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The return of the Phillips curve and other recent developments in business cycle theory

Jordi Galí

Universitat Pompeu Fabra, Department of Economics, Ramon Trias Fargas 25–27, E-08005 Barcelona, Spain (e-mail: jordi.gali@econ.upf.es)

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1 Macroeconomics stories

It's 3 am. and you are sleeping peacefully when someone breaks into your room, shakes you up violently, and to your astonishment asks you: quick, what is the impact on the economy of an increase in the money supply ? Stanley Fischer used to say every economist should be ready to face a situation like this (as infrequent as it may be), which requires having some reference framework that allows one to organize ideas and to articulate a quick response.

In macroeconomics, that reference framework is clearly not the same for everyone, though at any given time there often exists a dominant paradigm around which a certain consensus emerges. That paradigm has changed over time, displaying an evolution that has been far from smooth. One thesis for the present talk is that the evolution of business cycle theory has itself some cyclical elements (i.e., of a return to early situations). Of course we would all like to believe that such cycles take place around an upward trend, which reflects not only a deeper understanding of the phenomenon, but also an increasing standard of rigor and relevance.

If our macroeconomist's sleep had been disrupted in the 60s or early 70s, the most likely reference framework would have been an IS-LM model, sup-

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plemented with *some* Phillips curve. Such a model, still central in most undergraduate textbooks, contains the key elements of the Keynesian paradigm, and constitutes the core of most large-scale macroeconometric models used by central banks, governments, and commercial forecasters. The vision of the business cycle associated with that paradigm assigned a central role to demand variations, and the gradual adjustment of wages and prices, as factors accounting for short-term fluctuations. The fact that the model also incorporated some classical elements in the long run (e.g., a vertical Phillips curve), led Samuelson to refer to it as the "neoclassical synthesis."

The consensus around the neoclassical synthesis was perturbed by two simultaneous developments. On the empirical front, the stagflation of the 70's, with the effective breakdown of the traditional Phillips curve, and the seeming inability of governments in industrialized countries to achieve full employment through demand management policies, called into question the relevance of the Keynesian paradigm. On the theoretical front, the rational expectations revolution proclaimed the death of Keynesian economics on two grounds: (a) lack of microfoundations (especially on the supply side), and (b) the Lucas critique, which focused on the impossibility of evaluating alternative policy regimes using the traditional macro model.[1]

Simultaneous to the critical assessment of the Keynesian paradigm, there was a first effort to develop an alternative framework that would replace it, and which would presumably overcome many of the problems that were being brought to light. It consisted of a monetary theory of the business cycle based on the assumption of imperfect information (more especifically, agents' inability to distinguish between changes in relative prices and changes in the general price level).[2] The theory maintained, in any event, the classical assumptions of perfect competition and price flexibility. That research program was soon abandoned, largely as a result of its empirical shortcomings and, more specifically, the difficulties of the "nominal confusion" mechanism to generate fluctuations of sufficient magnitude and persistence.

In the early 80s a new paradigm broke into the macroeconomics scene, one which was bound to have an unquestionable influence on the profession: Real Business Cycle (RBC) theory, largely associated with the names of Prescott and collaborators.[3] RBC theory was a revolution in at least two dimensions. First, it was a revolution in *methodology*, associated with (a) the systematic use of dynamic stochastic general equilibrium models (with optimizing consumers and firms), and (b) an emphasis on quantitative analysis of calibrated models (with the comparison of their implied statistical properties with those observed in the data). In fact, much of the success and popularity of the RBC program can arguably be explained by the ability of calibrated versions of that model to reproduce, at

[1] See, e.g., Lucas and Sargent (1979) for a detailed discussion of the alleged pitfalls of the Keynesian paradigm.

[2] See, e.g., Lucas (1973).

[3] See, e.g., Kydland and Prescott (1982) and Prescott (1986) for early examples of RBC models.

least qualitatively, the sign and patterns of some key second moments of U.S. time series.

Secondly, RBC theory implied a revolution in the *conception of the Business Cycle*, by (a) pointing to the possibility of explaining economic fluctuations without reference to any monetary variables, (b) showing how business cycles are not necessarily associated with an inefficient allocation of resources (thus implying that stabilization policies could be counterproductive), and (c) assigning to technological variations a central role as a source of aggregate fluctuations (meaning a dramatic departure from the traditional view, which restricted technological change to be a source of long-term growth).

