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Richmond Fed Research Digest

Summaries of work by economists in the Bank's Research Department published externally from June 1, 2014, through May 31, 2015

Welcome to the fourth annual issue of the *Richmond Fed Research Digest*. The Federal Reserve Bank of Richmond produces several publications that feature the work of economists in its Research Department, but those economists also publish extensively in other venues. The *Richmond Fed Research Digest*, a mid-year annual, brings this externally published research together in one place with brief summaries, full citations, and links to the original work. (Please note that access to articles may require registration or payment.) So bookmark this spot on the Richmond Fed website and mark your calendar for June 30, 2016, when the Bank will publish the next issue of the *Richmond Fed Research Digest*.

The Cyclicality of the User Cost of Labor

By Marianna Kudlyak
Journal of Monetary Economics*, November 2014, vol. 68, pp. 53–67*

Macroeconomists have long been interested in the cost of labor that firms face over the business cycle. The literature usually considers average wage to be the measure of the price of labor. However, relationships between workers and firms are often long-term, and thus wages may not be a good measure of the price of labor. In a *Journal of Monetary Economics* article, Marianna Kudlyak of the Richmond Fed introduces the concept of the user cost of labor as the relevant wage measure for studying the price of labor.

Kudlyak demonstrates that the user cost of labor is the relevant price faced by a firm considering hiring a new worker.

The user cost of labor is the expected difference between the present discounted value of wages paid to a worker hired in the current period versus a worker hired in the next period. If a worker is contracted for more than one period, then the difference does not necessarily have to equal the wage, as economic conditions at the time of hiring may have an impact on future wages. The user cost thus takes into account both the wage at the time of hiring and the effect of the economic conditions at the time of hiring on future wages. Analogous to the price of any long-term asset, the user cost, and not the wage, is the relevant price of labor for a firm that is considering adding a worker.

Kudlyak finds that the user cost of labor is significantly more procyclical than the average wage or wages of newly hired workers. She shows that a 1 percentage point increase in unemployment generates a more than 4.5 percent decrease in the user cost of labor. The intuition behind this large cyclicality is that when a firm is hiring a worker during a period of high unemployment, the hiring wage will be low. Once a worker is hired, his wage does not respond as much to the contemporaneous labor market conditions as the hiring wage does. Hence, the stream of wages to be paid to a worker hired when unemployment is high is expected to be lower than the stream

of wages to be paid to a worker hired when unemployment is low. Consequently, the user cost of labor is lower than the already low hiring wage because the user cost also captures comparatively low future wages in the relationship that starts when unemployment is high.

Kudlyak uses this empirical result to study the unemployment volatility puzzle. This puzzle was studied by Robert Shimer of the University of Chicago in a 2005 paper. Shimer has shown that the textbook search and matching model lacks amplification of the productivity shock to generate the empirical volatility of the vacancy-unemployment ratio. Wage rigidity has been proposed as a solution to this puzzle. Kudlyak tests this solution by using the estimate of the user cost of labor and finds that the user cost of labor is too procyclical to generate enough variation in the profitability of vacancy creation. Thus, wage rigidity cannot fully account for the unemployment volatility puzzle.

The author also demonstrates that the cyclical behavior of average wages and the wages of new hires are not particularly useful for assessing the importance of allocative wage rigidity. Her study contributes to the long-standing debate in macroeconomics over the allocational price of labor and its cyclicality.

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Optimized Taylor Rules for Disinflation when Agents Are Learning

By Timothy Cogley, Christian Matthes, and Argia M. Sbordone
Journal of Monetary Economics*, May 2015, vol. 72, pp. 131–147*

In a 1982 paper, New York University economist Thomas Sargent examined how reforming the central bank and appointing new leadership could help ease the transition from a high-inflation environment to a new low-inflation regime. By effectively changing the rules of the game through reform, Sargent argued that the government can persuade the private sector in advance that a low-inflation policy is its best response. This would allow the central bank to engineer a sharp disinflation at low cost.

Building on this insight, other studies have explained the high cost of the disinflation under Fed Chairman Paul Volcker by pointing to the Fed's lack of transparency and credibility. Because the private sector was initially unconvinced that Volcker would disinflate, the Fed's new policy collided with expectations inherited from the old regime and brought about a deep recession.

In a *Journal of Monetary Economics* paper, Timothy Cogley of New York University, Christian Matthes of the Richmond Fed, and Argia Sbordone of the New York Fed modify the scenario originally proposed by Sargent to more closely match the Volcker disinflation. First, they assume that there is only a change in central bank personnel and no institutional reforms. Second, they assume that the private sector does not have advance knowledge of the central bank's new policy and must instead learn about it.

Rather than seeking to explain the Volcker disinflation, Cogley, Matthes, and Sbordone use a stylized version of that episode to illustrate what happens when a new policy must be learned by the private sector and explore how that affects the central bank's choices. They use a modified dynamic New Keynesian model in which target inflation need not be zero and Bayesian learning

replaces rational expectations. The central bank in the model commits to a simple Taylor-type rule whose functional form is known but whose coefficients are not. Firms and individuals learn those coefficients via Bayesian updating, and the bank chooses policy-rule parameters by minimizing a loss function that takes learning into account.

