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Comment

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Introduction

The paper by Beaudry and Portier (BP) is motivated by two stylized facts concerning the US economy in the post-1987 period. The first empirical observation is the remarkable stability of inflation, relative to the fluctuations in economic activity. The simplest version of the New Keynesian Phillips curve (NKPC) states that the current realization of inflation depends on expected future inflation and on output deviations from its flexible-price counterpart—the so-called output gap. Based on this equation, BP interpret the stability of inflation as evidence that output fluctuations have been mainly driven by movements in flexible-price output, accompanied by monetary policy accommodation and a stable output gap.

According to the Real Business Cycle (RBC) literature, the main candidate to explain fluctuations in flexible-price output are technological innovations. However, BP discard this view, because they notice that the empirical pattern of expansions and recessions in the post-Volcker period has been essentially uncorrelated with the behavior of total factor productivity (TFP), especially the measure of TFP proposed by Fernald (2012), which controls for variable capital utilization. This observation constitutes a challenge for Real Business Cycle models.

These difficulties with the NK and the RBC views of business cycles motivates BP's search for an alternative framework, in which fluctuations in flexible-price output can be due to non-TFP shocks. Coming up with such a model is a challenging task, because a number of macroeconomic variables—such as consumption, investment, hours worked, and output—comove in the data over the business cycle. Yet, we know

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since Barro and King (1984) that non-TFP shocks cannot generate positive comovement in frictionless models with standard preferences and technologies.

To overcome the Barro and King (1984) impossibility result, BP propose to introduce two key frictions. First of all, they assume that labor is specialized and, more generally, that the factors of production are not perfectly mobile across the sectors of the economy. Second, BP assume that financial markets are incomplete, so that households cannot insure against all possible disturbances. BP argue that these two assumptions are at the core of a plausible model of business cycles, in which the gains from trade across sectors in response to demand shocks naturally produce macroeconomic comovement. Finally, the paper embeds this model in a sticky-price setting to argue that demand shocks, if accommodated, generate little inflation, as in the data.

As should be clear from my brief description of the motivation, this is an ambitious paper. At this point, the analysis is entirely qualitative and it is unclear whether this model will ultimately be quantitatively and empirically successful. If so, it clearly has the potential to change our views about the sources of business cycles and macroeconomic comovement.

My remarks will focus on two issues regarding the premise and the main conclusion of the paper. First of all, I will dig into the evidence of the apparent disconnect between fluctuations of real activity and inflation, which is a crucial starting point of the paper. I will argue that the empirical evidence is easier to reconcile with available models than suggested by BP. However, some discrepancies between existing models and data remain also according to my calculations. These discrepancies are most pronounced in the late 1990s and during the latest recession. Therefore, in the second part of my discussion, I will evaluate the main claim of the paper, that is, that these discrepancies—the "noninflationary demand-driven business cycles"—are easiest to explain if one moves away from the representative agent framework. In this respect, I will point out that the class of models proposed by BP inherits from the NK literature the dependence of inflation on real marginal costs. Therefore, the BP model is also likely to have similar implications for the behavior of inflation, especially if we require the model to be consistent with empirical proxies of real marginal costs. An alternative avenue to explain the discrepancies between predicted and actual inflation would be to alter the relationship between inflation and marginal costs.

A Reassessment of the Inflation-GDP Disconnect

In the first part of my discussion, I will dig deeper into the main motivational evidence of the paper—that is, the fact that inflation has been very stable relative to real activity post-1987—from the perspective of conventional models. BP base this claim on the simplest version of the log-linearized NKPC, given by

$$\pi_t = \beta E_t \pi_{t+1} + \kappa \tilde{y}_t, \tag{1}$$

where π_t denotes the net rate of inflation, $\tilde{y}_t$ is the output gap (log-deviations of output from its flexible-price or natural level), and β and κ are constant coefficients. Assuming that the output gap follows an AR(1) process with autoregressive parameter ρ, it is easy to show that (1) implies

$$\pi_t = \frac{\kappa}{1 - \beta\rho} \tilde{y}_t. \tag{2}$$

BP use HP-filtered GDP as a proxy for the output gap, estimate ρ using data, and calibrate κ and β following Galí (2008). Figure 2 in their paper plots the inflation rate implied by the equation (2.2), which is substantially more volatile than actual inflation. Observe that this conclusion is key to the paper. In fact, if we were to find that observed inflation is consistent with the implications of the NKPC, then we would not need any "noninflationary" demand shocks, but the traditional shocks that drive output away from potential would work just fine. For future reference, I reproduce their plot in figure C1. The only difference in my figure is that I compare the predictions of the model to the percentage change in the GDP deflator, as opposed to core CPI.

