Discussion of Monetary Policy Under Uncertainty in Micro-Founded Macroeconometric Models, by Levin, Onatski, Williams and Williams

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The marriage of micro-founded dynamic stochastic general equilibrium models and nominal rigidities has opened up new possibilities for policy analysis, and in particular for conducting welfare-based analysis using estimated macro models. Andy Levin, Alexsei Onatski, John Williams, and Noah Williams (henceforth LOWW) have exploited these possibilities in an excellent paper, one in which they accomplish three things. First, they specify a second generation new Keynesian model and estimate it using Bayesian techniques. Second, they use this model to calculate the welfare costs of fluctuations under alternative policies. Third, they investigate the robustness of policy rules to parameter and model mis-specification.

Each of these tasks is carried out in elegant fashion, producing a paper that not only represents the state of art in modern monetary economics, but provides an outstanding example of how to do policy analysis. But because LOWW provide such a carefully and well-specified model, one that includes all the bells and whistles of the latest generation of new Keynesian models, it offers an opportunity for assessing the ability of these models to serve as the workhorse for monetary policy analysis. I will argue that this estimated new Keynesian model fits the data in a very non-Keynesian manner. By this I mean the model attributes most of the actual output

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fluctuations experienced in the U.S. economy to fluctuations in the flexible-price equilibrium level of output, suggesting that nominal rigidities have contributed little to observed business cycles. The model also implies an interpretation of the early 1980s and the Volcker disinflation that is at odds with the views shared by most new Keynesians. Further, while the authors find that the labor market is critical for the welfare costs of fluctuations, the estimated output gap implied by their model bears little relationship to fluctuations in the unemployment rate.

In my comments, I first very briefly describe the model, make a few points about the empirical strategy, and assess the results. Then, after discussion the authors' policy findings, I conclude with some comments on the specification of the labor market.

1 The model, empirical strategy and results

In the model LOWW specify, wages and prices are sticky, with the adjustment of both governed by the standard Calvo mechanism augmented by Woodford-type partial indexation (Woodford 2003). Intertemporal consumption preferences exhibit internal habit persistence, capital utilization is variable, and there are investment adjustment costs. These modeling choices have become standard in new Keynesian models, particularly when a goal is to take the model to the data (see for example, Christiano, Eichenbaum, and Evans 2005 and Smets and Wouter 2003). Indexation is included to justify the presence of lagged wage and price inflation in the wage and price adjustment equations and habit persistence is used to motivate the presence of lagged output in the Euler equation. Variable capital utilization serves to dampen the impact of output movements on marginal cost and therefore on inflation. While there is little micro evidence to justify some of these extensions, they have all become accepted components of the standard model, necessary to capture the persistence typically displayed by the data.

Where LOWW differ from the earlier literature is in the set of economic shocks that their model includes. Some of these are standard, such as serially correlated disturbances to the marginal disutility of work and to the

production function. Others are less common; for example, they include serially correlated disturbances to the representative household's subjective rate of time discount, to investment adjustment costs, to the demand elasticity faced by individual forms, to the elasticity of labor demand faced by individual households, and to the asset pricing Euler equation. These last three disturbances are assumed to be i.i.d., while the first three are treated as AR(1). The paper provides little discussion rationalizing these particular modeling choices.

Let me briefly mention four of the authors' choices in taking their theoretical model to the data that may bear further investigation. First, to close the model, monetary policy is represented by an interest rate rule with a serially correlated stochastic inflation target. This treatment of monetary policy, while standard, is somewhat at odds with the general approach adopted in the paper. The micro-founded specification of the private sector takes as given that decision rules are not primitives – one specifies objective functions and constraints and from these decision rules are derived. Hence, while LOWW treat private agents in their model as rational optimizers, this is not how they treat their central bank policymaker when they estimate the model. The central bank is assumed to implement a simple instrument rule for the nominal rate of interest. That is, the decision rule of the central bank is treated as a primitive. The debate over representing central bank behavior as a simple rule, or recommending that a central bank actual implement a simple rule, is an active one. One argument for simple rules is that they provide good policy guidance when the central bank has only limited information about the economy. But LOWW assume the central bank has complete information, letting it respond to an output gap measure whose calculation requires knowledge of the entire model. It might be interesting to assume alternatively that a central bank equipped with complete knowledge of the model would in fact implement the optimal policy, rather than relying on a simple (and suboptimal) rule. Dennis (2005) has followed this approach in jointly estimating the structural parameters of a simple new Keynesian model, along with the weights in the central bank's objective function. An interesting exercise would be to see if the empirical parameter estimates are

