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New Keynesian Models: Not Yet Useful for Policy Analysis*

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ABSTRACT

In the 1970s macroeconomists often disagreed bitterly. Macroeconomists have now largely converged on method, model design, and macroeconomic policy advice. The disagreements that remain all stem from the practical implementation of the methodology. Some macroeconomists think that New Keynesian models are on the verge of being useful for quarter-to-quarter quantitative policy advice. We do not. We argue that the shocks in these models are dubiously structural and show that many of the features of the model as well as the implications due to these features are inconsistent with microeconomic evidence. These arguments lead us to conclude that New Keynesian models are not yet useful for policy analysis.

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Viewed from a distance modern macroeconomists, whether New Keynesian or neoclassical, are all alike, at least in the sense that we use the same methodology, work with similar models, agree on what reduced form shocks are needed to fit the data, and agree on broad principles for policy. Viewed up close, however, there is considerable disagreement. This disagreement revolves around a new set of shocks as well as a new set of features that have been introduced in the recent New Keynesian literature. In this paper we argue that these new shocks are dubiously structural and that the new features are inconsistent with microeconomic evidence. Until these issues are resolved, the New Keynesian models are not useful for policy advice.

Consider first the areas of agreement. In terms of methodology we all agree that in order do serious policy analysis, we need a structural model with primitive interpretable shocks which are invariant to the class of policy interventions being considered.

Macroeconomic models are also similar. In practice, most macroeconomists now analyze policy using dynamic stochastic general equilibrium (DSGE) models. These models can be so generally defined that they incorporate all types of frictions, including various ways of learning, incomplete markets, imperfections in markets, spatial frictions, and so on. The only practical restriction from these models is that they specify an agreed-upon language by which we communicate. A standard aphorism is that if you have a coherent story to propose, then you can do so in a suitably elaborate DSGE model.

Macroeconomists are also beginning to agree on the nature of reduced form shocks needed to fit the data. In Chari, Kehoe, and McGrattan (2007), henceforth *CKM* we argue that two reduced form shocks, which we term the *efficiency wedge* and the *labor wedge* play a central role in generating business cycle fluctuations. The efficiency wedge, at face value, looks like time-varying productivity and the labor wedge distorts the static relationship the marginal rate of substitution between consumption and labor and the marginal product of labor. A consensus appears to be emerging on the importance of these reduced form shocks over the business cycle. This emerging consensus implies that we need to develop structural models which generate these wedges from primitive interpretable shocks.

Modern macroeconomists also broadly concur on the desirable properties of monetary policy. First, the success of policy depends on policymakers' commitment. Second, interest rates and inflation rates should be kept low on average. More practically, most macroeconomists are comfortable with some form of inflation targets with well-defined escape clauses.

Disagreement stems primarily from differences in model building and assessment. One tradition, which we prefer, is to keep the model very simple, keep the number of parameters small and well-motivated by micro facts, and put up with the reality that such a model neither can nor should fit most aspects of the data. Such a model can still be very useful in clarifying how to think about policy. Typical examples are the general equilibrium models of optimal fiscal policy pioneered by Lucas and Stokey (1983) which make clear general principles, such as the optimality of smoothing distortions over time and across states. When these models are quantitatively implemented, a simple rule of thumb used to discourage the adding of free parameters is that every time a new parameter is added, some new micro evidence to discipline that parameter should be added as well.

The other tradition, typified by the work of Christiano, Eichenbaum, and Evans (2005) and Smets and Wouters (2007), emphasizes the need to fit macro aggregates well. The urge to fit these aggregates well leads researchers in this tradition to add many more features and shocks and then try to use the same old aggregate data as before to estimate the associated new parameters without the discipline of microeconomic evidence.

The main concern we have about the second tradition is that it leads to models that are not useful for policy analysis. We make this concern concrete by critiquing the recent New Keynesian literature, as typified by the model in Smets and Wouters (2007). We focus on this model because it is widely considered the state-of-the-art New Keynesian model. Indeed, a version of it is now being used at the European Central Bank to help inform policymaking.

Proponents of the New Keynesian model argue that it is promising for two reasons. It represents a detailed economy that can generate the type of wedges we see in the data from interpretable primitive shocks; and second, it has enough microfoundations that both their shocks and parameters are *structural*, in that they can reasonably be argued to be invariant to monetary policy shocks. A model with both of these features would potentially be useful for monetary policy analysis.

We disagree. We argue that these models cannot generate the type of wedges we see in the data from interpretable primitive shocks. And it is doubtful that many of the features added on in the quantitative implementation of the models are structural. Hence, the models are not yet useful for policy analysis.

The Smets-Wouters model has seven exogenous random variables. We divide these into two groups. The *potentially structural shocks* group includes shocks to total factor productivity, investment-specific technology, and monetary policy. The *dubiously structural shocks* group includes shocks to wage markups, price markups, exogenous spending, and risk premia.

Consider, for example, the wage-markup shock. This shock is modeled as arising from fluctuations in the elasticity of substitution across different types of labor. We argue that this interpretation makes little sense. When we express this shock in units of a markup it has a mean of 50% and a standard deviation of over 2,500%. Clearly, this level of volatility is patently absurd when it is interpreted as reflecting variations in the the elasticity of substitution between carpenters, plumbers, neurosurgeons and the like.

We show that introducing the two markup shocks amounts to mechanically sticking in a labor wedge into the model. We thus argue that these shocks are not structural and search for other interpretations. We show that these shocks are equally as interpretable as fluctuations in the bargaining power of unions or fluctuations in the value of leisure of consumers. We show that policy implications vary drastically depending on what interpretation is adopted. Furthermore, either interpretation seems strained. In the bargaining power view, a contagious attack of greediness among workers leads them to demand higher wages. In general equilibrium, this attempt is frustrated, and these workers simply bid themselves out of jobs. In the fluctuating value of leisure view, a contagious attack of laziness among workers leads them all to take vacations by quitting, thus causing the economic downturn. Many macroeconomists will find either interpretation uninteresting and hence will find the model not an attractive guide for policy.

The exogenous spending (or government spending) shock is also not structural. This shock has little to do with actual government spending since it has 3.5 times the variance of measured government spending in the data. Rather it is defined residually from the national income identity and includes variables such as net exports which are clearly not invariant to monetary policy. The risk premium shock is both enormous (it has 6 times the variance of short term nominal rates) and has little interpretation as it stands. We argue that it is best interpreted as a flight to quality shock that affects the attractiveness of short term government debt relative to other assets. Such a shock is unlikely to be invariant to monetary policy.

We then turn to two other structurally dubious features: backward indexation and the common specification of the Taylor rule. We argue that they are both inconsistent with the data. Consider the backward indexation of prices. This feature is a mechanical way for the model to match the persistence of inflation. We show that this feature is flatly inconsistent with the micro data on prices. Consider next the Taylor rule, which is a specification of how the Federal Reserve sets the short-term nominal rate as a function of what it observes. We argue that the Smets-Wouters specification, which follows a long tradition in assuming the short rate is stationary and ergodic, is incapable of generating anything close to the observed behavior of the long-term nominal rate. Since the behavior of the long-term rate reflects in an important way how the policy instrument, the short rate, affects the real side of the economy, misspecifying this relationship leads to a very inaccurate assessment of policy.

We argue that the last two problems, the backward indexation and the dubious specification of Fed policy, may be linked. Once we specify the Fed's policy as having a random walk–like component, the resulting model can fit the aggregates without the structurally dubious backward indexation. (See Cogley and Sbordone 2005.) In particular, the persistence of inflation seen in the data naturally follows from the persistence of policy, instead of having to be tacked on to the model in a mechanical way. To see why getting the true structure correct is critical for policy, consider the costs of an abrupt disinflation. With backwardly indexed prices, these costs are huge; without them, the costs are tiny. Thus even though tacking on mechanical, structurally dubious features can improve a model's fit doing so may render it useless for policy analysis.

So far we have argued that the New Keynesian model is not useful for policy analysis. Nonetheless, we have argued that the neoclassical economists and New Keynesian economists broadly concur in their policy recommendations. How can this be?