The learning process has the potential to generate volatility when there is substantial disagreement between the central bank's new policy and the private sector's perception of that policy based on prior information. Cogley, Matthes, and Sbordone argue that one way the central bank can minimize this volatility is by choosing a policy that is close to the private sector's initial beliefs, meaning it reacts less aggressively to inflation.

This conclusion differs from the results of other analyses using New Keynesian models with adaptive leaning. Those studies demonstrate that learning enhances inflation persistence, which suggests that central banks should react more aggressively to inflation to counteract this persistence. The conclusions by Cogley, Matthes, and Sbordone differ because the loss function faced by the central bank in their model penalizes transitional volatility. Hence, the central bank seeks to minimize volatility by taking a less aggressive anti-inflation stance. The results of this study highlight the importance of accounting for transitional volatility when private agents learn about a new monetary policy rule.

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Time to Produce and Emerging Market Crises

By Felipe Schwartzman
Journal of Monetary Economics*, November 2014, vol. 68, pp. 37–52*

A key decision for policymakers in developing countries is whether or not to integrate their national economies with international financial markets, thus turning them into "emerging markets" for foreign investors. Critics of financial globalization argue that emerging economies' access to international financial markets is unstable and that financial instability leads to macroeconomic instability. This view is supported by recurrent emerging market crises, in which pronounced and persistent output collapses occur in tandem with large reversals of foreign capital inflows. Some economists, however, have challenged the interpretation that these output collapses stem primarily from rises in interest rates that cause a reversal of foreign capital inflows. They have argued that such reversals are more likely a consequence rather than a cause of the output collapses.

Relative to existing formulations, Schwartzman's model has the advantage that "time to produce" has clear implications for inventory data.

In an article in the *Journal of Monetary Economics*, Felipe Schwartzman of the Richmond Fed brings cross-industry data to bear on the question of whether large and persistent drops in output observed after emerging market crises can be traced to an increase in the cost of capital to domestic firms. If this is the case, then it also must be true that manufacturing industries that take longer to produce and distribute goods (industries characterized by higher inventory/cost ratios) should be more intensely affected by these crises.

Schwartzman's key empirical finding is that manufacturing industries that normally exhibit higher inventory/cost ratios do indeed take longer to recover following emerging market crises. The difference is particularly significant three to five years after the crises. An aggregate productivity shock cannot match this cross-industry pattern by itself, but a persistent increase in the cost of foreign capital can.

The author also develops a quantitative equilibrium model that uses cross-industry data to measure the impact of a shock to the cost of capital on aggregate output. His model features multiple industries, each equipped with a specific time to produce and distribute goods (time to produce, for short) calibrated to match long-term averages of industry-specific inventory/cost ratios. The model indicates that the cross-industry variation observed in the data is consistent with a gradual increase in the cost of foreign capital relative to its pre-crisis level. In the context of the model, this increase generates a 5.4 percent reduction in output relative to trend during the three to five years following a crisis. This decline accounts for 48 percent of the overall average deviation of GDP relative to trend.

In the model, production is subject to "time to produce" technology—that is, technology that requires some of the inputs be used before the final output is achieved. This production function is similar to the working capital constraints emphasized in prominent papers in the emerging market business cycle literature whereby firms need to acquire variable inputs in advance of production. Relative to existing formulations in the literature, Schwartzman's model has the advantage that "time to produce" has clear implications for inventory data.

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Comment on "Scarcity of Safe Assets, Inflation, and the Policy Trap" by Andolfatto and Williamson

By Huberto M. Ennis
Journal of Monetary Economics*, forthcoming*

In recent years, the U.S. economy has experienced very low nominal interest rates with the short-maturity end of the yield curve pegged effectively at the zero lower bound. At the same time, on average, inflation has been positive and largely fluctuating in a range of 1 percent to 2 percent on an annual basis. The implication of these facts is that the effective real interest rate has been very low (and even at times negative) for a considerable period of time.

Policymakers need to be wary of the prescriptions derived from simple macroeconomic models when it comes to monetary policy and stability.

Simple models that generate, in a plausible way, relatively low real interest rates in the medium to long run are hard to find. Standard macroeconomic models tend to generate risk-free interest rates that are too high for what was observed in the United States during the 20th century. In the process of adapting models to deal with this fact, it is now well-recognized that one way to lower real rates in a representative-agent model is to introduce a transaction role for risk-free bonds. In a forthcoming article in the *Journal of Monetary Economics*, David Andolfatto and Stephen Williamson exploit this idea by developing a model that is consistent with the recent U.S. experience. They then use that model to study the implications for monetary policy.

During the current period of low interest rates, many experts and policymakers have argued that the zero lower bound is binding, and it would be optimal to lower the short-term nominal rate below zero if that were possible. In a forthcoming comment in the *Journal of Monetary Economics*, Huberto Ennis of the Richmond Fed notes that Andolfatto and Williamson's model contrasts with this view. Under certain circumstances, the model economy may find itself with a real and a nominal interest rate that are actually too low. Further reducing the nominal interest rate in this case exacerbates the problem, causing output (and welfare) to fall further away from its efficiency level.

