Sydney Ludvigson, Charles Steindel, and Martin Lettau

Monetary Policy Transmission through the Consumption-Wealth Channel

Introduction

Asset market values react to economic news and policy changes, and consumers react to changes in asset market values. The consumption-wealth channel of monetary policy spells out this mechanism: changes in monetary policy affect asset values, which in turn affect consumer spending on nondurable goods and services.

This paper attempts to quantify these linked effects. After sketching the evolution of research on the wealth channel, we turn to evidence of its size from a number of large-scale econometric models. We then estimate a small, structural vector autoregression (VAR) under some identifying assumptions to provide our preferred estimates of the wealth channel. We find that evidence of an important wealth channel for monetary policy is scant. However, there is some role for a consumption-wealth channel in the large-scale models—with considerable variation as to its size. Finally, the structural VAR framework is found to show little or no sign of a consumption-wealth channel.

Evolution of Thought on the Wealth Effect

The wealth channel has deep roots in the literature on monetary policy and economic stabilization, reaching back at least to the earliest literature stimulated by Keynes' *General Theory*. Early on, Gottfried Haberler and A.C. Pigou noted that changes in consumer spending generated by countercyclical changes in the real value of the money stock could help provide an automatic stabilizing force to an economy subject to inflationary and deflationary forces (see the discussion in Gilbert [1982]). Subsequent work, notably by Modigliani (1944, 1963) and Patinkin (1965), elucidated the conditions needed in the money, goods, and labor markets through which this "real balance effect" could stabilize the economy at full employment.[1]

Other work of Modigliani and collaborators, in particular, expanded this theoretical literature on the real balance effect into a full-blown analysis of the impact of wealth changes *induced* by monetary policy (as opposed to the passive change in the real balances examined in the earliest literature). Modigliani's life-cycle model of consumer spending emphasized the critical role of household wealth in determining spending on nondurable goods and services (Brumberg and Modigliani 1954, 1980; Ando and Modigliani 1963).

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Parallel to this work on the life-cycle model of consumption was the development of the Federal Reserve Board's econometric model of the U.S. economy, which specifically traced the connection between changes in monetary policy instruments and changes in asset markets (de Leeuw and Gramlich 1969; Modigliani 1971).[2] Point estimates from this model (Modigliani 1971) suggest that roughly one-half of the impact of monetary policy changes on real economic activity through time periods of policy interest could be attributed to changes in spending arising from policy-induced changes in stock market values.[3]

Aside from the *quantitative* evidence, it is possible that the qualitative importance of the wealth channel for policy analysis grew during the 1970s and 1980s. In the 1960s and early 1970s, some of the most obvious impacts of monetary policy were evident through monetary policy's effects on thrift deposit inflows, mortgage lending, and homebuilding. This was an artifact of the Regulation Q ceilings on deposit rates and the illiquidity of mortgages. With the removal of deposit ceilings and the development of secondary mortgage markets, this mortgage credit channel faded as a dramatic sign of monetary policy effects. However, if the traditional econometric model evidence of a strong consumption-wealth channel remained intact, there would be obvious effects (and guideposts along the way, in the form of changes in long-term rates and stock market values) of policy changes.

In the absence of particularly large monetary policy changes in recent years, specific discussion of the wealth channel of monetary transmission has diminished. But clearly there are many analysts who contend that the massive run-up in the stock market in the second half of the 1990s has been a decisive element behind the strong growth of consumer spending and the economy in that period.[4] This brings up the obvious line of thought that perhaps monetary policy helped, intentionally or not, to sustain the surge in the market and thus contributed to the growth of spending. There is also the issue of how much future policy changes can be expected to affect consumer spending through changes in the market.[5] Finally, given the long time that has passed since the early studies of the wealth channel, reexploring the issue seems warranted.

Evidence on the Wealth Channel from Large-Scale Models

This section explores statistical evidence on the wealth channel based on large-scale econometric models. We do not regard such evidence as particularly persuasive. It is well established that estimates of policy effects measured by "structural" econometric models of the type we examine have numerous sources of error—most notably, the instability of the expectational mechanisms specified in many sectors toward changes in policy, as emphasized by Lucas (1976).

Nonetheless, to provide a baseline for our later results, we start by exploring the traditional work. We first look at the importance of the consumption-wealth channel in the transmission of monetary policy in three large-scale econometric models: the Data Resources, Incorporated (DRI) model, the Washington University Macroeconomic Model (WUMM), and the new Federal Reserve Board (FRB/US) model.

The DRI and WUMM models have many features in common with the old FRB model used in Modigliani's study. Policy-induced changes in short-term interest rates affect longer term interest rates, stock market valuation, household wealth, and consumer spending. The models differ in the specifics of the estimated relationships (for instance, in the lag structures of the equations and in other variables introduced into the behavioral equations) and the level of detail (the DRI model decomposes consumer spending into many more categories than does the WUMM). While these differences can greatly alter the timing and ultimate size of policy effects, the similarities may be more substantive.

The wealth effect on consumption is typically defined as the marginal impact of wealth on consumption, controlling for other fundamentals of spending such as labor income. Ideally then, the policy experiment we would like to conduct is one that, subsequent to an innovation in monetary policy, shuts off the *marginal* effect of wealth on consumption, as opposed to shutting off the effect of wealth on all variables in the system. We conduct this experiment in the next section using a small structural VAR. Unfortunately, the structure of the large-scale models investigated in this section is not readily suited to studying this marginal effect of wealth on consumption. But it is straightforward, subsequent to a monetary policy shock, to shut off the effect of wealth on *all* variables in the system, yielding an estimate of the wealth channel of monetary transmission to the entire economy rather than to consumption alone. We do this next.

The policy exercises for the two models were identical: first, simulate the impact of a 100-basis-point cut in the federal funds rate path. Second, repeat the first simulation, but freeze the value of the stock market to lie on its initial path. Comparing the two simulations gives a sense of the importance of the wealth channel for monetary policy.

Panel A of the table presents the effects of the hypothesized change on the growth rate of the entire economy. In the WUMM, a 100-basis-point cut in the funds rate boosts real

GDP almost 1 percentage point after four quarters, and more than 2 percent after twelve quarters. If, however, the gain in the value of household equity holdings associated with the funds rate cut is removed, the associated increase in output after three years is cut in half—a result very similar to the 1971 Modigliani result.

The impact of monetary policy is smaller in the DRI model. In this model, a 100-basis-point cut in the funds rate raises real output by much less than 1 percentage point within a year. The cumulative impact of the cut peaks roughly two years after its start, and the ultimate gain in output is less than 1 percent. Like the WUMM, if the increase in household equity holdings associated with the funds rate reduction is removed, the gain in output is roughly halved.