To answer this question we need some historical perspective. The major conflicts in terms of macro policy in the postwar era was between the Old Keynesians and the neoclassical economists. The *Old Keynesian* view is eloquently and forcefully summarized by Modigliani (1977, p. 1), who argues that the fundamental practical policy implication that Old Keynesians agree on is that the private economy "*needs* to be stabilized, *can* be stabilized, and therefore *should* be stabilized by appropriate monetary and fiscal policies." The neoclassical economists recommended very different policy: commitment to low average inflation rates on the monetary side and tax smoothing on the fiscal side. Moreover, neoclassical economists argued that even efficient allocations could fluctuate sizably.

What seems not to be sufficiently appreciated in the profession is that even though the New Keynesian model has many of the elements of the Old Keynesian stories, such as sticky prices, the policy implications are drastically different from the Old Keynesian recommendations and remarkably close to those of the neoclassical economists. We illustrate this argument with the work of Correia, Nicolini, and Teles (2008) who show that given a sufficiently rich set of instruments, optimal policy in a sticky price model is exactly the same as it is in a flexible price neoclassical model.

How did this convergence in policy recommendations of New Keynesians and neoclassicals happen? Three considerations drive us to the view that the main convergence was from the Old Keynesian view to the New Keynesian view, which turns out to be very close to where the neoclassical view has been all along. First, since modern macroeconomists use equilibrium models with forward-looking private agents, a commitment to rules is essential for good economic performance. Second, even in the frictionless version of all modern models, efficient allocations fluctuate sizably. In this sense, even under optimal policy, the model will display sizable business cycle fluctuations, and eliminating all of these fluctuations is bad policy. Third, New Keynesian models typically incorporate sticky prices or wages, and optimal monetary policy in such models typically keeps inflation low and stable in order to avoid sectoral misallocations.

1. Setting up our Critique

Here we use CKM's framework of *business cycle accounting* to make two points that set up our critique of the New Keynesian model. First, we show that a particular shock, referred to as the *labor wedge* plays a central role over the business cycle especially in accounting for employment fluctuations. Second, we show that the precise sense in which the labor wedge is a reduced form shock by showing that two structural models with very different policy implications are consistent with the same labor wedge.

In our critique below we argue that the wage markup shock in the New Keynesian model is essentially the labor wedge in our accounting framework. As such, not surprisingly it plays an important role in accounting for employment. We argue that it is no more structural than the labor wedge. Hence, the New Keynesian model is not useful for policy analysis. We show that similar arguments apply to many of the other shocks in the New Keynesian model.

A. Reduced Form Versus Structural Shocks

We begin by clarifying the distinction between reduced form and structural shocks. This distinction is critical in policy analysis. The reason is that in order to do policy analysis, we need to predict the consequences of changes in policy both for outcomes of the standard economic variables and for welfare. Such a prediction is possible only with a structural model. Specifically, a structural model must have two ingredients. First, the relevant elements of the model—including the shocks—must be invariant with respect to the policy interventions considered. Second, the shocks must be interpretable, so that we know whether they are what could be thought of as "good shocks" that policy should accommodate or "bad shocks" that policy should offset. Shocks which have both of these properties are referred to as *structural shocks* and ones that do not are referred to as *reduced-form shocks.*

CKM argued that a simple business cycle model augmented with several reduced form shocks, referred to as wedges, could account for much of the observed movements in macroeconomic aggregates in the data. In particular, one shock, referred to as the *labor wedge* plays a central role in accounting for employment in the data. CKM showed that such a model with these reduced form shocks could account for much of the movements in economic aggregates. While CKM argues that understanding which reduced form shocks are needed to fit the data can be very useful in determining which classes of structural models are promising, by itself such a model is useless for policy analysis.

B. A Growth Model With Reduced Form Shocks

We begin with a prototype growth model which is a standard business cycle model with four reduced form shocks, referred to as *wedges:* the *efficiency wedge* A_t, the *labor wedge* $1 - \tau_{lt}$, the *investment wedge* $1/(1+\tau_{xt})$, and the *government consumption wedge* g_t.

In this economy, consumers maximize expected utility over per capita consumption c_t and per capita labor l_t,

$$E_0 \sum_{t=0}^{\infty} \beta^t U\big(c_t, 1 - l_t\big),$$

subject to the budget constraint

$$c_t + (1+\tau_{xt})\, x_t = (1-\tau_{lt})\, w_t l_t + r_t k_t + T_t$$

and the capital accumulation law

$$(1) \qquad k_{t+1} = (1-\delta) k_t + x_t,$$

where k_t denotes the per capita capital stock, x_t per capita investment, w_t the wage rate, r_t the rental rate on capital, β the discount factor, δ the depreciation rate of capital, and T_t per capita lump-sum transfers. Notice that in this prototype economy, the efficiency wedge resembles a blueprint technology parameter, and the labor wedge and the investment wedge resemble tax rates on labor income and investment.

The equilibrium of this prototype economy is summarized by the resource constraint,

$$(2) \qquad c_t + x_t + g_t = y_t,$$

where y_t denotes per capita output, together with

$$(3) \qquad y_t = A_t F\big(k_t, l_t\big),$$

$$(4) \qquad \frac{U_{lt}}{U_{ct}} = (1-\tau_{lt})\, A_t F_{lt}, \text{ and}$$

$$(5) \qquad U_{ct}\,(1+\tau_{xt}) = E_t\left[\beta U_{ct+1}\{A_{t+1} F_{kt+1} + (1-\delta)(1+\tau_{xt+1})\}\right],$$

where, here and throughout, notations like U_{ct}, U_{lt}, F_{lt}, and F_{kt} denote the derivatives of the utility function and the production function with respect to their arguments.

CKM show that the efficiency and labor wedges together account for essentially all the movement in output and that the labor wedge plays a central role in accounting for the movement in labor, both for the Great Depression period and in postwar business cycles.

Here we focus on the labor wedge. To get a feel for this wedge, in Figure 1, we report on U.S. output (relative to trend) and the measured labor wedges for the Great Depression period from 1929 to 1939. We see that the underlying distortions that manifest themselves as labor wedges became substantially worse from 1929 to 1933 and stayed roughly at this level at least until 1939. In Figure 2, we plot the 1929–39 data for U.S. labor, along with the model's predictions for labor when the model includes just the labor wedge. We see that the model captures almost all of the movements in labor. (See CKM for details.)

C. Two Structural Models That Generate Labor Wedges

We briefly discuss two structural models that can give rise to the labor wedge in a prototype economy and their policy implications. The first model has government policies toward unions fluctuate. The second model has the consumer's value of leisure fluctuate.

This discussion is useful in two ways. First, it helps focus attention on particular promising models of the labor wedge. Second, it sets up our discussion of possible interpretations of the markup shock in Smets and Wouters' (2007) model and our discussion of how radically different are the policy implications under the two interpretations.

Fluctuating Government Policy Toward Unions

Consider, then, the following economy in which fluctuations in policies toward unions show up as fluctuations in labor market distortions in the an associated prototype economy with reduced form shocks. (See Cole and Ohanian (2004) for a discussion of such policies during the Great Depression.)

The technology for producing final goods from capital and a labor aggregate after a history of exogenous shocks s^t is constant returns to scale and is given by

$$(6) \qquad y(s^t) = F\big(k(s^{t-1}), l(s^t)\big),$$

where $y(s^t)$ is output of the final good, $k(s^{t-1})$ is capital, and

$$(7) \qquad l(s^t) = \left[\int_0^1 l(i, s^t)^{\frac{1}{1+\lambda}} di\right]^{1+\lambda}$$

is an aggregate of the differentiated types of labor $l(i,s^t)$. Capital is accumulated according to (1). The discounted value of profits for the final goods producer is

$$(8) \qquad \sum_{t=0}^{\infty}\sum_{s^t} q(s^t)\left[y(s^t) - x(s^t) - w(s^t)l(s^t)\right],$$

where $q(s^t)$ is the price of a unit of consumption goods at s^t in an abstract unit of account and $w(s^t)$ is the aggregate real wage at s^t. The producer's problem can be stated in two parts. First, the producer chooses sequences for capital $k(s^{t-1})$, investment $x(s^t)$, and aggregate labor $l(s^t)$ subject to (1) and (6). Second, the demand for labor of type i by the final goods producer is

$$(9) \qquad l^d(i,s^t) = \left(\frac{w(s^t)}{w(i,s^t)}\right)^{\frac{1+\lambda}{\lambda}} l(s^t),$$

where $w(s^t) \equiv \left[\int w(i,s^t)^{-\frac{1}{\lambda}}\, di\right]^{-\lambda}$ is the aggregate wage.