2 RBC theory: Critical views

While the methodological revolution led by the RBC school may have had permanent effects, the initial enthusiasm around its conception of the business cycle has gradually vanished. Three different reasons may help explain the growing skepticism around the RBC worldview.

The first reason has to do with the excessive protagonism assigned to technological shocks as a source of business cycles. That central role is largely the consequence of a mirage: the high volatility and procyclicality of the Solow residual, and the latter's interpretation as a good approximation to short term variations in total factor productivity (TFP). In a recent paper, Basu et al. (1998) have modified the conventional Solow residual by taking into account the existence of variable factor utilization, imperfect competition, and increasing returns to scale, as well as other factors which may drive a wedge between the Solow residual and "true" TFP. The outcome of that adjustment is a measure of technology variations which has a near-zero correlation with GDP, and a standard deviation which is roughly one-half the size of its Solow residual counterpart.

A second source of skepticism lies in the strong monetary neutrality that is inherent to monetary versions of the RBC model, to the extent that the assumptions of perfect competition and flexible prices is maintained.[4] That neutrality property makes them useless as a reference framework to guide or evaluate monetary policy. Furthermore, that neutrality contrasts with the empirical evidence on the dynamic effects of identified exogenous monetary policy shocks.[5]

Finally, the evidence generated by a recent literature that seeks to identify and estimate the effects of aggregate technology shocks has added to the growing skepticism. Thus, in Galí (1999) I have estimated the effects of a technology shock using as an identifying restriction the assumption that only such shocks may have permanent effects on the level of labor productivity, a property that is shared by a wide variety of models (including conventional RBC models). The estimates point to a short run decline in employment in response to a positive technology shock, a result that is at odds with the predictions of standard RBC

[4] See, e.g., Cooley and Hansen (1989).
[5] See Christiano, Eichenbaum and Evans (1998) for a recent survey of that evidence.

models: in the latter, a positive response of both output and employment to an improvement in technology is central to their ability to generate fluctuations that resemble observed business cycles. Basu et al. (1998) obtain similar results using a completely different methodology: they identify a technology shock as the innovation in their "corrected" TFP measure. Again, they find that a positive innovation in technology leads to a short run reduction in input use. That evidence suggests that, independently of how important technology shocks are as a source of output fluctuations, standard RBC models may not even be able to provide a correct description of the macroeconomic effects of aggregate technology shocks![6]

3 Towards a new synthesis?

The last chapter in our story takes place in the 90s and has as a central theme the efforts to integrate Keynesian-type elements into the class of dynamic stochastic general equilibrium models generally associated with RBC theory. Such a research program seeks to overcome some of the limitations of RBC theory mentioned above, while adopting without any hesitation its methodological approach, as well as many of its tools. The new class of models has two key ingredients: nominal rigidities and imperfect competition. Nominal rigidities constitute the main source of monetary non-neutralities. Imperfect competition takes the form of firms setting prices optimally, given the constraints on frequency and cost of that adjustment. The existence of a positive markup guarantees their willingness to accommodate small changes in demand through changes in the quantity produced and sold, at unchanged prices.

That marriage between Keynesian assumptions and a neoclassical apparatus has been labeled by Goodfriend and King (1997) as the New Neoclassical Synthesis, and lies at the root of the recent explosion of research on the effects of alternative monetary policy rules, and other aspects of monetary economics which had been put aside during the era of RBC hegemony. Examples of natural applications of the new models can be found in the recent work by Rotemberg and Woodford (1998) and Clarida et al. (1998), among others.

In the remainder of the paper I present a sketch of what we could call a canonical model of the new synthesis, and briefly discuss its most novel aspects. As we will see, some of the conditions defining the equilibrium of the canonical model can be viewed as the modern counterpart to the elements of the conventional IS-LM-Phillips curve model. Fortunately, their origin and interpretation are now better defined.

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[6] Given the strong positive correlation between output and employment, that evidence may also tempt one to conclude that technology shocks cannot be a dominant source of the business cycle. But in that case one would still have to provide a satisfactory explanation for the countercyclical behavior of prices, which seems to point to the supply-side as an originator of fluctuations.