There are a number of limitations in the strategy adopted by BP to argue that predicted inflation is much more volatile than actual. First of all, a vast literature has emphasized that various sources of strategic complementarity in price setting can substantially reduce the slope of the NKPC, without the need for implausible assumptions about the frequency of price changes (e.g., Kimball 1995, Basu 1995, Woodford 2003, Carvalho 2006, Nakamura and Steinsson 2010, Altig et al. 2011). Such a reduction in the slope would easily bring the predictions of the model much closer to the empirical evidence. For this reason, I will not explore this issue further in this discussion. Instead, I will focus on some other shortcomings of the BP procedure. In particular, HP-filtered GDP is unlikely to be a good proxy for the output gap. In addition, an AR(1)

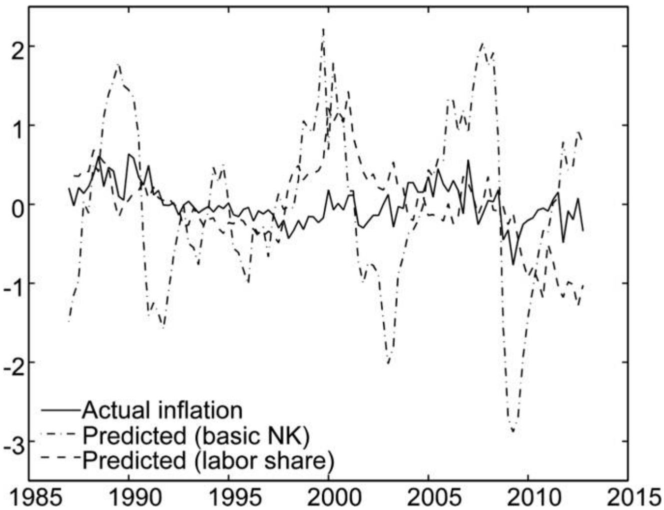

Fig. C1. Actual inflation (percentage change in the GDP deflator), and predictions of the basic NK model (summarized by equation [2]) and the model of the next subsection in which the labor share proxies for real marginal costs. All three series have been demeaned.

might be a poor forecasting model of the output gap. Finally, and most important, a large literature has pointed out that the NKPC can be written as a function of the output gap only under very strong assumptions (e.g., one-sector economies and perfectly competitive labor markets). A much more general and robust formulation of the NKPC links inflation to real marginal costs as follows:

$$\pi_t = \beta E_t \pi_{t+1} + \lambda mc_t, \qquad (3)$$

where mc_t denotes the log-deviation of real marginal costs from their steady state, and λ is a constant parameter. The intuition is straightforward: inflation results from firms' decisions to change prices in response to variations in marginal costs.

In the rest of this section, I will use two alternative approaches to address these problems and, in particular, overcome the challenge that the driving force of inflation in the NKPC are real marginal costs, and not necessarily the output gap. To begin, I will evaluate the fit of the NKPC using the labor share as a proxy of real marginal costs. In an alternative experiment, I will use data on the output gap, but map it into marginal costs using a fully specified DSGE model with sticky prices and wages. I will show that both of these experiments will bring the predictions of the model much closer to the data.