There is a representative union that, when setting its wage, faces a downward-sloping demand for its type of labor, given by (9). The problem of the ith union is to maximize

$$(10) \qquad \sum_{t=0}^{\infty}\sum_{s^t} \beta^t \pi(s^t)\, u\left(c(i,s^t), 1 - l(i,s^t)\right)$$

subject to the budget constraints

$$c(i,s^t) + \sum_{s_{t+1}} q(s^{t+1}|s^t) b(i,s^{t+1}) \leq w(s^t) l^d(i,s^t) + b(i,s^t) + d(s^t)$$

and the borrowing constraint $b(s^{t+1}) \geq -\bar{b}$, where $l^d(i,s^t)$ is given by (9). Here $b(i,s^t,s_{t+1})$ denotes the consumers' holdings of one-period state-contingent bonds purchased in period t and state s^t, with payoffs contingent on some particular state s_{t+1} at $t+1$, and $q(s^{t+1}|s^t)$ is the bonds' corresponding price. Clearly, $q(s^{t+1}|s^t) = q(s^{t+1})/q(s^t)$. Also, $d(s^t) = y(s^t) - x(s^t) - w(s^t)l(s^t)$ are the dividends paid by the firms. The initial conditions $b(i,s^0)$ are given and assumed to be the same for all i.

The only distorted first-order condition for this problem is

$$(11) \qquad w(i,s^t) = (1+\lambda)\frac{u_l(i,s^t)}{u_c(i,s^t)}.$$

Notice that real wages are set as a markup over the marginal rate of substitution between labor and consumption. Clearly, given the symmetry among the consumers, we know that all of them choose the same consumption, labor, bond holdings, and wages, which we denote by $c(s^t)$, $l(s^t)$, $b(s^{t+1})$, and $w(s^t)$, and the resource constraint is as in (2).

We think of government pro-competitive policy as limiting the monopoly power of unions by pressuring them to limit their anti-competitive behavior. We model the government policy as enforcing provisions that make the unions price competitively if the markups exceed, say, $\bar{\lambda}(s^t)$, where $\bar{\lambda}(s^t) \leq \lambda$. Under such a policy, then, the markup charged by unions is $\bar{\lambda}(s^t)$, so that the key distorted first-order condition is that

$$(12) \quad w(s^t) = [1 + \bar{\lambda}(s^t)] \frac{u_l(s^t)}{u_c(s^t)}.$$

We now show that this detailed economy has aggregate allocations which coincide with those in a prototype economy. In that prototype economy, the firm maximizes the present discounted value of dividends

$$(13) \quad \max \sum_{t=0}^{\infty} \sum_{s^t} q(s^t) \left[F\big(k(s^{t-1}), l(s^t)\big) - x(s^t) - w(s^t) l(s^t) \right]$$

subject to $k(s^t) = (1 - \delta) k(s^{t-1}) + x(s^t)$. Consumers maximize

$$(14) \quad \sum_{t=0}^{\infty} \sum_{s^t} \beta^t \pi(s^t)\, u\left(c(s^t), 1 - l(s^t)\right)$$

subject to

$$(15) \quad c(s^t) + \sum_{s_{t+1}} q(s^{t+1}|s^t) b(s^{t+1}) \leq [1 - \tau(s^t)] w(s^t) l(s^t) + b(s^t) + d(s^t) + T(s^t),$$

where $\tau(s^t)$ is a tax on labor income, $d(s^t) = F\big(k(s^{t-1}), l(s^t)\big) - x(s^t) - w(s^t) l(s^t)$ are dividends, and $T(s^t) = \tau(s^t) w(s^t) l(s^t)$ are lump-sum transfers . The resource constraint is as in (2). The only distorted first-order condition is that

$$(16) \quad [1 - \tau(s^t)] w(s^t) = \frac{u_l(s^t)}{u_c(s^t)}.$$

Comparing (12) and (16), we see that the following proposition immediately follows:

Proposition 1. Consider the prototype economy just described with the following stochastic process for labor wedges:

$$(17) \quad 1 - \tau(s^t) = \frac{1}{1 + \bar{\lambda}(s^t)}.$$

The equilibrium allocations and prices of this prototype economy coincide with those of the unionized economy.

Note that in this structural model the equilibrium allocations are inefficient. The optimal policy of the government is to limit the monopoly power of unions to the greatest extent possible. Crudely put, relentless union-busting is optimal.

Fluctuating Utility of Leisure

In the detailed economy, let consumers' discounted utility be of the form (14), where the period utility function is separable and of the form

$$(18)\quad u\left(c(s^t), 1-l(s^t)\right) = u(c(s^t)) + \psi(s^t)v(1-l(s^t)),$$

where $\psi(s^t)$ is an exogenous stochastic shock to the utility of leisure. The consumer maximizes utility (14) subject to the budget constraint

$$c(s^t) + \sum_{s_{t+1}} q(s^{t+1}|s^t)b(s^{t+1}) \leq w(s^t)l(s^t) + b(s^t).$$

The firm's problem here is identical to that in (13). The consumer's first-order condition for labor in this detailed economy is given by

$$(19)\quad \frac{v'(1-l(s^t))}{u'(c(s^t))} = \frac{w(s^t)}{\psi(s^t)}.$$

The associated prototype economy is nearly identical to the one described above. The consumer maximizes (14) subject to (15), where now the period utility function is of the form

$$(20)\quad u\left(c(s^t), l(s^t)\right) = u\left(c(s^t)\right) + v(1-l(s^t)\right),$$

which is the same separable form as in (18) except there is now no shock to the utility of leisure. The firm maximizes profits of the form (13). The consumer's first-order condition in this prototype economy is that

$$\frac{v'(1-l(s^t))}{u'(c(s^t))} = [1-\tau(s^t)]w(s^t).$$

The following proposition is then immediate:

Proposition 2. Consider the prototype economy just described with the following stochastic process for labor wedges:

$$(21)\quad 1-\tau(s^t) = \frac{1}{\psi(s^t)}.$$

The equilibrium allocations and prices of this prototype economy coincide with those of the detailed economy with a fluctuating value of leisure.

The policy implications for this structural model are simple: the equilibrium allocations are efficient so laissez-faire is optimal.

In sum, even though the union model and the leisure model generate the same observations as the prototype model with reduced form shocks, the models have drastically different policy implications.

2. Our Critique of New Keynesian Models

In our view the New Keynesian model is not very much different from the prototype growth model with reduced form shocks described above. From this perspective it is equally useless for policy analysis.

As we have noted we have divided the seven exogenous random variables in the Smets-Wouters model into two groups. The potentially structural shocks group includes total factor productivity, investment-specific technology, and monetary policy. The dubiously structural shocks group includes wage markups, price markups, exogenous spending, and risk premia.

A. The Dubiously Structural Shocks

We begin by showing that the dubiously structural shocks play an important role in the New Keynesian model. We then discuss why these shocks are difficult to interpret as structural.

Importance of the Dubiously Structural Shocks

Using the estimated Smets-Wouters model, we can back out a predicted time series for aggregate variables for any combination of the stochastic shocks. In Figures 3A, 3B, and 3C we plot actual (logged-detrended) output, hours, and inflation for the U.S. economy and the predicted values of the variables from the Smets and Wouters model with just the dubiously structural shocks[1]. These figures show that the dubiously structural shocks account for a sizable fraction of the movements in output, most of the movements in labor, and virtually

[1] Labor in the U.S. data is measured as total hours worked per person in the nonfarm business sector multiplied by the total number of civilians employed (workers aged age 16 years and older).

all of the movements in inflation.