Ennis highlights some key insights derived from Andolfatto and Williamson's model. First, their analysis suggests that at the time of setting policy, the monetary authority needs to be mindful of the reaction of the fiscal authority, if the ultimate goal is to maximize the welfare of society. Another important lesson is that policymakers need to be wary of the prescriptions derived from simple macroeconomic models when it comes to monetary policy and stability. Equally plausible models of the economy often deliver very different policy recommendations, suggesting that the process of setting monetary policy appropriately can be very sensitive to the structure of the economy.

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Labor Market Upheaval, Default Regulations, and Consumer Debt

By Kartik Athreya, Juan M. Sánchez, Xuan S. Tam, and Eric R. Young
Review of Economic Dynamics, *January 2015, vol. 18, no. 1, pp. 32–52*

In late 2005, the federal government implemented the Bankruptcy Abuse Prevention and Consumer Protection Act (BAPCPA), which made personal bankruptcy much more costly relative to delinquency. Two years later, the United States entered its most severe recession in 70 years, and while personal bankruptcy rates rose, they rose only modestly given the severity of the rise in the unemployment rate and the average unemployment duration. By contrast, delinquency rates rose sharply. In the subsequent recovery, households have been "deleveraging"—undergoing their largest reduction in unsecured debt in several decades.

In a *Review of Economic Dynamics* paper, Kartik Athreya of the Richmond Fed, Juan Sánchez of the St. Louis Fed, Xuan Tam of the City University of Hong Kong, and Eric Young of the University of Virginia measure the relative roles of the BAPCPA and higher labor market risk in accounting for consumer debt defaults and delinquencies during the recession of 2007–09.

The authors' results imply that the Bankruptcy Abuse Prevention and Consumer Protection Act (BAPCPA) likely prevented a substantial increase in bankruptcy filings but had only a limited effect on delinquencies.

Athreya, Sánchez, Tam, and Young extend the lifecycle model of unsecured debt they developed previously to allow for aggregate fluctuations in labor market risk. They add an aggregate shock that moves between "steady state," "expansion," "recession," and "crisis," altering the job-finding and job-separation rates to approximate changes in the U.S. labor market from 2004 through 2011. The authors calibrate their model to represent the economy in 2004 (before the BAPCPA). Then they compute the model's predictions for labor market and credit market variables in response to the BAPCPA along with the observed changes in hiring and separation rates. They parameterize the model to match the dynamics of employment and unemployment duration by exploiting the mechanical relationship between these objects and the job-finding and job-separation rates, and they ask what would have happened if the BAPCPA had not been implemented.

The authors' results imply that the BAPCPA likely prevented a substantial increase in bankruptcy filings but had only a limited effect on delinquencies. Thus, the reform appears to have "worked" in the narrow sense that it reduced default rates overall without encouraging households to find alternative routes to default. Their model also suggests that the level of defaults would have fallen in absolute terms if the labor market had not experienced substantial negative shocks.

The authors also isolate shocks to the job-finding rate and the job-separation rate by using two counterfactual exercises. They find that decreases in the job-finding rate explain most of the dynamics of default during the recession. Their model also suggests that if hiring had not declined substantially, the BAPCPA would have produced a persistent decline in bankruptcy filings and no change in delinquencies.

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Stepping Stone and Option Value in a Model of Postsecondary Education

By Nicholas Trachter
Quantitative Economics, *March 2015, vol. 6, no. 1, pp. 223–256*

Academic two-year colleges often serve as stepping-stone institutions. They give high school graduates a cheaper (safer) way to learn more about their academic abilities while acquiring human capital that could help them succeed at a four-year college or in the workforce.

In this *Quantitative Economics* paper, Nicholas Trachter of the Richmond Fed develops a micro-estimated model of postsecondary education to quantify the value of this stepping stone and the value of options to drop out of or transfer from both academic two-year colleges and four-year colleges. He uses data from the *National Longitudinal Study of the High School Class of 1972* to calibrate the model, and he assumes that observable measures of academic ability correlate with high school graduates' initial beliefs about their academic abilities. Pessimistic graduates join the workforce, optimistic students enroll in four-year colleges, and students who are unsure of their academic abilities enroll in two-year colleges, where they gradually learn more about their abilities and decide whether to drop out or transfer to a four-year college.

Trachter's results contradict the conventional wisdom that academic two-year colleges are key players in postsecondary education because they train many students at the margin.

Trachter uses this model to run counterfactual analyses to determine the value of each option (drop out or transfer), the importance of risk aversion, the degree of substitutability between college types, and the value of gradually learning about academic ability. He analyzes not only changes in the enrollment pattern but also how return to enrollment, relative to joining the workforce directly after high school, is affected by each option.

The decomposition of returns to enrollment shows that the dropout option accounts for 31 percent of the full average return to enrolling in an academic two-year college, while the transfer option accounts for 69 percent. No one would enroll in an academic two-year college if these options were not available. For four-year colleges, the dropout option accounts for 87 percent of the full average return to enrollment, while the rest is explained by simple human capital accumulation from enrollment to graduation.

Trachter finds that if students were risk-neutral instead of risk-averse, enrollment in academic two-year colleges would fall from nearly 16 percent to 10 percent, while enrollment in four-year colleges would rise from 27 percent to nearly 50 percent. He concludes that introducing an exam capable of fully assessing students' academic abilities would increase the annual return to the availability of postsecondary education by 6.3 percent from a benchmark of 3.6 percent in the baseline economy.

