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The new Keynesian Phillips curve and the cyclicality of marginal cost

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ABSTRACT

Several authors argue that if the labor income share is used as the proxy for real marginal cost, then the New Keynesian Phillips Curve does a good job of approximating US inflation dynamics. However, this paper argues that the labor share is not an ideal measure of real marginal cost for two reasons: it is countercyclical whereas marginal cost is likely to be procyclical, and it assumes that labor can be costlessly adjusted at a fixed real wage rate. Relaxing this assumption to a more realistic one leads to a measure of marginal cost that does turn out to be procyclical, which when tested produces results that are contradictory to the entire underlying model of the NKPC. Indeed, this paper argues that having procyclical marginal cost precludes us from even having the correct coefficient signs in the NKPC, which highlights a major problem that exists in the model.

1. Introduction

Taylor (1980) and Calvo (1983), amongst others, laid the foundations for modern econometric analysis of inflation by looking at nominal wage and price-setting by forward-looking individuals and firms. When we aggregate over such individual behavior, we are left with a relation between short-run inflation and real marginal cost, known as the (partial equilibrium, sticky-price) 'new Keynesian Phillips curve' (henceforth referred to as the 'baseline' NKPC). Although one can point out that there are overly restrictive assumptions that underlie the NKPC, many researchers continue to use it for the lack of a better alternative. Indeed to this day, the NKPC remains prominent amongst many macroeconomists.

Gali and Gertler (1999) were the first to claim empirical success of the marginal cost-based NKPC, where they use labor's share of income as their proxy for real marginal cost. Many authors have since tested the basic NKPC model with the labor share, and there is plenty of evidence to suggest that the model is successful with this measure. However one could think of several limiting assumptions that underlie the NKPC, and this paper focuses on one particular assumption that can be easily improved upon. Specifically, I detail the reasons as to why the labor income share is not an ideal proxy for real marginal cost, and then innovate upon existing work to develop a more reasonable marginal cost measure.

This paper argues that the labor income share is an imprecise proxy for real marginal cost for two main reasons: first, the labor share is countercyclical. However, simple reasoning from microeconomics suggests that short-run marginal cost is likely to be procyclical. This has been empirically confirmed by many authors, such as Bils (1987) and Rotemberg and Woodford (1999). Yet the labor income share is countercyclical, as it rises during times of recession, contrary to what intuition and theory tells us about marginal cost.

The second flaw of the labor share measure of marginal cost is that it is based on an overly restrictive assumption. Specifically, Gali and Gertler assume that labor input can be adjusted freely at a fixed real wage rate. However this assumption is too simplistic once we examine it closely. In practice, labor can be decomposed into the number of employees

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multiplied by the respective hours that they work, and as Oi (1962) argues, employment is not likely to be perfectly flexible in the short run.

Instead, it is hours which can be adjusted flexibly, with little-to-no adjustment costs. This is particularly true of some industries, such as the manufacturing sector, where hours are frequently varied. However hours are not adjusted at a fixed wage rate; instead, wages in these industries are dependent on the number of hours worked, since varying hours necessitates that firms give their workers overtime pay. Hence labor cannot be adjusted costlessly at a fixed wage rate.

This paper seeks to improve upon the measurement of marginal cost. To do this, I use the Bils (1987) idea that the marginal cost of increasing output can be computed by looking at the cost of increasing any of the inputs of production, where that input is chosen freely, while holding the other inputs fixed at their optimal levels. Since labor can be decomposed into employment and hours, I examine hours adjusted at the margin, whilst holding the other inputs fixed. I then improve upon existing methods by combining this with a wage rate that is dependent on the number of hours worked, so that the payment to each extra hour worked is not fixed as it is in the Gali and Gertler (1999) framework. Indeed, the general expression for real marginal cost now includes overtime hours as one of its components.

Computing the general expression of marginal cost requires good data on overtime hours and overtime premia, but this data is not available at the aggregate level. However, reliable data is published for the manufacturing sector, which is the industry that I therefore focus on. Applying the general expression for real marginal cost to manufacturing data produces a series that is highly procyclical, just as we expect it should be. Therefore one can think of this as a much more plausible proxy for real marginal cost than the countercyclical labor income share.

Since I look at marginal cost for the manufacturing sector, I develop a sector-level version of the baseline NKPC for testing purposes. I provide this by adapting the underlying equations of the model to industry-level ones, and from this I derive the relationship that describes the behavior of inflation. Testing the improved measure of marginal cost in this 'disaggregated NKPC' yields a statistically significant negative coefficient on real marginal cost. However in order for the NKPC to be valid, this coefficient must be positive and significant. Therefore the more reasonable measure of marginal cost produces results which strongly reject the model.

Given these results, one must conclude that the NKPC with the labor income share does not do a good job of explaining inflation dynamics. In particular, this paper argues that having a positive coefficient on marginal cost is at odds with having a procyclical measure of marginal cost, which is a criticism of the model that future research must address.

2. Labor income share in the NKPC

2.1. Background

The sticky-price NKPC, which is derived from Calvo's (1983) model of random price adjustment, is commonly recognizable in the following form:

$$\pi_t = \lambda x_t + \beta E_t\{\pi_{t+1}\}, \tag{NKPC}$$

where π_t is the rate of inflation, and x_t is (log) real marginal cost. In their seminal paper, Gali and Gertler (1999) estimate the baseline NKPC using the generalized methods of moments (GMM) estimator. They show that using detrended log GDP as the proxy for the output gap, applied to quarterly data, yields a negative and significant coefficient for λ.[1] The NKPC requires that λ must be positive in order for the model to make structural sense, so the finding of a negative coefficient is evidence that the model is not behaving as theory predicts.

For the remainder of this paper, I will use the 'λ-sign criterion' to determine if the baseline NKPC is functioning as theory predicts it should. More precisely, I define that $\lambda > 0$ indicates that the criterion is passed and that the NKPC succeeds against this test, whereas $\lambda < 0$ is a failure of the criterion, representing a rejection of the model.

Gali and Gertler claim to find a solution to correct for the empirical failure of the NKPC by measuring real marginal cost directly, instead of using an ad hoc output gap as its proxy. In their paper, Gali and Gertler explain that real marginal cost, X, will be the ratio of the real wage rate to the marginal product of labor: $X = \frac{\omega}{\partial Y/\partial L}$, where ω is the real wage rate, L is (total) labor, and Y is output.[2] To derive $\partial Y/\partial L$, Gali and Gertler use a Cobb–Douglas production function $Y = AK^{\alpha}L^{1-\alpha}$, where A is technology, K is capital, and $0 < \alpha < 1$. Solving for this expression of marginal cost in (1) now yields:

$$X = \frac{1}{1-\alpha}\frac{\omega L}{Y} = \frac{S}{1-\alpha}, \tag{1}$$

which is in effect $1/(1-\alpha)$ multiplied by the ratio of total labor compensation to real output. This ratio is also called the labor income share: $S = (\omega L/Y)$, which can also be thought of as real average unit labor costs. Now letting lower case letters denote percent deviations from the steady state gives: $x_t = s_t$. This states that real marginal cost can be represented by the labor income share, so Gali and Gertler's baseline NKPC becomes: $\pi_t = \lambda s_t + \beta E_t\{\pi_{t+1}\}$.

[1] The finding of a negative coefficient on the output gap is robust across a wide range of possible instrument sets, measures of inflation, and GDP detrending procedures, as other authors have also demonstrated (Gali et al., 2005; Rudd and Whelan, 2007).

[2] Note that all variables in this paper are in real terms where applicable, unless otherwise stated.