In Table 1 we report the variance decomposition of forecast errors at horizons of 4 quarters, 10 quarters, and the unconditional variance decomposition for output, labor, and inflation. We also report the sum of the variances due to the four dubiously structural shocks. This table confirms the visual impression of the figures. For example, at a horizon of 10 quarters the forecast error variance for output, hours, and inflation due to the dubiously structural shocks are about 44%, 69%, and 87% respectively.

The Dubiousness of the Dubiously Structural Shocks

Given that the shocks to the wage-markup, price-markup, exogenous spending, and risk premia play a central role in generating fluctuations we now turn to arguing these shocks are not structural. For the wage-markup and the price-markup shocks we will argue that these are reduced form shocks in the sense that they are subject to multiple interpretations with very different policy implications. For the remaining two shocks we argue that it is doubtful that the shocks are invariant with respect to policy.

The Wage-Markup Shock—A Fancy Name for a Labor Wedge? In the Smets-Wouters model, one shock, the *wage-markup shock*, accounts for a significant fraction of the fluctuations in aggregates, especially labor. This shock appears as an additive shock in a linearized wage equation that relates current wages to past and expected future wages. We argue that this shock is a dubiously structural reduced-form shock that mechanically plays exactly the same role as our labor wedge. In this sense this shock can be interpreted in at least two ways: either fluctuations in workers' bargaining power or shocks to leisure. As we have argued above, these interpretations have radically different implications for policy. Obviously, then, until we have concrete microevidence in favor of at least one of these interpretations, the New Keynesian model should not be used for policy analysis.

The additive shock to the linearized wage equation in the Smets-Wouters model is motivated as coming from shocks to the labor aggregator. This labor aggregator relates aggregate labor l_t to a continuum of differentiated types of labor services $l_t(i)$ according to

$$(22) \quad 1 = \int_0^1 G\left(\frac{l_t(i)}{l_t}; \lambda_t\right) \, di,$$

where λ_t is referred to as the *wage-markup* shock. For intuition's sake, we find it useful to focus discussion on a special case of this aggregator, the *constant-elasticity of substitution* case explored by Smets and Wouters (2003), in which $G(l_t(i)/l_t; \lambda_t) = (l_t(i)/l_t)^{\frac{1}{1+\lambda_t}}$, so that

$$(23) \quad l_t = \left[\int_0^1 l_t(i)^{\frac{1}{1+\lambda_t}} di \right]^{1+\lambda_t}.$$

Clearly, making λ_t stochastic is just a simple way to make stochastic the elasticity of substitution between different types of labor in the labor aggregator (23), namely, $(1+\lambda_t)/\lambda_t$.

Given our business cycle accounting analysis, we are not surprised that this wage-markup shock plays a important role in generating fluctuations. We argue that this shock is equivalent to a labor wedge. To see this equivalence, consider a stripped down flexible-wage version of the Smets-Wouters model with period utility function $u(c_t, 1-l_t)$. Here, as in our union interpretation above, think of consumers as being organized into unions, so that the ith union consists of all consumers with labor of type i. The first-order condition for union i is to set the nominal wage for that type of labor $W_t(i)$ so that the corresponding real wage $w_t(i) = W_t(i)/P_t$ satisfies $w_t(i) = (1+\lambda_t)u_{lt}/u_{ct}$. Since all unions are symmetric, $w_t(i)$ equals the aggregate real wage w_t. This model therefore implies that

$$(24) \quad w_t = (1+\lambda_t)\frac{u_{lt}}{u_{ct}}.$$

(If we also abstract from sticky prices and monopoly power by firms, both of which play a quantitatively minor role in generating fluctuations in labor in the Smets-Wouters model, we have that the real wage equals the marginal product of labor.)

Now compare the wedge between the real wage and the marginal utility of leisure in (24) to the corresponding wedges in the two models described earlier and characterized by equations (17) and (21) of Propositions 1 and 2. Clearly, all the wage-markup shock λ_t does is generate a labor wedge in the model. In this sense, adding this shock is completely equivalent to mechanically sticking into the model an exogenous labor wedge, as we did in the prototype model.

We have already argued that the wedges identified in business cycle accounting cannot, by themselves, be used for policy analysis. Can the wage-markup shock? Consider a literal interpretation in which the wage-markup shock consists of fluctuations in the elasticity of substitution for different types of labor. To help with interpretation of units, we consider the constant-elasticity of substitution case with the labor aggregates given by (23). We re-estimated the Smets-Wouters model for this case after imposing, as Smets-Wouters did, that the mean markup was 50%. We found that the standard deviation of the markup was absurdly large, 2,587%. In the Smets-Wouters model, fluctuations in λ_t, taken literally, correspond to fluctuations in the elasticity of substitution $\big((1+\lambda_t)/\lambda_t\big)$ between carpenters, plumbers, neurosurgeons, and the like. We take it as a given that everyone, including Smets and Wouters, would regard these fluctuations as being several orders of magnitude outside of a reasonable range. Hence, a literal interpretation of the wage-markup shock is not palatable. We view it instead as a reduced-form shock that stands in for some deeper shocks.

Since the wage-markup shock accounts for much of the fluctuations in labor and inflation the Smets-Wouters model cannot be used for policy analysis until we take a stand on the deeper shocks that it represents. Specifically, we need to argue that the shock is invariant to monetary policy. Furthermore, this shock must be interpretable enough so that we know whether it is a "bad shock," which policy should seek to offset, or a "good shock," which policy should seek to accommodate.

We turn now to two interpretations of the wage-markup shock.

Bargaining Power of Unions One possible interpretation of the wage-markup shock is that it represents the bargaining power of unions, in particular, and labor, more generally. What gives rise to the shock's fluctuations and are these shocks invariant to monetary policy? Those questions, of course, are impossible to answer given how reduced-form the model. We tend to doubt, however, that they are invariant to policy. Presumably, though, advocates of this view see the bargaining power of unions relative to firms as related to the outside opportunities of the union members and firms. The whole point of a monetary policy intervention is to affect the real side of the economy and thus to change these opportunities. So this interpretation fails the policy-invariant requirement.

For argument's sake, however, suppose we do view these shocks as standing in for fluctuations in bargaining power and invariant to monetary policy interventions. The question then is, do we end up with a view of business cycles that most macroeconomists would find appealing? Under this interpretation, fluctuations in the bargaining power of workers lead them to become discontented at working at their current wages and to try to bid wages up. If workers are unsuccessful at bidding up their wages, they quit (so as to satisfy (24)), and if they are successful, the firm lays them off. Of course, if the model is to be consistent with the fact that wages are not countercyclical in the data, then what must be happening is that workers attempt to bid up their wages, fail to do so, become discontent, and quit. Hence, in equilibrium, the workers' greediness for higher wages simply leads to a fall in both their real income and their utility.

Under this interpretation, fluctuations in this shock are "bad," and the government should use all of its powers to offset their real effects on the economy. Indeed, the general principle here is that policy should be set so as to replicate the efficient equilibrium in which there is no monopoly power by workers and no sticky wages. In this efficient equilibrium, all variables, including labor, are at their efficient levels. Since most of the movements in labor are driven by this wage-markup shock, it will not be volatile. Monetary policy, which is a very poor tool for offsetting these shocks, should balance the benefits of keeping nominal wages constant against the other costs in the model of doing so.

Of course, if one actually believes that this type of shock drives the business cycle, then there is a much more powerful and effective policy to combat them: the government should crack down on unions very hard at the first hint of recession. Such a policy, which would be of the form that led to (12), would effectively eliminate business cycles in the U.S. economy.

Is this a palatable story of business cycles? We find it far-fetched to think that most New Keynesians would agree either that this is sensible policy or that it could eliminate most of the business cycle movement in labor. If, somehow, New Keynesians believe that worker greediness is responsible for recessions, then they should support this view with some detailed microeconomic evidence. For example, what fraction of the labor's fall in the recession can be accounted for by strikes?

The Value of Leisure An alternative interpretation of the wage-markup shock is that it simply reflects consumers' utility of leisure along the lines discussed above. This interpretation of the shocks turns out to lead to an observationally equivalent economy in terms of aggregates to the one just discussed, but with vastly different policy implications. Thus, without more to go on than aggregate data, the policy implications of the New Keynesian model cannot even be pinned down. This finding is troubling to say the least.

