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80 years on, the Great Depression defies economists' efforts to fully explain its causes, mechanisms and consequences. The Great Recession promises to be equally confounding. By the same token, both the Depression and the Recession unleashed streams of innovative research into largely neglected topics, thereby enriching economic understanding well beyond the crises themselves.

In this Research Digest, the *Region* reviews three examples of such work, recent studies by Minneapolis Fed economists and their colleagues on distinct aspects of the Great Recession. The first digest looks at international synchronization (or lack thereof) of economic cycles and the factors that may cause nations to climb or plummet in concert; the second explores interactions between financial frictions and firm-level volatility, and whether a model built around these phenomena might explain economic patterns seen in U.S. data between 2007 and 2009. And the third examines policy alternatives to pull an economy out of the doldrums when in the midst of what monetary economists refer to as a “liquidity trap”—when interest rates have reached the zero bound.



Fabrizio Perri

Financial integration and business cycle sync

Credit shocks are a key factor in explaining how global banking ties affect synchronization, and lack thereof, among national economies

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It seems almost a tautology that global financial integration leads to international synchronization of business cycles. But economic research—both empirical and theoretical—has found the relationship to be far more nuanced. While many empirical studies have indeed found a positive relation between international financial linkage and cycle synchronization among countries, some recent research on developed nation ties has discovered that cross-border connections are actually associated with less synchronization when the years under study include few financial crises, such as the pre-2007 period.

Theoretical research to date is inconclusive in the sense that integration could lead to either divergence or convergence of cycles. Much depends on the *source* of the overall, or aggregate, fluctuations, suggests theory. If the negative shock is to a national *banking* sector and its efficiency, then problems in one country will likely spread to others, as global banks will also likely pull funds from unaffected countries. In other words, if Citibank Europe goes down, it's likely that operations of Citibank U.S. will be negatively affected.

But if the crisis is a negative shock to a specific nation's "real" economy (that is, a *nonfinancial* sector), then that crisis could actually lead to a divergence in international

growth, since banks will tend to pull credit from affected nations and send more of it to untroubled economies, where it's likely to provide higher returns. So, if Volkswagen is a customer of Citibank Europe and Volkswagen gets into trouble, then Citibank will devote more funds to U.S. firms, improving conditions in the United States.

The issue is quite relevant from the policy perspective. A better understanding of the mechanisms at work could clarify the potential impact on the United States of a euro-area meltdown or aid developing countries in understanding whether more financial integration with the rest of the world is desirable.

To bring greater clarity to the "ambiguous, and sometimes conflicting, answers" from the empirical and theoretical literature, Fabrizio Perri of the Minneapolis Fed, with economists Sebnem Kalemli-Ozcan and Elias Papaioannou, has written "Global Banks and Crisis Transmission," National Bureau of Economic Research Working Paper 18209, July 2012, and forthcoming in the *Journal of International Economics*.¹ Their paper takes on two tasks: It analyzes relevant data, and it then creates a model to help explain what the data reveal. In so doing, it tells a consistent and compelling story of the relationships between global financial integration, co-movement in business cycles and banking

crises. The study is not the final word on these matters, of course, but it will undoubtedly lead future research in fruitful directions.

Key empirical findings

The economists begin by analyzing a unique database: quarterly data on country-pair bank links from 20 developed nations between 1978 and 2009. The three-decade period is one of international financial calm, by and large, punctuated by several financial crises, particularly that of 2007-09. A critical feature of the data set is that it provides information about *indirect* banking links as well as direct ties, thereby permitting measurement of the importance of financial exposure between countries through banks in offshore accounts in, for example, the Cayman Islands. Their statistical analysis—running regressions of relevant variables—reveals three central findings:

- When financial markets are calm, the association between banking links and business cycles is significantly negative—consistent with the study mentioned earlier.
- In periods of financial crisis, this negative correlation approaches zero. This suggests that "a financial crisis is an event that induces co-movement" among

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countries that share financial links, thereby muting the usual negative association.