The FRB/US model is currently used for policy analysis at the Board of Governors, replacing the old FRB model. It is rather different in its structure from the DRI, WUMM, and FRB models, and partly addresses some of the key criticisms of the older models (see Reifschneider, Tetlow, and Williams [1999]). In the FRB/US model, changes in monetary policy cannot be described simply as a movement in a short-term interest rate. The effect of a policy-induced move in rates depends on the extent to which it was anticipated (model simulations may include policy reaction mechanisms, such as "Taylor rules," to capture these anticipations). The far right columns of each of the three sections of panel A show the effect of a 100-basis-point cut in the federal funds rate in the FRB/US model when anticipations of the federal funds rate are formed from a VAR. In this case, the initial cut in the rate is unexpected. The one-year increase in output with a fully operative wealth effect is in line with the DRI model, while the two-year increase is in line with the WUMM. However, the FRB/US model estimates that only about one-fourth of the movement in real GDP over two years resulting from the change in the funds rate can be attributed to changes in the stock market. This is of some importance, but it is clearly considerably smaller than the share Modigliani estimated and those derived from the DRI and WUMM models.

The data in panel A of the table relate to overall GDP. Discussion of the wealth channel tends to focus on the link from policy-induced changes in asset values to consumer spending on nondurable goods and services. (We take this focus in the next section.) Panel B presents evidence on the effects of a reduction in the funds rate on such spending in the models, with and without a change in equity values.[6] The timing of the wealth effect is similar to that on overall GDP, and the relative magnitude of such effects across models is also comparable. Notably, in all three models, even with an operative wealth effect, consumer spending on nondurable goods and services is less responsive to a change in the funds

Estimates of Monetary Policy Effects and Importance of the Wealth Channel in Large Econometric Models

	With-Wealth Effect			Without-Wealth Effect			Wealth Effect		
Quarter	WUMM	DRI	FRB/US	WUMM	DRI	FRB/US	WUMM	DRI	FRB/US
	Panel A: Effect on Real GDP (Percent)								
1	0.1	0.1	NA	0.1	0.1	NA	0.0	0.0	NA
4	0.9	0.6	0.6	0.6	0.2	0.5	0.3	0.4	0.1
8	1.8	0.8	1.7	1.1	0.3	1.2	0.8	0.5	0.5
12	2.5	0.9	NA	1.3	0.4	NA	1.3	0.5	NA
	Panel B: Effect on Real Spending on Nondurables and Services (Percent)								
1	0.1	0.0	NA	0.0	0.0	NA	0.0	0.0	NA
4	0.5	0.2	0.3	0.2	-0.2	0.2	0.3	0.4	0.1
8	1.1	0.2	1.1	0.4	-0.3	0.5	0.6	0.5	0.6
12	1.7	0.2	NA	0.4	-0.3	NA	1.3	0.5	NA

Sources: Washington University Macroeconomic Model (WUMM); Data Resources, International (DRI) model; authors' calculations; Federal Reserve Board (FRB)/US model; David Reifschneider.

Notes: For the WUMM and the DRI model, the table reports the effect of a 100-basis-point reduction in the federal funds rate on a baseline forecast made beginning in 2001:1; the without-wealth-effect computation was made by restoring real aggregate household equity holdings to the baseline path. For the FRB/US model, the table reports the effect of a 100-basis-point reduction in the federal funds rate, assuming vector autoregression expectations.

rate than is the economy as a whole. There are clearly important channels of monetary policy other than the consumption-wealth channel.

In summary, the WUMM provides the strongest evidence that stock market responses provide a predominant way through which movements in the federal funds rate affect the economy, but even in that model, the consumption-wealth channel does not appear to be of overwhelming importance. Stock market responses are a significant channel of policy in the DRI model, but that model is rather unresponsive to monetary policy, and spending on nondurable goods and services is even less responsive to policy. The FRB/US model estimates that stock market changes are an important, but hardly dominant, way for monetary policy to affect the economy. These exercises, of course, hardly settle the issue of a consumption-wealth channel for monetary policy, especially given the many questions raised about the meaning of policy simulations with such models.[7] In the next section, we produce our own evidence on the size of the consumption-wealth channel from a small, structural VAR.

A Small Structural VAR

Large-scale macroeconomic models are useful tools for simulating the economic effects of policy shocks when one is interested in the dynamic response of multiple sectors. The drawback with these models, however, is that they incorporate a large number of strong assumptions about the economic structure (Sims 1980). Estimates of policy responses in one sector are sensitive to possible misspecification of the underlying economic structure in another sector. Thus, if the goal is to understand a small number of primitive relationships, it may be preferable to impose the minimum number of identifying assumptions necessary to study the specific economic relationships in question. This minimalist approach can be undertaken by working with small structural VAR models. In this section, we adopt this methodology to study the transmission of monetary policy to consumption via its influence on household wealth.

We also adopt the approach, commonplace in the VAR literature on monetary policy, of studying the response of real variables to unsystematic policy shocks, as measured by innovations in the federal funds rate. One reason for the focus on unsystematic shocks is that systematic monetary policy will have no effect on the real economy if people form expectations rationally (Lucas 1976). Others have studied the effects of systematic, or endogenous, changes in monetary policy (Bernanke, Gertler, and Watson 1997; Cochrane 1998; Hoover and Jordá 2001).[8] Procedures for identifying how the systematic component of monetary policy operates through the consumption-wealth link are beyond the scope of this paper and are left to future research.

The purpose of this paper is to investigate how innovations in the federal funds rate influence household wealth, and how those changes in wealth influence consumer spending. Our investigation has two steps. First, as a baseline, we estimate a small, dynamic structural model that includes three variables that are clearly central to household spending: the log of consumption, c_t, the log of labor income, y_t, and the log of asset wealth, a_t. Also included in this baseline model are the federal funds rate, FF_t (an indicator of monetary policy), and a measure of inflation, $\pi_t \equiv p_t - p_{t-1}$ (upon which monetary policy clearly depends).[9] Throughout this paper, we use lowercase letters to denote log variables, that is, $p_t \equiv ln(P_t)$. We investigate this five-variable system as a benchmark; below, we also discuss the results of estimating a six-variable system that includes a commodity price index in addition to the variables just mentioned.

This baseline model can be used to construct standard impulse response functions (IRFs) showing the dynamic response of consumption to a shock to the federal funds rate. Such a response gives the total effect of a federal funds rate shock on consumption, including the effect via the possible influence of that shock on wealth.

The second step in our approach is to simulate the consequences of a federal funds rate shock under a counterfactual regime, following the methodology in Bernanke, Gertler, and Watson (1997) and Sims and Zha (1999). The specific counterfactual experiment we consider is one that "shuts off" the wealth channel to consumption that would otherwise be implied by the baseline model. The difference between the total effect of a federal funds shock on consumption and the estimated effect from the counterfactual experiment is then interpreted as a measure of the contribution of the consumption-wealth channel in the transmission of monetary policy.

To implement this two-step approach, we need a structural model of the contemporaneous relationships between the variables in our benchmark system. Thus, we specify a structural VAR model.[10] Below, we provide the intuition behind the model.