To get some intuition for this observational equivalence result, consider an economy with a utility function of the form (18). Comparing (19) and (24), we see that in an economy in which the coefficient on leisure is given by

$$\psi(s^t) = 1 + \lambda(s^t), \tag{25}$$

which has no distortions or monopoly power, the first-order condition for leisure will be equivalent to those in a stripped down flexible price version of the Smets-Wouters model with the fluctuations in monopoly power that gave rise to (24).

The Smets-Wouters model is actually more complicated than the stripped-down version because with the Calvo-type way of making wages sticky, wages are set as a markup over a present value of the marginal utility of leisure. But the equivalence between fluctuations in the value of leisure and fluctuations in monopoly power holds even in this setting. Indeed, as Smets and Wouters (2003, 2007) argue, in the log-linearized model they use in estimation, it is impossible to identify whether their wage-markup shocks are really shocks to the elasticity of substitution in the labor aggregator, as in (23), or shocks to leisure, as in (18).

Note that the policy implications of interpreting the wage-markup shock as fluctuations in leisure are radically different than those of the bargaining power interpretation. Under the leisure interpretation, fluctuations in the shock are "good," and the Fed should accommodate them. But this interpretation of the shock in the New Keynesian model has serious issues. To get a feel for these issues quantitatively, we followed Smets and Wouters (2003) and allowed for an AR(1) taste shock and an i.i.d markup shock (as did Levin et al. (2006)). We refer to this model as the *taste-shock* version of the Smets and Wouters model. In Figure 4, we plot the potential and actual output from 1965 to 2005 from the taste-shock version of the Smets-Wouters model estimated for the United States.

We see that in the period from 1979 to 1984, the United States went through two recessions that many economists attributed in good part to the Fed's actions aimed at reducing inflation. The figure shows that as output fell, so did output in the efficient equilibrium.

Indeed, in much of the early 1980s, the efficient output level was lower than the observed output level.

In short, are the New Keynesians willing to accept their model's implication that the driving force behind the postwar recessions is that, in Modigliani's (1977) terminology, workers suffered contagious attacks of laziness? Are they willing to accept their model's implication that the recessions between 1979 and 1984 had almost nothing to do with monetary policy? Do they accept their model's implication that the Fed should have tightened even more during recessions because its actual monetary policy discouraged workers from taking the even longer vacations from working that they desired?[2]

In sum, we have difficulties with both interpretations of the key shock in the New Keynesian model and the associated policy recommendations. Presumably, the New Keynesians do as well.

Dubious Other Shocks So far we have argued that wage markups are dubiously structural. Similar concerns apply to price markups. We now argue that also dubiously structural are the exogenous spending shocks and the risk premium shocks also added to help New Keynesian models fit the data.

Consider first the exogenous spending shocks. These shocks are referred to by Smets and Wouters as either "exogenous spending" or "government spending shocks." Unfortunately, the resulting shocks have little to do with measured government spending. For example, the variance of the Smets and Wouters exogenous spending shock is 3.5 times the variance of measured government spending in the data. The reason is that in the Smets-Wouters empirical implementation, these shocks are residually defined from the national income identity and include, among other variables, net exports. Variables like net exports are not likely to be structural with respect to monetary policy.

Consider next the risk premium shocks. (By the way, we find the term *risk premium shocks* exceptionally confusing because the Smets-Wouters model has no risk premium.) These shocks enter the consumer's first-order condition for government debt, but not the first-order condition for accumulating capital. In this sense, these shocks resemble

[2] Walsh (2006) expresses similar skepticism about this version of the New Keynesian model.

(unobserved) time-varying taxes on short-term nominal government debt (relative to taxes on capital income). In the Smets-Wouters model, these shocks are enormous.

In Figure 5 we plot the short term nominal interest rate and the risk premium shocks from the Smets and Wouter (2007) model[3]. Note that the risk premium shocks are dramatically more variable than short term nominal interest rates. The variance of the risk premium shocks is more than 6 times the variance of the short term nominal rates.

The only sensible economic interpretation that we can give to these shocks is that they are meant to capture financial market episodes when there is a "flight to quality" in the sense that consumers' preference for holding government debt increases abruptly. Unfortunately for the Smets-Wouters model, under this interpretation, these shocks are hardly likely to be structural with respect to monetary policy.

B. Other Structurally Dubious Features

So far we have focused on issues with the shocks in the New Keynesian models. The model also has other features that are arguably nonstructural. Here we focus on two related features: the backward indexation mechanism for generating persistent inflation and the modeling of the Fed's policy function.

A Dubious Mechanism for Generating Persistent Inflation

Consider next another feature of the New Keynesian model that has important implications for policy but has only a dubious structural interpretation.

Several researchers, including Fuhrer (1996) and Mankiw (2001), have pointed out that the simple New Keynesian models, even with Calvo price- and wage-setting, cannot generate persistent inflation. Motivated by some VAR evidence showing that inflation is persistent, Christiano, Eichenbaum, and Vigfusson (2004) have shown that by adding backward indexation of prices, the New Keynesian model can generate persistence in inflation.

Smets and Wouters (2003, 2007), building on the work of Christiano, Eichenbaum, and

[3] To be precise equation 2 in Smets and Wouters (2007) is the log-linearized consumption Euler equation

$$c_t = c_1 c_{t-1} + (1 - c_1) E_t c_{t+1} + c_2 (l_t - E_t l_{t+1}) - c_3 (r_t - E_t \pi_{t+1} + \varepsilon_t^b).$$

In Figure 5 we plot r_t and ε_t^b.

Vigfusson, incorporate this feature into their models. Specifically, Christiano, Eichenbaum, and Vigfusson assume that even those firms that are not allowed to freely adjust their prices at t, mechanically adjust them to lagged inflation, so that the price p_{jt} charged by a non-adjusting firm j in time period t equals

$$p_{jt} = \pi_{t-1} p_{jt-1}, \tag{26}$$

where p_{jt-1} is this firm's price in $t-1$ and π_{t-1} is the rate of gross inflation of the aggregate price level between periods $t-1$ and t. Smets and Wouters (2003, 2007) assume something similar, except they allow for only partial indexation.

The problem with this assumption is that it is counterfactual. We know this thanks to the work of Bils and Klenow (2004), Midrigan (2006), Golosov and Lucas (2007), Nakamura and Steinsson (2007), and others. Their evidence on price behavior at the micro level strongly suggests that the backward price indexing assumption is greatly at odds with the data.

It is easiest to see this point in a concrete example from the data. To that end, consider the actual prices charged for a particular product in scanner data from a grocery store. In Figure 6, we plot the price charged for a package of Angel Soft Bathroom tissue at Dominick's Finer Food retail store in Chicago along with what the price would look like if it were backward-indexed along the lines of (26) as is assumed by Christiano, Eichenbaum, and Evans (2005). Clearly, the path of the actual price does not look like that assumed. We have picked a particular series to illustrate our point but we could have shown literally thousands more that look similar.

More generally, the key statistics reported in the budding literature on the properties of individual prices are the average number of months before the price is changed. Bils and Klenow (2004) report that number to be on the order of four months, while Nakamura and Steinsson (2007) use a different procedure and report a number on the order of eleven months. Note that the New Keynesian model's predictions with backward indexation are simply inconsistent with the micro data. If we used either Bils and Klenow's algorithm or Nakamura and Steinsson's algorithm on prices generated from the New Keynesian models, we would find that prices changed every single period.

There seems to be some confusion on this point in the literature that uses the backward indexation assumption. When, for example, Bils and Klenow report that the average time between price changes is four months they are not providing an estimate of the Calvo probability of changing a price in a economy which, because of backward indexation, all prices change in every period. Rather Bils and Klenow's numbers imply that to be consistent with the micro data the model has to have the prices be completely and utterly fixed between price changes and then on average that price changes every four months.

In short, while sticking an ad hoc backward price indexation equation of the form of (26) into a model can make the model mechanically generate persistence in inflation, the mechanism by which it does so is flatly inconsistent with the micro data.