The Labor Share As a Proxy for Real Marginal Costs

Under the assumption of a Cobb-Douglas production function, real marginal costs are proportional to the labor share of income. Therefore, following Galí and Gertler (1999) and Sbordone (2002, 2005), in this subsection I use data on the labor share to proxy for marginal costs and evaluate the fit of the NKPC. Iterating equation (2.3) forward, I obtain

$$\pi_t = \lambda \sum_{j=0}^{\infty} \beta^j E_t mc_{t+j}. \tag{4}$$

I can now construct the forecasts of future marginal costs using a vector autoregression (VAR) model, as in Sbordone (2002, 2005). In particular, I estimate a VAR(2) with three variables: the logarithm of the labor share in the nonfarm business sector, the growth rate of per capita GDP, and the federal funds rate. The only complication with this strategy is the well-known fact that the US labor share has been trending down for the last twenty-five years. Addressing the causes of this interesting phenomenon is beyond the scope of this discussion. Therefore, I solve the problem by simply detrending the series with a very low-frequency filter, that is, an HP filter with coefficient equal to 10^6. Figure C2 plots the logarithm of the labor share and the trend that I am subtracting from the series.

I estimate the parameters of the VAR(2) using data from 1987:Q1, the

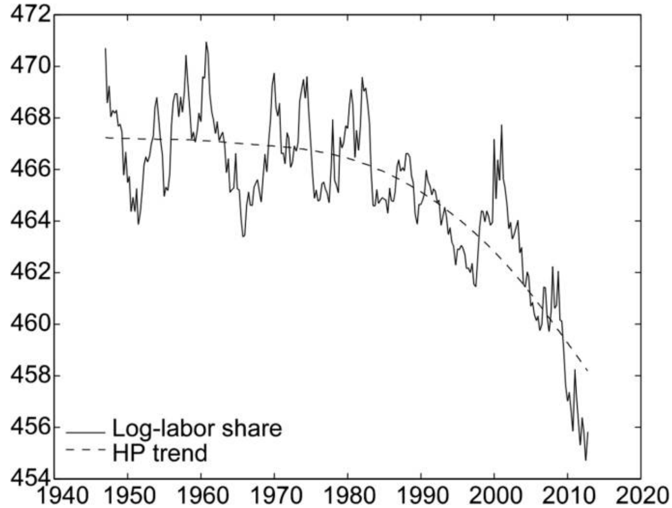

Fig. C2. Logarithm of the labor share in the nonfarm business sector (multiplied by 100) and Hodrick-Prescott trend (obtained with a coefficient equal to 10^6)

beginning of the BP sample, to 2008:Q3, the last quarter before the federal funds rate hit the zero lower bound. Conditional on the estimated VAR coefficients, I construct the forecasts $\{E_t mc_{t+j}\}_{j=0}^{\infty}$ for each t, and compute the summation in equation (2.4) using the values of β and λ recommended by Galí (2008). The outcome of this procedure is represented by the dashed line in figure 1. The model overpredicts inflation during the late 1990s, and underpredicts it during the last recession, an issue I will return to in the next section. However, relative to the assessment of BP, the implications of the NKPC seem now more in line with the data on inflation.

A Fully-Fledged DSGE Model with Price and Wage Rigidities

In this subsection, I will adopt an alternative strategy to evaluate the NKPC. As in the previous subsection, this approach will also be consistent with the basic lesson of the NK literature that real marginal costs should be a more robust predictor of inflation than the output gap. In particular, I will use data on GDP and the output gap, but translate these data into implied real marginal costs using the mapping provided by a fully-fledged DSGE model. I will then analyze the implications of the model for inflation, showing that they are not far from the data. A key feature of the model is the presence of sticky wages, which relaxes the tight link between the output gap and real marginal costs typical of the simplest version of the NK model (Woodford 2003, or Galí 2008), improving the fit of the NKPC.

The model features five classes of agents: producers of a final good, intermediate-goods producers, households, employment agencies, and a government. At every point in time, perfectly competitive firms produce the final good Y_t by combining a continuum of intermediate goods $Y_t(i)$, $i \in 0,1]$, according to the aggregator

$$Y_t = \left[\int_0^1 Y_t(i)^{(\varepsilon_p - 1)/\varepsilon_p} di\right]^{\varepsilon_p/(\varepsilon_p - 1)},$$

with constant elasticity of substitution ε_p. Each intermediate good i is produced by a monopolistically competitive firm with production function

$$Y_t(i) = A_t L_t(i)^{\alpha},$$

where $L_t(i)$ denotes the labor input for the production of good i, and A_t is a nonstationary productivity shock with a growth rate [$z_t \equiv \log(A_t/$

$A_{t-1})$] evolving according to a Gaussian AR(1) process. As in Calvo (1983), every period a fraction ξ_p of intermediate firms cannot optimally choose their price, but index it to the level of steady-state inflation.