- During the 2007-09 financial crisis (though not in other crises in the period studied), there was a positive association between business cycle synchronization and exposure to the U.S. financial system. But curiously, *indirect* links through the Cayman Islands were a powerful explanatory factor in this financial contagion. “The positive correlation between output synchronization and financial linkages to the U.S. emerges only when, on top of direct links to the U.S., we also consider indirect links via the Cayman Islands, the main off-shore financial center of the U.S. economy.”

These findings provide a logical bridge between two separate bodies of research on financial integration, one that looks at business cycles and another that focuses on financial contagion. Financial crises spread contagiously from one country to another through bank connections, it appears, and this creates greater business cycle co-movement among countries that are tightly connected financially. During the recent crisis, many observers believed that the U.S. credit shock spread internationally via bank networks, but empirical evidence for the idea was

largely absent. That evidence now exists.

In part, the quality of the study’s data set is what allows the economists to provide this elusive confirmation. Its depth and structure enable them to distinguish the effect of financial connections between individual country pairs from the impact of large shocks common to *all* nations. With its greater historical range, a better measure of financial integration and solid panel data, the researchers can isolate the specific importance of *bilateral* financial links.

A model with credit shocks

The second part of the paper is devoted to building a model of international business cycles with banking and then running it quantitatively, to see if, with reasonable parameters, it can generate patterns seen in actual data. The idea is to create a mathematical representation of the economic mechanisms that may be at work in an integrated financial world. If this model can faithfully replicate real-world results, then those mechanisms—and the theory behind them—may in fact be a reasonable explanation, during crisis and calm, of the impact of global banks on national economies.

The economists create an international business cycle model in which global banks allocate funds

between, on one hand, households and others who save and, on the other hand, firms and other borrowers who invest those funds—the process referred to as “financial intermediation.” In this model, both banking shocks and productivity shocks can cause economic fluctuations. As the economists write, the model serves two purposes: “to precisely spell a causal link between financial integration and business cycle synchronization” and “to show that our empirical findings can be used to identify sources of output fluctuations, and thus to shed light on the causes of the triggering and spreading of the 2007-2009 crisis.”

They calibrate the model with standard real-world parameters for factors like depreciation rates and capital’s share of output, but also for less standard variables like the degree of financial integration between pairs of countries, the costs incurred by banks in intermediating funds and banks’ share of portfolios devoted to risky assets.

Testing: One, two, three ...

With the model built, the economists see how it performs. First they show that when run with both banking shocks and productivity shocks, the model generates plausible business cycles and, indeed, helps explain some features that standard models (without credit shocks) have trouble with. Standard

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models without credit shocks can't generate realistic values, for example, for changes in employment relative to gross domestic product or international correlations in consumption.

Then they give it the real test: checking its quantitative results against the empirical results from the first part of their paper. The primary test is to run the same regression equation on the model's artificial data as they ran earlier with the empirical (real-world) data. If roughly the same relationships appear in both, the model is a good fit and the mechanisms it contains hold explanatory power.

In specific, they compare results for synchronization of GDP growth among countries—business cycle co-movement. During tranquil times, the data show a synchronization coefficient ranging from -0.302 to -0.220. The model generates a coefficient of -0.35—the correct sign (negative) and a close numerical match. During crisis periods, the

data's output coefficient ranged from 0.123 to 0.264. The model: 0.25—an excellent fit.

"The comparison between coefficients," they write, "suggests that the relation between financial integration and output co-movement implied by our model is statistically close to the one we estimate in the data." Both model and actual data indicate that when financial times are calm, greater bilateral financial integration leads to diverging business cycles, but when crises hit, this negative relationship is muted, as credit shocks transmit through international banking ties and business cycles synchronize more closely.

Lessons and future research

The model suggests that financial integration is a crucial determinant of synchronization of business cycles. When compared with the statistical relationship seen in real-world data, the model's estimates are quite close. "Although this does not formally prove that financial integration is indeed a causal driver of international business cycle integration," the economists observe, "it shows that this hypothesis is entirely consistent with the data patterns."

A second lesson from their model is that credit shocks are crucial in explaining the tendency for nations with close banking ties to contract simultaneously during crises. "This

leads us quite naturally to conclude that indeed large credit shocks to financial intermediaries could have been the underlying source of the global contraction in economic activity that took place during the 2007-2009 global crisis."

