

What drives inflation? Testing non-nested specifications of the New Keynesian Phillips Curve

Vasco Gabriel* Luis Martins**

*Department of Economics, University of Surrey and NIPE-UM

**Department of Quantitative Methods, ISCTE

July 26, 2008

Motivation

- The NK Phillips Curve postulates that inflation is driven by expected future inflation plus a measure of inflationary pressures

$$\pi_t = \beta E_t \pi_{t+1} + \lambda x_t, \quad (1)$$

- Initial formulations suggested taking a measure of the output gap as x_t
- However, empirical estimates delivered the wrong sign for λ
- Gali and Gertler (1999) and Sbordone (2002) suggest using real unit labour costs as a proxy for marginal costs (firms' pricing behaviour)
- More recently, a number of papers have included labour market frictions in order to account for inflation persistence (Blanchard and Gali, 2007, Ravenna and Walsh, 2007, Blanchard and Gali 2008)

Motivation

- What are the relative empirical merits of these approaches? Which measure of x_t provides the best fit? How can they be compared? Can we draw useful conclusions for DGSE modelling?
 - 'Data-driven' approach!
- We resort to a single-equation approach, using moment-conditions estimators
- Alternative specifications imply different forcing variables for inflation \Rightarrow need to use non-nested testing procedures
- Recent tests proposed by Smith and Ramalho (2002, building upon Smith (1992), and Hall and Pelletier (2007) allow us to carry out this empirical exercise
- We will compare three different formulations of the NKPC: the baseline NKPC with Calvo-pricing, a 'reformed' output-gap based NKPC and a formulation with labour market frictions
- We proceed in two steps: initially we compare the different alternatives of NKPC with labour market frictions and then test the best model (if any) against the Calvo and output gap formulations

Gali and Gertler (JME 1999)

- We all know this one...
- Calvo-pricing mechanism, firms set prices in a forward-looking fashion, with real marginal costs driving inflation dynamics:

$$\pi_t = \beta E_t \pi_{t+1} + \lambda mc_t, \quad (2)$$

- pure forward-looking version does not fully capture inflation persistence \Rightarrow 'hybrid' version¹:

$$\pi_t = \gamma_f \pi_{t+1} + \gamma_b \pi_{t-1} + \lambda mc_t \quad (3)$$

- Main problem: how to measure marginal costs? Simplest proxy is real unit labour costs, but not very satisfactory

¹The reduced form coefficients γ_f and γ_b are defined as $\beta\theta\phi^{-1}$ and $\omega\phi^{-1}$, respectively, and $\lambda = (1 - \omega)(1 - \theta)(1 - \beta\theta)\phi^{-1}$, with $\phi = \theta + \omega[1 - \theta(1 - \beta)]$, where ω measures the degree of 'backwardness'.

Neiss and Nelson (JMCB 2005)²

- Failure of output-gap based NKPC due to measurement problems
- inconsistency between concept and measure (detrended output): shocks affecting potential (flexi-price) output (technology, productivity, taste or government spending shocks) are unlikely to be reflected as smooth trends (Woodford, etc)
- GG assume $mc = \kappa(y - y^*)$, which holds only if the labour market is competitive and flexible
- NN obtain new measures of the output-gap that are theory-consistent (with a NK DSGE model including capital and habit formation)
- bad news: calibration is required; good news: output gap series is publicly available

²see also Basistha and Nelson, JME 2007

Blanchard and Gali (2007)

- BG 2007 derive a NKPC with real wage rigidities (simple partial adjustment mechanism) and supply shocks (non-produced input, e.g. oil)
- Interestingly, this gives rise to an almost traditional inflation-unemployment (reduced-form) relationship:

$$\pi_t = \delta_1 \pi_{t-1} + \delta_2 E_t \pi_{t+1} + \delta_3 u_t + \delta_4 \Delta v_t + \zeta_t, \quad (4)$$

- Δv_t is the raw materials inflation and ζ_t captures expectational errors
- The presence of real wage rigidities causes involuntary unemployment

A model with search-match unemployment

Blanchard and Gali (2008) version

- BG 2008 go a step further by combining nominal frictions with labour market imperfections along the lines of the Diamond-Mortensen-Pissarides setup
- Adding real wage rigidities as in BG 07 leads to inefficient fluctuations in unemployment
- An augmented NKPC is derived in which inflation dynamics is directly linked to labour market conditions and productivity (reduced-form):

$$\pi_t = \gamma_1 E_t \pi_{t+1} - \gamma_2 u_t + \gamma_3 u_{t-1} + \gamma_4 E_t u_{t+1} - \gamma_5 \hat{a}_t, \quad (5)$$

- The term \hat{a}_t represents log deviations of productivity from its steady state
 - Note that this is eq. 84 in Paul's paper, without a 'cost channel'
- BG 2007 do not estimate this relationship, but this is possible provided that some structural parameters are calibrated

