# The Complexities of Monetary Policy

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BY ANTHONY M. SANTOMERO

As a former academic researcher who is now president of the Federal Reserve Bank of Philadelphia, I've encountered several places where macroeconomic theory intersects with real world economics.

As a long-time research economist, I derive great enjoyment from spending time with fellow economists. Some call us practitioners of the "dismal science," but all of us in this room know better. After all, this is a meeting of the Downtown Economists Club. "Club" certainly has a festive, friendly ring to it, so I'm confident our time together will be anything but dismal.

As you know, I came to the Federal Reserve Bank of Philadelphia after spending many years on the faculty of the Wharton School. So I thought I would spend my time with you today talking about the interplay between my long experience as an academic researcher and my new responsibilities as a central banker.

Since I joined the Fed last summer, I've encountered several conundrums. I suppose you could also call them "points of tension" — places where macroeconomic theory intersects with real world economics.

Whatever terminology one uses, these conundrums illustrate the challenges that one confronts in analyzing economic conditions, forecasting their likely future course, and using information that is often imperfect to map out appropriate monetary policy.

As it happens, my tenure at the Fed has partly coincided with events that illustrate some of the fundamental issues that I would like to talk about today. Not long ago there was concern about an overheating economy. Then, in little more than the blink of an eye, there was concern about a possible recession. How quickly things change and how suddenly pressure for policy response shifts direction! I once viewed this from the relatively safe haven of the academy. I now view it from the trenches as a policymaker. It's been an interesting time.

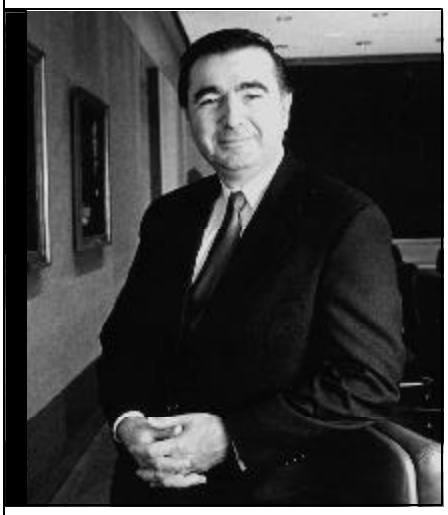
Today I'll talk about four conundrums I've come upon in making monetary policy decisions. Let's take them one at a time.

## ON THE SUPPLY SIDE

The first we might call the "supply side" conundrum. The key challenge here lies in resolving the fundamental issue of how rapidly the economy can grow on a sustained basis. There has been much discussion about the U.S. economy's long-run capacity for growth in light of the remarkable gains in productivity in the latter half of the 1990s. The strength of the economy over that period, accompanied by a remarkably low inflation rate, was due, in no small measure, to more rapid productivity growth, which stemmed largely from technology investments made during the decade. With the technology sector undergoing substantial change and reevaluation, it might be interesting to examine this relationship as the first area of focus.

Let me begin with what we know: productivity growth has improved because of technology. But this statement is not as useful as it might be, because one does not know exactly what this foretells about the future pace of productivity growth.

Put another way, we don't have the equation that describes how technology affects productivity. Nor do we have the equation that describes how technology evolves. In the end, we do not even have a satisfying



**Anthony M. Santomero**, President, Federal Reserve Bank of Philadelphia

measure of the variable we call technology. So when we ask ourselves how fast the economy can grow going forward, we must acknowledge that there is a substantial degree of uncertainty about the answer because of our limited knowledge of the processes underlying future productivity enhancement.

As an economist I can accept this. But as a policymaker, I have to take the next step — the one that makes me uncomfortable as an economist. That is, in spite of our uncertainties, indeed our ignorance, I have to make some assessment of the rate at which the application of technological innovations raises potential output going forward. Making that "supply side" assessment is essential to laying out the path of long-term, sustainable economic growth that monetary policy aims to match from the demand side.

Well, what is my estimate? I expect annual productivity growth to average 2 to 3 percent for the foreseeable future. Why? Because I believe that "new economy" technologies have yet to fully infuse the "old economy" with the productivity gains they offer. When I talk with business people around our District, they tend to agree. It seems that advances in information technology and information management are still in the process of revolutionizing the way businesses design, produce, and deliver their products and services. This process takes time and often lags the purchase of technology, but the benefits accruing to real sector productivity are real and sustained.

So if information technology continues to revolutionize industry, then the economy can sustain real GDP growth of 3 to 4 percent without accelerating inflationary pressures for the foreseeable future. But let me stress that this figure is a long-run average. One must allow for some margin of error around this number and expect it to exhibit some cyclical variability. Only simple equations are straight lines; real economies tend to move less linearly.

As an economist I am comfortable with this complexity because theory tells me that the marketplace will weigh them all and consistently drive the real rate of interest to its proper equilibrium, whatever it may be – even as that equilibrium shifts over time.

I believe that "new economy" technologies have yet to fully infuse the "old economy" with the productivity gains they offer.

**ON THE DEMAND SIDE**

The second of my conundrums is what might be called the "demand side" conundrum. As economists, we know there is some interest rate that induces investors to invest just the right amount, and savers to save just the right amount, to bring the economy to its potential output. The key questions here are: What is that interest rate? And how does it evolve over time? One needs to answer these questions in order to assess whether monetary policy is properly positioned to foster the economy's achieving its full growth potential.

As an economist I am comfortable with the idea that a myriad of factors affect both saving and investment decisions.

Some are identifiable and measurable – like income on the saving side, or depreciation rates on the investment side. Others are identifiable, if not so easily measured – like expected returns to savings or wealth targets on the saving side, and technological breakthroughs, capacity utilization, or acceptable hurdle rates on the investment side.

I also know that some of these factors are subject to high-frequency fluctuations – like changes in wealth due to stock price variation – and some are subject to low frequency trends – like changing demographics.

As a monetary policymaker, I cannot be quite so comfortable. That is because, whether we like it or not, monetary policy today is an interest rate policy. And so gauging the stance of monetary policy – determining whether the Fed is being stimulative, contractionary, or neutral – is essentially an exercise in assessing where we have set the real rate relative to that long-run equilibrium path.

Let me give you a very practical example of how this problem plays out. If trend productivity growth is higher now than it was 10 years ago, then, everything else constant, businesses now have a stronger demand for funds to invest in new projects and consumers save less because they expect their incomes to rise faster. So the equilibrium real rate of interest should now be higher. How much higher? And, of course, since everything else is never constant, how much higher on net?

My own point of view is that the average equilibrium real rate probably is higher now than it was 10 years ago. But again, I would allow for a wide margin of error around any estimate. Short-term and cyclical variations alter the appropriate momentary natural rate of interest, making it of considerably less use in determining the stance of monetary policy. Actually, gauging monetary

policy at any point in time presents other problems as well. This brings me to my next conundrum.

## ABOUT THE DYNAMICS OF POLICY

My third conundrum I would label the "policy dynamics" conundrum. This one is certainly nothing new. Milton Friedman summarized the problem years ago, coining one of the most famous phrases in modern economics, when he said that the impact of monetary policy is subject to "long and variable lags." Consequently, at any point in time, monetary policymakers cannot tell whether what they see going on in the economy is the reflection of changing market conditions or, alternatively, the lagged effect of their own past actions. And so an activist monetary policy intended to fine-tune the economy's performance could, in fact, destabilize it.

Friedman argued that the best approach for monetary policymakers to take would be to fix the growth rate of the money supply at some constant amount. Following this rule would allow the economy to achieve its peak efficiency, recognizing that this would inevitably include some cyclical ups and downs.

As an economist, I respect Friedman's analysis. But as a policymaker, I am left with the dilemma of how one would put his prescription into practice. Today there is no monetary aggregate reliably linked to spending growth, and so monetary policy is, as I said a moment ago, an interest rate policy. Obviously, fixing an interest rate is not the same thing as fixing the money growth rate. Indeed, holding short-term interest rates constant – not allowing them to move as market conditions change – is a sure-fire prescription for destabilizing the economy.

So how does one balance the need to move short-term interest rates in response to shifting economic conditions with the need to provide the marketplace with a stable and reliable monetary policy? I think there are two answers. One answer is to move beyond a commitment to stable money growth and make a credible commitment to low and stable inflation.

I believe that over the past 10 years, the Fed has successfully made that transition. Whatever the subtleties of particular monetary policy actions, it is clear that the Fed's ultimate goal is to help create the financial conditions that foster maximum sustainable economic growth. In the long run, the most important contribution the Fed can make toward this goal is to maintain a low inflation environment. To a considerable extent, the public's expectations about long-run inflation are measures of its confidence in the Fed's commitment to that mission.

As many of you know, our own Reserve Bank conducts a quarterly survey of professional economic forecasters. Results of that survey show that long-run inflation expectations remain low and stable and have been for the last several years. I consider that an important signal that the Fed has established its commitment.

The second way to solve the policy puzzle of preserving flexibility in setting interest rates while also providing stability in monetary policy is more tactical. Fed policymakers must stand apart from the incessant demand for instant reaction and the expectation of instant results. There is a tendency among observers to focus on the Fed's next interest rate move, with the implication that the Fed can and should fine-tune the economy's performance. But the fact is that it takes time for a policy action's impact to play out, and we are frequently waiting for past actions to reach fruition and achieve their desired effect on the economy.

## ABOUT CONFIDENCE

But before we get too comfortable with the wisdom of a "wait and see" approach, let me describe the fourth and final conundrum I want to discuss with you today. This is one that I personally have found particularly perplexing since joining the Fed. It is also one that has gotten a lot of "ink" recently. I'll call it "the confidence conundrum," because it centers on how confidence plays a role in macroeconomic dynamics.

The issue is this: when waves of confidence – or doubt – wash over the economy, how should monetary policymakers respond to them? This is a conundrum because there is ample evidence that expectations about the future are rational in the long run, and the marketplace validates them on average. But in the short run, the marketplace is beset by waves of confidence that move expectations and thus may significantly affect spending in ways that may or may not be either sustainable or desirable.

What to do in the face of variations in consumer or business confidence is not an easy issue to resolve. Macroeconomists usually assume that the economy behaves as if consumers and businesses form their expectations rationally, and they forecast the future based on observations of stable historical economic and financial patterns. This is a convenient assumption because it obviates the need to model people's decision-making explicitly, and it keeps changes in expectations from playing an independent role in the performance of the economy. But we know that reality is not that simple.

While measures of consumer confidence usually track historical movements in economic variables – income, wealth, indebtedness, unemployment, and the like – there are occasions when confidence moves beyond what the incoming economic

data might warrant. These exogenous shifts in confidence may not be rational. Consumers and investors are capable of over- and underreaction. After all, we are only human.

Nonetheless, these shifts in confidence can cause changes in expectations that affect spending decisions and so can become self-fulfilling, or at least self-sustaining, processes for a considerable period of time. Consequently, the role played by expectations can be at once more significant and more complicated than our standard macroeconomic models allow.