We write our baseline dynamic structural model as a five-variable VAR:

$$(1) \qquad B_0 z_t = k + B_1 z_{t-1} + B_2 z_{t-2} + \ldots + B_p z_{t-p} + u_t ,$$

where $z_t = (\pi_t, y_t, c_t, a_t, FF_t)'$. (An extension of the basic model, presented below, includes a commodity price index as a sixth variable.) The vector of disturbances, u_t, represents the structural innovations; these disturbances are assumed to be serially uncorrelated and uncorrelated with each other. The matrix B_0 governs the contemporaneous relations among the variables in the system.

To identify the structural innovations, we must specify a set of restrictions on the model, specifically on B_0. Such restrictions will allow us to identify the parameters in equation 1 and trace out the dynamic influence of the one variable on other variables in the system through impulse response functions. A common approach is to assume that B_0 is lower triangular. This approach requires the presumption that all variables react to an innovation in the federal funds rate with a lag. This assumption may be reasonable for "slow-moving" macroeconomic variables, but it is clearly less plausible for asset values, which can react almost instantaneously to news about monetary policy. The opposite also seems plausible: it is clearly possible for monetary policy to react within a quarter, or even a month, to movements in asset values. It follows that a traditional approach to identifying structural innovations is unlikely to capture the true contemporaneous relationships between consumption, asset wealth, and monetary policy. Thus, we offer an alternative set of identifying assumptions, which we now describe.

Since we are not concerned with identifying the effects of innovations in the other variables in the system, we may "sweep out" the block of variables not directly involved in the consumption-wealth–federal-funds relationship (that is, π_t and y_t) and achieve identification by placing restrictions on the lower right-hand submatrix of B_0, which governs the contemporaneous relations between c_t, a_t, and FF_t. Thus, we start by writing B_0 as

$$(2) \qquad B_0 = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ \beta_{21} & 1 & 0 & 0 & 0 \\ \beta_{31} & \beta_{32} & 1 & \beta_{34} & \beta_{35} \\ \beta_{41} & \beta_{42} & \beta_{43} & 1 & \beta_{45} \\ \beta_{51} & \beta_{52} & \beta_{53} & \beta_{54} & 1 \end{bmatrix},$$

and focus on placing the number of further restrictions needed on the lower-right-hand, three-by-three submatrix to ensure identification of the structural model (equation 1). We place only the number of restrictions necessary to identify exactly the structural model. Although overidentified models can be estimated, we consider only exactly identified models because (as is typically the case) substantive overidentifying assumptions are not obvious. Next, we discuss these restrictions in detail.

First, following Bernanke and Blinder (1992) and many others, we assume that the federal funds rate responds contemporaneously to developments in the macroeconomy (consumption and labor income), but changes in interest rates (given planning and production lags) can only affect these variables with a one-period lag.[11] Thus, we set $\beta_{35} = 0$.

Second, we assume that wealth, a_t, which is measured at the *beginning of the period*, is not influenced contemporaneously by c_t, a flow *over the period*.[12] This restricts $\beta_{43} = 0$. We justify this assumption with another one, namely, that the log of aggregate consumption is close to a random walk, consistent with a permanent-income type of behavior.[13] Since wealth is measured at the beginning of the period, consumption can only affect asset values contemporaneously if it captures expectations of consumption as of the end of the previous period. But if consumption is close to a random walk, lagged consumption—already accounted for in the asset wealth equation—completely summarizes expectations of consumption as of the end of the last period. Quarterly spending, of course, is not exactly a random walk; there is a small predictable component in consumption growth related to a small predictable component in labor income growth (Campbell and Mankiw 1989). So, more generally, we assume that the key variables that capture expectations of future consumption are already contained in the asset wealth equation. Thus, thinking of these equations as structural relations, we note that only those variables either known as of the end of $t-1$, or plausibly related to expectations formed as of the end of $t-1$, should influence a_t contemporaneously.

Third, we allow asset wealth, a_t, and the federal funds rate, FF_t, to influence each other simultaneously within the period, but we restrict the way in which asset values influence policy. Specifically, we assume that the Federal Reserve does not target asset values directly, but only cares about them insofar as they signal important movements in real variables or prices ($\beta_{54} = 0$). This assumption is consistent with the results in Bernanke and Gertler (1999), who find no evidence that the Federal Reserve responds to stock market returns independently of their implication for forecasts of inflation and the output gap.[14] In addition, we assume that the Federal Reserve does not attempt to use asset values to forecast real variables or inflation more than one quarter hence. Although in-sample regressions suggest that asset values have led some real variables and inflation at some times over the postwar period, such forecasting power is found to be unstable and, as a consequence, is not evident in out-of-sample forecasting tests (Stock and Watson 2000). Accordingly, we assume that the Federal Reserve does not attempt to exploit such unreliable forecasting power in predicting macroeconomic variables more than one quarter in advance, despite the possibility that there may be some episodes in history during which asset prices are found, ex post, to have led real variables and inflation.

These three assumptions are sufficient to identify the structural innovations in equation 1 and imply that B_0 takes the form

$$(3) \qquad B_0 = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ \beta_{21} & 1 & 0 & 0 & 0 \\ \beta_{31} & \beta_{32} & 1 & \beta_{34} & 0 \\ \beta_{41} & \beta_{42} & 0 & 1 & \beta_{45} \\ \beta_{51} & \beta_{52} & \beta_{53} & 0 & 1 \end{bmatrix}.$$

This matrix is clearly not lower triangular, but it nevertheless leaves the model exactly identified since there are now ten free parameters in B_0 to be estimated. Thus, to the extent that the identification assumptions we make here are plausible, the discussion so far implies that it would be misleading to make structural inferences about the relationships between the variables studied here from traditional recursive VAR models.

These assumptions *do not* imply that the Federal Reserve is unresponsive to contemporaneous movements in asset values, but rather that it reacts only indirectly to those movements to the extent that they contemporaneously influence real variables and prices. For example, consumer spending can react contemporaneously to movements in asset values, and the federal funds rate in turn may react within the period to movements in consumer spending. In particular, our assumptions allow for the possibility that wealth may influence consumer spending when asset values rise on the expectation of higher trend productivity growth, an expectation that presumably gets reflected immediately in higher stock prices. Thus, even if the higher expected productivity growth (and the enhanced productive capacity that accompanies it) may be largely realized sometime in the future, our model allows for the possibility that consumer demand may rise immediately on such an expectation. This possibility was raised by Alan Greenspan in his February 17, 2000, testimony before the House Committee on Banking and Financial Services.