affected when the central bank is treated as an optimizing, rational agent, as the private sector already is.

Second, the model is estimated over the period 1955 to 2001. Given the simple structure of the model and the major changes that have occurred in the U.S. economy over the past half century, one must question whether parameters have remained constant over the entire sample. In addition, previous work (for example, Judd and Rudebusch 1998) shows that Federal Reserve behavior was not constant over this period of time.

Third, consumption, investment, output, hours, and the real wage are all measured as log deviations from linear trends. In a micro-founded model, the choice to separately detrend these variables seems open to question. Theory should tell us something about the common sources of the growth trends in these variables, and this information should be used if possible.

Fourth, government spending is treated as an exogenous disturbance. However, in the actual estimation, the government spending variable is measured by government purchases plus net exports. This is necessary as the theoretical framework corresponds to a closed economy, but the data come from an open economy. The problem is that, while one might be willing to treat government spending as exogenous, this is not a reasonable assumption with respect to net exports.

While the authors discuss the estimation results for individual parameters, they do not evaluate the overall ability of the model to match the data. One means of doing so is to examine the way the model decomposes output into potential output and the output gap. This is done in Figure 1. The solid line is log, detrended real GDP, expressed in percentage terms, the authors' measure of output. The dashed line is their estimate of potential output y^*, while the dotted line is the output gap, $y - y^*$. Potential output is defined as the flexible-price equilibrium output level that would occur in the absence of price, wage, and equity "cost-push" shocks. As the figure reveals, the model attributes almost all of the fluctuations in actual output to fluctuations in potential output. Expressed alternatively, despite the new Keynesian addition of sticky wages and prices, the estimated model basically delivers a real business cycle representation of output. And recall

that the output series has already been detrended so that the authors' y is itself a measure that is often identified as an output gap in empirical work.

How should this close parallel between output and potential output be interpreted? In versions of the new Keynesian model in which the steady-state is Pareto efficient, the flexible-price equilibrium output level, LOWW's potential output, is also the welfare maximizing output level. Hence, one interpretation of Figure 1 is that the Federal Reserve has managed to keep actual output very close to the welfare maximizing output level. Such an interpretation seems at odds with the model itself, which finds both that the impulse responses to shocks under the estimated policy rule differ significantly from the impulse responses implied by the optimal policy and that the estimated interest rule leads to higher welfare costs than the optimal Ramsey policy.

Another way to assess the model is to focus on a particular historical episode for which most of us have fairly strong priors about the role of monetary policy. The period from late 1979 to 1984 was one in which the U.S. experienced two back-to-back recessions that almost all economists attribute to the Federal Reserve's actions to bring down inflation. Output declined significantly over this period before recovering. If this decline was the result of monetary policy, potential output should not show a similar decline, and we should expect to see parallel movements of the output gap and actual output. Figure 2 shows the decline of y and its subsequent recovery. However, the figure also shows that the model attributes this decline entirely to a decline in potential output y^*. In fact, the model implies that the early 1980s were a period of positive output gaps, with actual output exceeding the flexible-price equilibrium level. Thus, according to the model, far from generating a recession, Volcker failed to allow output to decline as much as y^* fell.[1]

Figure 2 also shows the unemployment rate (expressed as a deviation

[1] Interestingly, the graph of potential output for the euro area presented in Smets and Wouter (2003) also shows a large drop in potential output from roughly 1979 to 1982, producing a positive and increasing output gap even though actual output was falling over this period.

from its sample mean). Consistent with the standard interpretation of this period as one of economic recession, the unemployment rate rose in 1980, eventually peaking in the fourth quarter of 1982. This behavior does not seem consistent with a period that, according to the model, was experiencing a positive output gap. I will return to the relationship between the unemployment rate and the estimated output gap series below.

