The Role of Segmented Markets in Monetary Policy

BY AUBHIK KHAN

The popular press would lead us to believe that during the stock market boom of the 1990s just about everyone was buying and selling bonds every day. In fact, evidence shows that most households make only infrequent changes to their investment portfolio. In this article, Aubhik Khan discusses this market segmentation and its implication for the way monetary policy affects interest rates and inflation.

Reading the newspapers during the stock market boom of the late 1990s, one could be forgiven for thinking that every man, woman, and child was buying and selling stocks and bonds every day. Nothing could be further from the truth. Recently, economists have begun to assess evidence that shows that most households make only infrequent changes to the stocks, bonds, mutual funds, and money market funds they own. At any time, most households are not participating in the majority of financial markets. Jointly, I call these observations evidence of *market segmentation* because only a segment of the population is participating in the market at any time, whether directly or through a broker.

Seemingly unrelated is a belief held by many, though not all, economists that when there is a change to the stock of money in the economy, interest rates respond immediately, while inflation responds slowly. More generally, changes in the supply of money in the economy appear to have persistent effects on economic activity, influencing consumption, investment, employment, and output.

Actually, the effects of monetary policy on interest rates and inflation may, in part, be a consequence of market segmentation. Recent advances in economic theory suggest that the real effects of open market operations — that is, the effect of changes in the money supply on output and employment — may be amplified by market segmentation.

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MICROECONOMIC EVIDENCE OF SEGMENTED ASSET MARKETS

In most macroeconomic models, households are continuously participating in asset markets. The somewhat simplistic assumptions underlying these models imply that if it is worthwhile for one household to invest in a particular stock or bond, it is worthwhile for all households to do so. Of course, this does not imply that all households hold the same portfolio. The economic models are consistent with the observation that wealthier households tend to hold more assets than poorer ones. However, these models often predict that all households will hold the same fraction of their wealth in each asset, which requires all households to be readjusting their portfolios continuously.

Economist Annette Vissing-Jørgensen finds that this prediction is not consistent with the household data. To study the behavior of a representative sample of U.S. households, she uses data for 1968-93 from the survey research sample of the Panel Study of Income Dynamics from the University of Michigan. Supplements also provide data on financial wealth. In her paper, Vissing-Jørgensen finds that, over time, an increasing number of those households with positive financial wealth (just above 80 percent of the total number of households) are participating in the stock market. Nonetheless, even as recently as 1994, only 44.1 percent of households participated in the stock market. In this sense financial markets are segmented: Only a fraction of the population of households is trading at any time. This finding is

inconsistent with the simplest financial models of portfolio choice.

Interestingly, households that are active in the stock market change over time. In the data, some households held stocks, bonds, or both, in 1989, but not in 1994. Other households held either stocks, bonds, or both in 1994, but not in 1989. Thus, a simple model that assumes some households can never hold stocks would be inconsistent with the data. Instead, a useful model for these purposes must explain why a household is sometimes active and sometimes inactive. Vissing-Jørgensen also finds there are significant changes in the fraction of wealth held as stocks. In particular, it varies across households and also across time for a given household.

Examining several possible explanations for segmented stock and bond markets, Vissing-Jørgensen finds that transaction costs are the most likely explanation. These costs, which include broker's fees and the costs of informing oneself about the risks and returns associated with individual stocks and bonds, are more easily borne by wealthy households and are prohibitive for some poor households.

In related work, economists John Heaton and Deborah Lucas find that households whose income — excluding income from stocks and bonds — is very risky are less likely to participate in the stock market. For example, a household whose principal earner works in an industry where there are frequent layoffs is less likely to buy and sell stocks than another household, with the same average income but with less risk to its income. Stocks are relatively risky investments, and this finding suggests that households that already face considerable risk to their incomes are less tolerant of the additional risks associated with participating in the stock market. Economists James Poterba and Andrew Samwick find that participation in the stock and bond markets varies with age. In their paper, they note that older households are more likely to hold stocks and less likely to hold tax-exempt bonds.

Motivated by these empirical findings about market segmentation, economists have incorporated segmented markets into their theoretical models.[1] By assuming that households are able to participate in stock markets infrequently, and different households have access to the market for stocks and bonds at different times, these models capture some — but not all — of what the data show. In particular, most models of segmented markets don't explicitly take account of important differences across households, such as age and wealth, and simply assume that different households have access to the market for stocks and bonds at different times.[2]

Heaton and Lucas find that households whose income is very risky are less likely to participate in the stock market.