The model also suggests an obvious direction for future research, say the economists: "The analysis of the effectiveness and desirability of policies geared toward reducing capital losses of the financial/banking sector, like the 2008 bailout." The model indicates that capital losses to banks strongly affect domestic and international economic output; in the future, policymakers might therefore consider measures to prevent or buffer such shocks, or to mitigate their transmission to the broader economy.

—Douglas Clement

¹ See "Not-So-Great Expectations," Region, December 2011, on related research by Perri, minneapolisfed.org/pubs/region/11-12/Research_Digest_Dec2011_Region.pdf.

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Cristina Arellano (seated) and Yan Bai; Patrick Kehoe at right

"A promising parable"

Cristina Arellano, Patrick Kehoe and Yan Bai develop a model that convincingly generates macro patterns of the Great Recession

In "Financial Frictions and Fluctuations in Volatility," a Minneapolis Fed staff report published in July (SR466 online at minneapolisfed.org), economists Cristina Arellano and Patrick Kehoe of the Minneapolis Fed and Yan Bai of the

University of Rochester develop a model that can convincingly generate several central macroeconomic patterns seen in U.S. data during the Great Recession. In particular, the economists explore the financial and microeconomic underpinnings of sharp declines in employment and economic output between 2007 and 2009, accompanied by relatively stable labor productivity. In almost all recessions, productivity and output *both* decline, but in the most recent downturn, *productivity was nearly unchanged*. What economic mechanisms account for this anomaly?

One clue that informs their investigation is the severe credit contraction during the recent U.S.

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financial crisis. Another clue, at the micro level, is the large increase in dispersion of growth rates among firms—that is to say, growth at some companies suffered very little during the crisis, while other firms contracted dramatically. Even during normal times, companies grow at different rates, of course, but during the 2007-09 recession, the range between the highest and lowest growth rates nearly doubled.

These observations are building blocks for a quantitative model with heterogeneous firms (for which growth rates can differ) and financial frictions (meaning that credit markets don't function smoothly). The economists' goal is to create a model in which increasing volatility at the firm level leads to higher dispersion in firms' growth rates along with declines in both aggregate labor and economic output, but stable labor productivity. Their aim, in short, is to better understand the U.S. economy during the recent recession by building a model that can replicate its behavior between 2007 and 2009.

Central to the model: Risk, and firms hedging against it by trimming financial obligations wherever feasible—specifically, by hiring fewer inputs. “The key idea in the model,” write the economists, “is that hiring inputs to produce output is a risky endeavor.”

Firms receive revenue from

selling their output only *after* they have already paid for inputs, such as employees, necessary to produce that output. Hiring labor (or buying materials or purchasing machinery) therefore entails risk, since demand for a firm's output may fall after the input expenditure is incurred. If financial markets were “complete,” as economists say, firms could protect themselves against that event by borrowing against future profits; but in this model, financial market frictions mean that firms must bear the risk themselves.

“This risk has real consequences if, when firms cannot meet their financial obligations, they must experience a costly default,” observe the economists. “In such an environment, an increase in uncertainty arising from an increase in the volatility of idiosyncratic shocks leads firms to pull back on their hiring of inputs.” (Though the word “hiring” suggests employees only, here it applies to other inputs as well: raw materials, capital equipment and the like.)

If we build it, will it work?

The economists proceed in stages. First, they build a “benchmark” model. Then they calibrate and quantify it to gauge how well it matches real U.S. data. They create two alternatives to their benchmark model to pinpoint whether the results are driven by both factors (imperfect financial markets

and volatility shocks) or just one. Lastly, they extend their model with refinements that bring it closer to how economists believe economies truly work.

The model has three key pieces:

- (1) Firms hire inputs before knowing how much demand they'll experience for their output.
- (2) Financial markets don't necessarily provide firms with credit, and they're especially averse when the economy is volatile; as a result, firms default if they're unable to pay their debts.
- (3) Since firms pay a fixed cost to start their operations, they make positive profits in the future to cover those fixed costs; the cost of default is the loss of future expected profits.