If actual policy has not been fully optimal, two other interpretations of Figure 1 are perhaps more plausible. The model contains ten stochastic shocks. LOWW assume that seven of these shocks, all but the equity, wage, and price cost-push shocks, cause movements in y^*. The decomposition of output between y^* and $y - y^*$ will depend on which shocks are assumed to be reflected in movements in y^* and which are not. The high correlation between y and y^* suggests, perhaps not surprisingly, that understanding the sources of the exogenous shocks will be critical in assessing whether the fluctuations they induce are efficient or welfare reducing.

A final interpretation is simply that the model is missing some critical aspect that is important for the actual behavior of business cycles. One possibility is that the failure to capture the standard interpretation of the 1980s is due, in part, to the way LOWW specify the monetary policy instrument rule. This instrument rule contains two stochastic elements, one is the inflation target, the other is a shock to the equation as a whole (labelled a policy shock). Given the linear structure, these two can only be disentangled because the policy shock is assumed to be white noise while the inflation target is allowed to be serially correlated.[2] The time variation to the inflation target is assumed to be known perfectly by all agents in the model. Thus, I suspect that to fit the data the estimated inflation target falls in 1980, but because this decline is known and perfectly credible, it has little impact in the model on the output gap. To match the decline in actual output, the model must attribute the recession to a fall in y^*. In contrast, Erceg and Levin (2003) argue that accounting for the imperfect credibility of the Fed's inflation target is important for understanding the economy's behavior during the Volcker disinflation.

[2] The standard deviation of the policy shock is estimated to be essentially equal to zero.

2 Policy analysis

Household welfare is the metric LOWW employ to evaluate alternative policies, thereby providing a model-consistent means of comparing outcomes under different policies. By assuming the presence of labor and production subsidies that neutralize the distortions arising from imperfect competition, LOWW take the flexible-price equilibrium to be Pareto optimal. Results are reported in terms of consumption equivalents, and they find sizable costs of economic fluctuations, amounting to a 1.4 percent decrease in permanent consumption even under the optimal Ramsey policy. Presenting policy comparisons in terms of consumption equivalents is an excellent idea, one that others should emulate. LOWW's results highlights how policies that lead to similar volatility of inflation and the output gap – the standard metrics for comparing policy outcomes – can actually result in quite different levels of welfare.

Perhaps their most interesting finding, however, is that a simple difference rule, in which the change in the nominal interest rate responds to the rate of wage inflation, does virtually as well as the fully optimal Ramsey policy, and it does significantly better than the estimated policy rule. This result is a consequence of the critical role nominal wage rigidity plays in the model. As the authors explain, the welfare costs of fluctuations depend critically on the degree of wage stickiness. And because wage volatility is so critical for generating the costs of fluctuations, optimal policy will place a large weight on stabilizing wage changes. Thus, a simple rule that reacts strongly to wage inflation comes close to replicating outcomes under the fully optimal policy. Also iof nterest is their finding that a wage inflation rule is robust to several forms of parameter uncertainty and model mis-specification.

3 The labor market

Perhaps the most important lesson from LOWW is that the labor market is critical in accounting for the welfare costs of economic fluctuations. These

costs are due to the dispersion of hours worked across households that occur when wages are sticky. As LOWW put it, "Overall, our results have emphasized the central importance of the labor market for welfare and policy analysis." This finding is consistent with the work of Galí, Gertler, and Lopez-Salido (2002) who find that the economy's "efficiency gap" is primarily the result of stochastic fluctuations in the wedge between the households' marginal rate of substitution between leisure and consumption and the real wage. Because of its importance, LOWW consider some alternative specifications of the labor market. However, they limit their focus to alternative models of nominal wage stickiness. This may not be the only aspect of the labor market specification that should be examined. I will mention two others.