Monetary Policy through the Consumption-Wealth Channel: Benchmark Experiments

Our data span 1966:1 to 2000:3. The VAR is estimated using a constant and four lags, as determined by Akaike and Schwarz criteria. The data for consumption, labor income, and wealth are real, measured in 1996 chain-weighted dollars. Our main results use the log of nondurables and services expenditure as consumption, c_t, but we also repeat our analysis using the log of total personal consumption expenditure (PCE).[15] The log of labor income, y_t, is measured after tax and is divided by the PCE chain-weighted implicit price deflator. The log of wealth, a_t, is total household net worth compiled from Flow of Funds data, and is also divided by the PCE chain-weighted implicit price deflator. The other variables we study in this section are the first difference of the log of the consumer price index, π_t, and the level of the federal funds rate, FF_t. (The appendix describes our data and data sources in detail.)

The Overall Effect of a Federal Funds Rate Shock

Chart 1 presents impulse responses of the five variables—inflation, labor income, consumption, wealth, and the federal funds rate—to a one-standard-deviation shock in each of the variables, as well one-standard-error bands. Several aspects of the chart stand out.

First, many of the impulse response functions to a funds rate shock are comparable to what has been reported elsewhere in the VAR literature on monetary policy. The funds rate shock itself is transitory, taking about ten quarters to die out completely. Labor income and consumption decline almost immediately in response to such a shock, and both series take about ten quarters to reach their troughs before gradually recovering. Also, the positive funds rate shock leads a temporary increase in inflation, a phenomenon often labeled "the price puzzle." Although researchers often include a commodity price index in the system in an attempt to eliminate this price puzzle, others have attributed the finding to the Federal Reserve's superior information about future economic conditions (Romer and Romer 2000). The Federal Reserve may raise rates, for instance, because it correctly believes that inflation will rise in the future. The rate increase may not fully offset the rise in inflation.

Second, a result not widely documented in the VAR literature is that a positive innovation in the funds rate takes about one quarter to begin depressing asset values. The effect of an innovation in the federal funds rate on assets is found to be both statistically and quantitatively important three quarters after the initial shock, at which time a one-standard-deviation increase in the federal funds rate reduces wealth by about 0.25 percent before recovering. Thus, the impact of the federal funds rate on wealth is largely transitory, dying out in about two and a half years.

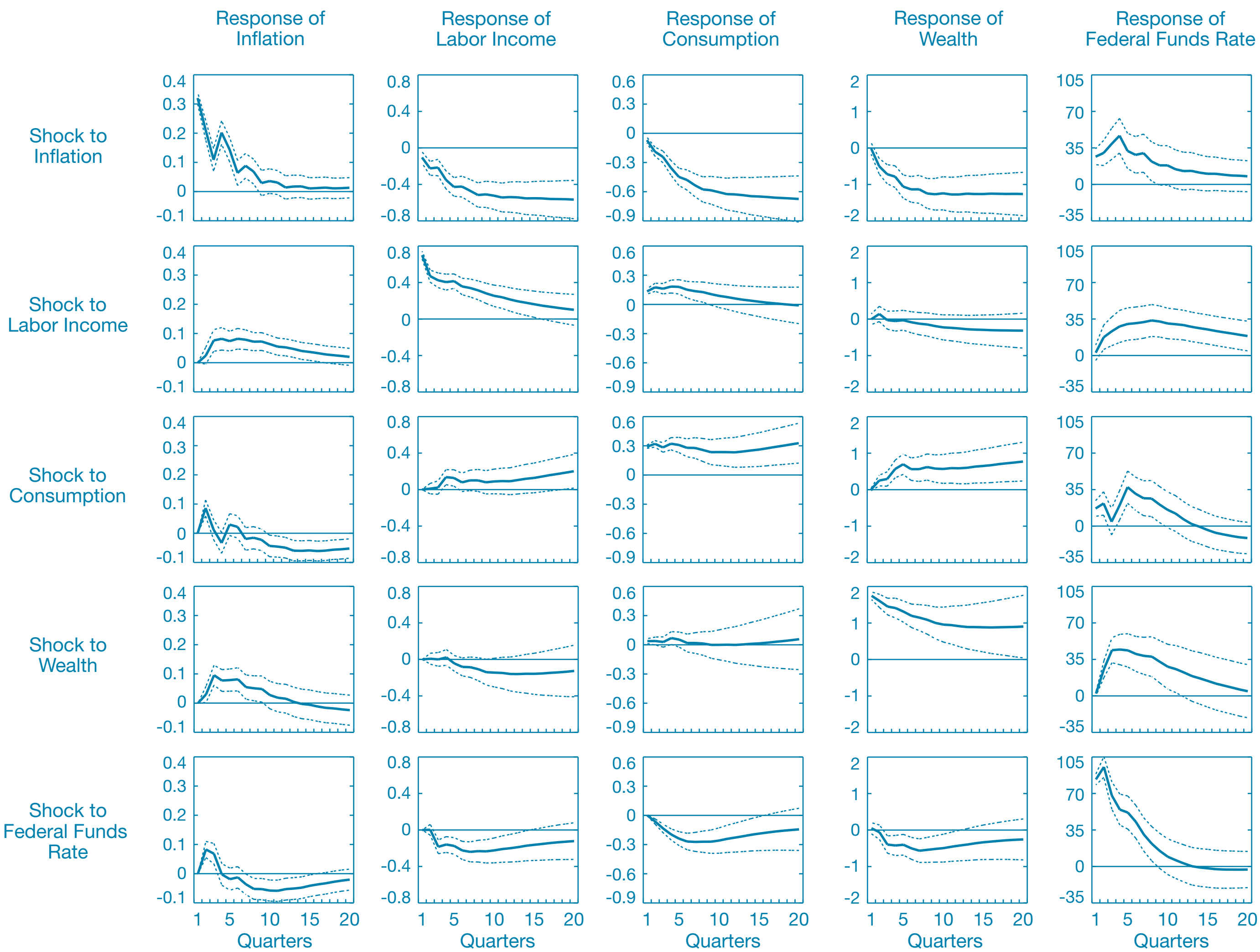
A third notable feature of Chart 1 is that the federal funds rate rises in response to a positive wealth shock. This could occur because the Federal Reserve targets asset prices directly.

Such a hypothesis, however, is not supported by the empirical evidence discussed above and is ruled out by our identifying assumptions. An alternative explanation is that the funds rate rises in response to a wealth shock because asset values have, at some times over the postwar period, led real variables and prices—indicators that in turn directly affect the federal funds rate. Indeed, a wealth shock appears to have a significant inflationary impact in the short run, which may explain why the Federal Reserve responds so energetically to such shocks. As we have argued above, it is questionable whether this predictive power could be exploited in real time (see, for example, Stock and Watson [2000]).

Finally, Chart 1 shows that higher inflation leads to immediate declines in real income, consumption, and asset

Chart 1

Impulse Responses, Baseline Five-Variable Structural VAR Using Nondurables and Services Consumption



Source: Authors' vector autoregressions using data described in the appendix.