4 A sketch of the canonical new Keynesian model

In the present section I sketch some of the central elements of the canonical new Keynesian model, briefly mentioning where they come from. The interested reader can find a more careful derivation in Yun (1996), and Woodford (1996).

4.1 The IS-LM block

The IS-LM block of the canonical model can be derived by log-linearizing two optimality conditions of a standard representative consumer problem, and imposing a market clearing condition that equates output to consumption:[7]

$$m_t - p_t = y_t - \varphi\ r_t \tag{4.1}$$

$$y_t = -\sigma\ (r_t - E_t\{\pi_{t+1}\}) + E_t\{y_{t+1}\} \tag{4.2}$$

where m_t, p_t, and y_t are the (logs) of money, prices and output, and r_t is the nominal interest rate. Equation (4.1) can be interpreted as a straight LM equation. Equation (4.2) is a log-linearized Euler equation, often referred to as the new IS curve, since it implies a negative relationship between output and the real interest rate. The latter feature becomes clearer if we solve (4.2) forward and rewrite it as:

$$y_t = -\sigma\ rr_t^e$$

where $rr_t^e \equiv \sum_{k=0}^{\infty} E_t\{r_{t+k} - \pi_{t+k+1}\}$ can be interpreted as an expected long term real rate.

4.2 The New Phillips Curve

Following Calvo (1983), we assume that each firm may reset its price only with probability $1 - \theta$ each period, independently of the time elapsed since the last adjustment. Thus, each period a measure $1 - \theta$ of producers reset their prices, while a fraction θ keep their prices unchanged. Accordingly, the aggregate price index evolves as

$$p_t = \theta\ p_{t-1} + (1 - \theta)\ p_t^* \tag{4.3}$$

where p_t^* denotes the (log) price set by firms that adjust prices in period t.

How are newly set prices determined ? Let me take a shortcut here and simply assume that firms choose a price that is a constant markup over a weighted average of expected future marginal costs:

$$p_t^* = (1 - \beta\theta) \sum_{k=0}^{\infty} (\beta\theta)^k\ E_t\{mc_{t+k}^n\} \tag{4.4}$$

[7] All along I drop uninteresting constants, in order to simplify the algebra as much as possible.

where mc_t^n is the (log) nominal marginal cost, and where the discounting takes into account the fact that p_t^* will remain effective in period $t + k$ only with probability θ^k. Letting $mc_t \equiv mc_t^n - p_t$ denote the (log) real marginal cost, we can combine (4.3) and (4.4) to yield (after some manipulation) the inflation equation

$$\pi_t = \beta\, E_t\{\pi_{t+1}\} + \lambda\, mc_t \tag{4.5}$$

where $\lambda \equiv \frac{(1-\theta)(1-\beta\theta)}{\theta}$.

Under standard assumptions, the equilibrium real marginal cost (i.e., the reciprocal of the markup) is stationary, with its (log) deviation from steady state given by

$$mc_t = \kappa\, (y_t - y_t^*) \tag{4.6}$$

where y_t^* is the natural level of output, defined as the level of output which would obtain under flexible prices. The term $y_t - y_t^* \equiv x_t$ is often referred to in the literature as the *output gap*. Thus, y_t^* will fluctuate as a result of real shocks (technology, fiscal policy, preferences, etc.), but will be invariant to monetary policy (at least to a first approximation). Combining (4.6) with (4.5) we obtain the *New Phillips Curve (NPC):*

$$\pi_t = \beta\, E_t\{\pi_{t+1}\} + \lambda\kappa\, (y_t - y_t^*) \tag{4.7}$$

Closing the model requires that we specify a monetary policy rule. One possibility is to assume an exogenous process for the growth rate of the money supply:

$$\Delta m_t = u_t \tag{4.8}$$

where $\{u_t\}$ to follows a stationary process. In that case (4.7), (4.2), (4.1), and (4.8), together with exogenous processes for u_t and y_t^* fully describe the equilibrium dynamics of the model. This corresponds, in its essence, to the model analyzed in Yun (1996), where it is shown the central role played by the degree of nominal rigidities (parameterized by θ) in generating large volatile and persistent output fluctuations.

Alternatively, and perhaps more realistically, one could specify a Taylor-type interest rate rule:[8]

$$r_t = \phi_\pi\, \pi_t + \phi_x\, x_t + u_t$$

In the latter case, the equilibrium dynamics for π_t, y_t and r_t will be fully described by the interest rate rule, (4.7), (4.2) and exogenous processes for u_t and y_t^*. The LM curve is then somewhat redundant, its role being restricted to determining the money supply that is needed to support the desired interest rate.

