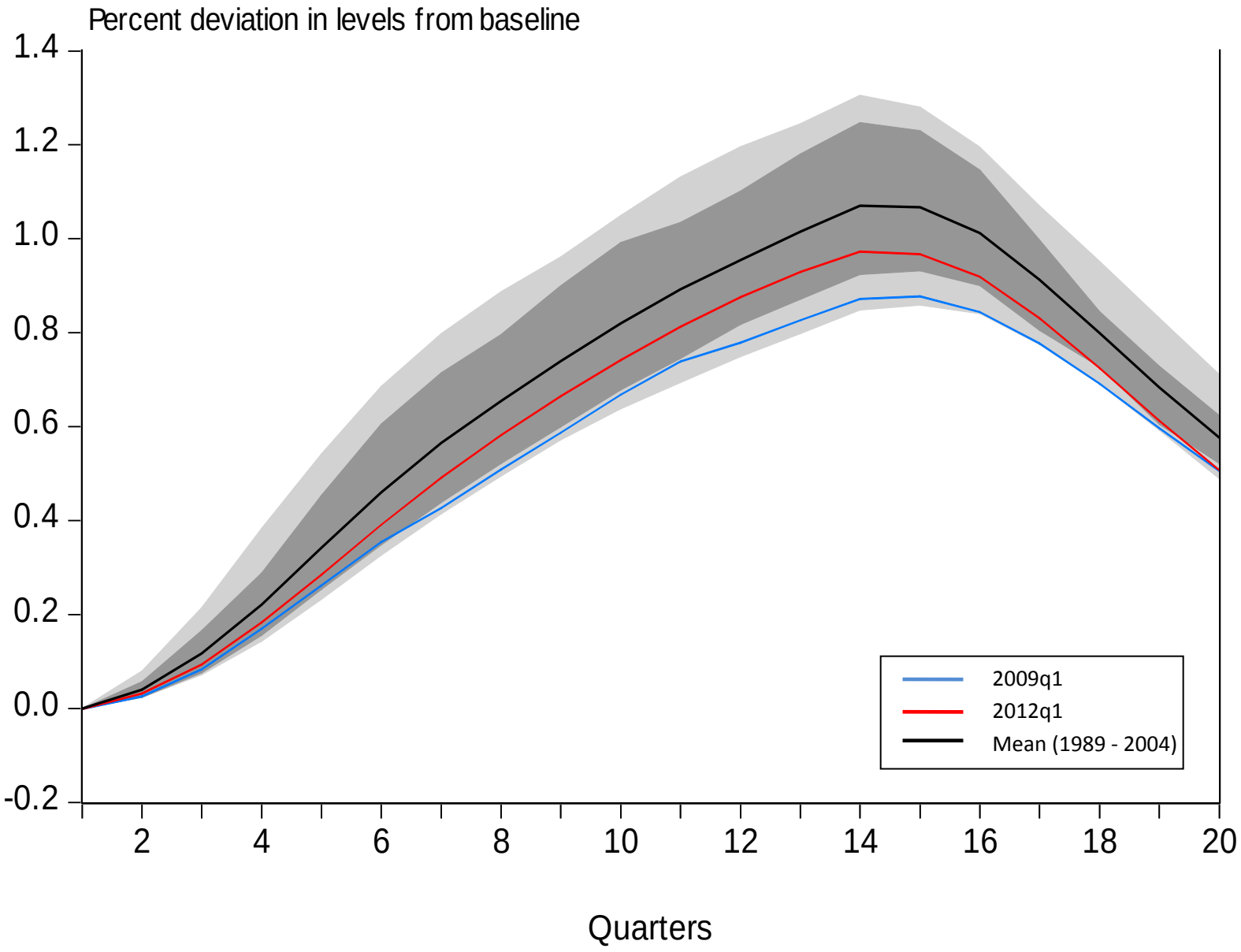
Table 1
Estimated Effect on Lending of a One-Dollar Capital Surplus or Shortfall

Capitalization concept	*Symmetric effect of capital surplus/shortfall*		*With differential effect of surplus or shortfall*			
			Surpluses		Shortfalls	
	Pre-2008	Recent	Pre-2008	Recent	Pre-2008	Recent
Common equity	$1.47***	$0.76	$1.47***	$0.62	$4.66**	$3.73
Tier 1	$1.33***	$1.20	$1.39***	$0.88	a.	$2.48**
Total risk-based	$2.01***	$1.64	$2.41***	$2.68	$0.11	$0.58
Leverage ratio	$1.91***	$1.00***	$2.01***	$1.27*	b.	c.

Notes: The first two columns of figures give the dollar increase (decrease) in lending that results from a one-dollar capital surplus (shortfall). The middle two columns give the *increase* in lending that results from a capital *surplus*, and the last two columns give the *decline* in lending that results from a capital *shortfall*. ***/**/* denotes significant at 1/5/10 percent level, respectively.