These three essential parts mean that firms trade off expected risk and return whenever they choose their inputs. Hiring more inputs enables them to make more profit as long as they don't default. But because more hiring raises their financial obligations, it also increases the chance of defaulting. It's a tough choice, and becomes more so when the broader economy is looking uncertain—or, in the idiom of economics, “when the variance of idiosyncratic shocks increases.”

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The model includes identical households, heterogeneous firms and financial intermediaries. Households buy goods produced by firms, but the demand for each good is subject to idiosyncratic demand shocks. The volatility of these demand shocks varies over time, and this is the source of aggregate fluctuations in the model.

Firms are the guinea pigs in this model. They differ from one another, and they face not only volatile demand for their products, but imperfect or incomplete financial markets that don't allow them to insure against fluctuations in that demand. Thus, they may sink or swim based in large part on those fluctuations, as well as their hiring decisions. If they default on their debts, they fail: They "exit the market."

Benchmark and beyond

The benchmark model is calibrated to the U.S. economy with standard values for such variables as interest rates, annual sales growth for firms and the like. The economists test the model with these parameters by checking whether it can match U.S. data accurately; it does—with, for example, the fraction of labor employed by new firms at 1.8 in both data and model, and the liability-to-sales ratio at 5.5 in the data versus 5.6 from the model. A near-perfect fit.

Then they see how it responds

to "impulses"—that is, how the model's mechanism reacts to a sudden increase in demand volatility. In this test, just as in the actual U.S. economy during the recent crisis, the model's output and labor (that is, employment) drop strongly when volatility increases, but labor productivity (defined as the ratio of gross domestic product to aggregate employment) increases slightly at first and then stabilizes. "The overall response," the economists write, referring to labor productivity, "is fairly flat compared to the responses of output and labor."

In addition, wages fall about 1.4 percent after the volatility shock and then continue a slow decline, and the interest rate drops just a bit initially and remains slightly depressed. The benchmark, in short, works well as a representation of the U.S. economy during the financial crisis, at least for one-time shocks in demand volatility.

They then build two alternate versions of the benchmark to investigate whether this success is due primarily to its inclusion of incomplete financial markets or to its volatility shocks. This investigation finds that "*both* financial frictions and the source of the shocks—volatility instead of productivity—are critical to our benchmark model's results" (emphasis added). In other words, neither financial frictions by themselves, nor just volatility shocks, are

But the fundamental question is, how well can this model account not for a theoretical one-time volatility shock, but for a series of shocks like those experienced in the real economy during the Great Recession? The answer: very well. "We show that our model can account for much."

able to generate economic responses that resemble the real world during the Great Recession.

Real world testing

But the fundamental question is, how well can this model account not for a theoretical *one-time* volatility shock, but for a *series* of shocks like those experienced in the real economy during the Great Recession? The answer: very well. "We show that our model can account for much," the economists write.

To reach that conclusion, they first find the volatility shock sequence that generates dispersion among firms' sales growth rates similar to that actually measured in U.S. data between late 2007 and the third quarter of 2009. The data reveal nearly a doubling in this range of growth rates, from 17 percent to 31 percent. The economists feed that shock sequence into their

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model and see what happens to macroeconomic output, labor and productivity.