We should not lose sight of how important expectations are to people's decision-making and how far-reaching the impact of changes in expectations can be. Expectations can change quickly and can dramatically alter aggregate demand.

As a former finance professor, I am intimately familiar with the investment decision process. It is, to a large extent, a process of expectations. Businesses routinely try to project the future gains to be derived from investments made today. This is fundamental to capital budgeting, a subject that I taught too many MBA students over the course of too many years!

Likewise when individuals make consumption and savings decisions, expectations play an important role. The appropriate amount to save for retirement, for example, depends in large part on expectations of future rates of return.

In short, when it comes to making economic decisions, expectations matter. And I would add that shifts in that intangible we call confidence affects those expectations. I believe that we are in the midst of dealing with one of these shifts in confidence right now. The key issue that we must address is the extent to which it will have a significant impact on the aggregate economy going forward.

So how should monetary policy respond? I do not think the Fed should routinely take policy actions for the sole purpose of boosting expectations or merely to affect confidence. This would ultimately be a dangerous and destabilizing game. However, I believe that if a decline in confidence is viewed as having a substantial dampening effect on overall real sector demand growth, then monetary policy can and should respond – with the aim of restoring overall demand growth to a pace consistent with potential supply growth.

We should not lose sight of how important expectations are to people's decision-making and how far-reaching the impact of changes in expectations can be.

I believe the Fed's recent policy actions are consistent with this approach. It responded to a variety of indications that aggregate demand growth has been weakening, including a deterioration in confidence that was more severe than the underlying data seemed to indicate. And the Fed remains vigilant by continually monitoring the behavior of the real economy.

The lesson I take away from this experience is that sometimes monetary policy decisions have to be based on something more than well-constructed theory and overwhelming evidence from the data. Sometimes they must be based on our sense of the situation. Such situations do not arise very often, but when they do, it is important, given the lags in the impact of monetary policy, that the Fed move expeditiously.

Well, I have shared with you some of the musings of a professor turned policymaker. At the end of the day, where do all of these conundrums leave me?

By their nature, conundrums are not easily resolved, and so I will continue to consider them in the months and years ahead. Even at this stage, however, I think they suggest a useful approach to monetary policymaking. To deal prudently with the uncertainties on both the supply side and the demand side of the economy, as well as the dynamics of monetary policy, monetary policy ought to move in careful increments and at a measured pace.

Overlaying this is the fact that expectations matter and we must deal with the real impact of sharp shifts in public confidence in a more expeditious manner. Doing so requires a sensitivity to nuance and timing that I expect policymakers will always find challenging.

For me personally, the transition from academic life to the world of central banking is proving to be an invigorating challenge. In my new role I've learned that I can be the proverbial two-handed economist only up to a point. In the end, decision-making requires a one-handed economist who must take action, even if issues remain open and questions remain unanswered.

# Why Does Countercyclical Monetary Policy Matter?

BY SATYAJIT CHATTERJEE

Modern capitalistic economies use stabilization policies to minimize fluctuations in the unemployment and inflation rates. In the United States, the Federal Open Market Committee (FOMC) lowers the target interest rate for interbank loans as economic activity slows or when a financial crisis looms (as in the fall of 1998) and raises it when inflation threatens to accelerate (as in late 1999 and early 2000).

Such countercyclical monetary policy is one example of a stabilization policy. Other examples of U.S. stabilization policies include the federal insurance of bank deposits (and the concomitant supervision and regulation of banking) and income-maintenance programs, such as unemployment insurance.

Macroeconomists have devoted much effort to understanding how countercyclical monetary policy affects the volatility of the unemployment and inflation rates. In contrast, macroeconomists have directed much less effort to understanding why countercyclical monetary policy is beneficial. This neglect reflects the fact that, until recently, macroeconomists of very different persuasions agreed that policies aimed at reducing the volatility of unemployment and inflation are desirable. Of course, economists disagreed about what form those policies should take, but no one questioned the premise that a less volatile macroeconomic environment was a desirable policy goal.

That is no longer the case. During the last dozen years or so, an influential minority of macroeconomists has questioned the supposed benefits of reducing volatility and, by implication, the supposed benefits of countercyclical monetary policy.

The source of this development is the same as that which underlies most major developments in macroeconomics in the last half-century, namely, the desire to ground macroeconomics in sound theoretical foundations. As in the other sciences, "sound theoretical foundations" means explaining macro-level phenomena in terms of micro-level phenomena; for example, using theories of household and business behavior to explain the behavior of, say, aggregate consumer spending or aggregate business investment.

The desire for microfoundations also means that macro-level policies (such as countercyclical monetary policy) need to be justified in terms of micro-level effects — how such policies ultimately benefit households. Surprisingly, the link between less macroeconomic volatility and improved household well-being has proven weaker than many macroeconomists might have supposed.

Concerns about the benefits of countercyclical monetary policy (and of stabilization policies in general) are obviously of great importance to the Federal Reserve System. My purpose in this article is to accomplish two tasks: to state clearly the mainstream view of the supposed benefits of countercyclical monetary policy and the challenge posed to it by recent microfoundations-oriented research; and to consider how this challenge may alter our views about the benefits of countercyclical monetary policy.

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## A PRIMER ON MAINSTREAM MACROECONOMICS AND ITS POLICY IMPLICATIONS

Let's begin with a brief account of how mainstream macroeconomics makes sense of countercyclical monetary policy.[1] In the mainstream view, the actual unemployment rate can deviate from the *natural*, or long-term, unemployment rate. This natural rate is determined by factors that change slowly, such as demographics, technology, laws and regulations, and social mores. Because markets don't work perfectly, there can be extended periods when the actual unemployment rate exceeds the natural rate. During such times, mainstream macroeconomic theory predicts that the inflation rate will fall because aggregate demand for goods and services will tend to fall short of aggregate supply. At other times, the unemployment rate can fall below the natural rate, and during those times, theory predicts that the inflation rate will rise because aggregate demand will tend to exceed aggregate supply. According to mainstream macroeconomics, business cycles are a manifestation of these deviations between the actual and natural unemployment rates.

This mainstream view of business cycles provides the rationale for countercyclical monetary policy. Suppose that the monetary authority uses monetary policy to eliminate the gap between the actual and the natural unemployment rates. In practice, the monetary authority would lower short-term interest rates whenever the actual unemployment rate threatened to exceed the natural rate and raise them whenever the opposite happened. If this policy were successful, the actual unemployment rate would track the natural unemployment rate closely. Since the natural unemployment rate changes only gradually over time, the result would be a less volatile actual unemployment rate. Without persistent gaps between the actual and natural unemployment rates, the inflation rate would also be less volatile. Generally speaking, households and businesses do not care for volatility in the unemployment rate or inflation rate, so such a policy would enhance public well-being.

> "How much would an average person in the U.S. pay to avoid all cyclical volatility in aggregate U.S. consumer spending?"
>
> *Robert E. Lucas, Jr.*

However, the mainstream view acknowledges some important limits on the scope of countercyclical monetary policy. First, countercyclical monetary policy cannot change the level of the natural unemployment rate directly. As noted earlier, the natural unemployment rate is determined by factors such as technology, demographics, laws and regulations, and social mores. Effective countercyclical monetary policy may provide an environment that is conducive to innovation (and therefore the advance of technology), but it does not have a direct effect on the natural unemployment rate.

Second, the natural unemployment rate is not directly observable; it can only be inferred from long-term trends in the economy. Thus, policymakers will sometimes judge a change in the unemployment rate to be a deviation from the natural rate when, in fact, it reflects a change in the natural rate itself, or vice versa. In such situations, countercyclical monetary policy will make the inflation rate more volatile, not less. For instance, a persistent attempt to reverse a decrease in the natural unemployment rate will lead to deflation, and a persistent attempt to reverse an increase in the natural unemployment rate will lead to inflation — both of which reduce public well-being. Thus, misperceptions concerning the natural rate may lead to policy errors.

Third, mainstream macroeconomics recognizes that the effects of monetary policy actions are felt with long and variable lags. Uncertainty about the length of time it takes for policy to have an effect on the economy is another potential source of policy errors.

## STANDARD OF LIVING AS A CRITERION FOR EVALUATING MACROECONOMIC POLICY

The fact that countercyclical monetary policy has both benefits and costs suggests that it's important to find out whether the benefits exceed the costs to determine if such policies are worth pursuing. University of Chicago economist and Nobel laureate Robert E. Lucas, Jr. was the first to explore this issue in the context of the U.S. economy. Lucas observed that cyclical volatility in the unemployment and inflation rates per se is not important to people. What really matters is the resulting cyclical volatility in people's standards of living. Since consumer spending is one of the most commonly used indexes of living standards, Lucas posed the question: "How much would an

[1] Some textbooks call this theory the New Keynesian or IS-LM approach to macroeconomics. But labels can be misleading; for instance, Bradford De Long calls the same theory a subspecies of monetarism. To avoid confusion I call it the "mainstream view" because it is the view that characterizes a broad swath of academic macroeconomics and virtually all of policy-oriented macroeconomics.

average person in the U.S. pay to avoid all cyclical volatility in aggregate U.S. consumer spending?" From the perspective of mainstream macroeconomics, an answer to this question provides an estimate of the maximum potential benefit from the Fed's pursuit of countercyclical monetary policy.[2]

As one would expect, the answer depends on how much households dislike random fluctuations in their standard of living (i.e., on their degree of risk aversion), and Lucas experimented with a variety of estimates, some more plausible than others. What he found was that a person would be willing to pay rather small amounts to avoid all fluctuations in the aggregate standard of living. One estimate, based on a plausible amount of risk aversion, implies that a person would pay no more than $23 per year for such a benefit! Such a paltry sum makes it hard to build a case for countercyclical monetary policy.

Of course, Lucas's finding that cyclical volatility is not very painful was (and remains) controversial. For one thing, economists were quick to note that the degree of risk aversion can be judged in a variety of ways, and some of these alternative ways suggest that the gains from eliminating all cyclical volatility in consumer spending are several hundred-fold larger than Lucas estimated. Also, as Lucas himself noted, his calculations assumed that all households share the burden of business cycles equally. In reality, the burden falls disproportionately on people who become unemployed during recessions. Taking this fact into account is likely to raise estimates of the maximum potential benefit of countercyclical monetary policy.

However, such criticisms miss a deeper point: Lucas's insistence that the benefits of countercyclical monetary policy be judged from the effect such policies have on the welfare of individual households. As he put it: "[A]n economic system is a collection of people and serious evaluation of economic policy involves tracing the consequences of policies back to the welfare of the individuals they affect." This quote succinctly expresses one of the core principles of microfoundations-oriented research: volatility in the unemployment and inflation rates should concern policymakers only if it results in unacceptable volatility in the standard of living. As I explain in the remainder of this article, evaluating policies based on the standard of living has surprising implications for the benefits of countercyclical monetary policy.