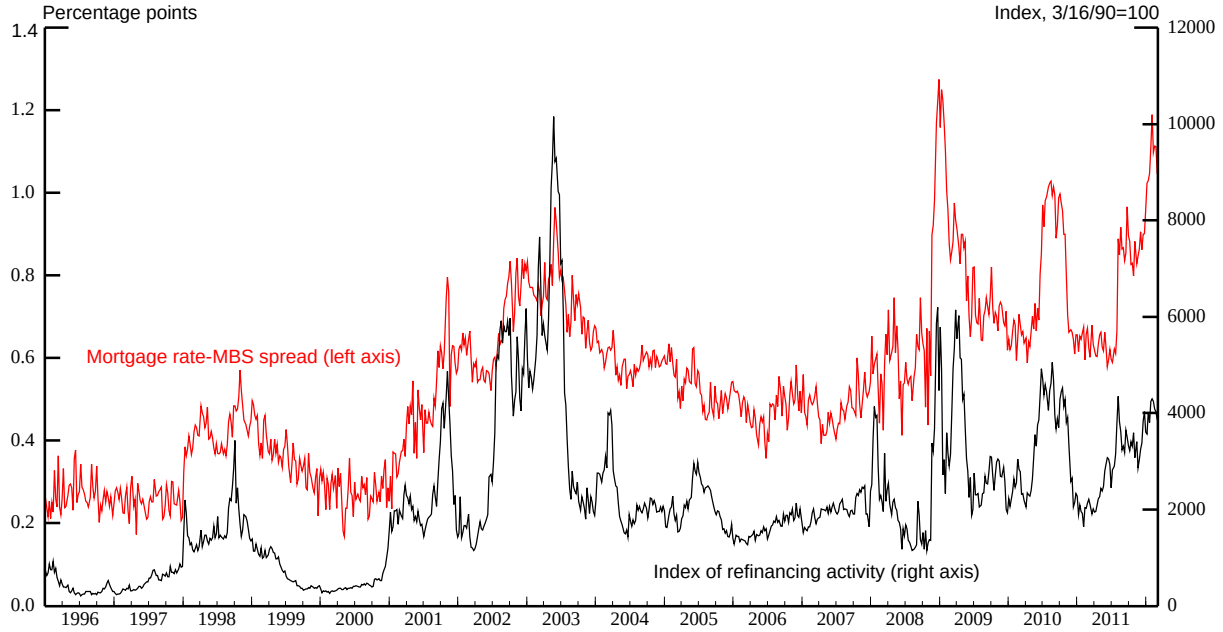
a. Negative and insignificant point estimate.
b. Negative point estimate, significant at 5 percent level.
c. Negative and insignificant point estimate.

Figure 1
Response of Real GDP to Monetary Policy Shocks



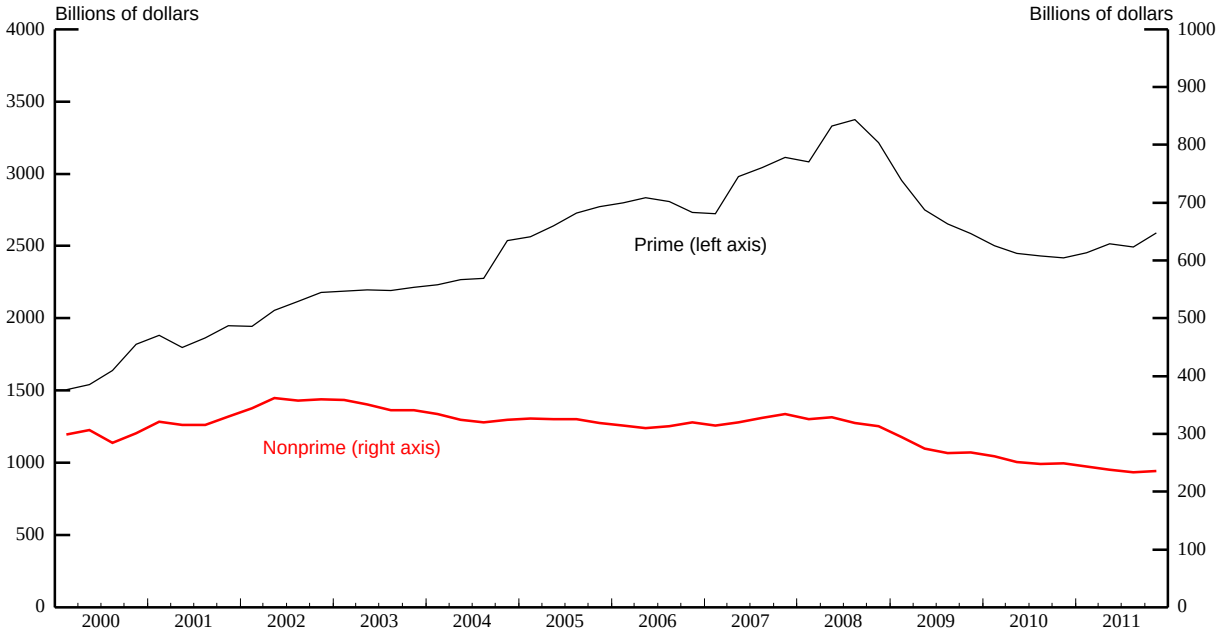
Note: The dark shaded area is the 68% confidence interval around the mean. The light shaded area is the 90% confidence interval.

Figure 2
Mortgage refinancing activity and spread between mortgage rates and MBS yields



Source: For refinancing activity, Mortgage Bankers Association; for mortgate rate, Freddie Mac; for MBS yield, Barclays.

Figure 3
Credit limits for prime and nonprime consumers



Source: Equifax.