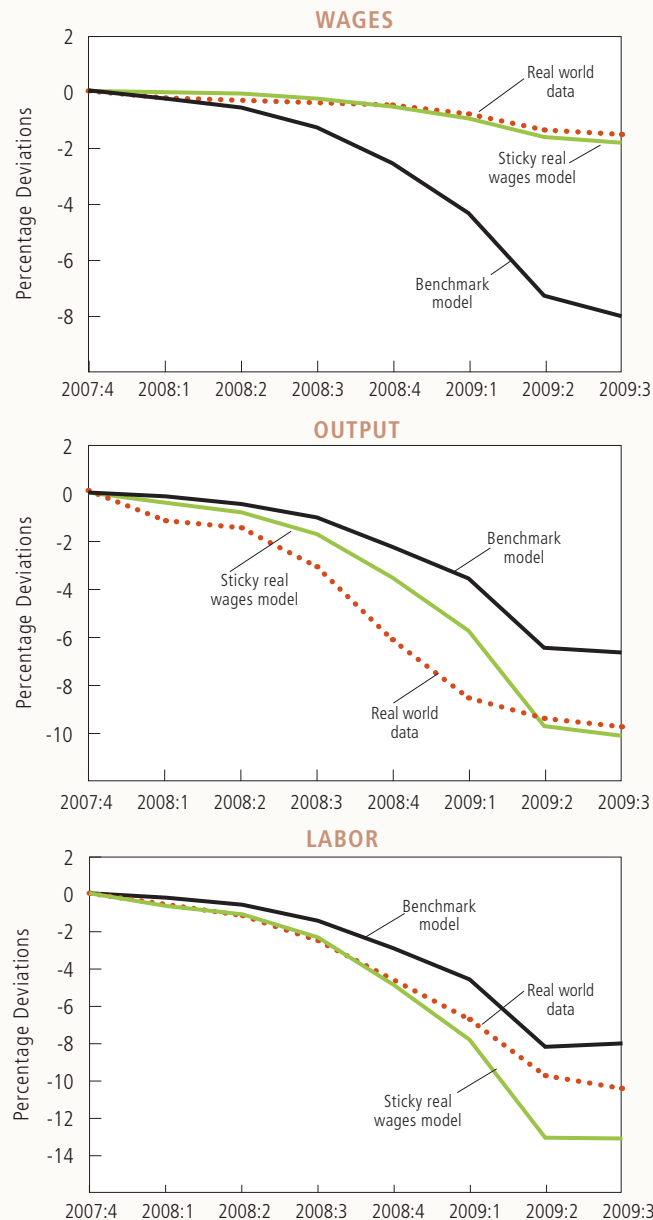
Given how crude the model is—in the sense of leaving out countless aspects of an actual national economy—it does a remarkable job of generating results similar to real world figures. “The model generates a decline in output of 6.5 percent, whereas in the data output declines 9.7 percent,” they find. And it “produces about an 8 percent decline in labor, whereas in the data labor declines about 10 percent.”

While not dead on, the model’s results are quite close, suggesting that the mechanisms at its heart are what drive the actual economy, through good times and bad. When the economists summarize the overall results, they conclude that the model “can explain 67 percent of the overall contraction of output and 73 percent of the contraction in labor during the Great Recession.” The model produces a fairly flat productivity profile for the recession, while in real data, productivity first falls and then rises modestly. But “both in the model and in the data, productivity at the end of this event is essentially unchanged ... even though output has fallen 10 percent.”

Refinement

The economists explore several dimensions of, and refinements

Model Results versus Real World Data during Great Recession, 2007–09



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to, their model. One is to alter the model by introducing “sticky wages,” the idea that in the real world, most prices don’t change instantly. A gallon of gasoline may rise or fall in price several times a day or week, but wages, automobiles and even items on a restaurant menu take a while to adjust to trends in the economy—to a broad recession or to a rise in the cost of health care, steel or eggs. This factors into the model, since in the benchmark version of the model, wages fall when volatility increases, and such response dampens the labor adjustment firms make.

And indeed, by making the model’s input prices less responsive to volatility, the economists find that sticky prices “diminish offsetting equilibrium effects.” The charts on page 35 show their results. They compare real wage trends in the data, the benchmark model and the sticky real wage model for the entire span of the Great Recession and show that while they drop by about 2 percent in the data and over 8 percent in the benchmark model, “in the sticky real wage economy, real wages drop about the same as in the data.” Sticky real wages also amplify the output and employment effects of increased volatility.

Thus, Arellano, Bai and Kehoe’s model, with key features and additional enhancements, does a striking job of duplicating patterns

seen in the U.S. economy in recent years. “Hence,” they conclude, “we think of the model as a promising parable for the Great Recession of 2007-2009.”