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## SELF-INSURANCE AS A SUBSTITUTE FOR COUNTERCYCLICAL MONETARY POLICY

Let's examine how reducing the volatility of the unemployment rate affects the volatility of consumer spending. Fluctuations in the unemployment rate affect members of a household in two ways: the probability of job loss for employed members and the probability of job gain for unemployed members. For instance, during a recession, when the unemployment rate is relatively high, the probability of job loss for employed workers is also relatively high, and the probability of job gain for unemployed individuals is relatively low. Thus, all individuals face a higher risk of lost earnings. Conversely, during an economic expansion, the probability of job loss for employed workers is relatively low, and the probability of job gain for unemployed workers is relatively high. Thus, all individuals face a lower risk of lost earnings. If countercyclical monetary policy successfully keeps the unemployment rate equal to the natural rate over time, the probability of job loss for employed individuals and the probability of job gain for unemployed individuals would be less variable. So an effective countercyclical monetary policy reduces the volatility of household earnings by reducing fluctuations in the risk of unemployment.

How does a reduction in the volatility of earnings affect fluctuations in a household's standard of living? Suppose that a household always spends the full amount of its monthly earnings and does not borrow or save. In this case, fluctuations in consumer spending will exactly match fluctuations in household earnings, and a policy-induced reduction in the

[2] The answer provides only an estimate of the maximum potential benefit for two reasons. First, it ignores the costs of policy errors. Second, it ignores the fact that some portion of the volatility in consumer spending should be excluded from the benefit calculation because it stems from fluctuations in the natural unemployment rate and cannot be eliminated by countercyclical monetary policy.

volatility of household earnings will have a direct and equal effect on the volatility of consumer spending.

But what if households save or borrow? Then, consumer spending may not fluctuate as much as earnings. If a member of the household becomes temporarily unemployed, the household may draw on a pool of savings (built up over the years for such an eventuality) to protect its standard of living. So, consumer spending will not fall as much as earnings. When the member regains employment, household spending will not rise as much as earnings because a portion of the earnings will be used to replenish the savings drawn down during unemployment. Building up and maintaining a stock of savings to protect oneself from temporary spells of unemployment or unanticipated expenses is called *self-insurance*.[3]

A surprising implication of self-insurance is that it weakens the ability of countercyclical monetary policy to improve public well-being because, from a household's point of view, self-insurance is a *partial substitute* for countercyclical monetary policy. To see this, suppose the monetary authority introduces a new countercyclical policy that lowers the volatility of household earnings. Faced with lower volatility of earnings, a household will have an incentive to lower its stock of savings. Recall that these savings were accumulated, in part, to protect living standards from shortfalls in earnings; however, lower earnings volatility means that such situations arise less often.

Thus, improved countercyclical policy will have two effects: it will reduce the volatility of a household's earnings, and it will induce households to reduce the savings built up to protect against such volatility. These two effects have *opposing* consequences for the volatility of consumer spending. The first effect lowers the volatility of consumer spending while the second raises it.[4]

What will the combined effect be? Theory predicts that the first effect will dominate and the volatility of consumer spending will decline. But theory also suggests that this decline will be minor. In other words, private stocks of savings are a partial substitute for the beneficial effects of countercyclical policies: an improved countercyclical policy partly substitutes for actions that a household takes to deal with the ill effects of earnings volatility.[5]

The significance of self-insurance for assessing the benefits of countercyclical policy was first recognized in an article published in 1989 by Ayse Imrohoroglu. Imrohoroglu simulated an economy in which individuals could borrow and save to protect their living standards in the face of temporary spells of unemployment. Her simulations showed that even if countercyclical policies made the unemployment rate constant and ensured that each individual faced a constant (rather than fluctuating) probability of job loss, the gain in well-being would be around $69 per person per year.[6] Although larger than Lucas's estimate, the gain was still quite small.[7] As Imrohoroglu noted in her article, her findings reflected the fact that individuals in her artificial economy self-insured themselves pretty well against temporary spells of unemployment. As a result, although effective countercyclical policy did reduce the volatility of consumer spending, the resulting gain in well-being was minor.[8]

What about volatility in the inflation rate? From a household's point of view, inflation volatility could be important because it affects the volatility of the real return on financial assets, the assets that households use to self-insure against temporary loss of earnings. If the expected real return on these assets is poor, it will blunt the

[3] Building up savings includes the case of paying off debt to keep open the option of borrowing more in the future.

[4] It will raise the volatility of spending because, all else remaining the same, a lower stock of savings means that a household is less able to protect living standards in case of a loss in earnings.

[5] That being said, it's important to recognize that some households may not be in a position to self-insure. For instance, a poor household living hand-to-mouth is not going to be able to self-insure and will benefit substantially from a less volatile macroeconomic environment. But such households do not constitute the majority. Furthermore, there are social programs in place that attempt to deal directly with the many causes and consequences of poverty. Given these programs, the appropriate goal of monetary policy is to concentrate on improving the well-being of the typical household.

[6] Even if countercyclical monetary policy manages to keep the unemployment rate constant, an individual's earnings may still fluctuate over time because of the possibility that an individual may lose his or her job. Thus, even when monetary policy is perfect, households have to self-insure against temporary spells of unemployment.

[7] In her article, Imrohoroglu presented results from several different simulations. The result reported here is for the simulation where individuals borrow at an annual real interest rate of 8 percent and save at a real interest rate of 0 percent. Like Lucas's, Imrohoroglu's calculations provide an estimate of the maximum potential benefit from countercyclical monetary policy. She ignores the potential costs of countercyclical monetary policy, and she assumes that a fully effective countercyclical policy corresponds to no fluctuations in the unemployment rate.

[8] Improved countercyclical policy permits households to lower savings. The additional one-time increase in consumer spending permitted by the decline in savings is another benefit of improved countercyclical policy. But a one-time increase in consumer spending cannot *permanently* improve well-being. For permanent improvements, one must look at how improved countercyclical policy affects the volatility of consumer spending. But that effect, as already noted, is minor.

incentive to self-insure. In a sequel to her first article, Ayse Imrohoroglu and Edward Prescott used simulation techniques to investigate the impact of inflation volatility on public well-being. Assuming that fluctuations in the expected inflation rate led to opposite fluctuations in the expected real return on assets, they found that inflation volatility had virtually no adverse effect on well-being.[9] As they noted in their article, what mattered most to people in their model was the *average* expected real return on financial assets, not the volatility of the expected real return.

In short, both theory and simulation results suggest that self-insurance acts as a partial substitute for effective countercyclical policies. Households can protect their standard of living from temporarily low earnings by drawing on a pool of savings built up for such eventualities. If they do not have savings, they can borrow, then repay the debt when earnings go back to normal. In such a situation, improvements in countercyclical policy partly substitute for private actions that people take to contain volatility in their standard of living. Consequently, the net effect on public well-being is not as large as one might otherwise suppose.

Of course, the decline in household income due to loss of employment is often mitigated by state unemployment insurance programs and by the progressive nature of the federal tax code (tax liabilities fall faster than earned income). From a household's perspective, self-insurance is also a substitute for social insurance programs and so raises troubling questions about the net benefits of these programs as well. However, Ayse Imrohoroglu and Gary Hansen have shown that even if households self-insure, unemployment insurance programs are generally quite beneficial, at least as long as the programs don't adversely affect people's desire to seek work.

In short, both theory and simulation results suggest that self-insurance acts as a partial substitute for effective countercyclical policies.

Before we take the policy implications of self-insurance seriously we must ask if, theory and simulations aside, households really do self-insure. Fortunately, a body of evidence now speaks to that question.[10] First, self-insurance accords with common sense. For instance, one financial planning guide recommends that households accumulate a stock of savings to deal with uncertainty: "It is generally held that your liquid assets should roughly equal four to six months' employment income. If you are in an unstable employment situation…the amount should probably be greater" (Touche Ross, 1989, p.10). Perhaps because of this commonsense aspect, surveys of household finances show that saving for emergencies is the most important reason cited for saving. These surveys also find that a household's stock of financial wealth is very volatile, even over short periods. Furthermore, studies show that households that face greater uncertainty about earnings tend to accumulate more financial wealth.

All these findings are consistent with households' using financial wealth as a buffer against random shocks to income and expenses. In addition, self-insurance accounts for several puzzling patterns in consumer spending. It would take us too far afield to discuss all of these here, but one is worth mentioning. Researchers have known for some time that a typical household does not begin to save for retirement until fairly late in life. This late start in providing for retirement has puzzled economists because it seems inconsistent with forward-looking behavior. However, simulations have now shown that self-insurance may dominate other motives for saving until an individual reaches his or her late 40s. It's only in late middle age that retirement-related considerations surface as the main determinant of savings behavior. Thus, self-insurance may go a long way toward accounting for the puzzling delay in providing for retirement.[11]

From a theoretical point of view, self-insurance is a basic outcome of forward-looking behavior, and the idea played a key role in Milton

[9] The real return on financial assets depends on the difference between the yield (or interest rate) on these assets and the inflation rate. According to mainstream macroeconomics, the real return on financial assets is countercyclical. The yield on financial assets does not rise as much as the inflation rate when the unemployment rate falls below the natural rate, and it does not fall as much as the inflation rate when the unemployment rate rises above the natural rate. The article by Imrohoroglu and Prescott examined the extreme case in which the interest rate on financial assets stayed constant, so that any change in the expected inflation rate led to an equal and opposite change in the expected real return.

[10] This discussion draws heavily on Christopher Carroll's 1997 article on the subject.

[11] This result emerges because self-insurance requires that households save in safe financial assets, the return on which is usually low. The low return discourages saving for retirement until late middle age.

Friedman's Nobel Prize-winning work on the theory of consumer spending.[12] It's remarkable that although macroeconomists have been aware of self-insurance since the 1950s, its significance for countercyclical monetary policy remained unappreciated until the late 1980s. In all likelihood, the reason for this lies in the fact that for a long time, the criteria for evaluating countercyclical policies made no direct reference to living standards. When Lucas insisted that macroeconomists use living standards as a criterion for policy evaluation, the significance of self-insurance quickly became apparent.

## SO WHY DOES COUNTERCYCLICAL MONETARY POLICY MATTER?

Self-insurance raises doubts about the goals of countercyclical monetary policy as conceived by mainstream macroeconomics. Since households can self-insure against the adverse effects of earnings and inflation volatility, and the evidence suggests that they do, policy-induced reductions in earnings and inflation volatility are predicted to yield only a minor improvement in public well-being. One could conclude from these findings that improving countercyclical monetary policy is not worth the cost; monetary authorities should de-emphasize reducing volatility and concentrate on other monetary policy goals, such as maintaining a low rate of inflation. However, such a conclusion overlooks a potentially devastating side-effect of self-insurance: *unbridled* self-insurance can be a *source* of macroeconomic instability. A simple example illustrates how this can happen.