In LOWW, the wedge between the households' marginal rate of substitution between leisure and consumption and the real wage arises from stochastic fluctuations in the wage elasticity of labor demand $\lambda_{w,t}$. The relevant real wage for labor supply should be the consumption real wage, but because the model is a closed economy model, the authors use the real product wage in its place. Thus, there is the possibility that what the estimated model attributes to $\lambda_{w,t}$ (and recall, $\lambda_{w,t}$ is assumed to generate inefficient movements in output) is really just the wedge between the real consumption wage that should appear in the wage inflation equation and the real product wage that actually appears. Under this interpretation, $\lambda_{w,t}$ reflects variations in the consumer price index relative to the GDP deflator, variations that are not exogenous but are associated with, for example, exchange rate movements. An interesting extension would incorporate open economy aspects into the model to see if this is in fact the source of LOWW's cost-push shock and whether accounting for it affects the estimated welfare costs of fluctuations.[3]

Since the labor market seems to be critical for the welfare costs of fluctuation, how do unemployment fluctuations relate to their authors' estimated output gap? Okun's Law provides a convenient and conventional link be-

[3] This wedge would also be affected by time variation in taxes, anther factor that it may be important to incorporate.

tween output gap fluctuations and movements in the unemployment rate relative to the natural rate of unemployment. This relationship is shown in the top panel of Figure 3, in which the unemployment rate is plotted on the horizontal axis and detrended log GDP, LOWW's y, is plotted on the vertical axis. The bottom panel shows the relationship between the unemployment rate and LOWW's estimated output gap, $y - y^*$. The model-consistent output gap is essentially unrelated to the unemployment rate. The fluctuations LOWW identify as due to nominal rigidities appear not to be associated with the fluctuations we observe in the unemployment rate, raising the question of whether movements in the rate of unemployment are in fact misleading measures of cyclical inefficiencies, or whether the new Keynesian model is providing a distorted view of business cycles.

LOWW employ Bayesian methods to estimate their model; similarly, I interpret Figures 1, 2, and 3 from a Bayesian perspective. My prior is that most short-run movements of output and the unemployment rate are not simply a reflection of fluctuations in potential output and the natural rate of unemployment. From that perspective, the failure of the new Keynesian model to uncover a relationship between unemployment and output gaps is troubling.

My hunch is that this failure can be traced to the way labor markets are treated in most new Keynesian models. These models have yet to incorporate what Hall (2005) refers to as the modern theory of unemployment, a theory based on the work of Mortensen and Pissarides (1994). In fact, new Keynesian models such as the one employed by LOWW follow RBC models in emphasizing the intensive margin, variations in hours per worker, rather than the extensive margin, variation in the number of workers employed. Exactly the opposite emphasize, on the extensive rather than the intensive margin, is likely to provide a better match with labor market experiences.

In the Mortensen-Pissarides framework, unemployed workers and firms with vacancies engage in a costly matching process. While most papers employing this framework have assumed flexible prices, a few papers have begun to explore the interactions of nominal rigidities with labor market search (Walsh 2005, Trigari 2005). Given the importance that the labor

market plays in policy analysis, at least according to LOWW's findings, incorporating the modern theory of unemployment into the new Keynesian framework must be high on the research agenda.