MACROECONOMIC EVIDENCE OF THE EFFECTS OF OPEN MARKET OPERATIONS

Money Is Neutral in the Long Run. It is widely accepted among pundits and business people that monetary policy has real economic effects. The monetary authority adjusts the stock of currency in the economy through open market operations. In an expansionary open market operation, the monetary authority buys government bonds. Since these bonds are bought with currency, these purchases reduce bond holdings but increase the cash balances of the private sector.

Economists (and others) believe that when the central bank adjusts the money supply through open market operations, this action affects interest rates, which, in turn, affect nonfinancial variables such as consumption, investment, output, and unemployment, as well as inflation. Put differently, unanticipated changes to the money supply are believed to have persistent real effects. While these effects are thought to persist for some time, most economists believe they are not permanent. Economists describe such phenomena as short-term nonneutralities.

Let's discuss the origin of this term. There is a widely held belief among economists that while changes in the money supply might be used to dampen fluctuations in the economy, they have no lasting effect on real economic activity. This is sometimes referred to as the classical *neutrality of money,* which says that there is a separation between the nominal side of the economy, where the amount of currency provided by the government determines the price level, and the real side of the economy, where production and employment take place.[3]

[1] The paper by Fernando Alvarez, Robert E. Lucas, Jr., and Warren E. Weber provides a detailed introduction to monetary models with segmented markets and includes a list of references to related papers. The model we describe in this paper is based on the work of Alvarez, Andrew Atkeson, and Chris Edmond.

[2] In our working paper, Julia Thomas and I analyze a model where households choose when to adjust their portfolios.

[3] A variable that is nominal is being measured in dollars. In contrast, a variable that is real is being measured in its own units. For example, if potatoes cost $0.25 each, and a family buys 10 of them, its nominal purchase of potatoes is $2.50, while its real purchase is 10.

To understand the neutrality of money and short-term nonneutralities, it is useful to introduce the concept of the velocity of money. Simply put, velocity describes how many times in a given period money must change hands so that a given supply of money is sufficient to pay for all goods and services. (See *A Simple Example of the Determination of the Velocity of Money*.)

The neutrality of money is the proposition that if there were twice as much money in the economy, then the price of all goods and services would double. Despite this change in prices, no one would exert more effort to produce more, and real economic activity would be unaffected because people's (nominal) money balances have doubled as well. Thus, velocity would not change.

Figure 1 provides some evidence for the relative constancy of velocity in the long run using M2— a standard measure of the money supply — and personal consumption expenditures.[4] We see that prices and the ratio of money to real consumption grow at roughly the same rate, at least until the late 1980s. As the money supply has grown, prices have risen proportionately. But this means that velocity is roughly constant in the long run, which is evidence in support of the long-run neutrality of money.

Money Is Not Neutral in the Short Run. However, there is evidence that when the supply of money relative to personal consumption expenditures rises, velocity falls in the short run (Figure 2). The figure plots the difference between the actual value of each variable and its long-run trend rate of growth. When the money supply grows above or below its long-run trend, the figure shows money growth as positive or negative, respectively. Similarly for velocity.

Notice that whenever the ratio of money to consumption rises above trend, velocity tends to fall below 0. This suggests that prices adjust sluggishly, that is, slower than the rate of growth of the money supply, and that velocity falls. The decline in velocity indicates that there may be real short-run effects of a change in the money supply.

DOES MONETARY POLICY AFFECT THE REAL ECONOMY?

Academic economists, pundits, and policymakers agree that monetary policy — which directly affects the interest rate on government bonds — also affects other interest rates, most specifically the fed funds rate, the interest rate banks charge one another for overnight loans of reserves.[5]

However, academic researchers disagree about the extent to which changes in the fed funds rate brought about by the central bank actually affect economic activity. While this may seem surprising, it is less so when you consider the difficulty of studying the effects of open market operations. It is very difficult to empirically link changes in the macroeconomy with

[4] M2 is a broad definition of money that includes both currency and interest-bearing assets that are relatively easy to convert into currency. Personal consumption expenditures are a measure of the goods and services purchased by consumers.