Imagine a small community served by a single bank. The bank accepts deposits from local households and uses those deposits to make loans to local businesses. Imagine also that there is no federal insurance of bank deposits or unemployment insurance. A bank deposit is one financial asset that households use to self-insure themselves; another is cash. Under normal circumstances, a bank deposit is the preferred financial asset for self-insurance, since it accrues interest and cash does not.

Now imagine that some shock adversely affects many businesses in this community. Some businesses close; some people become unemployed; and those that still have jobs face a higher probability of job loss. The logic of self-insurance says that the employed will increase their savings to offset the heightened probability of job loss. As households reduce their spending, businesses in the community will experience a further fall in sales. The decline in sales will send more firms out of business, causing more unemployment and making households even more eager to self-insure.

If business failures continue, households will begin to think that the next business to fail will be the bank, and they'll rush to convert their savings into cash. The bank may well be sound, but the large-scale withdrawals of deposits will cause it to fail. The bank failure will deprive local businesses of a source of credit and, thus, force even more businesses to close. This cycle of falling demand, rising unemployment, more hoarding, and further decline in demand is an *economic crisis*. The sequence of events in this hypothetical community can, and does, happen on a larger scale. Indeed, it's what happened to many U.S. communities during the Great Depression.

This example highlights the point that actions that are beneficial from an individual's point of view can be self-defeating when taken simultaneously by many. The effect of a single household's increasing its savings to self-insure against a heightened possibility of job loss is quite different from the effects of *all* households doing the same. A simultaneous increase in the desire to self-insure may be self-defeating because it can make the event against which insurance is sought more probable. John Maynard Keynes observed long ago that an economy in which saving and investment decisions are carried out by different sets of people is susceptible to the *paradox of thrift:* if all individuals attempt to save more cash (so that the additional savings do not lead to a corresponding increase in business investment), aggregate demand will fall and so will income *and* savings.[13]

Once we recognize that a simultaneous increase in the desire to self-insure could destabilize the economy, the current U.S. policy arrangement begins to make more sense: self-insurance is only *part* of the solution to reducing earnings volatility. Some of the burden of providing insurance against loss of earnings is borne by the government through the other two prominent stabilization policies mentioned in the introduction: federal insurance of bank deposits and state-run unemployment insurance programs. Deposit insurance eliminates the need for households to

[12] The idea also attracted the attention of economic theorists, most notably Truman Bewley of Yale University. In a series of articles published in the 1970s, Bewley provided a wide-ranging discussion of the implications of self-insurance. More recently, macroeconomists have picked up where the theorists left off. Influential articles by macroeconomists include those by Mark Hugget and S. Rao Aiyagari.

[13] The possibility that individually rational actions can have bad social consequences is a recurring theme in economics. For a wide-ranging and very readable discussion of this theme, see Thomas Schelling's book.

self-insure in the form of cash, and unemployment insurance permits households to face a higher probability of job loss with greater equanimity. Both programs attenuate the potentially destabilizing effects of households' response to heightened economic insecurity.

The benefit of countercyclical monetary policy can also be understood in these terms. *By attempting to reduce the volatility of the unemployment rate, countercyclical monetary policy makes it less likely that households will face a large simultaneous increase in the probability of job loss.* In other words, countercyclical monetary policy helps to nip the problem of macroeconomic instability in the bud. One might think that with two other stabilization policies in place, it's unnecessary for monetary policy to attempt to reduce fluctuations in the unemployment rate. However, the two insurance programs provide partial, not complete, protection. The federal guarantee of bank deposits protects each individual account up to $100,000, so large accounts are not fully protected. Most state unemployment insurance programs replace somewhere between one-half to two-thirds of a worker's most recent weekly pay, but only for a maximum of 28 weeks. Because both deposit and unemployment insurance are not complete, the possibility remains that a large enough increase in the unemployment rate may lead to enough of an increase in the desire to self-insure so as to destabilize the economy.

That stabilization policies exist to protect against instability should not come as a surprise. What is somewhat odd is that mainstream macroeconomics does not really accept the point that stabilization policies are *necessary* to prevent instability. The mainstream view is that market economies are self-regulating: if a shock moves the unemployment rate away from the natural rate, market forces eventually bring the unemployment rate back to the natural rate. The cycle of rising unemployment, more hoarding, and more unemployment that I highlighted earlier is assumed to be impossible.[14] But there is no theoretical presumption that market economies are necessarily self-regulating. It's possible to construct macroeconomic models in which the forces of self-regulation are weak enough that adverse shocks precipitate economic crises.[15] Whether the forces of self-regulation can be relied on to avoid crises in actual economies is a controversial issue.

By attempting to reduce the volatility of the unemployment rate, countercyclical monetary policy makes it less likely that households will face a large simultaneous increase in the probability of job loss.

If the true benefit of countercyclical monetary policy lies in preventing economic crises, how much of an effect does it have on living standards? The answer depends on how likely it is that economic crises will occur in the absence of countercyclical monetary policy. Although there is no accepted estimate of that likelihood, some of my research suggests that if counter-cyclical policy eliminates even a very small likelihood of a Great Depression-like event, the resulting gain in living standards can be quite significant. We estimate that a person would pay as much as $1,380 per year to eliminate a once-in-83-years chance of living through a Depression-like event.[16] Thus, if countercyclical monetary policy does nothing other than prevent economic crises, that benefit alone may provide an adequate justification for pursuing it.

**SUMMARY**

Macroeconomists typically view reducing the cyclical volatility of the unemployment and inflation rates as the proper goal of countercyclical monetary policy. Generally speaking, macroeconomists and policymakers have not been very explicit about why such reductions enhance well-being. This article discussed some research that bears on this question. In particular, it laid out the implications of the view that the benefits of countercyclical monetary policy ultimately derive from the effect such a policy has on people's standard of living.

The standard-of-living criterion has unexpected implications for assessing the benefits of countercyclical monetary policy. If the goal of countercyclical monetary policy is to reduce volatility in the standard of living, such a policy is unlikely to be

[14] The textbook New Keynesian or IS-LM model does not allow for the possibility of economic crises. While a decline in aggregate demand may cause a temporary rise in unemployment, the model predicts that market forces (in the absence of any further shocks to aggregate demand) will eventually bring the unemployment rate back to the natural rate.

[15] MIT professor Peter Diamond demonstrated this possibility in a series of influential articles in the early 1980s. His views are summarized in his 1982 book.

[16] See my working paper with Dean Corbae for details.

very beneficial. The problem is that if monetary authorities succeed in reducing the volatility of the unemployment and inflation rates, this success will partly substitute for private actions taken to safeguard living standards (self-insurance). Thus, because of self-insurance, the overall reduction in the volatility of the standard of living will not be as great as one might otherwise suppose.

On the other hand, self-insurance may be a mixed blessing. Sudden increases in the desire to self-insure can be a source of macroeconomic instability. Taking this possibility into account suggests that an important benefit of countercyclical monetary policy (along with deposit and unemployment insurance) is to reduce the likelihood of a sudden upward jump in the unemployment rate. Such a jump could trigger a destabilizing rise in the desire to self-insure and cause an economic crisis. If countercyclical monetary policy eliminates even a small likelihood of economic crisis, the gain in the average person's living standard may be large enough to justify the potential costs of such a policy.

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# Understanding Changes In Aggregate Business Fixed Investment

BY AUBHIK KHAN

When economists talk about business fixed investment, they mean the expenditures by firms on equipment and structures. Business fixed investment is commonly held to be an important determinant of an economy's long-run growth. [1]

On average, higher levels of such investments raise production by increasing the productivity of the labor force. While the significance of short-term changes in business investment is less widely recognized, the importance of such changes for the business cycle has been known to economists since the beginning of the last century. For example, many believe that the current record expansion has been driven, at least in part, by strong investment in computers and related equipment. In this article, I attempt to explain some of what economists have learned about how investment changes over the business cycle.

[1] The definition of business fixed investment used throughout this paper does not include software expenditures by firms because these data are not available.

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## INVESTMENT AT THE PLANT LEVEL

For individual plants, investment is simply the expenditure required to adjust its stock of capital. Capital includes all equipment and structures the plant uses. The plant combines capital with other inputs, such as labor and energy, to produce goods or services. When a mining company acquires diesel engines, it is investing in equipment. When an automobile manufacturer builds a new warehouse, it is investing in structures. Because it takes time to manufacture, deliver, and install new capital goods, investment expenditures today do not immediately raise the level of a plant's capital. So investment involves a planning decision that trades off present against future earnings. Investment expenditures today reduce current profit but increase a plant's future possible production and, as a result, future profit.

Since investment spending raises future capital and thus the quantity of goods and services that may be produced in the future, plants will tend to adjust their investment levels in response to forecasted changes in the market's demand for their own output. Changes in productivity — the efficiency with which inputs may be combined to produce output — will also tend to increase investment. For example, if productivity increases, the firm may be able to sell more of its product, since it can offer it at a more attractive price. The firm may then expand and more workers may be hired. These workers will need equipment, and, as a result, investment will rise.

## AGGREGATE INVESTMENT OVER THE BUSINESS CYCLE

When plants anticipate increased demand for their output or higher productivity, they will generally raise their investment spending. For most sectors of the economy such increases in investment occur when GDP rises, for example, during economic expansions. In contrast, if plants expect a decline in demand, such as occurs for most plants when GDP falls, investment spending will fall. As a result, *aggregate investment* — the sum of all investments by all plants in the economy — is *procyclical:* it rises when output rises and falls when output falls over the business cycle.

Even a casual glance at the

data will reveal that investment is much more volatile than output (Figure 1). [2] During periods of above-trend growth, aggregate investment experiences a much larger percentage rise. Moreover, when growth rates are below trend, such as during recessions, aggregate investment falls far more sharply than does aggregate output. Indeed, if we use a standard measure of variability, quarterly investment is 3.4 times more volatile than quarterly output over 1956 - 1994.[3]

The reader will likely note another striking regularity between the two series: investment and output almost always move in the same direction. For example, in the sharp recession of the early 1980s, detrended output fell almost 5 percent, and concurrently, investment fell more than 10 percent.[4] Plants adjust investment in anticipation of changes in output demand, and consequently, investment moves similarly to output. It follows that to understand the business cycle, we must understand why aggregate investment changes over time. As Harvard economist Robert J. Barro has stated, "As a first approximation, explaining recessions amounts to explaining the sharp contractions in the investment components" (p. 245).

But to understand why aggregate investment fluctuates, economists are learning that they must understand the decisions of individual plants. Such emphasis on the role of an individual entity characterizes recent progress in many areas of macroeconomics.

[2] Episodes of negative growth rates in Figure 1 do not imply recessions, at least as they are commonly understood. For example, if the output trend is 3 percent, and actual output grows at 2 percent, Figure 1 will report –1 percent. Of course, actual recessions will be recorded when growth is negative.

[3] The percentage standard deviation of output is 1.4 while that of investment is 4.9, hence the ratio of 3.4.