[8] See Taylor (1994). A forward-looking version of the Taylor rule has been proposed and estimated by Clarida et al. (1997, 1998).

A framework of this sort has been used in numerous recent papers, with the purpose of analyzing the macroeconomic implications of alternative rules,[9] or the derivation of the optimal (or second-best) rule for a given central bank loss function.[10]

5 Evidence on the New Phillips Curve

As the previous section has made clear, the canonical new Keynesian model contains the same building-blocks as the traditional IS-LM-Phillips curve framework. But several differences remain, and some are perceived by many as shortcomings of the new paradigm. The most common criticism focuses on the forward-looking nature of the New Phillips Curve (NPC) (4.7) though, as I will argue below, that criticism may be largely misguided. First, the critical views.

A number of authors have pointed out that while the NPC may be theoretically more appealing, it cannot account for many features of the data that motivated the traditional Phillips curve specification. To be specific, let us assume that $\beta \simeq 1$, so that we can rewrite (4.7) as

$$\pi_t = \pi_{t-1} - \lambda\kappa \, x_{t-1} + \varepsilon_t \tag{5.1}$$

where $\varepsilon_t \equiv \pi_t - E_{t-1}\pi_t$. Thus, the NPC implies a negative correlation between inflation changes and lagged output gap. Yet, when detrended GDP is used as a measure of the output gap as that correlation is clearly positive in the data, as has been pointed out by Fuhrer and Moore (1995) among others. In other word, the data appears to be more consistent with a traditional, backward-looking Phillips curve than with the new.

That evidence seems reinforced by many of the estimates of hybrid Phillips curves of the form

$$\pi_t = \phi \, \pi_{t-1} + (1 - \phi) \, E_t\pi_{t+1} + \delta \, (y_t - y_t^*)$$

found in the literature, and which generally point to a significant (if not completely dominant) influence of lagged inflation as a determinant of current inflation.[11]

In a recent paper,[12] Mark Gertler and I have argued that some of the existing evidence may be distorted by the fact that the conventional measures of the output gap x_t are likely to be ridden with error, primarily due to the unobservability of the natural rate of output y_t^*. The conventional approach involves fitting a deterministic trend to (log) GDP, which implicitly assumes that $\{y_t^*\}$ varies smoothly over time. But there is no reason to presume such behavior since many types of shocks (fiscal, technology, etc.) may lead to fluctuations in the natural level of output.[13] Furthermore, even if the output gap were observable

[9] See, e.g., Clarida et al. (2000) and Rotemberg and Woodford (1998).

[10] See, e.g. Clarida et al. (1999), and Woodford (1998).

[11] See, e.g., Chadha et al. (1992) and Fuhrer (1997).

[12] See Galí and Gertler (1999).

[13] As discussed in Galí (1999), the presence of nominal rigidities is likely to make output respond by less than its natural rate to supply shocks, thus generating a negative correlation among (detrended) output and the true output gap.

the conditions under which it is proportional to the (current) marginal cost may not be satisfied, which would prevent us from deriving (4.7).

As a way to overcome that problem we have proposed going back to (4.5), thus letting *marginal cost* be the driving force underlying changes in inflation, as implied by the Calvo price-setting structure discussed above.

Given a specification of technology, together with the assumption of cost minimization, we can generally find an expression for marginal cost in terms of observables. For the sake of concreteness, suppose that technology can be represented by a production function which implies a constant elasticity of output with respect to labor (say, α). Then it is easy to show that real marginal cost will be proportional to the labor income share (S_t^n), so that, in percent deviations from their steady state values we have $mc_t = s_t^n$, all t. Accordingly we can rewrite (4.5) as

$$\pi_t = \beta\, E_t\{\pi_{t+1}\} + \lambda\, s_t^n \tag{5.2}$$

where, again, $\lambda \equiv \frac{(1-\theta)(1-\beta\theta)}{\theta}$.