Overall, the author finds that the value of academic two-year colleges comes mostly from the transfer option rather than the two-year graduation premium. He also finds a high degree of substitutability between two- and four-year colleges. In accordance with this high degree of substitutability, the welfare effect of two-year colleges is moderate at most. These results contradict the conventional wisdom that academic two-year colleges are key players in postsecondary education because they train many students at the margin.

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Sales, Inventories and Real Interest Rates: A Century of Stylized Facts

By Luca Benati and Thomas A. Lubik
Journal of Applied Econometrics, *November/December 2014, vol. 29, no. 7, pp. 1210–1222*

Inventory behavior has attracted enormous amounts of attention in macroeconomics. While inventory investment comprises only a small fraction of gross domestic product (roughly 0.5 percent), it can account for up to 90 percent of GDP's cyclical variation. Theoretical inventory models, however, find it difficult to reproduce some salient facts that are present in the data. In particular, theoretical inventory models predict that increases in interest rates should lead to lower inventory investment, but this relationship is difficult to establish empirically.

These insights suggest that theoretical inventory models must include a role for the real effects of monetary policy while emphasizing the residual role of inventories as a buffer for demand shocks.

In this *Journal of Applied Econometrics* paper, Luca Benati of the University of Bern and Thomas A. Lubik of the Richmond Fed use Bayesian time-varying parameter vector autoregressions (TVP-VARs) with stochastic volatility to study the statistical relationships between sales, inventories, and real interest rates in the United States since 1919. Their main finding is that interest rate shocks have systematically and robustly induced a positive correlation between inventories and real interest rates over the entire sample. The authors find that the reduced-form correlation between these variables is negative in the years between World War I and World War II, which would be consistent with theory. They conclude, however, that this pattern is driven by the differential incidence of demand and supply shocks. Once the authors condition this correlation on interest rate shocks, a positive relationship emerges. These findings provide a challenge to theoretical inventory models that is even deeper than previously thought.

Benati and Lubik also demonstrate the need to establish stylized facts conditional on identified shocks because the changing patterns of demand and supply shocks render the notion of fixed relationships meaningless. They suggest the following theoretical mechanism. An unanticipated increase in the interest rate has two effects. First, it prompts firms to reduce their inventories to minimize higher carrying costs. Second, the interest rate shock generates an unexpected decrease in sales, causing inventories to grow. The net change for inventories crucially hinges on which of these two effects is greater.

The results of the study are potentially useful in the development of theoretical inventory models. The key to understanding the inventory-interest rate relationship is the observation that inventories serve as a buffer between sales and production. These variables can exhibit different co-movement patterns depending on the type and persistence of shocks they experience. A monetary policy shock, for example, leads to decreases in sales and production. Its net effect

on inventories depends on whether production decreases by more or less than sales. Evidence from VAR studies suggests that sales respond faster and more strongly than output at high frequencies. Consequently, the interest rate-induced decline in sales is at first not matched by a commensurate decline in output so that surplus production bolsters inventories. In this scenario, the interest rate is positively related to inventories. These insights suggest that theoretical inventory models must include a role for the real effects of monetary policy while emphasizing the residual role of inventories as a buffer for demand shocks. In other words, final good inventories should play a larger role than input inventories. Moreover, models should separate sales and production decisions.

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Choosing the Variables to Estimate Singular DSGE Models

By Fabio Canova, Filippo Ferroni, and Christian Matthes
Journal of Applied Econometrics, *November/December 2014, vol. 29, no. 7, pp. 1099–1117*

The solution of dynamic stochastic general equilibrium (DSGE) models can often be represented as state space systems that are singular. This occurs because the number of endogenous variables generally exceeds the number of exogenous shocks. While singularity is not a problem for limited information structural estimation approaches, such as impulse response matching, it creates headaches for researchers using full information likelihood methods, either classic or Bayesian.

The authors propose two complementary methods for choosing the variables used in the estimation of the parameters of a singular DSGE model.

Researchers in this situation typically take one of two approaches. The first involves enriching the model with additional shocks. The second is to solve variables from the optimality conditions until the number of endogenous variables equals the number of shocks. However, both approaches present problems. In the first case, when shocks with dubious structural interpretation are used only to avoid singularity, it can complicate inference when those shocks turn out to matter, such as for output or inflation fluctuations. In the second approach, the convenient state space structure of the decision rules is lost, and the likelihood is an even more nonlinear function of the structural parameters and cannot necessarily be computed with standard Kalman filter recursions. Additionally, with k endogenous variables and $m < k$ shocks, researchers can form many nonsingular systems with only m endogenous variables and, apart from computational convenience, there are no solid principles for choosing which combination should be used.

In a *Journal of Applied Econometrics* paper, Fabio Canova of European University Institute and the Center for Economic and Policy Research, Filippo Ferroni of the Bank of France and the University of Surrey, and Christian Matthes of the Richmond Fed propose two complementary methods for choosing the variables used in the estimation of the parameters of a singular DSGE model. The first method selects the variables to be used in likelihood-based estimation, keeping parameter identification in mind. The authors use two measures to evaluate the local identification properties of different combinations of observable variables. First, they examine the rank of the matrix of derivatives of the state space representation of the solution with respect to the parameters for different combinations of observables. Given an ideal rank, the selected vector of observables minimizes the discrepancy between the ideal and the actual rank of this matrix.