[4] This co-movement in investment and output is captured by a correlation coefficient of 0.92 between the two series.

## FIGURE 1

### Investment and Output over the Business Cycle

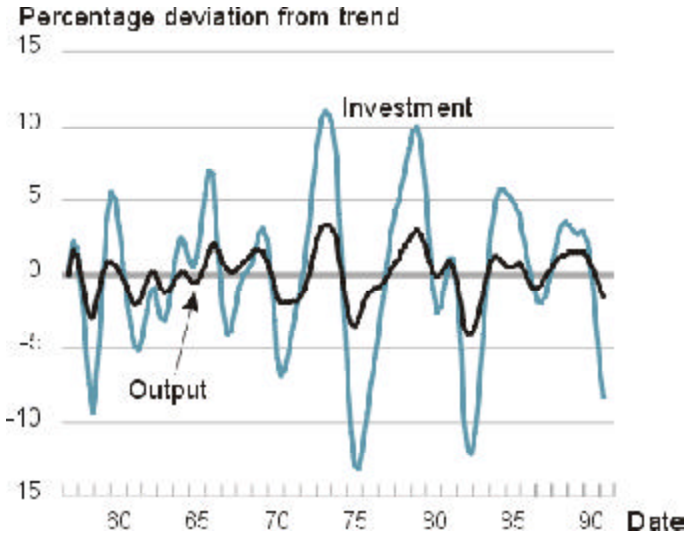



Figure 1 displays detrended quarterly total real business fixed investment and GDP in the United States in each quarter over the years 1956 – 1994. Since we want to concentrate on how these series move over the business cycle, we have detrended them. That is, the figure shows changes in output and investment from their longer-term trends. These trends were computed using the Band-Pass Filter developed by Marianne Baxter and Robert G. King in their 1999 paper. Note that the use of this filter eliminates several years of data at the beginning and end of our series.

## THE PARTIAL ADJUSTMENT MODEL

As with all other forms of scientific progress, progress in economics relies on the development of theories. The success of these theories is determined by their ability to contribute to an explanation of observed phenomena. In the study of investment, this has led to a theory of how firms choose their levels of investment.

Traditionally, economists tried to understand aggregate investment using an approach that ignored possible differences across individual firms. This approach led to a theory that relied on the fiction of a representative firm that undertook all investment that actually occurred in the economy. In reality, many firms own and operate several plants, and investment decisions are made at both the firm and the plant level. But as long as we examine representative firms, there is no meaningful distinction between a firm (an ownership unit) and a plant (a production unit).

Let's consider a representative firm, BIGCAP. Even if BIGCAP sees no reason to change the level of its capital stock, it will nonetheless have to undertake some maintenance to sustain capital stock at current

levels, since capital depreciates over time. Investment beyond the level needed to offset depreciation will raise the stock of capital BIGCAP will have in the future. This higher level of capital will allow BIGCAP to raise production. So investment today will affect future earnings and, thus, future profits. Therefore, by undertaking investment today and building capital, BIGCAP can influence its future profits. The fundamental assumption of the standard theory of investment is entirely reasonable: A firm chooses its stock of capital in order to maximize its shareholder value. This is the firm's *target level* of capital.

**Adjustment Costs.** However, modern variants of this theory make another important assumption: there is a cost associated with changing a firm's capital, the cost of adjustment itself. In their 1996 review paper, Daniel Hammermesh and Gerard Pfann discuss some of the sources of these adjustment costs. Adding a new machine takes time. During installation, the firm must reallocate production across its other machines, a move that may overburden these other machines and may present machine operators with unfamiliar working conditions. As a result, production will fall during this first adjustment period. Next, after the new machine has been installed, workers must be trained to use it. Again, the firm will be operating at temporarily reduced levels of productivity during this second adjustment period.

Overall, when a firm installs new capital goods it incurs internal costs over and above the cost of the equipment itself. These costs reduce the firm's profits over the adjustment period.

Consider what happens if BIGCAP purchases a new computer to add to its existing stock. In addition to the price of the computer equipment, BIGCAP will incur additional costs of integrating the machine into its network and setting it up with the required software. The nature of these costs — how they change with respect to the quantity of investment undertaken by BIGCAP — is critical in determining their effect. Traditional investment theory assumes that it costs more, *per unit*, to install more capital. Thus, BIGCAP's cost of installing two new computers would be more than twice the cost of installing a single machine.

Rising costs of adjustment imply that adjusting capital rapidly would cost more than doing it gradually. So traditional theory said that firms adjusted to their target capital stock — that which maximized shareholder value — slowly in an effort to reduce adjustment costs. So this theory was called the *partial adjustment model.*

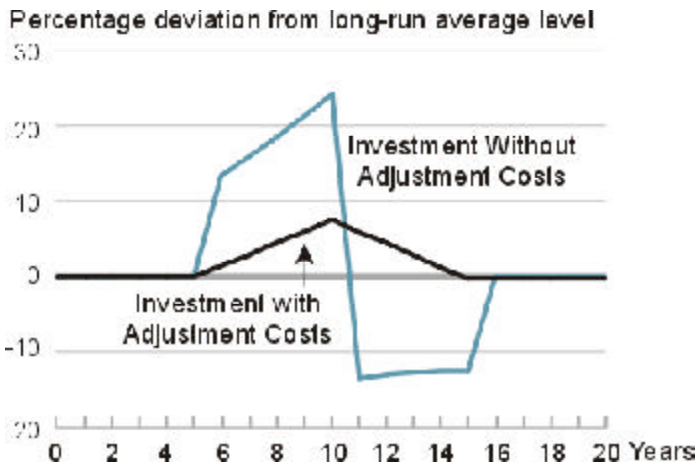
It is not at all obvious why the costs of adjustment should rise with the level of investment. We might well think that competent computer staff, learning from setting up the first computer, would install the second in much less time. However, when rising adjustment costs were ignored, the model performed very poorly, since it predicted too much volatility in aggregate investment. So by including rising adjustment costs, the model better matched the data for the economy as a whole.

Figure 2 shows how assuming rising adjustment costs leads to smoother aggregate investment. It displays two possible models of a firm's investment over time.[5] For each one, the vertical axis displays the firm's current level of investment over time, as a percentage of its long-run average level. Suppose the firm experiences a rise in productivity, lowering its costs, or, instead, a rise in expected demand

[5] Figures 2 and 3 were generated by solving economic models of a firm's behavior under different assumptions about the costs of capital adjustment.

## FIGURE 2

### Investment With and Without Adjustment Costs



for its product. As a result, it chooses to increase its capital stock so that it can produce more. The blue line indicates the investment the firm will make if it faces no adjustment costs: there is a sharp rise in investment as the firm immediately adjusts its capital stock to allow it to efficiently increase production. Subsequently, when productivity or demand eventually returns to normal, there is an equally dramatic disinvestment episode, as the firm sells off its excess capital stock. In contrast, if adjustment costs rise with the level of investment, the change in capital is much more protracted. Capital partially adjusts in each period as investment slowly raises it toward its target value. As a result, when the change in productivity or demand ends, the plant has much less disinvestment to do. Investment is much more gradual under partial adjustment.

Since we are looking at a representative firm, total investment for the economy is the same as this firm's investment. Hence, more gradual investment at the firm level means that aggregate investment, that is, the total investment of all firms, shares the same properties.

When we compare Figures 1 and 2, we see that the model without adjustment costs generates an investment series that is too volatile when compared with the data. For example, in the model without adjustment costs, the largest deviation of investment from its trend is 25 percentage points, but in the data over 1956 – 94, the largest deviation was 10 percentage points. But when we examine the model with adjustment costs, we see that it exhibits much less variability in investment. As a result, the introduction of adjustment costs allows for a far better match with the aggregate data.[6]

**Adjustment Costs Revisited.** The partial adjustment model means gradual change in investment at the aggregate level, which matches the data, but it also means gradual adjustment in investment at each individual firm — and this does not seem to match the data! When researchers at the Bureau of the Census undertook an extensive study of how manufacturing plants adjusted their stock of capital, the story they uncovered was *inconsistent* with the predictions of the partial adjustment model. Instead of changing capital slowly and gradually, plants made capital adjustments that were lumpy, that is, they would invest a lot at one time, then refrain from investing for a while, then invest a lot again, and so on. Typically, plant capital remains roughly constant for long periods of time, with low levels of associated investment. These long episodes of relative inactivity are interrupted by sudden bursts of investment spending that drive large increases in plants' capital stock over short periods of time. The partial adjustment model with rising adjustment costs predicted plant-level investment that was too smooth. Given the limited success of the partial adjustment model, macroeconomists began to reconsider the plausibility of the assumption about rising adjustment costs. Indeed, much of the recent progress in our understanding of investment has arisen from replacing the unrealistic assumption of rising costs of adjustment with a better one. (See *How Do Plants Adjust Their Capital?*)

[6] It should be noted, however, that the match is still imperfect. Adjustment costs reduce variability too much (the largest deviation from trend in the model with adjustment costs is about 5 percentage points).

## How Do Plants Adjust Their Capital?

In their 1998 paper, Mark Doms and Timothy Dunne examined capital adjustment at the plant level. Using the Longitudinal Research Datafile collected by the U.S. Bureau of the Census, they studied changes in the capital stock of 13,700 large U.S. manufacturing plants over 1972 – 1988. In terms of the total number of manufacturing plants, the sample is small: over this period, between 312,000 and 360,000 plants were operating in the manufacturing sector. However, the sample accounts for approximately 50 percent of total manufacturing production and 40 percent of employment. In addition to including relatively large plants, the sample is also unusual because all the plants present in the sample in 1972 were still in it through 1988.

In a typical year, over 80 percent of all plants in the sample undertook very little capital adjustment: their capital stocks changed less than 10 percent. But approximately 8 percent of plants adjusted capital by more than 30 percent, and more than half of the sample experienced capital growth of more than 37 percent in at least one year.

The partial adjustment model, which predicts gradual changes in investment due to the rising costs of undertaking too much capital adjustment at one time, cannot explain these sharp, sudden investment episodes followed by long periods of low adjustment.

As the mathematical sophistication of researchers in the field increased, they understood how to adapt the existing theory of investment to account for the new observations. The new theory assumes that the costs of capital adjustment are unrelated to the scale of the adjustment. Much of the adjustment cost borne by a plant would now be the same whether it was adding one, two, or even 10 computers to its network.

Such *fixed costs* (fixed because they are the same regardless of the amount of investment) lead to lumpy investment over time at the plant. Let's consider BIGCAP once again, assuming that BIGCAP is a firm that owns only one plant. BIGCAP determines its target level of capital, the level that maximizes shareholder value in the absence of adjustment costs. However, BIGCAP will adjust to this capital stock only if the rise in shareholder value from doing so is greater than the fixed cost associated with the capital adjustment. As explained by Ricardo Caballero in his 1999 paper, what this means is that a plant like BIGCAP will adjust its capital only when the current level of its capital stock is far enough away from its target level of capital stock.