Aside from that inconsistency, the problem with proceeding in this mechanical fashion is that the backward indexation feature shapes the policy advice from the model. In particular, as the literature has shown, the costs of disinflation in an economy with backward indexation are quite high. If the persistence of inflation is coming from another mechanism, then there may not be such high costs.

The Dubious Model of the Fed's Policy Function

The question naturally rises, is there a plausible mechanism that can generate the persistence in inflation that we see in the data in a way that is not inconsistent with the micro evidence? Yes. We argue that the persistence of inflation naturally arises from a random walk–like feature of interest rate policy that is being missed in the current model.

New Keynesian models assume that short-term nominal rates are stationary and ergodic; hence, the long-term nominal rates implied by that rule are much too smooth relative to the observed long-term nominal rates in the data. We argue that this discrepancy leads the New Keynesian models to misidentify the source of persistence in inflation, and hence, leads these models to give erroneous policy advice about the costs of disinflation.

The gist of our argument follows from two features of the data. First, as is well-known, during the postwar period, short rates and long rates have a very similar secular pattern. (For some recent work documenting this feature, see the 2008 work of Atkeson and Kehoe.) Second, a large body of work in finance has shown that the level of the long rate is well-accounted for by the expectations hypothesis. (See, for example, the 2008 work of

Cochrane and Piazzesi.) Combining these two features of the data implies that when the Fed alters the current short rate, private agents significantly adjust their long-run expectations of the future short rate, say, 30 years into the future. At an intuitive level, then, we see that Fed policy has a large random walk component to it.

When we incorporate this persistent feature of policy into a model, the model naturally delivers persistence in inflation. Indeed, as Cogley and Sbordone (2005) and Ireland (2007) show, once we allow the Fed policy function to have a random walk component, the model needs no backward indexation of prices in order to fit the data. Indeed, if we run a horserace between two models—one with a standard Taylor rule and backward indexation and one with a random walk component to interest rate policy and no backward indexation—the second model fits the data better.

Under this view of research, what happened is the following. Because the standard New Keynesian model does not adequately incorporate the random walk component of policy that the data on long rates call out for, a simple version of the model without backward indexation does not generate enough persistence in inflation. (See Collard and Dellas (2005) for a demonstration.) To get the model to generate persistence, researchers have mechanically added backward indexation of prices (and wages). The model so constructed implies that disinflation is very costly. However, if we recognize that the persistence in inflation is coming from persistence in policy, then no backward indexation is needed, and this version of the model implies rather small costs from disinflation. In this sense, trying to fix an empirical problem by adding mechanical features makes the model give the wrong answer to a basic policy question.

3. Does Price or Wage Stickiness Matter For Policy?

A widespread view is that the price and wage stickiness in New Keynesian models makes a substantial difference for the analysis of monetary policy relative to models in which prices and wages are flexible. We argue that this view is incorrect.

To see this point in the simplest and starkest possible way consider the work of Correia, Nicolini, and Teles (2008). They work out the monetary and fiscal policy implications of a sticky price models in which the government has a rich set of instruments: it can choose monetary policy as well as taxes on consumption, labor incomes, and profits. They compare the optimal monetary and fiscal policy in the sticky price version of the model–the New Keynesian version–to those of the model with flexible prices–the neoclassical version. Their main result is that optimal monetary and fiscal policy in the New Keynesian version of the model coincides exactly with the optimal policy in neoclassical version.

As we move away from the simple New Keynesian model studied by Correia, Nicolini, and Teles (2008) by restricting the set of fiscal instruments and adding more frictions the resulting optimal policy implications of sticky price models begin to differ from those of the flexible price models but perhaps by not that much. For example, Levin, Onatski, and Williams (2006) consider a version of the Smets-Wouters model with a very restricted set of instruments and find policy recommendations that are very neoclassical in flavor. Of course, as we have discussed above the details of the recommendations depend on the nature of the structural shocks, but given the shocks there seems to be little difference between the recommendations from neoclassical and New Keynesian models.

In short, then, in spite of our critique of New Keynesian models we view this movement as largely harmless to policy: the New Keynesians are now rediscovering and pushing policy recommendations very similar to those made by neoclassical economists like Lucas and Stokey (1983) made 25 years ago in their justly heralded work.

4. Conclusion

New Keynesian models are not yet useful for policy analysis. The main reason is that model builders in this tradition have added so many free parameters that the features and shocks in their models are only dubiously structural.

Changes in method can make these models potentially useful for policy analysis. The most important change in method needed is to resist the urge to add undisciplined free parameters in order to fit the same old aggregate time series. A far preferable procedure is to start with a small model, add features and shocks, one at a time, carefully disciplined by appropriate microeconomic evidence.

One example, specifically set in the context of the Smets-Wouters model, is to begin by noting that this model has large fluctuations in the cross-sectional distribution of employment, fluctuations that are inefficient. The primary job of optimal monetary policy is to reduce fluctuations in the cross-sectional distribution of employment by reducing the cross-sectional distribution of wages over the business cycle. (See Levin et al. (2006).) Given the importance of these cross-sectional distributions for shaping monetary policy, at the very minimum, researchers pursuing variants of the Smets-Wouters model should ask whether the data show significant fluctuations in these distributions as well as the links between the cross-sectional distributions of wages and employment. If the data appear promising in this regard, then these data should be used to discipline the estimation. If the data are not promising, then it is best to look elsewhere for a model.

Processes of this kind will be slow and painful, but will avoid the false promise of the Old Keynesian revolution that the profession had trustworthy tools for designing and implementing good policy.

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Figure 1. U.S. Output and The Measured Labor Wedge

Annual, Normalized to equal 100 in 1929

Source: Chari, Kehoe, and McGrattan (2007)

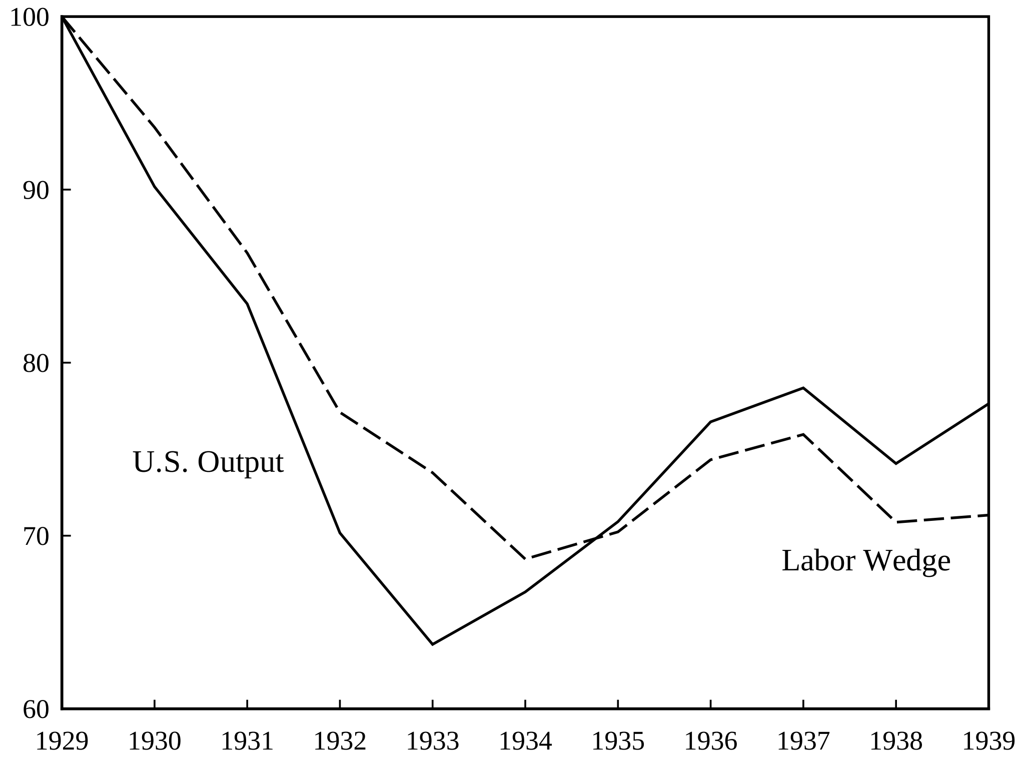


Figure 2. Data and Prediction of Model with Just Labor Wedge

Annual, Normalized to equal 100 in 1929

Source: Chari, Kehoe, and McGrattan (2007)