This approach does not necessarily deliver a unique candidate, and it is silent about the subtle issues of weak and partial identification. As a result, the authors complement the rank analysis by evaluating the difference in the local curvature of the convoluted likelihood function of the singular system and of a number of nonsingular alternatives that fare well in the rank analysis. The combination of variables selected makes the average curvature of the convoluted likelihoods of the nonsingular and singular systems close in the dimensions of interest.

The second method described by Canova, Ferroni, and Matthes employs the informational content of the densities of the singular and the nonsingular systems and selects the variables to be used in estimation to make the information loss minimal. They construct the density of singular and nonsingular systems and compare the informational content of vectors of observables, taking the structural parameters as given. Since the measure of informational distance depends on nuisance parameters, they integrate them out prior to choosing the optimal vector of observables.

The authors test these methods and find that the best models selected by their criteria capture the conditional dynamics of the singular model reasonably well, whereas the worst models do not. Additionally, they note that the practice of tagging-on measurement errors or nonexistent structural shocks to use a larger number of observables in estimation may distort parameter estimates and jeopardize inference. In conclusion, Canova, Ferroni, and Matthes caution that their procedures require some modification for researchers working with different assumptions than those made in their exercise.

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Productivity Insurance: The Role of Unemployment Benefits in a Multi-Sector Model

By David L. Fuller, Marianna Kudlyak, Damba Lkhagvasuren
Journal of Economic Dynamics and Control, *October 2014, vol. 47, pp. 39–53*

The literature on the provision of unemployment insurance (UI) has focused on its role in smoothing consumption between employment states. This role implies a trade-off between insurance and incentives. More insurance implies reduced output as the duration and incidence of unemployment increases. However, the relationship between UI and output may change if one recognizes that UI also encourages unemployed workers to seek higher productivity jobs, which in turn might lead to an increase in aggregate output.

The authors analyze how unemployment benefits affect equilibrium outcomes, focusing on the productivity effects.

In a *Journal of Economic Dynamics and Control* paper, David L. Fuller of the University of Wisconsin-Oshkosh and CIREQ, Marianna Kudlyak of the Richmond Fed, and Damba Lkhagvasuren of Concordia University, National University of Mongolia, and CIREQ introduce an additional role for unemployment benefits: insurance against idiosyncratic sector-specific productivity shocks while unemployed. They consider an environment in which, upon becoming unemployed, individuals are subject to idiosyncratic shocks that render their current skills less suitable for their most recent sector of employment. If a move from one sector to another is costless, such a shock poses no additional risk to the unemployed. If, however, the move is costly in some way, then unemployment poses a risk to future wage prospects if unemployed workers search in the relatively less productive sector. In such an environment, unemployment benefits may help insure individuals against this risk by effectively reducing the costs of moving.

The authors analyze how unemployment benefits affect equilibrium outcomes, focusing on the productivity effects. They show that the mobility decision is characterized by a reservation rule for productivity shocks. Faced with idiosyncratic shocks above their reservation values, the individuals would switch sectors; otherwise they would remain in their current sectors. This feature implies that the effect of benefits on productivity depends on how changes in benefits affect the reservation value. The authors illustrate two main effects on the reservation value, one that has a negative effect on productivity and one that has a positive effect.

The negative effect on productivity creates moral hazard because the benefit subsidizes job search. Increasing benefits increases the value of unemployment, reducing the gain from moving to higher productivity sectors. But an increase in unemployment benefits also may decrease the reservation productivity, thereby encouraging workers to move to sectors in which they are more productive.

The combined effect of benefits on productivity remains ambiguous. To quantitatively illustrate which effect dominates, the authors calibrate the model to the U.S. economy and find that the positive effect dominates, so that increasing benefits increases per-worker productivity as workers move more frequently in response to idiosyncratic productivity shocks. Unemployment increases while vacancies decrease. They find that a 25 percent increase in the benefit level increases per-worker productivity by 0.1 percent. They also analyze the welfare-maximizing unemployment benefit level and find that it depends on the size of the moving cost. They report that in response to a 1 percent increase in the moving cost, the optimal benefit decreased by 6 percent. Thus, while the magnitude of the productivity effects is relatively small, the overall role of unemployment insurance as productivity insurance may be quite important.

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Fed Credit Policy: What Is a Lender of Last Resort?

By Jeffrey M. Lacker
Journal of Economic Dynamics and Control*, December 2014, vol. 49, pp. 135–138*

In May 2014, policymakers and economists gathered at the Hoover Institution for a conference titled "Frameworks for Central Banking in the Next Century." Richmond Fed President Jeffrey Lacker addressed the conference to discuss a paper presented by the preceding speaker, Michael Bordo of Rutgers University, regarding the Fed's history as a lender of last resort. Lacker highlighted the distinction between credit policy and monetary policy and the distinction between ex-post and ex-ante approaches to promoting financial stability. His presentation was published, along with other papers from the conference, in a special issue of the *Journal of Economic Dynamics and Control*.