[5] The interest rate on bonds moves closely with other short-term interest rates, since holding government bonds is one of many alternatives available to investors and the interest rates on close substitutes can't diverge too much. For example, instead of holding government bonds, a bank could instead buy mortgages — or more realistically, securities backed by mortgages — for its portfolio if the interest rate on mortgages rose substantially beyond the interest rate on a government bond of comparable maturity.

A Simple Example of the Determination of the Velocity of Money

To better understand the concept of velocity, consider the following simple example. There are 100 residents of a deserted island, marooned there some time ago. At the time they arrived on the island, they had among them 250 identical silver coins that they shared equally. The only commodity on the island is a fruit. Half the residents live on the northern side of the island, where their trees bear fruit in the summer months; the other half live on the southern side of the island, where fruit trees are harvested in the winter. For the sake of discussion, assume that each islander harvests 10 pieces of fruit a year, and that each fruit is sold for one coin.

In the summer months, each southern resident buys five pieces of fruit from each northerner for five coins. The trade is reversed in the winter months. The 250 coins must pay for 500 pieces of fruit each year, and thus each coin must change hands twice. The velocity of money on the island is then two. It is the ratio of nominal spending, which is 500, divided by the money stock, 250. More generally, velocity is equal to price times output divided by the available stock of money.

FIGURE 1

Money, Price, and Velocity

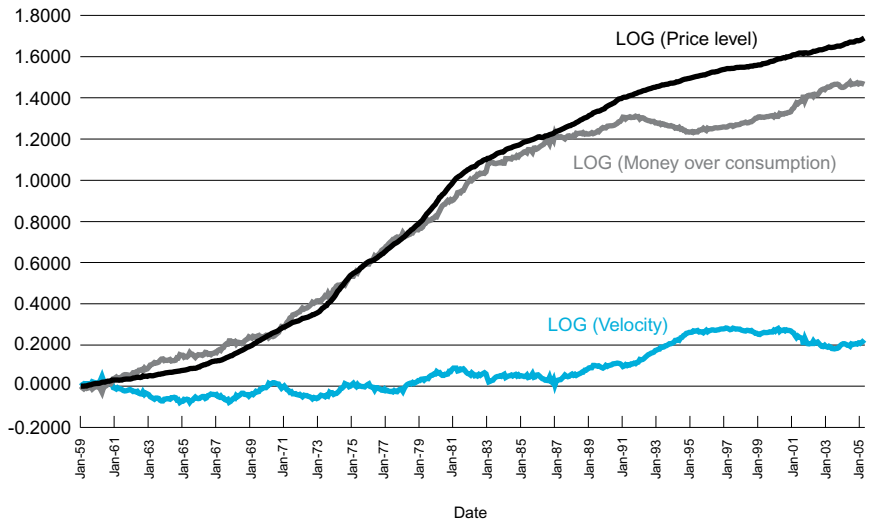
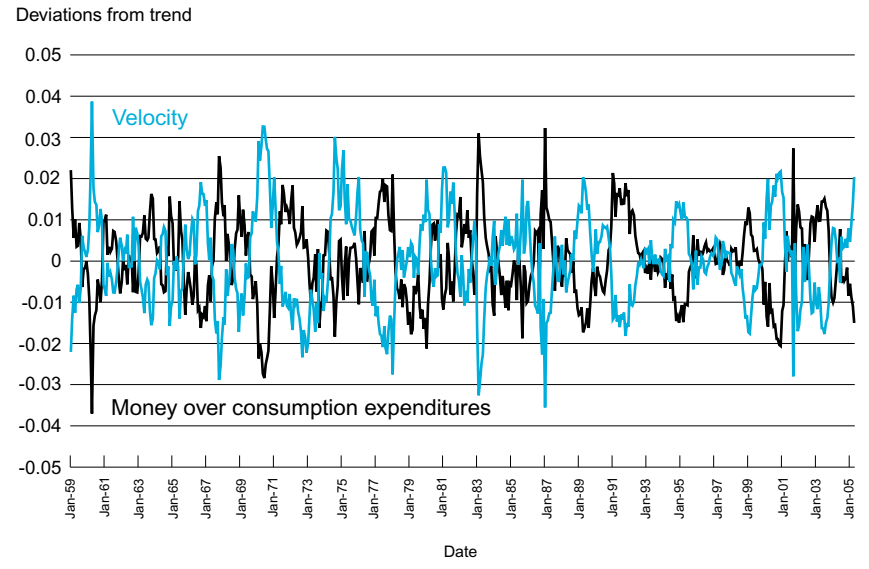


FIGURE 2

Ratio of Money to Consumption and Velocity



their cause; at this level, the economy undergoes many simultaneous changes.