If current and target capital levels are close, there's not much gain in shareholder value from adjustment; the fixed adjustment cost outweighs the benefits of adopting the target level of capital. But once it decides to adjust its capital stock, BIGCAP has no incentive to move gradually, since the adjustment cost is independent of the size of the adjustment. Notice that a simple modification of existing theory has led to a dramatic change in the model's predictions. Investment at the plant level is no longer slow and gradual but rather erratic and lumpy. Plants don't change their actual capital in response to small changes in their target capital. So there are typically long periods when plants don't undertake much investment. However, when target capital is sufficiently different from actual capital, there is sudden, sharp adjustment.

## THE SUM OF INDIVIDUALS: THE IMPLICATION OF FIXED ADJUSTMENT COSTS FOR AGGREGATE INVESTMENT

Fixed adjustment costs seem to fit the plant-level data quite well. But how well do they match the aggregate data? Before we add up individual plants' behavior, we must understand how these fixed adjustment costs vary across plants and across time. Once this is accomplished, we will see that the new model actually fits the aggregate data better than the partial adjustment model.

How can a model of lumpy plant-level investment match the aggregate investment data, which show gradual changes in investment? The answer is that the fixed costs that are the foundation of the new theory are assumed to vary both across plants and over time, that is, fixed costs behave randomly.

Recall our example of installing new computers. Now, let's consider the installation of two new machines, on two separate occasions, at our hypothetical plant. For the first installation, managers may have available a very competent senior technician. He or she may be able to efficiently integrate the new machine into the plant's network. The cost of capital adjustment will be relatively small. However, at a later date, the senior technician may be unavailable, and managers may have to rely on a novice. This technician, new to the plant and unfamiliar with its computer systems, is likely to take far longer to install the new computer and will therefore incur a much larger adjustment cost. A simple way to introduce such variations into models of investment is to assume that adjustment costs are random.

**What Do Random Adjustment Costs Mean for Aggregate Investment?** If these costs differ randomly across plants and over time, then even two similar plants are likely to behave differently because they'll have different adjustment costs. Consider a world full of plants that all start out with the same level of capital. Over time, they'll face different adjustment costs, and thus, their capital adjustment behavior will differ.

The difference between a plant's actual and target capital stock will also differ across plants. Plants that had small fixed costs will have adjusted their capital stocks and be close to their targets. Plants that were less lucky and experienced several large adjustment costs in a row will have much larger capital imbalances. Generally, plant actions will not be synchronized. Plants with larger capital imbalances will see higher gains from adjusting capital, no matter what the adjustment cost; hence, they'll be more likely to undertake adjustments. Plants with low capital imbalances will not be willing to absorb even moderate adjustment costs and will be unlikely to adjust capital. At any time, someone studying the entire population of plants will find that some actively adjust their capital while others do not.

Plants with larger capital imbalances will see higher gains from adjusting capital, no matter what the adjustment cost

Changes in aggregate investment will arise for two reasons: changes in the level of investment undertaken by plants actively investing and changes in the number of these active plants. When there are many plants, small increases in productivity or demand that affect most plants will, generally, induce small changes in the number of plants actually investing. But by raising target capital a little, a few more plants will be induced to become active and adjust capital. As a result, while individual plants may exhibit lumpy investment, the number of plants investing will evolve more gradually, leading to slower changes in aggregate investment.

We see that the fixed cost model is able to preserve the success of the partial adjustment model in explaining changes in aggregate investment, while it improves the match with the microeconomic evidence on plant-level investment.[7]

## SYNCHRONIZATION AND BUSINESS CYCLES

The fixed adjustment cost model and the partial adjustment model make different predictions about how investment should behave over the business cycle. While plants will typically not act together in the fixed adjustment cost model, at other times, plants will behave in a dramatically more synchronized manner in the model, mainly whenever there is a sharp change in some factor that affects all plants.

Economists agree that plants are subject to unforeseen events that can either increase or decrease their productivity. For example, a bank might be subject to new regulation, a farm might experience a drought, or a firm might adopt a new type of technology, for example, newer, faster computers.

The fixed adjustment cost model and the partial adjustment model make different predictions about how investment should behave over the business cycle.

Consider a large unforeseen rise in future productivity for all plants — what macroeconomists refer to as a large shock. Such a productivity shock, which might occur at the end of a recession, will yield a large change in the target capital of all plants. As a result, there will be few plants left with low capital imbalances, and most plants will adjust their capital. Their actions will, to a large extent, be synchronized. In their 1999 paper, Ricardo Caballero and Eduardo Engel show that such synchronization can lead to a sharp, unusual rise in aggregate investment.

The black series in Figure 3 represents the total investment of a group of plants when an extraordinary change in productivity results in a sudden synchronization of their investment. The blue series presents a hypothetical alternative case in which the number of plants allowed to adjust their capital is constrained to remain at ordinary levels. Notice the increased response in total investment due to the synchronization effect. Over the first 11 years, investment initially rises by a total of 17 percentage points more in the synchronized case. While this is partly offset by a steeper decline during years 12 – 14, the overall impact of synchronization is to raise investment spending by 4 percentage points.

*This is the principal achievement of the new theory of investment.* By allowing differences in capital imbalances across plants to evolve over the business cycle, the new investment theory allows the synchronization of investment activities during episodes involving large changes in the macroeconomy. It is through such episodes that the fixed cost model we have been examining overcomes the excessively low variability of investment in the partial adjustment model. The fixed cost model provides a considerably better match with both the aggregate and the plant-level data (these models are compared in Figure 4) and can explain the sharp increase in aggregate investment that follows a recession.[8]

## CONCLUSION

The theory of investment has evolved into one that's now better able to explain the facts about investment at both the macro and micro levels. Traditional theory, known as the partial adjustment model, ignored differences across plants and firms. As a result, while it was reasonably

[7] In fact, the fixed cost model is actually better able to explain aggregate investment than the partial adjustment model because the partial adjustment model reduced the variability of investment too much. And while the fixed cost model typically behaves like the partial adjustment model, at other times it allows for much sharper changes in investment. This undoes much of the excess smoothness of the partial adjustment model.

[8] This is shown in the 1995 paper of Ricardo Caballero, Eduardo Engel, and John Haltiwanger and the 1999 paper of Russell Cooper, John Haltiwanger, and Laura Power.

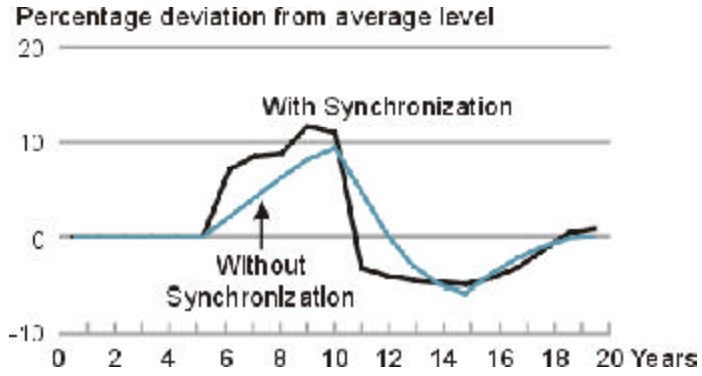
successful at explaining aggregate investment, it did poorly at explaining lumpy plant-level investment. Newer theories that explicitly address plant-level investment resolve the problems not addressed by traditional theory. These new theories of investment emphasize the role of fixed costs of capital adjustment in inducing large but occasional plant-level investment. Moreover, once it was understood that these costs were likely to vary across plants and over time, the fixed cost theory has been able to explain not only plant-level investment but also aggregate investment. Indeed, by allowing for unusual synchronization of investment across plants, fixed cost theory is able to explain brisk recoveries following recessions, something traditional theory could not do.

Of course, even the new theory leaves something out. For example, recent work suggests that changes in interest rates, ignored in the new theory, may have powerful effects on firms' investment decisions.[9] Nevertheless, the new theory certainly represents progress — it provides an explanation of changes in aggregate investment that, in contrast to traditional theory, is consistent with our observations of plants' investment behavior.

[9] See the 2000 paper by Julia Thomas and the 2000 paper by both Julia Thomas and me.

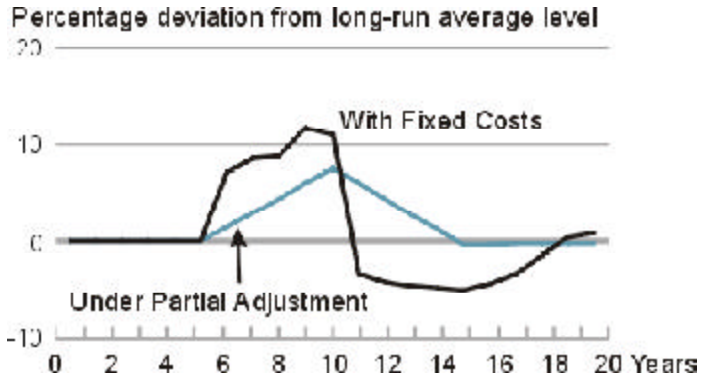
## FIGURE 3

### Investment With and Without Synchronization




## FIGURE 4

### Investment Under Partial Adjustment and With Fixed Costs

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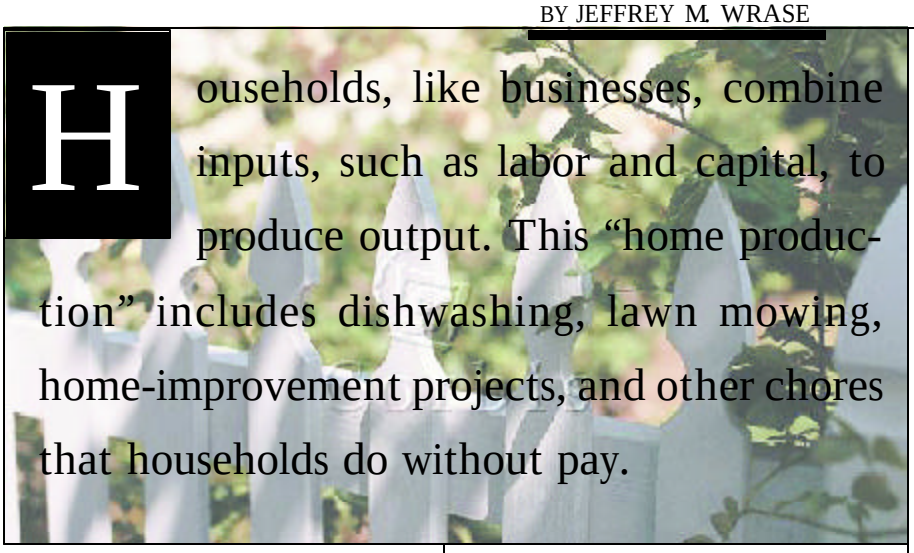
# The Interplay Between Home Production And Business Activity

BY JEFFREY M. WRASE



Households, like businesses, combine inputs, such as labor and capital, to produce output. This "home production" includes dishwashing, lawn mowing, home-improvement projects, and other chores that households do without pay.