Lacker explained that central banks conduct monetary policy when they alter the quantity of their monetary liabilities. They conduct credit policy when they change the composition of their portfolios without altering the quantity of their monetary liabilities. Expansionary monetary policy creates bank reserves, and so does Fed lending, but under the Fed's pre-crisis interest rate targeting regime, the additional reserves created by Fed lending were offset—or "sterilized"—by open market operations. So sterilized central bank lending constitutes credit policy, while unsterilized central bank lending represents both monetary policy and credit policy.

In the 19th century, Walter Bagehot and Henry Thornton advocated unsterilized lending to expand the money supply when demand for money surged during a financial crisis. A central bank that engaged in such unsterilized crisis lending came to be known as a "lender of last resort." That phrase, along with Bagehot's name, were often invoked "like Holy Writ" in policy discussions during the 2007–08 crisis, Lacker recalled. "But with the distinction between monetary and credit policy in mind, it's clear that the Fed's lending, which was sterilized prior to very late in 2008, had very little to do with what Thornton and Bagehot had in mind." Under the Fed's federal funds rate targeting regime, bank reserves expanded automatically through open market purchases of government securities when demand for reserves increased, as it did in August 2007. According to Lacker, "no lending programs were required."

Lacker said the Fed must establish credible limits to central bank intervention in credit markets. One way to do that is through the Dodd-Frank Act's resolution planning provisions—often called "living wills."

Lacker also emphasized the distinction between ex-post and ex-ante approaches to promoting financial stability. The ex-post perspective takes financial distress as given and considers possible central bank interventions—including crisis lending—designed to restore stability. In contrast, the ex-ante perspective focuses on how financial market participants will structure their affairs taking central bank behavior as given.

Substantial credit allocation during the past several decades likely increased market participants' expectations of central bank rescues, which in turn likely reduced their incentive to protect themselves against financial distress. To reverse that trend, Lacker said the Fed must establish credible limits to central bank intervention in credit markets. One way to do that is through the Dodd-Frank Act's resolution planning provisions—often called "living wills." If deemed credible, these resolution plans for financial entities once considered "too big to fail" would make a commitment to limit government rescues much more persuasive, Lacker concluded. Such a commitment would help the Fed avoid the distributional politics of credit allocation that threaten "the delicate equilibrium underlying central bank independence, which has been so essential to monetary stability."

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Figuring Out the Fed—Beliefs about Policymakers and Gains from Transparency

By Christian Matthes
Journal of Money, Credit and Banking, *February 2015, vol. 47, no. 1, pp. 1–29*

In standard New Keynesian models (or other rational expectations models featuring monetary policy), the central bank follows an explicit policy rule for setting monetary policy. Firms and households are aware of this rule and use that knowledge to form beliefs about the path of future interest rates. In reality, however, the private sector has often been uncertain about how central banks like the Federal Reserve set monetary policy. Firms and households instead constantly update their beliefs about monetary policy in response to new evidence from monetary policymakers. In this context, increased transparency from the central bank can improve the evolution of the public's beliefs about monetary policy.

To study this issue, Christian Matthes of the Richmond Fed creates a model in which the private sector is uncertain about how monetary policy is set and uses Bayes' law on a rolling data sample to update its beliefs about whether the central bank is setting policy with commitment or discretion.

These two policy approaches can differ along other dimensions as well. In Matthes' model, firms and households know the preferences of central banks following both approaches, and they must determine which path the central bank is most likely to be following given known information.

Matthes uses data on inflation, output, and interest rates since 1960 to model how the private sector's beliefs about Fed policy have evolved over time. In the 1960s, firms and households believed that the Fed was a discretionary policymaker, which fits anecdotal evidence from that period. Beginning in 1980, the actions of the Fed under Chairman Paul Volcker were able to convince the public that the Fed was acting under commitment with a preference for lower inflation. However, Matthes finds that this shift in expectations was less pronounced than commonly believed.

Matthes also uses the model to examine gains from increased central bank transparency. He does this by simulating a number of counterfactual scenarios, such as asking what output and inflation would have been if the Fed had not only convinced the public that it was acting under commitment, but also actually followed that policy. Comparing this to a scenario in which the public is uncertain about Fed policy, Matthes finds that when the public believes the Fed is acting under commitment and the Fed follows through, inflation is lower on average and less volatile than what is observed in the data. Looking at the sample period, Matthes finds that a transparent Fed acting under commitment could have largely avoided the increase in inflation that occurred during the 1970s. In contrast, when the public correctly believes the Fed is acting under discretion, the model predicts very high and volatile inflation. These comparisons highlight the potential gains from central bank transparency.

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An Experimental Analysis of Contingent Capital with Market-Price Triggers

By Douglas Davis, Oleg Korenok, and Edward Simpson Prescott
Journal of Money, Credit and Banking, *August 2014, vol. 46, no. 5, pp. 999–1033*

In the aftermath of the 2007-08 financial crisis, financial reformers have tried to develop policies to ensure that banks have enough equity to remain solvent in times of distress. One proposal would require banks to issue a new class of subordinated debt that would convert to equity in times of crisis. This so-called "contingent capital" offers several advantages to banks and to society. Contingent capital automatically raises equity precisely when doing so is the most difficult, thereby reducing the risk of failure and making it easier for the bank to continue lending.