Firms are owned by a continuum of households, indexed by $j \in$ 0,1]. Each household is a monopolistic supplier of specialized labor, $L_t(j)$, as in Erceg, Henderson, and Levin (2000). Competitive employment agencies combine this specialized labor into a homogenous labor input sold to intermediate firms, according to the aggregator

$$L_t = \left[\int_0^1 L_t(j)^{(\varepsilon_w - 1)/\varepsilon_w} dj\right]^{\varepsilon_w/(\varepsilon_w - 1)},$$

with constant elasticity of substitution ε_w.

Each household maximizes the utility function

$$E_t \sum_{s=0}^{\infty} \beta^s b_{t+s} \left[\log C_{t+s} - \varphi \frac{L_{t+s}(j)^{1+\nu}}{1+\nu}\right], \tag{5}$$

subject to the budget constraint

$$P_{t+s}C_{t+s} + T_t + B_{t+s} \leq R_{t+s-1}B_{t+s-1} + Q_{t+s-1}(j) + D_{t+s} + W_{t+s}(j)L_{t+s}(j),$$

where C_t is consumption, b_t is a Gaussian AR(1) exogenous process perturbing the stochastic discount factor, T_t are lump-sum taxes net of transfers, B_t denotes holding of government bonds, R_t is the gross nominal interest rate, D_t is the per capita profit that households get from owning the firms, and $Q_t(j)$ is the net cash flow from participating in state-contingent securities. The existence of these securities ensures that equilibrium consumption and asset holdings are the same for all households, which is why they are not indexed by j. Following Erceg, Henderson, and Levin (2000), in every period a fraction ξ_w of households cannot reoptimize their wages, but indexes them to their steady state growth rate.

The government finances its deficit by issuing short-term bonds, and sets their nominal interest rate following a Taylor type rule. In particular, the rule allows for interest rate smoothing, a systematic response to deviations of gross annual inflation from its steady state (Π), and deviations of output from its natural level (Y_t^*):

$$\frac{R_t}{R} = \left(\frac{R_{t-1}}{R}\right)^{\rho} \left[\left(\prod_{s=0}^{3} \frac{\Pi_{t-s}}{\Pi}\right)^{\phi_\pi/4} \left(\frac{Y_t}{Y_t^*}\right)^{\phi_Y}\right]^{1-\rho},$$

where R is the steady state for the gross nominal interest rate and Π_t is the quarterly gross rate of inflation.

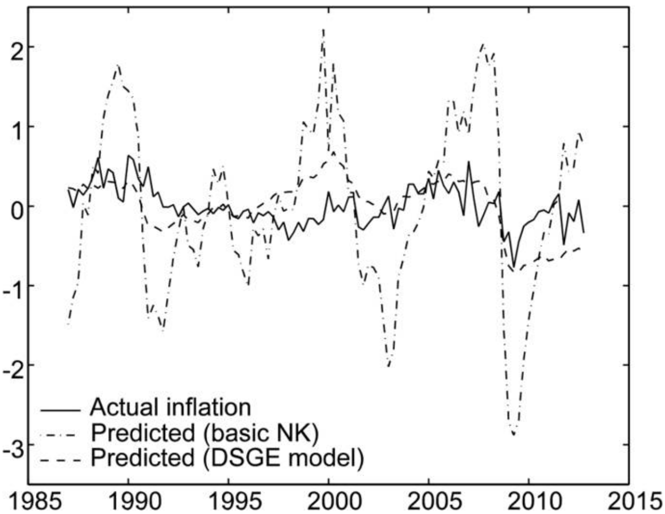

Fig. C3. Actual inflation (percentage change in the GDP deflator), and predictions of the basic NK model (summarized by equation [2]) and the DSGE model with price and wage rigidities. All three series have been demeaned.