4 Conclusions

I believe there is much to be learned from LOWW's paper. It provides a superb illustration of how policy analysis should be conducted, and it provides new estimates of the costs of economic fluctuations. A key lesson to draw from the paper is that labor markets are critical for understanding the costs of macroeconomic fluctuations. The results also suggests that simple wage inflation policy rules may be close to optimal, at least within the model the authors employ, and that these rules are robust to some aspects of parameter and model uncertainty. However, the fact that the model attributes almost all output fluctuations to fluctuations in the flexible-price equilibrium level of output, even during the Volcker disinflation of the early 1980s, and that the estimated output gap bears little relationship to such standard measures of the business cycles as the unemployment rate, call into question the ability of the current generation of new Keynesian models to provide an adequate foundation for monetary policy analysis.

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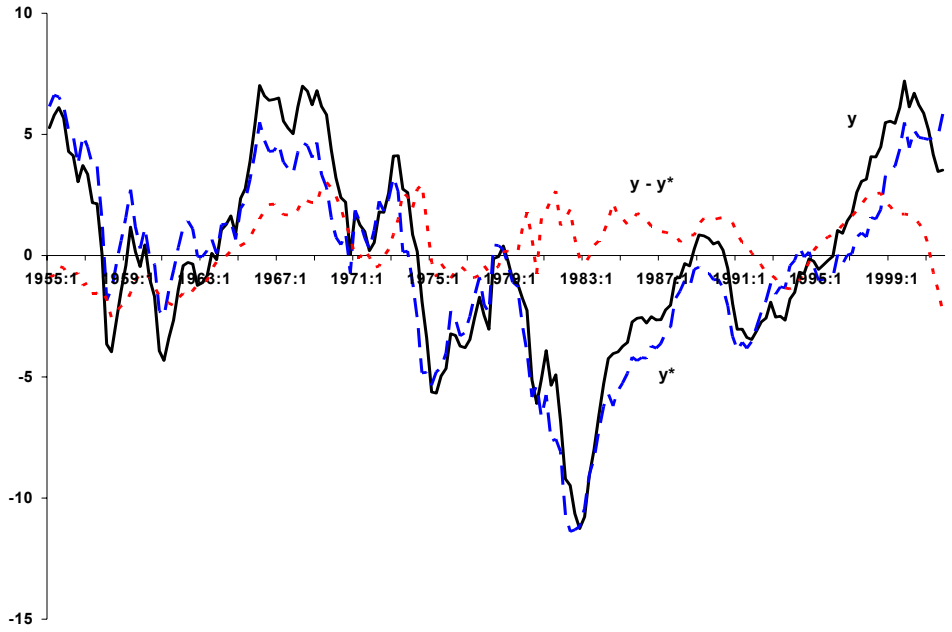

Figure 1: Estimated potential output y^* (dashed line) tracks actual output y (solid line) closely. Also shown is the output gap $y - y^*$ (dotted line).

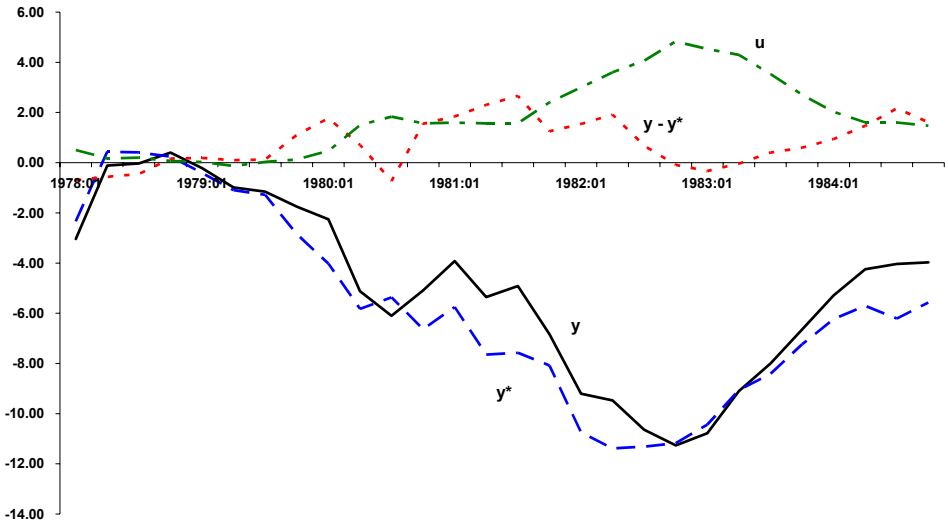

Figure 2: During the early 1980s, the model attributes the decline in output (solid line) to a parallel decline in potential output (dashed line). The output gap (dotted line) was actually positive. Also shown is the unemployment rate (dot-dashed line).