Given data on inflation and the labor income share, one can estimate structural parameters β and θ (as well as their implied value for λ) with a non-linear instrumental variables estimator. Here I use quarterly U.S. data for the period 1960:1 to 1997:4. I use the percent change in the GDP deflator for π_t, the labor income share in the non-farm business sector for s_t^n, and four lags of inflation, the labor income share, employment, the long-short interest rate spread, wage inflation, and commodity price inflation as instruments. The resulting estimates are $\widehat{\theta} = 0.82 \;\; (s.e. = 0.01)$ and $\widehat{\beta} = 0.92 \;\; (s.e. = 0.02)$, and the implied inflation equation is given by

$$\pi_t = \underset{(0.02)}{0.92}\; E_t\{\pi_{t+1}\} \;+\; \underset{(0.01)}{0.04}\; s_t^n$$

Thus, it appears that when the NPC is estimated in a way consistent with the underlying theory it fits the data much better than it had been concluded by the existing literature. In particular, all the point estimates have the predicted sign and show plausible values. Thus, the parameter θ is estimated to be about 0.8 with a small standard error, which implies that prices are fixed for roughly five quarters on average.[14] That period length is close to the average price duration found in survey evidence.[15]

In Galí and Gertler (1999), we extend the baseline theory underlying the NPC to allow for a constant fraction of firms that set prices according to a backward looking rule of thumb. The remaining firms set prices in a forward-looking way, as described by (4.4). We estimate the resulting model using measures of real

[14] In related work, Sbordone (1998) also examines the validity of alternative price setting models real marginal cost measures. Her empirical approach is different from that in Galí and Gertler (1998), however: she explores how well each model fits the data conditional on different choices of a parameter that governs the degree of price rigidity. Interestingly, she finds that the value of the price adjustment parameter that maximizes the model's goodness of fit also corresponds to an average of five quarters between adjustments.

[15] See Taylor (1998) for an overview of that evidence.

marginal cost, as in the exercise above. Our results imply that forward-looking behavior is very important: the estimates suggest that roughly eighty percent of firms exhibit forward-looking price-setting behavior. Backward looking behavior is statistically significant, though of limited quantitative importance. Thus, while the benchmark pure forward looking model is rejected on statistical grounds, it appears still to be a reasonable first approximation to the inflation dynamics.

6 Alternative sources of inflation inertia

The results discussed in the previous section seem supportive of the New Phillips Curve. But they also raise a puzzle. Traditional explanations of inertia in inflation (and hence the costs of disinflation) rely on some form of "backwardness" in price setting. To the extent this backwardness is not quantitatively important, we need to look for alternative sources of inflation inertia. One possibility, currently explored by Mark Gertler and myself, involves the link between aggregate activity and real marginal costs. Standard business cycle models imply a contemporaneous relationship between changes in output and real marginal costs, given the natural level of output (see Eq. (4.6)). Furthermore, the evidence discussed above suggests that inflation depends largely on current and future marginal costs, not on its lags. Accordingly, the only way to account for inflation inertia would seem to require sluggish adjustment of real marginal costs to movements in output, a feature that is missing from standard business cycle models. Given the central role of labor costs as a component of marginal costs, a candidate source for the necessary friction is wage rigidity, i.e. a sluggish response of real wages to labor market developments. In such an environment, and contrary to what (4.7) would imply, stabilizing output around its natural level (and credibly committing to continue do so in the future) would not be enough to bring inflation down to zero immediately, since may take some time for the (real) marginal cost to adjust to its steady state value.

7 Concluding remarks

In the present paper I have reviewed some recent developments in business cycle theory. In particular, I have pointed to the re-emergence of the IS-LM-Phillips Curve framework as a consequence of the introduction of imperfect competition and sticky prices in monetary version of an otherwise conventional RBC model. Some important differences vis a vis the traditional Keynesian model remain, however. Most importantly, expectations of future interest rates and marginal costs play a central role in the determination of output and inflation.

There are several issues on which the research program outlined above is likely to focus in the years to come. First, and as suggested in the previous section, the baseline model may have to be modified in order to account for the joint behavior of marginal costs, output, and inflation. This is likely to involve the introduction of labor market frictions. Second, it will be important to extend the baseline model in order to incorporate open economy features, and to do so in a way which preserves the tractability of the original framework. The resulting framework can then be used to analyze quantitatively several issues of current interest, e.g., the implications of alternative exchange rate regimes, or the transmission of the international business cycle, neither of which can be dealt satisfactorily by RBC theory.

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