The problem in isolating the real effects of monetary policy is that policy typically responds to external factors. Therefore, it's difficult to separate the real effect of these external factors from the real effect of monetary policy. Consider the following hypothetical example. Let's say there's a period of rapid productivity growth, as happened in the second half of the 1990s in the United States. The rapid growth in productivity drives corporate earnings higher, and stock prices increase. As a result of the rise in the value of their assets, households increase spending. In an effort to prevent a rise in inflation, the central bank pushes up the fed funds rate. But rates for mortgages, automobiles, and credit cards also rise. In the end, inflation does not increase.

Did monetary policy prevent inflation from increasing? Although this conclusion may well be correct, it cannot be proven in the context of the events described in our example. It is certainly possible that the increase in interest rates prevented spending from growing too fast, thereby offsetting a rise in inflation. Alternatively, there may have been no effect on spending growth, and inflation failed to rise because higher productivity growth allowed firms to increase production without raising prices more rapidly. The real effect of the central bank's increasing interest rates is ambiguous because we did not study an event in which central bank policy operated independently of other events.

The Real Effects of Monetary Shocks. However, there may be instances when movements in the money supply occur independently of other economic events — what economists call a monetary shock. These events offer the best settings in which to study the real effects of monetary policy, since they are independent of other changes in the economy. At such times we can observe the real effects of monetary policy in isolation and improve our understanding of how it works. How rapidly does a change in the central bank's interest rate affect nonfinancial variables? What is the size of this effect? How long does it last?

To the extent that there is a consensus among economists, it involves the following joint movements of money, interest rates, and prices in

response to a temporary rise in the growth rate of the money supply.[6]

Inflation responds slowly, and the rise in inflation persists for several quarters.

An expected increase in future inflation tends to reduce current real interest rates, which are measured by the difference between the nominal interest rates on bonds and the inflation rate.[7] This has been shown, for example, by economists David Barr and John Campbell.

Because the inflation rate adjusts slowly and real interest rates decline more rapidly, an open market operation reduces nominal interest rates. (Remember, the nominal rate is the sum of the real rate plus the inflation rate.) The fed funds rate falls, as do other nominal interest rates, such as those on government and corporate bonds and on mortgages and car loans.

MONETARY POLICY IN THE STANDARD FULL-PARTICIPATION MODEL

Temporary changes in real interest rates and in the pace of economic activity brought about by an unanticipated change in the growth rate of the money supply (that is, short-term nonneutralities) are a challenge for theoretical macroeconomics. Standard full-participation models have difficulty reproducing such temporary changes.

When the Money Supply Increases, Prices Rise Proportionately. Figure 3 shows what happens in the standard model when the central bank increases the rate of growth of the money supply by one percentage point and then lets it slowly return to its usual growth rate. Economists refer to this as a persistent shock to money growth rates.

As we can see, the inflation rate and the money growth rate are indistinguishable in the standard model. This is an implication of the neutrality of money in the classical model. That is, as the central bank increases the supply of money to households, firms increase their prices by the same proportion. Prices perfectly track changes in the stock of money, and this implies that the growth rate of prices, that is, the inflation rate, is equal to the growth rate of money.

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The Real Interest Rate Doesn't Change. In the bottom panel of Figure 3, we see that the change in the growth rate of money has had no effect on the real interest rate. In other words, though prices are changing, the temporary rise in the growth rate of money has no effect on the tradeoff facing households when they decide how much to spend and how much to save. This may surprise the reader; after all, the middle panel shows that the nominal interest rate has risen. Doesn't this mean that households can earn a higher return if they save their income by purchasing bonds? This is true only in the sense that for each dollar they save by buying bonds, they will earn more dollars in interest than before. However, since prices are rising faster than usual, this extra interest in dollar terms does not buy any more goods or services. That's why the real interest rate hasn't changed at all.

The Real Economy Is Unaffected. The real rate of return on bonds measures how much more goods and services a household could consume in the future by forgoing consumption today. Since the real return on bonds is unaffected by the temporary change in the growth rate of money, households have no reason to change their consumption of actual goods and services, and there are no real effects of this monetary shock in the standard model. All that happens is that the temporary rise in money growth rates increases inflation and the nominal interest rate.