Notes: The chart shows the twenty-quarter response of variables to a one-standard-deviation (81 basis points) innovation in the federal funds rate. The dashed lines represent one-standard-error bands. The sample period is 1966:1 to 2000:3.

values, and to an increase in the federal funds rate. Moreover, positive innovations in consumption, labor income, and wealth lead to both higher prices and a higher federal funds rate. Interestingly, a positive innovation in labor income leads to a decline in asset wealth, and vice versa, suggesting the presence of a persistent shock that shifts the composition of income between labor and capital. (Lettau and Ludvigson [2001b] document a similar finding in a different setting.) Similar results are also obtained when total PCE is used instead of nondurables and services spending. Using either consumer spending measure, our five-variable system responds to monetary policy shocks in a way that conforms with common views of monetary policy transmission.

Shutting Off the Consumption-Wealth Channel

How important is the direct effect of a funds rate shock on consumption relative to its indirect effect through the endogenous response of wealth? This section presents the results of our counterfactual experiment of shutting off the wealth channel to consumption. To see how we conduct our counterfactual experiment, consider a shock to the federal funds rate. The base case allows consumption to respond to this shock, and it incorporates the endogenous response of wealth and its influence on consumer spending. This is calculated by simulating the effects of a funds rate shock in the conventional way, and tracing out the impulse response function of consumption. To simulate the effects of a funds rate shock under the counterfactual regime, we shut off the wealth channel to consumption by setting to zero the contemporaneous response of consumption to wealth, as well as any lagged response of consumption to wealth given by parameters in the third rows of $B_1, \ldots, B_4$ in equation 1. (In practice, shutting off the lagged effect of wealth on consumption has little impact on the results, since consumption is not strongly predictable by variables other than lagged consumption.) We then recompute the effects of a funds rate shock on consumption and construct an alternative impulse response function for consumption. The difference between the two responses is then interpreted as a measure of the contribution of the consumption-wealth channel in the transmission of monetary policy.

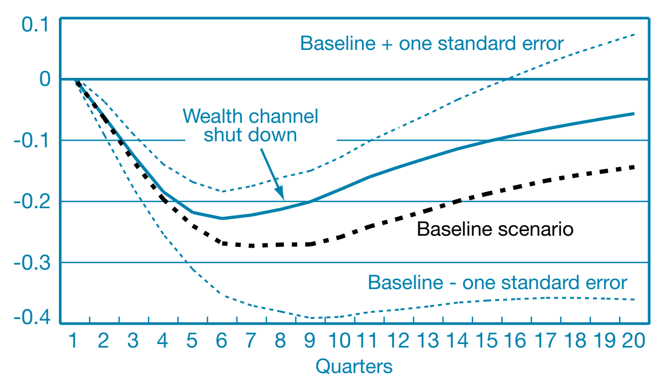
The impulse response function of consumption under two scenarios is shown in Chart 2. The baseline scenario shows the impulse response of consumption to a one-standard-deviation increase in the funds rate; this response is also presented in Chart 1 and reproduced here for comparison with our counterfactual scenario. This case shows the total effect of a funds rate shock on consumption including that stimulated by the endogenous response of wealth. The counterfactual scenario simulates the effect of a funds rate shock on consumption, but shuts off the wealth channel to consumption in the manner described above.

Chart 2 also shows that the absence of a wealth channel to consumption has only a small impact on the response of consumption to a federal funds rate shock: the response of consumption under the baseline scenario is close to that under the counterfactual scenario and within the standard-error bands of the baseline response. This finding does not imply that wealth has no effect on consumption, but that endogenous changes in wealth driven by innovations in the funds rate have little marginal impact on consumption. Thus, the substantial portion of the real effect of a funds rate shock on nondurables and services spending is attributable to its effect through channels other than household wealth.

The example using total PCE, shown in Chart 3, is somewhat different. There is now a small but noticeable difference between the baseline scenario and the counterfactual scenario. The decline of total PCE in response to a federal funds rate shock is about one-tenth of a percentage point less at its

Chart 2

Response of Nondurables and Services Consumption to a Federal Funds Rate Shock, Baseline Model



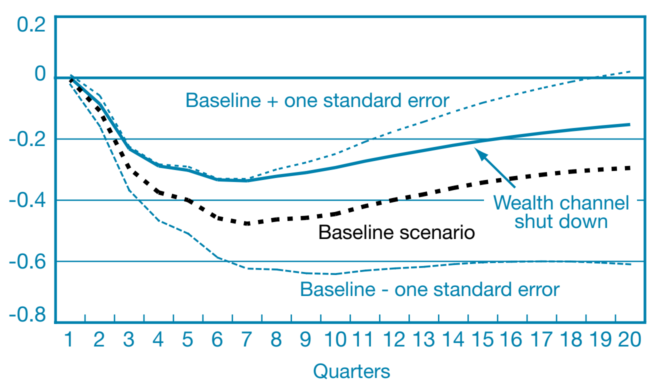
Source: Authors' vector autoregressions using data described in the appendix.

Notes: The chart shows a twenty-quarter response of variables to a one-standard-deviation (81 basis points) innovation in the federal funds rate. The vertical axis represents percent deviations of variables (basis-point deviations of the federal funds rate). The sample period is 1966:1 to 2000:3.

trough with the wealth channel shut off than it is under the baseline scenario, and total spending recovers more quickly from the shock under the counterfactual scenario than under the baseline scenario. Thus, there appears to be a larger role for the wealth channel in transmitting monetary policy shocks to total PCE than to expenditures on nondurables and services. Nevertheless, the response of total PCE under the counterfactual scenario still lies within the one-standard-error bands of the baseline scenario. Given the typical margin of error, even this counterfactual response is apparently not very different from the baseline scenario.

Why are the responses of consumption to a funds rate shock under the baseline scenario so similar to those under the counterfactual scenario? One explanation may lie with the finding, shown in Chart 1, that the effect of a funds rate shock on wealth is quite transitory, typically dying out in less than two years. Lettau and Ludvigson (2001b) show that such transitory changes in wealth have little, if any, impact on consumer spending. If important movements in consumption occur only in response to *permanent* changes in asset values, as indicated by results in Lettau and Ludvigson (2001b), the wealth channel of monetary policy transmission to consumption is likely to be quite small, consistent with what we find. This may also explain why the response of consumption to a wealth shock in Chart 1 is estimated so imprecisely: the response of wealth to its own

Chart 3
Response of Total Consumption Spending to a Federal Funds Rate Shock



Source: Authors' vector autoregressions using data described in the appendix.

Notes: The chart shows a twenty-quarter response of variables to a one-standard-deviation (81 basis points) innovation in the federal funds rate. The vertical axis represents percent deviations of variables (basis-point deviations of the federal funds rate). The sample period is 1966:1 to 2000:3.

innovation appears largely (but not entirely) transitory, suggesting that it is a mixture of permanent shocks (to which consumption may respond) and transitory shocks (which appear to have little influence on spending).