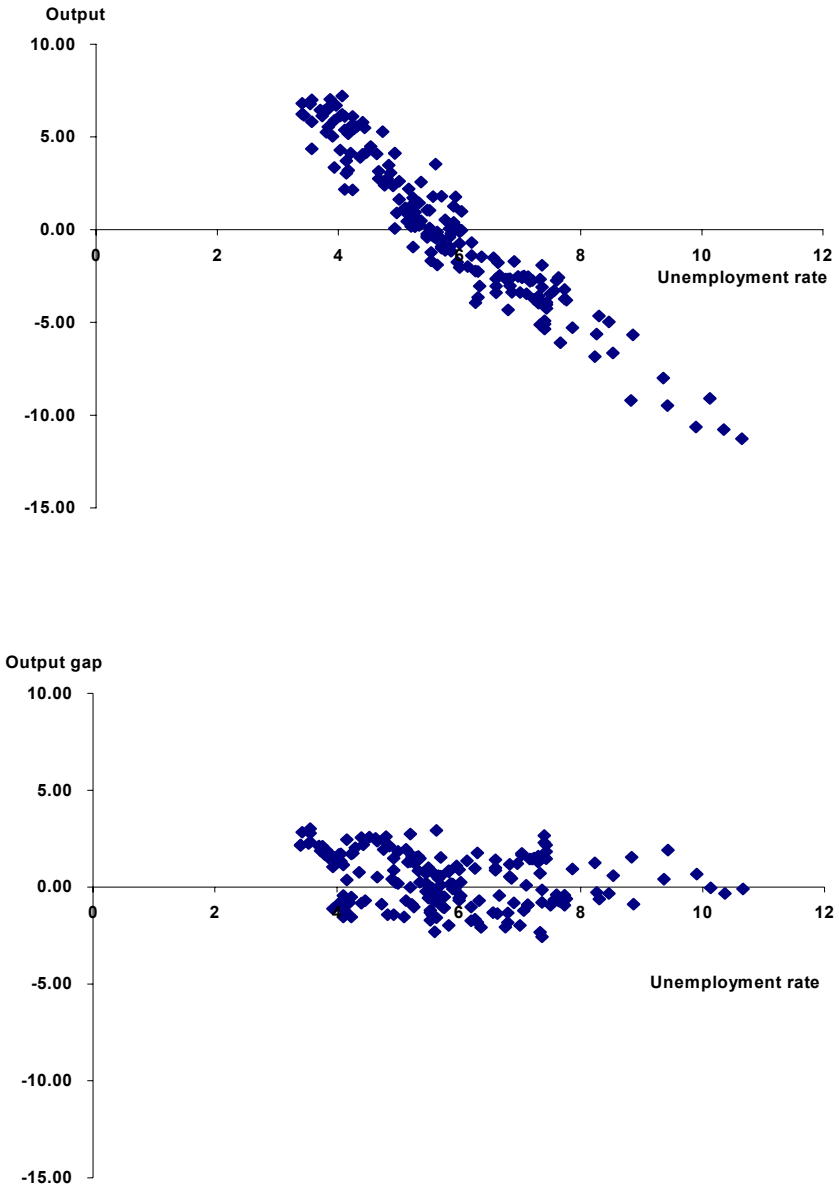

Figure 3: The top panel shows the standard Okun's Law relationship between the unemployment rate and detrended output. The bottom panel shows that LOWW's estimated output gap $y - y^*$ is unrelated to the unemployment rate.