Before we leave our study of the standard full-participation model, look again at the middle panel of Figure 3. In this panel, the nominal interest rate rose with the growth rate of money. This prediction of the full-participation model is opposite of what most macroeconomists believe happens to nominal interest rates when there's an open market operation. Partly in response to the difference between the observed data and such predictions of the standard model, macroeconomists have begun to explore models that include segmented markets.

MONETARY POLICY IN THE SEGMENTED MARKETS MODEL

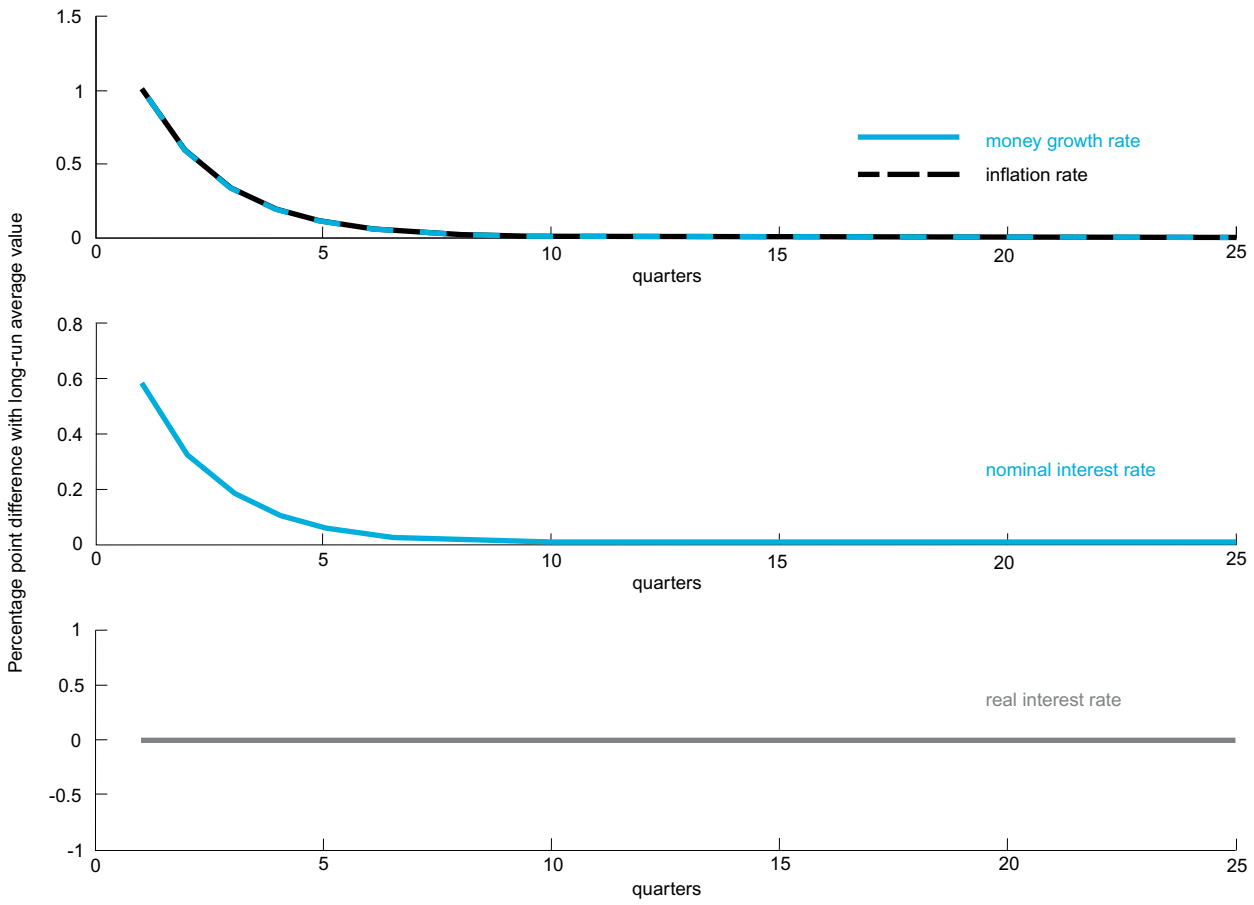
The segmented markets model we study is able to reproduce the decline

[6] Unfortunately, there is much disagreement about the proper approach to identifying monetary shocks. The paper by economist Harald Uhlig provides a summary of the current debate.