Although decisions households make about the amount of time and resources to devote to home production versus working in the marketplace influence official measures of economic conditions, these measures don't take home production into account.

Models of economic activity usually ignore home production as well. In fact, research on home production shows that the variability of many key macroeconomic variables, as well as how those variables respond to changes in the economic environment, may be skewed because the typical macroeconomic model does not fully account for how people allocate time and resources between market activity and other activities. Analysts, forecasters, and policymakers could benefit from economic models that incorporate such decisions.

This article explores how home production influences official measures of the economy.[1] It also discusses the potential gains from incorporating household decisions about allocating resources to home production into models used to forecast and to account for changes in economic conditions.

## HOME PRODUCTION AND ECONOMIC MEASUREMENT

Most people are familiar with headlines describing how fast or slow the economy's growth is, and many measures of growth are based on government statistics that gauge the total value of output produced in the economy. A substantial amount of the output captured by those statistics is devoted to goods and services *used* by households. However, some output, such as that *produced* by households, is not counted in official measures of economic activity.

**How Much Home Production Takes Place in the Economy?** Because official measures of economic activity do not explicitly include home production, it is not easy to say how much takes place at any point in time or how such production changes over time. Some economists have, however, attempted to measure home production and other nonmarket activity.[2] Others have studied how households divide their available time across alternative activities, such as market work and home production.[3]

We can gauge the magnitude of home production in two ways. One involves looking at the amount of time people devote to unpaid work at home. Thomas Juster, Frank Stafford, and Martha Hill have produced extensive research studies of how households use their time. Their studies use a number of sources, including an extensive database compiled by the Institute for Social Research at the University of Michigan, called the Michigan Time Use

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[1] Official measures refer to economic data produced by various statistical agencies, including the Bureau of Economic Analysis, Bureau of Labor Statistics, and the U.S. Department of Commerce. The data are available on the agencies' web sites or in various documents, such as the Federal Reserve Bulletin, the Survey of Current Business, or the Economic Report of the President.

[2] See the articles by Robert Eisner and the article by William Nordhaus and James Tobin.

[3] See the article by Thomas Juster and Frank Stafford and the one by Martha Hill.

Survey. This survey contains data on individuals' allocations of time to various activities during each day, based on extremely detailed diaries kept by respondents for one year.

According to these time-use surveys, a married couple, on average, devotes 25 percent of discretionary time to unpaid — and not officially measured — home production such as child care, cooking, and cleaning, and 33 percent of discretionary time to work in the marketplace for pay.[4] By this measure, home production is indeed significant.

Another way to gauge home production is to look at inputs and outputs. On the input side, economists Jeremy Greenwood, Richard Rogerson, and Randall Wright (1995) examined data from the U.S. national income and product accounts. They found that *household capital investment*, defined as purchases of residential structures and consumer durable goods, *exceeds business capital investment*, defined as purchases of nonresidential structures and producer durable goods.

On the output side, another economist, Robert Eisner (1988), reported that the value of home production could range between 20 percent and 50 percent of the value of the U.S. economy's output, officially measured as gross domestic product (GDP).[5] And with GDP currently around $10 trillion, 20 to 50 percent is a lot of unmeasured output.

Thus, all the measures above indicate that home production amounts to a significant portion of activity that is not explicitly picked up in official measures of the economy's performance. Furthermore, most macroeconomic models have little to say about it.[6] To better explain movements in official measures of economic variables, models need to account for the way inputs into home production and the resulting output change from period to period. We each have a fixed amount of time available each day, and we divide it among market production, home production, and leisure.[7] Accordingly, changes in home production over time will lead to changes in time allocated to economic activity picked up by official measures.

A married couple, on average, devotes 25 percent of discretionary time to unpaid home production and 33 percent of discretionary time to work in the marketplace for pay.

## WHY ARE THERE FLUCTUATIONS IN MACROECONOMIC ACTIVITY?

What fundamental forces drive business cycles?[8] And why do households devote more time to working in the marketplace during expansions and less time during recessions? Many possible answers to these basic macroeconomic questions have been put forth.

One answer emphasizes that macroeconomic fluctuations arise from the sometimes unintended consequences of economic policies, including changes in taxes or government expenditures, changes in regulations imposed on firms, or changes in the money supply. For example, an increase in taxes may slow the demand for goods by households and firms. The slowdown in demand could then lead to layoffs and, consequently, reduced time devoted by households to working in the marketplace. A major difficulty with this explanation is that it is hard to establish statistically a causal link between changes in economic policies and macroeconomic fluctuations.

Another answer proposes that the economy fluctuates between periods of expansion and contraction because of inexplicable shifts in consumers' preferences, in the preferences of firms that invest in goods to use in producing other goods, or in the preferences of savers, who supply funding for consumers and firms. Such shifts in preferences, sometimes called changes in consumer or investor optimism, or "animal spirits," could also lead to changes in overall demand for goods and, consequently, to changes in the amount of time that people devote to working in the market. The problem with this explanation of business cycles lies in the difficulty of obtaining convincing measures of preference shifts.

[4] Discretionary time refers to time not spent sleeping or on personal maintenance.

[5] GDP is the current market value of all final goods and services produced in a period by domestically owned factors of production.

[6] The idea of incorporating home production into economic models — or, more particularly, households' time-allocation decisions between activities other than simply leisure or work in the marketplace — is not new. Labor economists have included home production in models of the labor market for decades — at least as early as 1965 (see Gary Becker's article). But the relevance of home production and attention to households' time-allocation decisions across a variety of possible activities have only recently been considered in research into factors contributing to fluctuations in economic activity.

[7] Leisure includes time spent sleeping and on personal maintenance.

[8] Broadly defined, business cycles, also called macroeconomic fluctuations, are alternating periods of expansion and contraction of economic activity.

In the past 20 years, another answer has gained a lot of attention: fluctuations arise as a consequence of random shifts in technologies used by firms to produce goods and services. Specifically, these random shifts alter the effectiveness of inputs in producing output. For example, a technological change may mean that a given amount of labor, when combined with other inputs, can produce more output than before. Such changes in the productivity of labor, in turn, could lead to changes in the amount of labor that firms want to hire and perhaps the amount of time that households wish to supply to firms in the marketplace. So, random shifts in productivity — also called productivity shocks or technology shocks — can spark changes in employment, GDP, and other key variables. (See *How Important Are Technology Shocks for Growth and Fluctuations in Macroeconomic Activity?*)

## TYPICAL MACROECONOMIC MODEL

Most macroeconomic models attempt to account for changes in the amount of time devoted to market work over a business cycle by assuming that households devote time either to

## How Important Are Technology Shocks for Growth and Fluctuations in Macroeconomic Activity?

Nobel laureate Robert Solow calculated the sources of long-term economic growth, using what is known as the neoclassical growth model of the economy, based on data for the period 1909 to 1949.* His estimates revealed that changes in productivity accounted for 87.5 percent of the growth of output per worker and increased capital per worker accounted for 12.5 percent. Thus, during the period Solow studied, most of the growth of output per worker was due to improvements in productivity.

Updating Solow's estimates of the sources of growth using data from the mid 1950s to the early 1990s, Thomas Cooley and Edward Prescott obtained results similar to Solow's: the majority of growth in output per worker in the U.S. economy stems from improvements in productivity.

While the findings of Solow and others point to productivity improvements as the primary contributors to average growth in the economy, we are also interested in business cycles. Again, using the neoclassical growth model, Solow, followed by Cooley and Prescott, found that sources of business-cycle fluctuations seem to be different from sources of average growth. Because capital, such as machines and structures used by firms, is an input that does not change very much over business cycles, most fluctuations in GDP over business cycles stem from fluctuations in labor inputs. According to Cooley and Prescott, around two-thirds of fluctuations in output per worker stem from fluctuations in labor input; the remainder comes primarily from fluctuations in productivity.

A key lesson from the findings of Solow and those of Cooley and Prescott is that a model capable of accounting for both average growth in GDP and for fluctuations in key macroeconomic variables has two requirements. First, because changes in productivity are important contributors to business cycles, the model needs a way for productivity to change over business cycles. Second, because a majority of fluctuations in GDP stem from changes in labor inputs, the model must include incentives for both households and firms to make large changes in the time devoted to market work over the course of a business cycle.

Finn Kydland and Edward Prescott's influential theoretical and empirical work advanced the idea that fluctuations in macroeconomic conditions are driven largely by random changes in productivity. The work of Kydland and Prescott, as well as subsequent research by other economists, uses a typical macroeconomic model that includes measures of productivity shocks to account for fluctuations in key macroeconomic variables. Using data on labor inputs and capital inputs such as machinery and equipment, along with data on output produced in the economy, Kydland and Prescott, following Solow's earlier work, provide measures that represent the technology of a typical firm in the economy. These measures can be used to gauge how that technology changes over time.

* For a complete description of how researchers use data drawn from the economy to measure technology shocks, see Satyajit Chatterjee's 1995 article.

market work or to leisure. Time devoted to home production is typically not incorporated into the models. But, as we have seen, time and other resources devoted to home production are quantitatively significant.

To see why accounting for time devoted to home production can help a macroeconomic model account for business cycles, we first need a description of what constitutes a typical model, including the choices available to households and business firms in the model.[9] The typical macroeconomic model allows households and firms to make choices *within* a period, such as a quarter, as well as across periods. Market prices determine how goods are allocated *across* possible alternative uses — consumption by households, capital accumulation by firms to facilitate the production of still more goods, and, perhaps, the government's use of goods.

Allowing for choices *within* a period enables households and firms to allocate time available in that period to either work or leisure or other activities and to allocate available resources across possible alternative uses, such as consumption by households or capital accumulation by firms. Choices made within a period about how much time to devote to work in the marketplace and how much to leave for leisure or other activities are important because a majority of short-run fluctuations in GDP stem from variations in labor inputs.

Allowing for choices *across* periods enables the model to include important dynamic responses of households and firms to changes in the economy. For example, if labor productivity randomly increases, households will respond by determining how much capital to accumulate today to be able to produce and consume more in the future.

## WHY DO HOUSEHOLDS CHANGE TIME SPENT WORKING IN THE MARKET?

During recessions, fewer hours are devoted to market work, and during expansions, market work usually rises. But what do people who are laid off during recessions, or who have their regular work hours cut back, do with their remaining time? During expansions, what draws more people into market work or into devoting even more time than before to market work? Also, if some people put more time into market work, what happens to the rest of their available time? After all, we have only 24 hours each day.

The lower cost of choosing leisure gives households an incentive to switch from devoting time to market work to devoting more time to leisure.

Sleeping eight hours a day leaves 16 hours for market work, leisure, and home production. So, if during an expansion you decide to work 10 hours at market work, rather than your usual eight, you are left with six hours of nonsleep time. Do you cut back on leisure? Or do you cut back on home production?