The simulations of our restricted VAR show less of a role for the consumption-wealth channel than do the large-scale econometric models. In part, this divergence reflects a difference in the nature of the policy experiments. In the WUMM and DRI model simulations, all changes in the federal funds rate are treated as exogenous policy changes, and the resulting changes in all other variables are viewed as reflecting the impact of the change in the funds rate. In reality, policymakers react to the economic environment. It is easy to believe that increases (reductions) in the federal funds rate have in part been spurred by forces—such as increasing (declining) inflation—that have led to reductions (increases) in wealth and spending. The WUMM and DRI simulations could include these endogenous correlations, possibly overstating the role of the wealth channel.

The simulation with the FRB/US model is more similar to the one using our VAR, since the policy experiment consists of gauging the effect of an innovation in the funds rate, rather than a simple change in the rate. The FRB/US model does exhibit a larger long-run wealth channel than our VAR model, but it appears that for a period of a year or so the two models are in rough agreement. In the FRB/US model, a 100-basis-point innovation in the funds rate changes consumer spending on nondurable goods and services by about 1/4 percent after one year (see the table). This effect is reduced by about 0.1 percentage point if there is no associated change in wealth. In our VAR model, a one-standard-deviation innovation in the funds rate (about 80 basis points) reduces spending a bit less than 1/4 percent after one year (Chart 2), with something less than 0.1 percentage point of that response attributable to the wealth channel. The FRB/US model, however, does have a considerably stronger wealth effect than ours further out. The reasons for the divergence are unclear and could conceivably reflect some of the details of the modeling of sectors of the economy and financial system not addressed in our model. We believe that our strategy of concentrating directly on the wealth channel for consumption gives us a firmer idea of its general magnitude, though in principle a more fully specified model could yield better estimates. Although the FRB/US model is a major advance in large-scale econometric modeling, it has been subject to some of the same criticisms as the earlier models (see, for example, Leeper, Sims, and Zha [1996]).

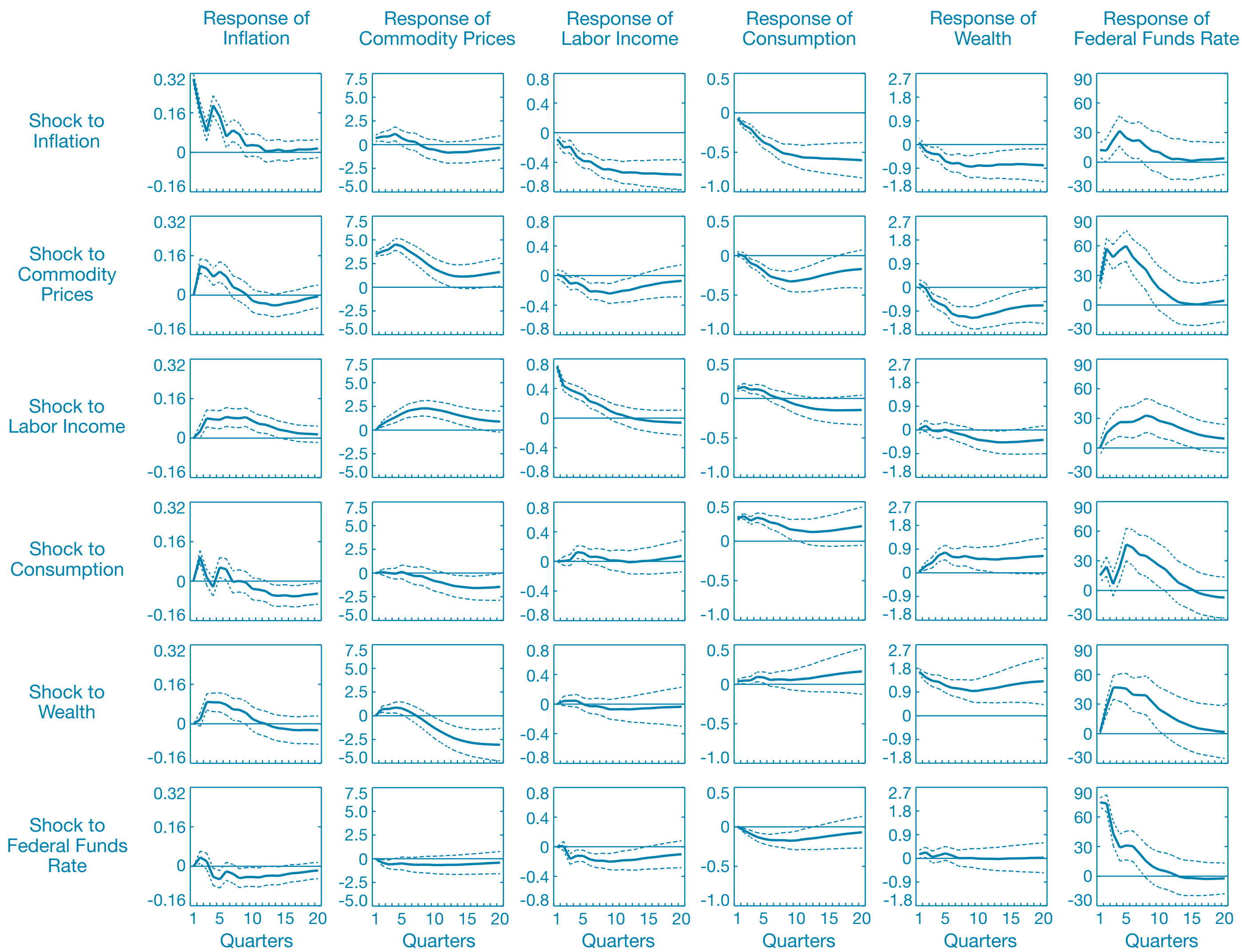
In summary, the results from our structural VAR models in Charts 2 and 3 provide little support for the view that the wealth channel is the dominant source of monetary policy transmission to consumption. In particular, the response of nondurables and services spending is virtually identical under our baseline and counterfactual scenarios, implying that, on the margin, it matters little for consumption whether wealth is affected by the monetary policy shock or not. This finding may be attributable to the transitory nature of funds rate innovations on asset values.

Including Commodity Prices

We present a six-by-six set of impulse responses in Chart 4, obtained when the system contains the log of a spot commodity price index, using nondurables and services spending as the measure of consumption. In the VAR literature on monetary policy, it is common to include a spot commodity price index system to account for price pressures not captured by other

Chart 4

Impulse Responses, Six-Variable Structural VAR with Commodity Prices Using Nondurables and Services Consumption



Source: Authors' vector autoregressions using data described in the appendix.

Notes: The chart shows the twenty-quarter response of variables to a one-standard-deviation (81 basis points) innovation in the federal funds rate. The dashed lines represent one-standard-error bands. The sample period is 1966:1 to 2000:3.

variables in the system about which the Federal Reserve may have information. In addition, the inclusion of a commodity price index is suggested by Sims (1992) as a way of eliminating the so-called price puzzle in monetary policy VARs. As is common in recent data, however (for example, Goto and Valkanov [2000]), we find that the inclusion of this index reduces, but does not eliminate, the finding that prices initially increase in response to a federal funds rate shock (Chart 4).