Perhaps the most challenging issue for implementing contingent capital is determining what would trigger its conversion from debt to equity. Some proposals rely on accounting measures, but accounting measures typically lag behind banks' current conditions. An appealing alternative is using banks' stock prices as triggers because stock prices are forward-looking and incorporate the expectations of market participants. Furthermore, market-price triggers would be less susceptible to political pressures because they are public information.

The small theoretical literature on using market-price triggers finds, however, that in rational expectations models market-price triggers would create their own problems. To investigate these theoretical issues, Douglas Davis and Oleg Korenok of Virginia Commonwealth University and Edward Simpson Prescott of the Richmond Fed perform an experimental analysis designed to approximate the costs of implementing contingent capital with market-price triggers.

They employ an experimental approach because there is no financial market evidence on this type of trigger. In their simulated market, traders deal in bonds with values that are affected by a contingent capital conversion feature. The researchers use this experimental framework to evaluate three market-based regimes for triggering the conversion of bonds to equity: a "fixed-trigger" regime, where price thresholds trigger mandatory conversion; a "regulator" regime, where regulators make conversion decisions based on prices; and a "prediction market" regime, where regulators also observe a market that predicts conversion. Consistent with the theoretical literature on market-price triggers, the researchers observe inefficiencies and conversion errors in both the fixed-trigger and regulator regimes. The regulator regime in particular has conversion errors over the widest range of shocks. Adding the prediction market improves the regulators' performance somewhat, but they still do not outperform the fixed-triggers regime.

Davis, Korenok, and Prescott interpret their results as strong evidence that contingent capital with market-price triggers has significant costs as measured by informational efficiency, allocational efficiency, and conversion errors. They warn that ignoring market prices altogether might be worse than using them as triggers. But to gain the full benefit of contingent capital, the search continues for a trigger that does not have, or at least reduces, the inefficiencies that the authors' experimental analysis identifies.

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When Is Sticky Information More Information?

By Pierre-Daniel Sarte
Journal of Money, Credit and Banking*, October 2014, vol. 46, no. 7, pp. 1345–1379*

Data from statistical agencies regarding the state of the economy typically lag current conditions. For example, the Federal Reserve Board releases manufacturing data with a one-month lag. At the monthly frequency, these data are also quite noisy in a way that partially masks underlying business cycle conditions. In an alternative attempt to track business cycles in real time, and to confirm initial Federal Reserve Board data releases, many institutions and government agencies also derive manufacturing indices from qualitative data. The Institute for Supply Management (ISM), for example, constructs a widely used monthly balance index of manufacturing production based on nationwide surveys.

In a *Journal of Money, Credit and Banking* article, Pierre-Daniel Sarte of the Richmond Fed focuses on the ISM index. He notes that to keep the surveys straightforward and to limit the burden on respondents, ISM researchers give participants only three options—they can say that production is "up," "down," or "the same" relative to the previous period. Individual responses are aggregated accordingly and used to construct the ISM index.

While various properties of balance indices have been studied in some detail, this work has been limited because firm-level data underlying individual survey responses are either not systematically recorded or not publicly available. It has been challenging, therefore, to determine whether survey responses reflect sticky information. It also has been difficult to explain why converting qualitative answers into balance indices has proven useful in following economic activity in real time.

To address this issue, Sarte compares sectoral manufacturing data from the Federal Reserve Board with the ISM index for 1972 through 2010. His empirical framework recognizes that many survey respondents use out-of-date production information to answer survey questions. And, in

fact, his analysis suggests that survey answers underlying the ISM index reflect information lags that average about 7.5 months. Furthermore, many respondents answer questions based on what they expect their firm's output to be given their most recent information rather than citing actual production numbers. Therefore, high-frequency output fluctuations that are unrelated to business cycles tend to be filtered out of survey responses, and the resulting index is better able to isolate variations at business cycle frequencies. In this way, sticky information provides a foundation for the widespread use of balance indices as economic indicators. Conversely, in a world populated by identical firms that are always fully informed about production, as in the standard real business cycle environment, balance indices would become degenerate.

Finally, Sarte's empirical work shows that information regarding changes in aggregate manufacturing output tends to be concentrated in only a few sectors. Hence, contrary to standard practice, researchers do not need to capture a representative sample of all manufacturing sectors to track changes in aggregate activity. In some sectors, changes in output mostly reflect factors that drive aggregate changes, while in other sectors, output variations mostly reflect idiosyncratic considerations. The author demonstrates how factor-analytic methods can be used to distinguish between the most- and least-informative sectors when constructing a balance index of manufacturing production.

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Large Excess Reserves in the United States: A View from the Cross-Section of Banks

By Huberto M. Ennis and Alexander L. Wolman
International Journal of Central Banking*, January 2015, vol. 11, no. 1, pp. 251–289*

Bank reserves in the United States increased dramatically starting in the fall of 2008. Prior to that period, total reserves, including vault cash, had fluctuated between $40 billion and $60 billion. But after the bankruptcy of Lehman Brothers in September 2008, reserves increased rapidly to more than $850 billion. By the first half of 2011, reserves had reached $1.6 trillion.

This rapid increase was the result of policies undertaken by the Federal Reserve to mitigate the effects of the financial crisis of 2007-08 and stabilize the economy. In November 2008, the Fed began an asset purchase program with the intent of increasing its holdings of agency debt and mortgage-backed securities by $600 billion. The Fed expanded this program in March 2009, resulting in another $300 billion increase in reserves. From December 2010 through June 2011, the Fed engaged in another round of asset purchases. The Fed also began paying interest on reserves in October 2008.