[7] To be more precise, I am referring to a bond that does not have its interest rate indexed to the rate of inflation. Also, since bonds differ by maturity, there is a real rate of interest corresponding to each maturity.

FIGURE 3

A Persistent Shock to Money Growth in Classical Model



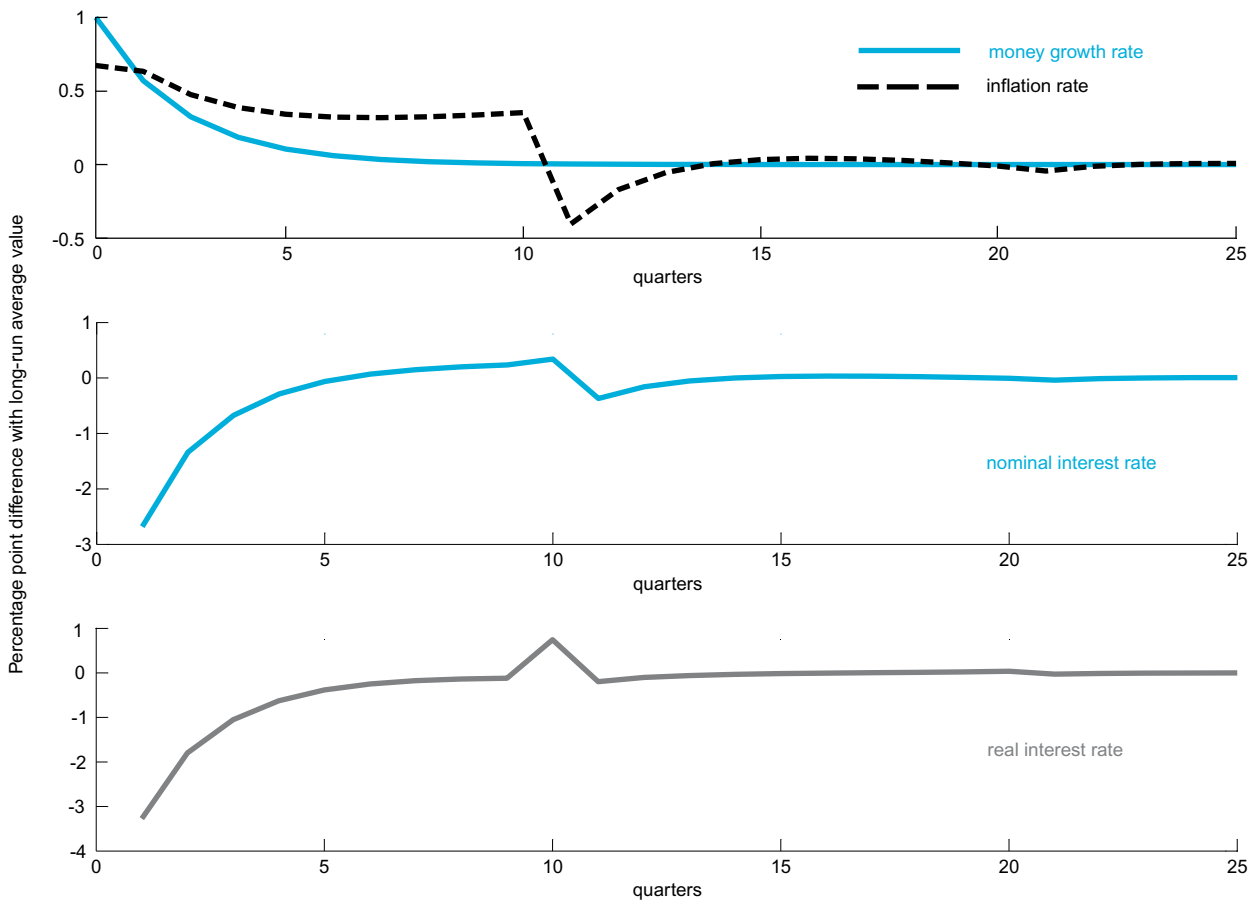
in interest rates — both nominal and real — following an increase in the money supply (Figure 4). In this model, an open market operation that increases the money supply does not lead to a proportionate rise in inflation. Prices don't initially grow as fast as the money supply, and both real and nominal interest rates fall.