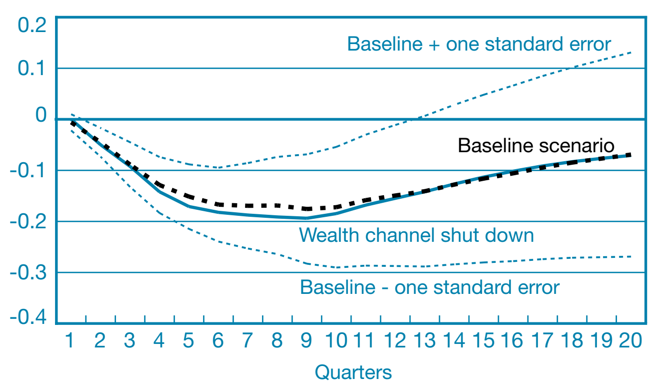
A commodity price shock has a strong negative effect on real consumption, real labor income, and real wealth—and raises the federal funds rate immediately. In addition, in the six-variable system that includes commodity prices, wealth is never adversely affected by a positive innovation in the federal funds rate, as it is in the five-variable system (although the standard-error bands indicate that the wealth response to funds rate shocks in the six-variable system is not statistically different from zero over most of the impulse horizon). Taken together, these findings suggest that asset prices are depressed not by federal funds rate shocks per se, but are instead depressed by the mounting price pressures, captured in the commodity price index and inflation itself, to which the Federal Reserve endogenously responds. Once we control for the Federal Reserve's endogenous policy response to these price pressures, federal funds rate shocks have no negative impact on household net worth. This is important because it suggests that direct inflationary pressures depress asset values, and that the majority of the impact of Federal Reserve policy on asset values is attributable to the central bank's response to such inflationary pressures—not to higher short-term interest rates as such. Results using total PCE as the consumption measure are comparable, except that the response of spending to a federal funds rate shock is not statistically different from zero.

The counterfactual simulations for the six-variable VAR are shown in Charts 5 and 6. Notice that because wealth now responds *positively* to a federal funds rate shock in Chart 4, the decline in consumption, in response to a funds rate shock with the wealth channel shut off, is now slightly *greater* than it is under the baseline scenario (Chart 5). As before, however, the response of consumption under the counterfactual scenario lies within the one-standard-error bands of the baseline scenario, suggesting that the two scenarios are not statistically different from one another. Similarly, the response of total PCE to a funds rate shock (Chart 6) under the baseline scenario is virtually indistinguishable from the alternative scenario in which the wealth channel is shut down.

In summary, there is no evidence that the inclusion of commodity prices alters the main conclusion from the five-variable VAR—namely, that the wealth channel is a relatively unimportant one in transmitting the effects of monetary policy to the consumer sector. The evidence does suggest that higher

Chart 5

Response of Nondurables and Services Consumption to a Federal Funds Rate Shock, Six-Variable Model

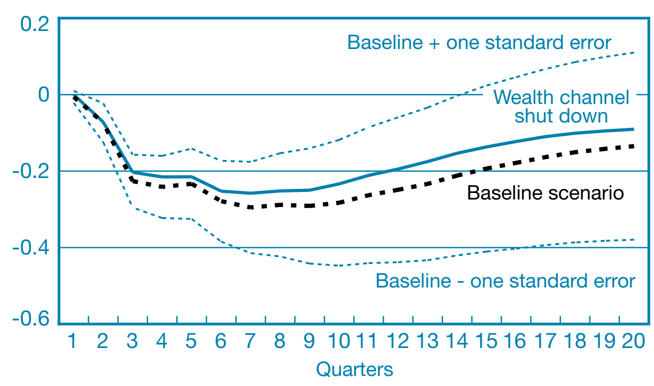


Source: Authors' vector autoregressions using data described in the appendix.

Notes: The chart shows a twenty-quarter response of variables to a one-standard-deviation (81 basis points) innovation in the federal funds rate. The vertical axis represents percent deviations of variables (basis-point deviations of the federal funds rate). The sample period is 1966:1 to 2000:3.

Chart 6

Response of Total Consumption Spending to a Federal Funds Rate Shock, Six-Variable Model



Source: Authors' vector autoregressions using data described in the appendix.

Notes: The chart shows a twenty-quarter response of variables to a one-standard-deviation (81 basis points) innovation in the federal funds rate. The vertical axis represents percent deviations of variables (basis-point deviations of the federal funds rate). The sample period is 1966:1 to 2000:3.

prices depress asset values and that the majority of the impact of Federal Reserve policy on asset values may be attributable to the central bank's response to inflationary pressures, and not to higher short-term interest rates per se.

We also explored two additional specifications of the VAR system studied above to check the robustness of our key results. First, we conducted our experiments using stock market wealth and non-stock-market wealth separately, in place of total household net worth. Second, we estimated the VAR separately in two subsamples: 1966:1 to 1979:1 and 1979:2 to 2000:3. Again, none of our main conclusions changed.[16]

Conclusion

The goal of this paper is to provide a better understanding of the channels through which monetary policy influences real variables. Focusing on monetary transmission to consumption, we ask how important the Federal Reserve's impact on household wealth is in influencing real spending.

In general, our results suggest that the wealth channel plays a minor role in the transmission of monetary policy to consumption. Instead, the direct effects of higher interest rates on consumption appear to be more important in transmitting monetary policy to the real economy. This finding may be attributable to the transitory nature of the federal funds rate innovations on asset values, which have been found elsewhere to have little impact on consumer spending. Our results also suggest, however, that asset values may be largely influenced not by federal funds rate increases per se, but by the mounting price pressures to which the Federal Reserve endogenously responds. Both higher consumer prices and higher commodity prices are found to lower real asset values substantially.

It would be interesting to extend our analysis to determine how much of the impact of higher prices on wealth is attributable to the central bank's endogenous response to such inflationary pressures, and how much is attributable to higher inflation alone. Such a focus requires a methodology for uncovering the systematic effects of monetary policy, a challenging and intriguing task for future research.

Appendix

Consumption

Consumption is measured as either total personal consumption expenditures or expenditures on nondurables and services, excluding shoes and clothing. The quarterly data are seasonally adjusted at annual rates, in billions of chain-weighted 1996 dollars. The components are chain-weighted together, and this series is scaled up so that the sample mean matches the sample mean of total personal consumption expenditures. Our source is the U.S. Department of Commerce, Bureau of Economic Analysis (BEA).

Total Personal Consumption Expenditures

Total personal consumption expenditures are measured as the sum of personal consumption expenditures on durable goods, nondurable goods, and services. The quarterly data are seasonally adjusted at annual rates, in billions of chain-weighted 1996 dollars. Our source is the BEA.