A large amount of excess reserves in the banking system has the potential to affect the transmission of monetary policy. Reserves can be thought of as a way for banks to "store" deposits that could later be used to finance lending. A banking system with a higher amount of "stored deposits" could, in principle, adjust lending more quickly than one that has already used most of its deposits to finance existing loans. This means that as the economy strengthens, loan activity could pick up faster than in the past, requiring that the Fed make appropriate adjustments to monetary policy.

In a paper in the *International Journal of Central Banking*, Huberto Ennis and Alexander Wolman of the Richmond Fed study the increase in bank reserves by examining the cross-sectional distri-

bution of reserves held by commercial banks, savings banks, and trust companies, as well as uninsured branches and agencies of foreign banks from 2008 through 2011. They report five major findings from the data. First, reserves were widely distributed across banks and appeared to get relatively more concentrated in large banks during periods of high growth in the total amount of reserves outstanding. When the total level of reserves stabilized, reserves became more evenly distributed. Uninsured institutions (primarily U.S. branches and agencies of foreign banks) absorbed a significant amount of the excess reserves that were created during the period. Although there were only about 200 such institutions, in the second quarter of 2011, they held more than 40 percent of total reserves.

Ennis and Wolman also find that the increase in reserves was not offset by changes in the holdings of liquid securities at banks, and as a result, total bank liquidity increased. Additionally, the authors find no evidence that the increase in reserves put pressure on insured banks' balance sheet capacity. Another of the authors' findings is that a considerable proportion of the excess reserves at the time were on the balance sheets of banks with relatively abundant capital. As a result, a large amount of reserves could, in principle, have been converted into loans without placing substantial pressure on those banks' capital ratios.

Lastly, the authors examine whether changes to the rate of return on lending could be driving the decision by banks to hold reserves. They find that during the period of 2008 through 2011, changes in rates of return on lending were small and not linked to changes in reserves across large banks. However, they note that this evidence is not conclusive, since effects may only become visible after more significant changes in rates of return on lending occur.

Ennis and Wolman's study contributes to an understanding of what large quantities of reserves might mean for monetary policy and economic outcomes. Such analysis remains relevant, as the total amount of reserves in the banking system has continued to increase and averaged over $2.5 trillion in the first half of 2015.

http://www.ijcb.org/journal/ijcb15q1a8.htm

Transition Dynamics in the Neoclassical Growth Model: The Case of South Korea

By Yongsung Chang and Andreas Hornstein
B.E. Journal of Macroeconomics*, July 2015, vol. 15, no. 2, pp. 649–676*

While capital accumulation is a core element of the neoclassical growth model, the model-implied dynamics are strongly at odds with the actual pattern of investment rates in many countries. So-called growth "miracles" in East Asian nations, such as Taiwan and South Korea, feature long periods of sustained capital accumulation characterized by gradually rising investment rates along with moderate rates of return to capital. Both of these conditions conflict with the standard neoclassical growth model, which would predict extremely high rates of return to capital and investment rates that decline from initial high points.

In an article in the *B.E. Journal of Macroeconomics*, Yongsung Chang of the University of Rochester and Yonsei University and Andreas Hornstein of the Richmond Fed use South Korean economic data from 1960 through 2011 to show that this apparent failure of the model is mainly due to using the "wrong" data to evaluate it. First, the neoclassical growth model, with its emphasis on capital

accumulation, applies to the capital-intensive, industrialized sectors of the economy not to the more labor-intensive agricultural sector. Second, in the early stages of economic development, the relative price of capital is high. Accounting for both of these features dramatically lowers the model-implied rates of return to capital during the early stages of development and contributes to the hump-shaped path for investment rates.

The authors' quantitative analysis, based on their calibrated model of the South Korean economy, suggests that the two most important sources of long-run capital accumulation were increasing employment in the nonagricultural sector and a declining relative price of capital, accounting for three-fourths of capital growth from 1960 through 2011. Reduced financial frictions contributed an additional 14 percent to capital accumulation; whereas the contribution coming from the endogenous transition of the capital stock to its long-run balanced growth path value accounts for only 10 percent. These standard transition dynamics were, however, more important from 1960 to 1980, accounting for 20 percent to 40 percent of capital accumulation during that period.

While Chang and Hornstein show that recognizing industrialization and the changes in the relative price of capital account for the overall transition in the data, their analysis abstracts from some important aspects of the South Korean development process. At the outset of the transition path, similar to many other developing economies, structures—residential buildings in particular—composed most of the aggregate capital stock. As a result, the capital-output ratio for equipment was much lower than for structures. Thus, the implied rates of return and financial frictions for the two types of capital are potentially quite different from the implied rates of return on the aggregate capital stock measure that does not differentiate between the two types. In the context of a disaggregated model of the capital stock, the interaction between human and physical capital might have been important for the sluggish accumulation of physical capital because the supply of skilled labor, that is, human capital, was limited in the early stages of economic development. Finally, the authors' model of the South Korean economy does not consider international trade, which has been recognized as an important factor for economic growth among East Asian countries.

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