I calibrate the model using the following parameter values: $\alpha = 0.65$, $\beta = 0.99$, $\xi_p = 2/3$, $\xi_w = 3/4$, $\varepsilon_p = \varepsilon_w = 6$, $\Pi = 1.005$, $z = 0.005$, $\rho = 0.94$, $\phi_\pi = 2.32$, and $\phi_y = 0.1375$. Most of these coefficients are identical to those of Galí (2008). The parameters of the policy rule are instead based on Campbell et al. (2012), who estimate a similar interest-rate rule on almost exactly the same sample of data.[1] Conditional on these parameter values, I compute the realization of shocks consistent with the observed time series of GDP and the output gap (defined as GDP deviations from the congressional budget office [CBO] measure of potential GDP). Given these shocks, I derive the model-implied paths of price and wage inflation, and compare them to the data.[2]

As shown in figure C3, the model fits the price-inflation data reasonably well, especially compared to the simplest NK model summarized by equation (2.2). In addition, the model predictions are similar to those I obtained in the previous subsection using the labor share as a proxy for real marginal costs. Interestingly, the fit of the model would deteriorate substantially if I counterfactually shut down wage stickiness, implicitly assuming that real marginal costs are proportional to the output gap.

To summarize, the results of this section suggest that it is important to recognize that inflation is driven by real marginal costs, and that they are generally not proportional to the output gap (Galí and Gertler 1999). Under this qualification, the NKPC provides a reasonable fit of the data. While this observation weakens the evidence of BP in favor of noninflationary demand shocks, it is still true that inflation increased less than predicted in the late 1990s, and fell less during the recent financial crisis. In the next section I will try to evaluate whether the excess stability of inflation in these two episodes might be due to noninflationary demand shocks, as suggested by BP, or to other factors.

The Main Conclusion of BP

In this section, I examine the main conclusion of BP; that is, that "noninflationary demand-driven business cycles" are easiest to explain by abandoning the representative agent framework, and by instead assuming imperfect mobility of the factors of production across sectors and incomplete insurance markets. I will argue that noninflationary business cycles—to the extent that they are a prevalent feature of the data—may remain difficult to explain, especially if we require the BP model to be consistent with available proxies of real marginal costs.

The main ingredient of the model proposed by BP is the assumption that labor is not freely mobile across the two sectors of the economy—the consumption and the investment sector. In their model, this assumption generates macroeconomic comovement in response to demand shocks, even under flexible prices. However, to obtain analytical results, BP also make a number of additional assumptions. For instance, they postulate that the production function of consumption goods is linear in capital and labor; that the production function of investment goods is linear in labor; and that prices are sticky in the consumption sector, but perfectly flexible in the investment sector. Under these other simplifying assumptions, the authors derive a Phillips curve in which inflation in the consumption sector depends on the aggregate output gap. Based on this framework, BP propose their explanation of post-1987 business cycles: they are due to demand shocks that affect potential output and are accommodated by the Fed, thus resulting in small output gaps and stable inflation.

It is important to emphasize that the existence of a Phillips curve relating inflation to the output gap is not a general implication of the BP model, but is due to some of the simplifying assumptions of the paper.

A more robust implication of the model—that only relies on the two-sector structure and the assumption of staggered price setting—is that the inflation rate in each sector depends on real marginal costs:

$$\pi_t^s = \beta E_t \pi_{t+1}^s + \lambda_s mc_t^s, \tag{6}$$

where $s = \{Consumption, Investment\}$ and λ_s is a constant parameter that converges to infinity as the degree of price stickiness tends to zero. In other words, the BP model inherits the dependence of inflation on real marginal costs typical of the NK literature.

Equation (3.1) identifies three classes of possible causes of the increased stability of inflation in recent years. First, the inflation-expectation formation process ($E_t \pi_{t+1}^s$) might have contributed to such stability. Another possibility is that the slope of the Phillips curves (λ_s) has fallen over time, thus reducing the impact of marginal costs on inflation. Finally, the process for real marginal costs might have become more stable. The latter explanation is the one preferred by BP, since real marginal costs in the consumption sector are proportional to the output gap in their model.

In the rest of this section, I will relax some of the auxiliary assumptions of BP in order to simplify the measurement of real marginal costs in their model. This will help to shed light on the possible causes of stable inflation, and will make some aspects of the model more consistent with the literature. For example, assuming a Cobb-Douglas production function for consumption goods, instead of linear, implies that real marginal costs are proportional to the labor share in the consumption sector. Therefore, we can use these data to measure the volatility of real marginal costs.