After-Tax Labor Income

Labor income is defined as wages and salaries + transfer payments + other labor income - personal contributions for social insurance - taxes. Taxes are defined as [wages and salaries/(wages and salaries + proprietors' income with IVA and Ccadj + rental income + personal dividends + personal interest income)] x personal tax and nontax payments, where IVA is inventory valuation and Ccadj is capital consumption adjustments. This measure is deflated using the chain-type price deflator referenced below. Our source is the BEA.

Wealth

Total wealth is household net wealth in billions of current dollars, measured at the end of the period. We lag this series one period to produce a measure of beginning-of-period wealth. Stock market wealth includes direct household holdings, mutual fund holdings, holdings of private and public pension plans, personal trusts, and insurance companies. Nonstock wealth is the residual of total wealth minus stock market wealth, and includes ownership of nonpublicly traded companies. This measure is deflated using the chain-type price deflator referenced below. Our source is the Board of Governors of the Federal Reserve System.

Price Deflator

The nominal after-tax labor income and wealth data are deflated by the personal consumption expenditure chain-type deflator (1996 = 100), seasonally adjusted. Our source is the BEA.

Federal Funds Rate

The federal funds rate is the effective quarterly rate, in percent per annum, calculated as the quarterly average of daily data. Our source is the Board of Governors of the Federal Reserve System.

Commodity Prices

Commodity prices are measured by the Commodity Research Bureau spot index for all commodities (1967 = 100). Data are quarterly averages of monthly data. Our source is the Commodity Research Bureau.

Prices

Prices are measured by the seasonally adjusted consumer price index for all items (1982-84 = 100). Our source is the U.S. Department of Labor, Bureau of Labor Statistics.

Endnotes

1. Necessary conditions included not only that the quantity of real balances affect the real demand for goods and services, but also that relative wage and price determination be independent of the price level.

2. Modigliani (2001) offers some interesting insights into the development of the life-cycle hypothesis and the FRB model.

3. Most notably, the output response to a change in short-term interest rates is reduced by more than one-half over a period of several years when the wealth response to the interest rate move is removed. This wealth effect, of course, includes changes in all forms of spending, not just on nondurable goods and services.

4. For instance, "the increase in stock market wealth from 1994 into early 2000 raised consumption growth by about 1 1/3 percent per year"(Council of Economic Advisers 2001, p. 61).

5. We have elsewhere (Ludvigson and Steindel 1999; Lettau and Ludvigson 2001a) argued that only "permanent" changes in the stock market affect consumer spending, and that a large fraction of the late-1990s bull market was not permanent. This earlier work, taken by itself, is only indirectly relevant to the policy transmission issue. The key question is whether changes in market values induced by policy changes are viewed by consumers as permanent.

6. In these full-model exercises, the difference between the estimates with and without wealth effects takes into account varying influences on consumer spending other than the stock market. In other words, these exercises still shut off the effect of wealth on all variables in the system, rather than just shutting off the marginal impact of wealth on consumption, as we do in the next section.

7. Nor do they settle the issue of a more generalized wealth channel for monetary policy. We viewed wealth channels as operating through changes in the real value of wealth. Many versions of wealth-credit channels of policy assert that nominal wealth changes affect real activity—for instance, by changing credit constraints.

8. Recent papers that investigate the importance of the systematic component of monetary policy include Bernanke, Gertler, and Watson (1997), which assesses the extent to which aggregate output and price fluctuations are attributable to the Federal Reserve's response to exogenous oil shocks. In a different approach, Hoover and Jordá (2001) use regime shifts to decompose monetary policy actions into systematic and unsystematic components.

9. The VAR literature that examines monetary policy often uses GDP as an income measure, but this is done in a context that excludes asset values from the VAR. Since we focus on monetary transmission to consumption, it makes sense to include variables in our system that would be implied by virtually any model of consumer behavior—hence the choice of labor income along with household wealth (see, for example, Campbell [1987], Galí [1990], Deaton [1991], and Lettau and Ludvigson [2001b]). Moreover, because wealth is part of the implied consumption function of our model, nonlabor forms of income (such as dividend, rental, and interest income) should already be capitalized in the value of asset wealth. Thus, all the forms of income that constitute GDP are fully accounted for in our empirical system. Regardless, our main conclusions are not substantively altered by replacing labor income with GDP.

10. Details of how we identify and estimate this VAR are provided in a technical appendix, available at <http://www.econ.nyu.edu/user/ludvigsons> or <http://www.stern.nyu.edu/~mlettau>.

11. This assumption is admittedly more plausible in monthly data than it is in our quarterly data, and admittedly less plausible for the commodity price index, which we include in the system later.

12. A timing convention is needed because the level of consumption is a flow during the quarter rather than a point-in-time value (consumption data are time-averaged). If we think of consumption for a given quarter as measuring spending at the beginning of the quarter, then the appropriate measure of wealth is beginning-of-period wealth. This seems to us the most reasonable assumption, since in this scenario households can "stock their refrigerator" at the beginning of the period and consume over the period by running down that stock during the period. However, if we think of consumption for a given quarter as measuring spending at the end of the quarter, then the appropriate measure of wealth is end-of-period wealth. As a robustness check, we performed our empirical tests under both timing assumptions and found that the conclusions we present here are not altered by whether wealth is measured at the beginning or end of the period.

13. For evidence that the log of nondurables and services expenditure can be well characterized by a random-walk process, see Harvey and Stock (1988), Cochrane (1994), Ludvigson and Steindel (1999), and Lettau and Ludvigson (2001a, b).

14. We also conducted a test of this assumption, similar to the one in Bernanke and Gertler (1999). Specifically, we estimated a single-

equation "reaction function" for the federal funds rate, FF_t , by instrumental variables (IV), using as instruments variables known at time *t* or earlier. Thus, FF_t is estimated as the dependent variable in an IV regression on Δc_t, Δy_t , Δp_t , plus the log difference of a spot commodity price index, Δcp_t. Three quarterly lags of each of these variables, and of the funds rate, were used as instruments. In addition, we added the current and three lagged values of the log difference in asset wealth, Δa_t . If monetary policy reacts *directly* to asset values, the contemporaneous and lagged value of Δa_t should have independent forecasting power for FF_t in the IV regressions. In a sample spanning 1966:1 to 2000:3, we find, consistent with the results in Bernanke and Gertler (1999), no evidence that the Federal Reserve reacts directly to asset values. The coefficients on the contemporaneous and lagged value of Δa_t are not jointly significant determinants of FF_t , and, more generally, the overidentifying restrictions of this regression are not rejected.

15. The log of aggregate consumption, *c*, is measured as real nondurables and services expenditure, excluding shoes and clothing. We focus on this measure because theories of consumer expenditure apply to the *flow* of consumption; durables expenditures are excluded in this definition because they represent replacements and additions to a capital stock, rather than a service flow from the existing stock.

16. The results are available at <http://www.econ.nyu.edu/user/ludvigsons> or <http://www.stern.nyu.edu/~mlettau>.

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