—*Douglas Clement*

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Juan Pablo Nicolini

Escape from the quagmire

An “unconventional” fiscal policy to spur the economy, with intentional inflation but minimal risk

In a liquidity trap, the nominal interest rate is at zero and can go no lower—it is at a limit referred to bleakly as the “zero bound.” And this, precisely, is the current state of monetary affairs in the United States and much of Europe—one of the most pernicious outcomes of the Great Recession of 2007-09.

In the United States, where inflation remains low but unemployment stubbornly high, policymakers eagerly seek to boost economic activity. To that end, Congress and the Obama adminis-

tration have wrestled over numerous expansionary fiscal policies. Several have been implemented, but with limited success.

The Fed, for its part, has nudged the fed funds rate toward zero—since December 2008 and counting—until it can go no further. The goal is to encourage business investing and consumer spending by minimizing the cost of borrowing.

Since hitting the zero bound, the Fed has tried nontraditional policy tools to stimulate the economy. The three major tools are the large-scale asset purchase programs, the maturity extension program and the Fed’s new forward guidance policy.¹ All three are designed to bring down long-term interest rates and thereby stimulate household and business spending.

A better path?

The economics profession (let alone policymakers) has yet to reach a consensus—or concession—on the correct policy avenue to pursue.

A recent paper, “Unconventional Fiscal Policy at the Zero Bound” (Working Paper 698 online at minneapolisfed.org/research/wp/wp698.pdf), by Juan Pablo Nicolini of the Minneapolis Fed, with Isabel Correia, Emmanuel Farhi and Pedro Teles, proposes a novel fiscal strategy. The four economists lay out a series of fiscal policy measures that would relieve the zero bound faced

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by monetary policymakers caught in the liquidity trap. It's this constraint, the impossibility of forcing nominal interest rates below zero, that undermines the Fed's standard policy intervention of lowering borrowing costs by injecting still more liquidity into credit markets.

The economists' fiscal policy proposal generates negative *real* interest rates that *will* stimulate investing and spending. And it will do so, the paper illustrates, effectively and efficiently—avoiding the harmful consequences of the more conventional fiscal policies advocated by some economists and the possibly long-term inflationary pressure that alternative monetary policy steps might create.

Creating inflation with taxes

It's a promising scenario, but as the economists acknowledge, their strategy of a tax policy that neutralizes the effects of the zero bound constraint is "unconventional." Explaining it requires careful technical description—it's a 50-page paper—but the central idea is fairly intuitive.

To encourage consumers and firms to engage in normal economic activity when the economy is stuck and nominal interest rates are at zero requires negative *real* interest rates. And "the only way to achieve negative real interest rates," note the economists, "is to generate

inflation." (Recall Irving Fisher's eponymous equation: The nominal rate equals the real interest rate plus inflation.) This will make holding on to money costly; the longer cash sits in your wallet, your savings account or under your mattress, the less it will buy. Purchasing power will relentlessly dissipate. To avoid poverty, people will spend and businesses invest.

However, caution the economists, generating inflation for *producer* prices is inefficient; it would create economywide distortions that reallocate resources wastefully and result in lower economic output than would otherwise be possible. Instead, "the idea is to induce inflation in *consumer* prices while keeping producer price inflation at zero," they write (emphasis added). "The result is negative real interest rates, and yet the distortions associated with producer price inflation are altogether avoided. This can be achieved by simultaneously adjusting consumption and labor taxes."

The strategy, then, is to raise tax rates on consumption and lower them on labor. But what's critical is that these changes *continue over time*. So the consumption tax rise isn't just a one-time hike, but an enduring upward trend. (Indeed, one way to implement this would be to initially reduce consumption taxes and slowly bring them up; the key thing is that consumers face

consumption costs that will be more expensive in the future than they are today.)

So, to reiterate, the hike and cut are ongoing: Rates climb over time on consumption and fall steadily on labor. The consumption tax, because it rises over time, effectively increases the price of purchasing something a year from now, making it advantageous to spend now—boosting economic activity.

Why cut labor taxes? Ongoing consumption tax hikes mean that workers have to put in more labor hours to pay for the constantly rising cost of products and services; that would alter labor decisions inefficiently. To prevent that distortion, labor tax rates must decline in mirror image to the rising consumption tax rates and, by effectively increasing take-home pay, balance out the increasing cost of consumer goods.