The typical business-cycle model has had difficulty answering these basic questions because it postulates a simple choice for households' time allocations: working in the marketplace or enjoying leisure. For example, suppose that, for some reason, the technology used by firms changes so that labor inputs, when combined with other inputs, become less productive, leading to a decline in the demand for labor. This decline in labor demand reduces wages paid to the households that supply labor in the marketplace. Reduced wages produce two effects on households' time-allocation decisions. One is that lower wages make leisure a less costly alternative to market work because households that forgo market work for leisure sacrifice a lower amount of wage income. The lower cost of choosing leisure gives households an incentive to switch from devoting time to market work to devoting more time to leisure. A second effect, though, is that for a given amount of time supplied as market work, lower wages make households less wealthy. This reduction in wealth would lead a typical household to give up some leisure time and spend more time on market work to fend off the loss of wealth.

It is normally assumed that the first effect of declining wages dominates the second. That is, in the face of reduced labor demand and lower wages, households, on balance, choose to switch from time spent at market work to more time spent at leisure. Therefore, a technology shock that lowers labor productivity, reduces labor demand, and lowers wages also leads to a decline in the amount of labor supplied to the market. As a result, employment and output decline, as do wages, and the economy could slip into a recession.[10]

The typical macroeconomic model implies that in times of recession, households facing lower wages *voluntarily* reduce market work in order to engage in more leisure. Many people find this claim dubious.

The typical model also

[9] A technical exposition of the typical macroeconomic model, in which consumption and investment goods are assumed to be identical, can be found in Gary Hansen's article.

doesn't allow for home production. Furthermore, in this model, households cannot accumulate or vary the use of household-capital goods, such as lawnmowers or vacuum cleaners, employed in home production. But, as we saw from estimates of home-production inputs and output, home production involves significant amounts of a household's time and capital goods.

The typical macroeconomic model has been used to describe movements in key macroeconomic variables in the U.S. economy, even though it ignores home production.[11] Let's see how adding home production enriches the model's ability to describe economic activity. Toward that end, we will first describe a standard way of evaluating the typical model's ability to account for key features of the U.S. economy. We will then show how adding households' home-production choices can enhance the typical model's ability to account for the data.

## CAN THE TYPICAL MODEL EXPLAIN THE DATA?

The standard way to evaluate a typical macroeconomic model's ability to explain fluctuations in economic variables is to run simulations using the model. Properties of the "artificial," or model-generated, data for key variables are then compared to properties of their counterparts drawn from national income accounts for the U.S. economy. Economists Jess Benhabib, Richard Rogerson, and Randall Wright, among others, have done just that for the typical model without home production. These authors point to a number of the model's shortcomings relative to actual data, shortcomings that including home-production decisions could potentially overcome.[12] Figure 1 shows the variability of GDP and the variability of consumption, investment, and hours worked relative to GDP. As the figure shows, the model finds that compared to U.S. data: (1) GDP itself fluctuates too little in the model; (2) consumption and hours worked fluctuate too little relative to GDP in the model; and (3) investment fluctuates too much relative to GDP in the model.

**Why Do the Shortcomings of the Typical Model Arise?** The fact that consumption is not variable enough and investment is too variable relative to output in the typical model can be easily understood. In the typical model, when labor productivity is high, for example, relatively fewer labor inputs are devoted to market production of goods for consumption, such as clothing or furniture, and relatively more labor inputs are devoted to production of investment goods, such as machines used by firms to produce output. This switch occurs because people don't want their consumption to fluctuate over time as much as output does. Channeling resources to the production of investment goods facilitates relatively smooth consumption over time because such goods can be accumulated, added to the economy's capital stock, and used to help provide goods for consumption in times when labor productivity is relatively low. Consequently, over time, consumption in the typical model does not vary relative to output as much as we see in actual data, and investment varies more

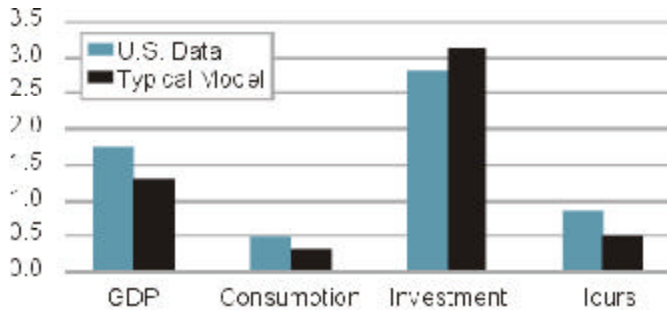
[10] The typical macroeconomic model views business cycles as ups and downs in economic activity relative to the underlying long-run trends in economic activity. The description of employment changes in response to a technology shock is a description of deviations from the long-run trend in employment. Over the long run, hours worked in the marketplace have been fairly constant in the post-war U.S., even though there has been productivity growth and accompanying increases in wages. However, in the short run, at business-cycle frequencies, hours worked in the marketplace tend to vary relative to the trend in hours worked.

[11] The key features of the economy come from data on variables such as GDP, households' consumption of goods and services, firms' purchases of goods as investments to be used in producing more goods in the future, exports and imports, major price indexes, and interest rates.

[12] The typical model refers to a variant of the model in Gary Hansen's article.

## FIGURE 1

### Variability of Important Economic Indicators




The variability of GDP is measured by its standard deviation, which is a statistical measure of how GDP fluctuates relative to its average value. Relative variability is the standard deviation of either consumption, investment, or hours worked relative to that of GDP. The data are from the article by Greenwood, Rogerson, and Wright.

relative to output than we see in the data.

Similarly, the fact that total hours devoted to market work do not vary much relative to output in the typical model is easy to understand. In the typical model, households switch between hours devoted to producing consumption goods and hours devoted to producing investment goods in response to changes in productivity. When labor productivity is high, for example, fewer hours are spent producing consumption goods, and more hours are spent producing investment goods, but *total hours* devoted to market work don't vary much in the typical model. So, the sum of total hours over a business cycle ends up far less variable relative to output than we observe in the data.

If there were a mechanism in the model to allow more hours to be devoted to producing more consumption goods in the market as well as more investment goods during good times, the typical model would benefit. Not only would hours become more variable than in the typical model, so, too, would total output become more variable. As we'll see, adding a home-production sector to the model provides the needed mechanism.

**Does the Addition of Home Production Improve the Typical Model?** On many dimensions, adding home production to the typical model improves its ability to account for what we observe in the economy because households now have more choices. Including home production in the model allows households to allocate time among leisure, market work, and home production. The typical model allows a choice only between leisure and market work. Adding home production also means that output must be divided among consumption, investment in business capital, and investment in household capital.

The enriched set of choices results in a model that allows more switching between using time and goods for market activity or for alternative activities in response to the state of the economy. For example, during recessions households become *relatively* more productive places than the marketplace. Hours of market work and household purchases of market goods both decline because households increase the time devoted to producing goods at home, an avenue of substitution ignored in the typical model.

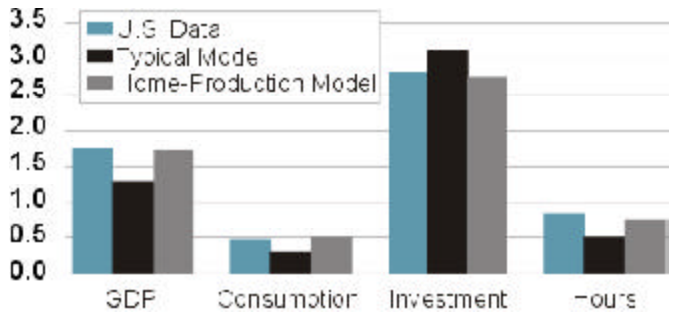
The shortcomings of the typical model can be remedied by including home-production decisions, and we can demonstrate this by comparing U.S. data with data from a typical macroeconomic model and from a model that allows for home-production decisions (Figure 2). To see how home-production decisions improve the typical model, suppose, for example, that there is a period of economic good times with high labor productivity in the marketplace. [14] As in the typical model without home-production decisions, a home-production model will allocate some resources, such as time, to produce additional investment goods that will facilitate production of more consumption goods in future periods.

But now that the model allows for home-production decisions, imagine that in the face of relatively high marketplace productivity, more people have their lawns mowed by landscaping companies — resources shift away from home production (homeowners previously mowed their own lawns) to market production (homeowners now hire landscaping services). Such shifts in resources in a home-production model reflect the fact that people are devoting less of their time to home production (mowing the lawn) while, at the same time, purchasing more consumption goods in the marketplace (landscaping services). Thus, in a model with home production, market production of consumption goods increases, as does

[14] Good times here means periods during which, perhaps because of shocks to technology used in the marketplace or to home-production technology, the marketplace is a relatively more productive place in which to devote resources.

## FIGURE 2

### Variability of Important Economic Indicators




The variability of GDP is measured by its standard deviation, which is a statistical measure of how GDP fluctuates relative to its average value. Relative variability is the standard deviation of either consumption, investment, or hours worked relative to that of GDP. The data are from the article by Greenwood, Rogerson, and Wright.

production of investment goods. So, not only will production of investment goods vary with increasing labor productivity in the marketplace, as in the typical model, but market production of consumption goods will vary as well and will fluctuate more than in the typical model.[15]

Finally, another shortcoming of the typical model — that output fluctuates too little — can be overcome by a model that includes home production. In the typical model, the size of output variation driven by marketplace productivity shocks reflects only the degree to which people are willing to substitute time and resources across periods in response to a change in marketplace productivity. For example, a household could give up some leisure today when productivity is high and devote that time to market work to allow for more leisure in the future. But when people can switch between market production and home production over time, the variability of market production overall — measured output — increases because of relative differences in productivity in the two types of production. The size of the variations in measured output resulting from relative productivity shocks in a model with home production depends on households' willingness to switch between home production and market production at a given time as well as over time.[16]

**SUMMARY**

Typical modern macroeconomic models do not account for some important features of U.S. economic data, in part because they ignore a substantial amount of unmeasured economic activity associated with the use of time and resources in the production of goods and services at home. Including home production in modern dynamic models of business cycles seems to be a promising way to help account for movements in key economic variables, especially when we consider the undeniably large amount of time and resources that go into home production.

[15] How well a model with home production explains the data depends critically on the incentives households have and their willingness to substitute between home and market production. The model's implications also depend on the form assumed for the home technology with which households combine time and capital, perhaps subject to random shocks to the technology. Unfortunately, to date there is not much evidence on how shocks to home-production technologies compare with shocks to technologies used by firms in the marketplace. The relative variability of market and home production depends, of course, on the variability of shocks to market productivity relative to home productivity.

[16] Jeremy Greenwood, Richard Rogerson, and Randall Wright present a formal model with home production in their 1993 article. This article also offers a comparison of quantitative implications of the model with properties of U.S. data on key macroeconomic variables.

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