Unfortunately, computing the labor share in the consumption-good producing sector is nontrivial, due to the ambiguity of the sector definition. As a rough proxy, I use data on real unit labor cost in the nondurable manufacturing sector (Christiano and Fisher 2003; Di Cecio 2009). Figure C4 plots the behavior of this variable, and compares it to the dynamics of the labor share in the aggregate nonfarm business sector (in deviation from the HP trend). If anything, this proxy for real marginal costs in the consumption sector is even more volatile than marginal costs in the whole economy. These findings provide little support for the view that inflation stability is due to stable marginal costs in the consumption sector.

This conclusion, of course, has to be taken with a grain of salt, given the difficulties with the measurement of the labor share in the consump-

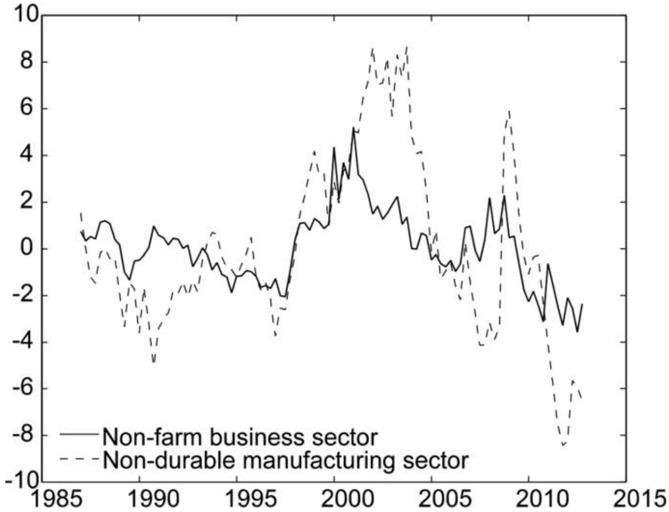

Fig. C4. Logarithm of the real unit labor cost (multiplied by 100) in the nondurable manufacturing sector and the nonfarm business sector (in deviation from the HP trend)

tion sector. On the other hand, the exclusive focus on the consumption sector is just an artifact of BP simplifying assumption of flexible prices in the investment sector. To illustrate this point, suppose that prices in the investment sector are as sticky as in the consumption sector. In addition, assume for simplicity an identical Cobb-Douglas production function for consumption and investment goods. Under these hypotheses, a Phillips curve identical to (2.3) would hold in the BP model, despite maintaining the key assumptions of factor immobility across sectors and imperfect insurance markets. Moreover, in such a model the aggregate labor share would be proportional to real marginal costs—exactly like in the standard NK model—and the shocks of the model would have to be consistent with these data. As a consequence, the BP model is also likely to have implications for inflation that are similar to those of the NK model, with all the successes and failures of this model that I have documented in the previous section.

To conclude, BP's key assumptions of factor immobility and imperfect insurance markets matter for the determination of real marginal costs, but do not affect the dependence of inflation on real marginal costs. As such, the BP model might have the same difficulties of the NK model in predicting inflation. An alternative avenue to explore, in order to explain the remarkable stability of inflation in recent years, would be to alter the relationship between inflation and real marginal costs. As

I mentioned earlier, this might result from a change in the slope of the Phillips curve, or an adjustment in the inflation-expectation formation process. For example, during the last recession, forward guidance and other nonconventional policy measures might have prevented inflation from falling more than it did through their effects on agents' expectations (Campbell et al. 2012; Del Negro, Giannoni, and Patterson 2012).

Endnotes

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1. I assume an Okun's coefficient of 2 to translate the unemployment gap of Campbell et al. (2012) into an output gap.

2. More formally, I compute the Kalman-smoothed estimates of price and wage inflation using the state equation provided by the log-linearized model, and a measurement equation that relates observations on GDP and the output gap to the relevant variables in the model. Because the model has two shocks and two observable variables, the results that I report are robust to the parameterization of the exogenous processes for z_t and b_t.

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