Changing consumption tax rates also distort investing decisions, generating temporary underinvestment in capital. To avoid this, a temporary investment tax credit or short-term capital income tax cut is also essential.

Reality check

The economists point out that others have raised similar ideas. In 2002, Harvard's Martin Feldstein suggested that to escape its own persistent liquidity trap, Japan could

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raise its consumption tax rate and reduce income tax rates. In 2008, economists Robert Hall and Susan Woodford proposed sales tax holidays at the state level.²

Both proposals hinged on the same fulcrum: Future consumption taxes must be higher than current taxes. The Hall-Woodford sales tax holiday proposal, for instance, would lower the tax immediately to zero and commit to increase it in the future, thereby encouraging consumers to spend now and thus spur the economy.

But this research paper is the first with a model that formalizes the concept and includes the additional taxes necessary for its efficient implementation. The greater part of the paper is devoted to the model’s mathematical structure and specification, and then its elaboration in alternative economic environments (when lump-sum taxes aren’t possible, for example, or idiosyncratic shocks occur).

The economists go further, measuring outcomes under a variety of tax rate scenarios to see if the necessary tax rate changes would be reasonable in scale, not just a theoretician’s pipe dream. And the plan does,

indeed, seem practical.

To implement this plan under one feasible scenario, they calculate, tax rates on consumption that are 5 percent in the midst of the liquidity trap would increase over five quarters (15 months) to 14 percent. Simultaneously, labor income taxes would decline from 28 percent to 21 percent. A 9 percent investment subsidy would be implemented immediately and slowly unwind to zero.

Benefits and caveats

Such policies would yield substantial economic benefits relative to the stagnant status quo. Assuming prices and wages are somewhat rigid or “sticky,” meaning that they don’t change instantly, the unconventional fiscal policy would generate a 1 percent increase in consumption over 10 quarters and a 0.2 percent permanent increase. If some price or wage flexibility exists, increases would be greater still; flexible prices and rigid wages would result in increases of over 4 percent temporarily and nearly 1 percent permanently. In the world of economics, these are substantial gains, especially in the moribund

landscape of a liquidity trap.

Other appealing features of this strategy: It’s revenue neutral—though it alters tax rates, it requires no net tax increase to implement. And it’s “time consistent”—an economist’s way of saying that policymakers won’t be tempted to change it later to achieve a better outcome.

In closing, the economists caution that this strategy does crucially hinge on the willingness to implement a policy of flexible taxes. But “after witnessing the policy response to the recent crisis in the United States and elsewhere,” they observe, “it is hard to argue for lack of flexibility of any fiscal policy.” Recent examples in the United Kingdom, the United States and Spain demonstrate that, faced with a recession that seems unending, policymakers will adopt promising policies—no matter how unconventional they may first appear.

—Douglas Clement

¹ For a more complete description, see remarks by Chairman Ben Bernanke, “Monetary Policy since the Onset of the Crisis,” Aug. 31, 2012, at the Federal Reserve Bank of Kansas City Economic Symposium in Jackson Hole, Wyo., at

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federalreserve.gov/newsevents/speech/bernanke20120831a.pdf. Also see the Board of Governors Maturity Extension Program and Reinvestment Policy page at federalreserve.gov/monetarypolicy/maturityextensionprogram.htm.

The Federal Open Market Committee provides forward guidance in its meeting statements. The Sept. 13, 2012, statement, for example, says, “To support continued progress toward maximum employment and price stability, the Committee expects that a highly accommodative stance of monetary policy will remain appropriate for a considerable time after the economic recovery strengthens. In particular, the Committee also decided today to keep the target range for the federal funds rate at 0 to 1/4 percent and currently anticipates that exceptionally low levels for the federal funds rate are likely to be warranted at least through mid-2015.” Available at federalreserve.gov/newsevents/press/monetary/20120913a.htm.

² Minneapolis Fed President Narayana Kocherlakota discussed related ideas in a 2010 speech, based on work by Nicolini and his co-authors. Available at minneapolisfed.org/news_events/pres/kocherlakota_speech_11182010.pdf.