What is it that makes the short-run response of the segmented markets model so different from the full-participation model? This has to do with which households in each model participate in an open market operation. Sophisticated readers may complain that the idea of households participating directly in open market operations is unrealistic, and for the most part, they are correct. Within the private sector, government bonds are ordinarily held by banks and other financial institutions. When the central bank buys government bonds, it increases the currency banks hold. Banks, in turn, lend these funds to households and firms. Our approach is to first study simple models with segmented markets that treat open market operations as if they involve direct transactions between households and the central bank. Later, we consider explicitly how including intermediaries may affect our conclusions.

With Segmented Markets, Prices Rise Less Than Proportionately When the Money Supply Increases. In the segmented markets model, only some households buy and sell assets out of their portfolios at any given time. A household that sells bonds during an open market operation knows that it is not likely to participate again soon, and so it increases money balances by more than it intends to increase immediate spending. Since households' money balances have increased by more than their expenditures, prices increase less rapidly than the supply of money in percentage terms. That is, there is only a partial

FIGURE 4

A Persistent Shock to Money Growth in Segmented Markets Model



rise in inflation and an increase in real money balances.[8]

[8] The careful reader might wonder how the spending of other households, those not selling bonds, is affected by the open market operation. The answer lies in the observation that these households experience no change in their money balances because they did not participate in the trading of bonds for money. Moreover, since they do not generally expect to participate soon, they must use what money they have to finance their spending not just today but also for some time in the future. Given this, and because prices are rising, they are unwilling to substantially increase their current spending. If they did, they would have to sharply lower the real quantity of goods and services they will be able to buy in the future. All in all, the spending of these households does not change very much.

Real Interest Rates Fall. Why do real interest rates fall? One way to think about this is to ask: What must happen to the real interest rate on bonds to make households willing to reduce their bond holdings and increase their real money balances — that is, for the government to successfully complete its open market operation? Real interest rates on bonds must fall. In summary, the monetary authority's expansionary open market operation has led to a decline in real interest rates, an increase in the real money supply, and a less than proportional rise in inflation.

This pattern is exactly what we find in Figure 4, where we reconsider the effects of a persistent shock to the growth rate of money identical to the one we studied in the standard full-participation model. Now the same shock, but observed through the lens of the segmented markets model, leads to a fall in both the nominal and real interest rates. Moreover, as we suggested above, when the money supply increases faster than usual, prices don't rise as fast; so after one quarter, money grows faster than inflation and real balances rise. The slow adjustment of prices in the segmented markets model is also found in the data, suggesting that this model may be useful for shed-

ding light on how the economy actually works.

CONCLUSION

Recent models that have segmented asset markets are able to explain some of the effects of monetary policy. They help us understand how increases in the money supply can reduce both nominal and real interest rates in the short term and why inflation responds slowly to such movements in money. These models explicitly model differences in households' participation in financial markets that are found in household data. In doing so, they continue a long trend in macroeconomic research of building models that explicitly acknowledge differences across households and firms and explore the economic consequences of such differences.

REFERENCES

Alvarez, Fernando, Robert E. Lucas, Jr., and Warren E. Weber. "Interest Rates and Inflation," *American Economic Review Papers and Proceedings*, 91 (May 2001), pp. 219-25.

Alvarez, Fernando, Andrew Atkeson, and Chris Edmond. "On the Sluggish Response of Prices to Money in an Inventory-Theoretic Model of Money Demand," National Bureau of Economic Research Working Paper 10016 (October 2003).

Barr, David G., and John Y. Campbell. "Inflation, Real Interest Rates, and the Bond Market: A Study of UK Nominal and Index-Linked Government Bond Prices," *Journal of Monetary Economics*, 39 (August 1997), pp. 361-83.

Khan, Aubhik, and Julia Thomas. "Inflation and Interest Rates with Endogenous Market Segmentation," Working Paper.

Vissing-Jørgensen, Annette. "Towards an Explanation of Household Portfolio Choice Heterogeneity: Nonfinancial Income and Participation Cost Structures," University of Chicago Working Paper (2002).

Heaton, John, and Deborah Lucas. "Portfolio Choice in the Presence of Background Risk," *Economic Journal*, 110 (2000), pp. 1-26.

Poterba, James M., and Andrew A. Samwick. "Household Portfolio Allocation over the Life-Cycle," NBER Working Paper 6185 (1997).

Uhlig, Harald. "What Are the Effects of Monetary Policy on Output? Results from an Agnostic Identification Procedure," Working Paper, Humboldt University (May 2004).