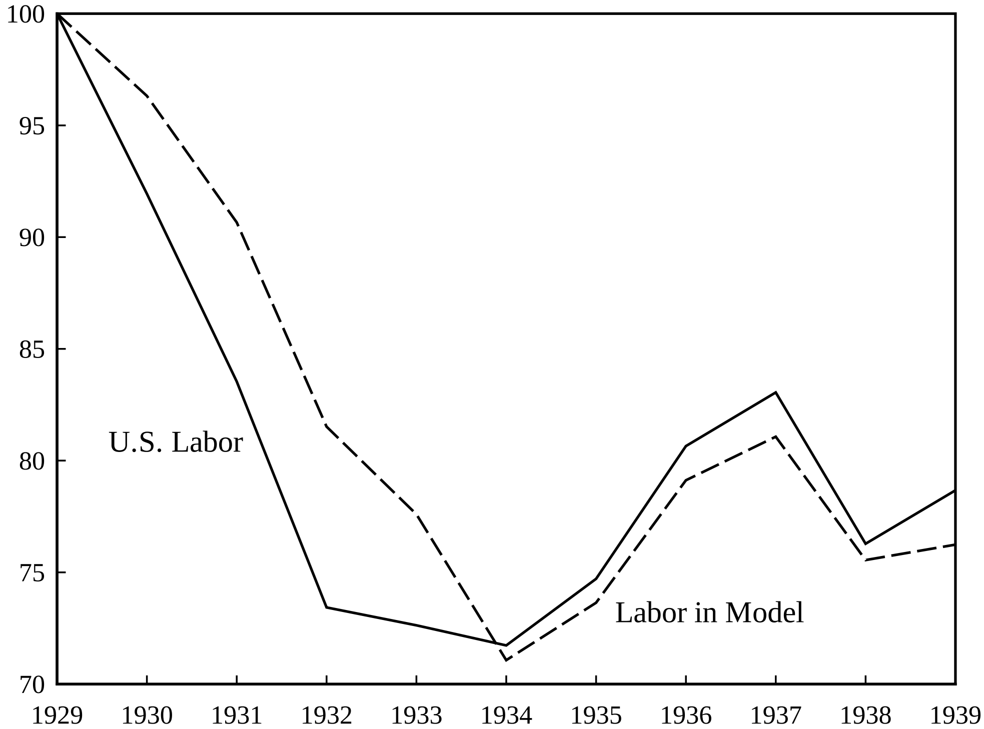
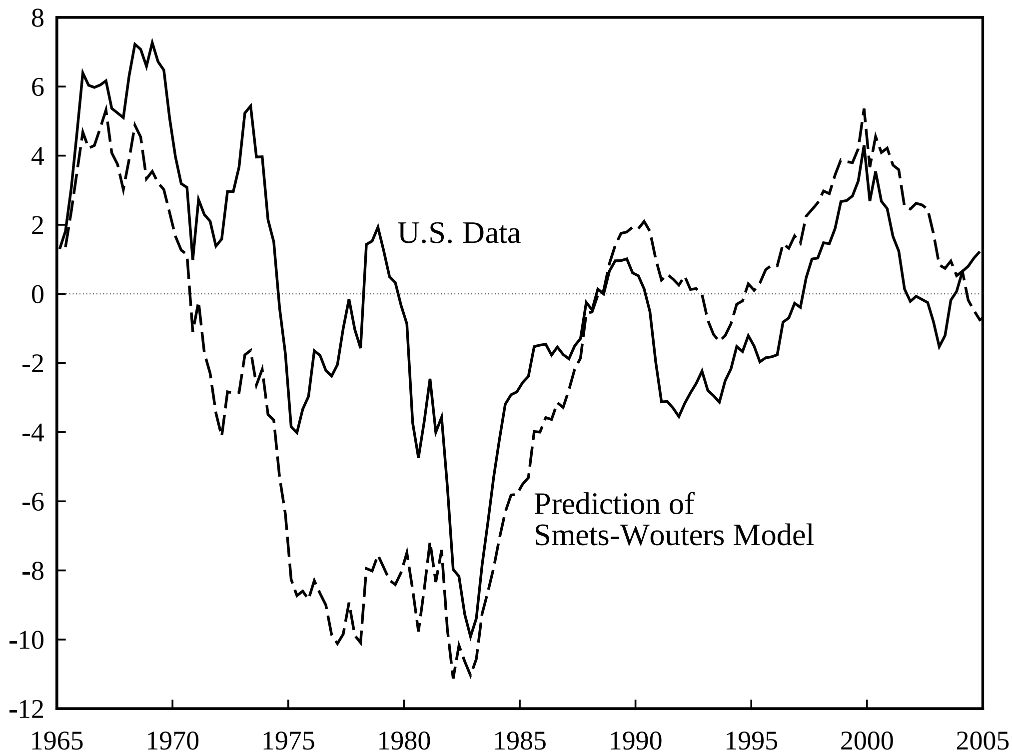
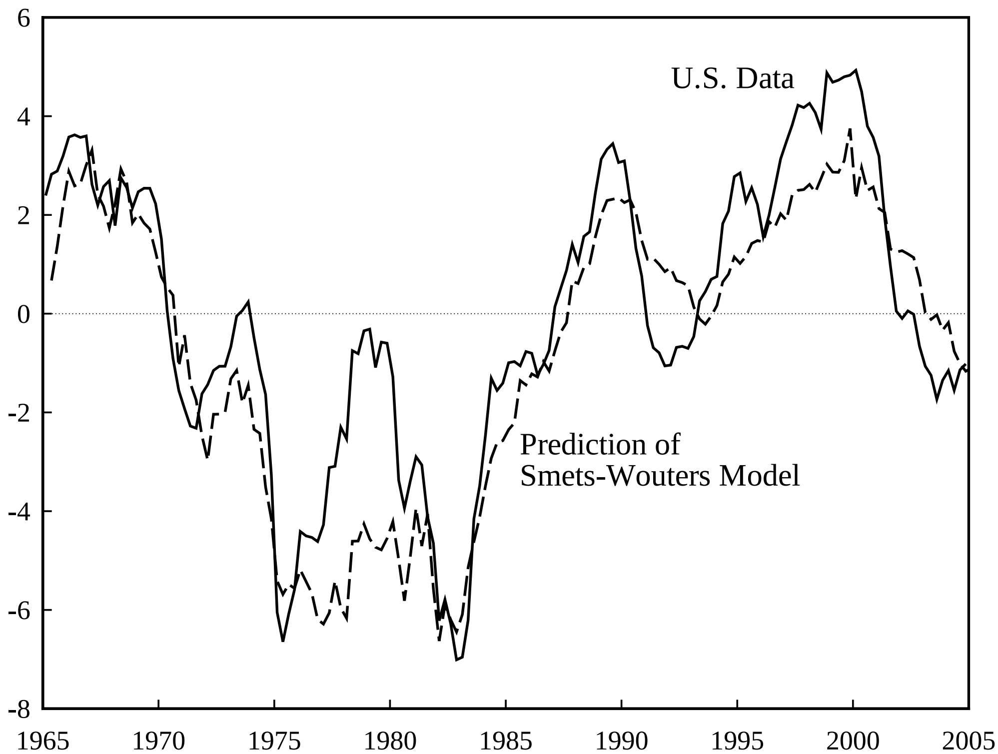


Figure 3A. Data and Output Prediction of Smets and Wouters (2007) Model with the Dubiously Structural Shocks*