Ravenna and Walsh (2007) version

- While other papers in this area have considered labour market frictions in the wider context of DSGE modelling, RW specifically consider the specification of the NKPC with unemployment (although labour adjusts only along the extensive margin)
- The introduction of search frictions implies an augmented expression for marginal costs, which now also depends on labour market variables
- The corresponding NKPC (without the cost channel!) is:

$$\pi_t = \beta_1 E_t \pi_{t+1} - \beta_2 mc_t^{NK} + \beta_3 \hat{a}_t + \beta_4 \hat{q}_t + \beta_5 E_t \hat{q}_{t+1} + \beta_6 i_t^*, \quad (6)$$

- This NKPC nests the baseline GG specification, but extends it by including productivity and the search-friction variable \hat{q}_t , measuring the probability of filling a vacancy
- A time series for \hat{q}_t has been obtained by Shimer (2005) for the US

Testing non-nested models

- The above models are non-nested, given that the forcing variables are different
- Two possible strategies:
 - build a more general model that nests competing models (for example, RW with raw materials) and test restrictions
 - test the different variants against each other
- Very few papers addressed testing non-nested models in a moment condition framework (more popular with least squares and likelihood methods), none looked at modern macro models
- Given the central role of the NKPC for macro analysis, it seems relevant to test competing specifications

Testing non-nested models

- We wish to compare two models H_g and H_h that imply moment conditions of the type

$$E[g(x, \beta_g)] = 0 \quad (7)$$

$$E[h(x, \theta_h)] = 0 \quad (8)$$

- Several possibilities:
 - Cox-type tests (Smith, 1992; Ramalho and Smith, 2002): Test H_g against H_h by evaluating, under H_g , the (scaled) difference of the estimated criterion functions (S GMM C; RS general form GC, GEL C, LC, SC)
 - Encompassing tests (S and RS): asks whether the null model is capable of predicting the features of the alternative model (S GMM Parametric Encompassing E; RS general form GE, GEL PE, ME, LME)
 - parametric encompassing: checks the behaviour of $\hat{\theta}$ under H_g
 - moment encompassing: behavior of $\hat{h}(\beta)$, i.e., behavior of a functional of \hat{h} under H_g
 - Model Selection tests (Rivers and Vuong, 2002, and Pelletier and Hall, 2007): compares measures of fit between H_g and H_h ; the null hypothesis is $H_g = H_h$ in terms of goodness of fit and distance

Empirical Results

- Data and Instruments: As in the original papers GG, NN, BG and RW... 1960:1-2004:4 and 1982:3-2004:4... Two and Four lags of instruments...
- N_l and N_z never rejects $H_g = H_h$ for all models.
- Read what follows as the percentage rate of acceptances of H_g against H_h (over the Cox-type and Encompassing tests):

Table: Cox-type and Encompassing Tests - Whole Sample

1960 : 1...						
$H_g \setminus H_h$	GG(99)	NN(05) <i>c35</i>	NN(05) <i>cap</i>	BG(07)	BG(08)	RW(07)
GG(99)	—	63	55	67	*	*
NN(05) <i>c35</i>	61	—	*	*	*	*
NN(05) <i>cap</i>	55	*	—	*	*	*
BG(07)	78	*	*	—	83	74
BG(08)	*	*	*	83	—	61
RW(07)	*	*	*	67	64	—

Empirical Results (cont.)

- Main Findings: Strong support for any NKPC specification to model inflation, specially during Volcker period. If one model is to be chosen... BG(2007)? Or to be dropped... NN(2005) and RW(2007)?
- General Model that nests all models... D statistics with $pvalue \approx 0$. Exception: D_{GG} for $Z_{2,short}$ and Z_2 and period 1960:1

Table: Cox-type and Encompassing Tests - Volcker period

1982 : 3...						
$H_g \setminus H_h$	GG(99)	NN(05) c_{35}	NN(05) cap	BG(07)	BG(08)	RW(07)
GG(99)	—	77	85	92	*	*
NN(05) c_{35}	77	—	*	*	*	*
NN(05) cap	77	*	—	*	*	*
BG(07)	100	*	*	—	83	95
BG(08)	*	*	*	72	—	77
RW(07)	*	*	*	73	59	—

Testing the NKPC: current questions

- Only pairwise comparisons are possible: no GMM tests of one model against several competitors, as in Davidson and Mackinnon (1981), for example
- reversing the hypotheses?...
- reduced-form vs structural parameters?
- (Too) many tests to choose from: several versions for each family of tests, not clear which ones have better finite sample performance
- Estimated NKPC are known to suffer from weak identification problems \Rightarrow how does this affect non-nested tests?...
- Cox-type and encompassing tests assume that *both* models are empirically valid; initial difficulties to replicate the (apparently) valid results reported in the papers...
- Inflation dynamics and NKPC models: Autoregressive component is most probably the main factor...