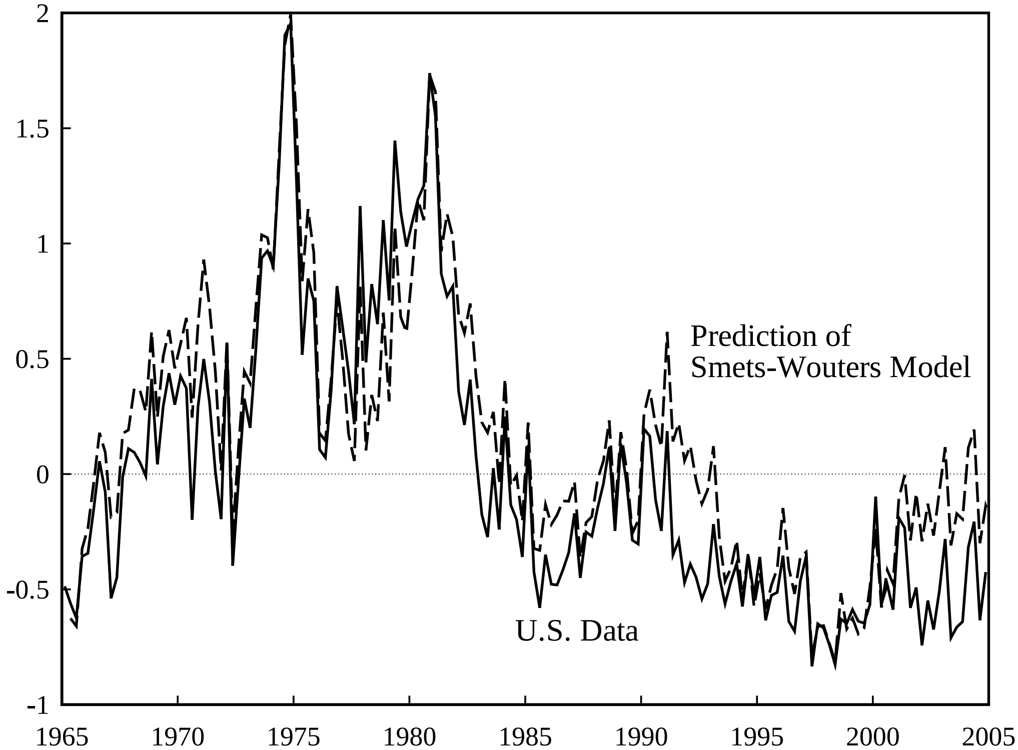
* The dubiously structural shocks include the wage markup shock, the price markup shock, the exogenous spending shock, and the risk premium shock.

Figure 3B. Data and Hours Prediction of Smets and Wouters (2007) Model with the Dubiously Structural Shocks*



* The dubiously structural shocks include the wage markup shock, the price markup shock, the exogenous spending shock, and the risk premium shock.

Figure 3C. Data and Inflation Prediction of Smets and Wouters (2007) Model with the Dubiously Structural Shocks*



* The dubiously structural shocks include the wage markup shock, the price markup shock, the exogenous spending shock, and the risk premium shock.

FIGURE 4. ACTUAL AND POTENTIAL OUTPUT IN VERSION OF SMETS-WOUTERS (2007) MODEL WITH AR(1) TASTE SHOCKS AND I.I.D. WAGE-MARKUP SHOCKS

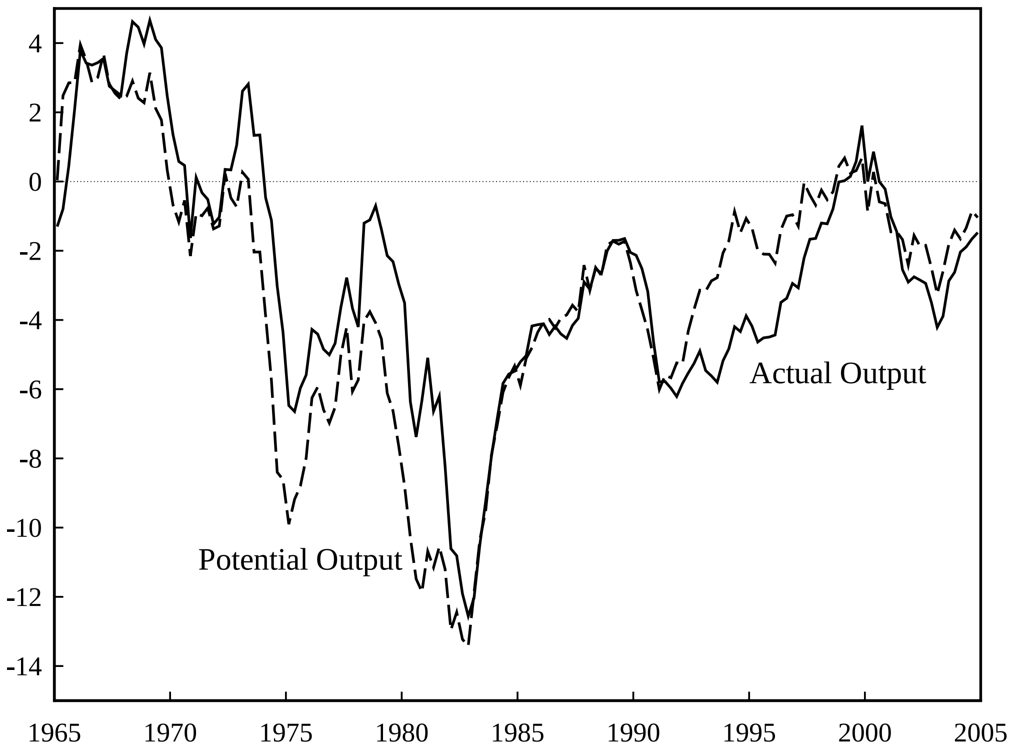


Figure 5. Annualized Interest Rate and Risk Premium Shock of the Smets-Wouters (2007) Model

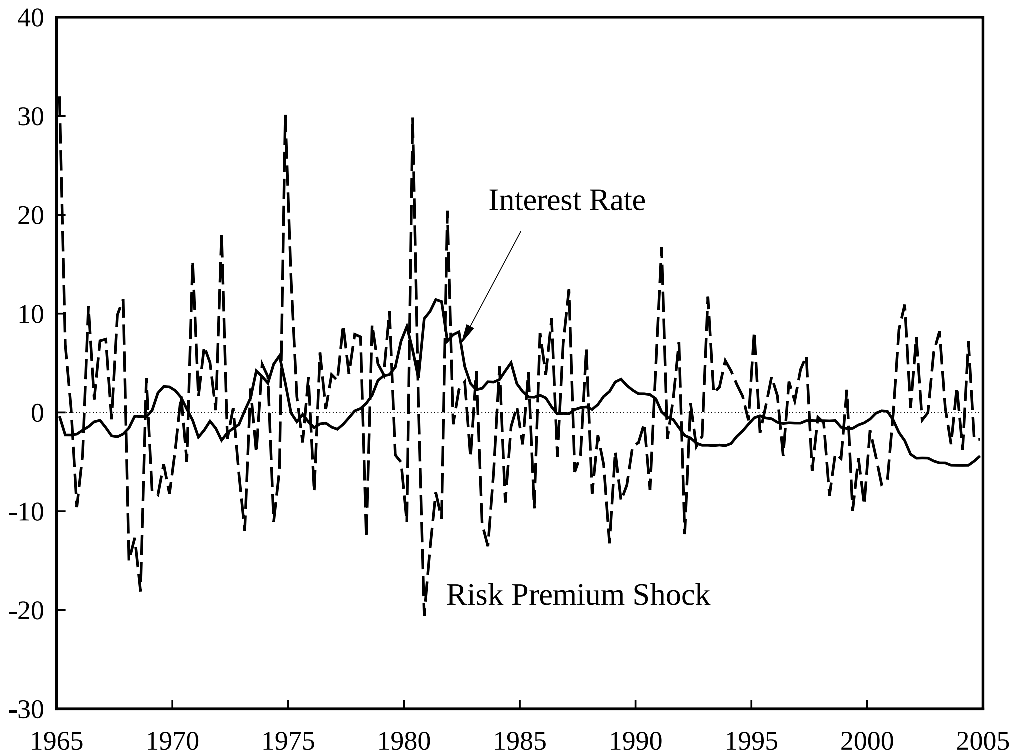


Figure 6. Price of Angel Soft Bathroom Tissue at Dominick's Finer Food and Price Implied by Backward Indexation