

REAL UNIT LABOR COSTS AND OUTPUT IN BUSINESS CYCLE MODELS: AN EMPIRICAL ASSESSMENT

Vít Pošta

Abstract

Modern macroeconomic models of business cycle, which are based on real business cycle models enhanced by various types of both nominal and real rigidities, work with a relation between price inflation and real marginal costs, which captures the sources of inflation introduced much earlier as the Phillips curve. Although it is possible to formulate the relationship with output gap or unemployment gap instead of real marginal costs, it is the formulation with real marginal costs which dominates both in theoretical and empirical analysis. The paper uses VAR models with measures of real activity, inflation, exchange rate and interest rate as endogenous and measures of output of the German economy and oil price as exogenous variables to examine the behavior of real unit labor costs as a proxy for real marginal costs in a business cycle framework in cases of the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland and Slovakia. The results differ significantly across the sample, which means a differentiated approach must be taken when estimating such a relationship.

Key words: business cycles, output gap, real unit labor costs, VAR

JEL Code: E30, E31, E32

Introduction

The purpose of the analysis is to give an empirical evaluation of the relationship between real GDP and real unit labor costs as proxies for real marginal costs within a standard business cycle framework. Vector autoregressive models are employed to accomplish this goal. The question is important from both theoretical and empirical perspectives as the relationship between real marginal costs and inflation builds one of the cornerstones of modern business cycle models. This relationship is called New Keynesian Phillips Curve (NKPC) and is typically built on forward looking behavior of price-setting firms facing a constraint on the frequency with which they can change their prices (Calvo, 1983). However, it was shown later that purely forward-looking behavior of price-setters seems to be too strong an

assumption for such models to match the data (Fuhrer and Moore, 1995). Roberts gave an overview of the various versions of the NKPC (Roberts, 1995) and Gali and Gertler formulated a model which incorporated both forward and backward-looking price-setters within an intertemporal framework, which has become a standard approach to this date (Gali and Gertler, 1999).

From the point of view of a small open economy, it is necessary to point out the paper by Gali and Monacelli who presented a NKPC model for an open economy (Gali and Monacelli, 2005).

Various proxies for real marginal costs have been used in the literature relevant to the economies examined in this paper. Results for Estonia, Latvia and Lithuania used labor share as a proxy and also marginal costs based on a production function with foreign import as input, but the role of these proxies in the inflation process was unclear (Dabušinkas and Kulikov, 2007). Insignificant estimates for output gap and real unit labor costs were obtained in a study for the Czech economy (Daniškova and Fidrmuc, 2011). On the other hand there are analysis which present statistically significant results with output gap as a proxy covering all or most of the economies in question: (Mihailov et al, 2011), (Vašíček, 2011) and (Basarac et al, 2011).

1 VAR models

I set up two VARs for each economy. The VARs consist of four endogenous variables: measure of real activity, inflation, interest rate and exchange rate and two exogenous variables: output of the German economy (outputde) and US dollar price of Brent oil (oil). The real activity is measured by real GDP (output) in VAR1 models and in VAR2 models by real unit labor costs (ulc). The quarterly data were retrieved from the eurostat database. Inflation is based on HICP measure of price level, three-month interest rates and nominal bilateral exchange rates to euro are used in the models. Estonia and Slovakia are euroarea countries and Lithuania has had its currency pegged to euro since 2002. In these three cases real exchange rate to euro based on consumer prices is used. That is why the sample ends in 2012Q2 for these three economies. Generally, the sample starts in 1998Q1, but there are exceptions depending on the availability of the data in each case. The exogenous variables are used to capture the relatively high openness of the economies and their dependence on the European market. The structure of the VARs is summarized in Table 1.

The data was seasonally adjusted and with the exception of interest rates log-differenced to achieve stationarity (the time series of interest rates used in levels were stationary as well). The number of lags of the endogenous variables were chosen so that the residuals of the estimated VARs did not contain autocorrelation and heteroskedasticity at 5 % significance level; also they were normal at at least 10 % significance level. I do not present the typical output for the lack of space.

Tab. 1: VAR models

Economy	Lag of Endogenous Variables		Lag of Exogenous variables	
	VAR1	VAR2	VAR1	VAR2
Czech Republic	4 (98Q1 – 12Q4)	3 (98Q1 – 12Q4)	outputde oil(1)	outputde oil(1)
Estonia	5 (98Q1 – 12Q2)	4 (98Q1 – 12Q2)	outputde oil	outputde(1) oil
Hungary	2 (98Q1 – 12Q4)	2 (98Q1 – 12Q4)	outputde oil	outputde oil
Latvia	2 (98Q1 – 12Q4)	2 (98Q2 – 12Q4)	outputde oil	outputde(1) oil
Lithuania	4 (00Q2 – 12Q2)	4 (00Q2 – 12Q2)	outputde oil(1)	outputde oil(1)
Poland	5 (98Q1 – 12Q4)	4 (00Q2 – 12Q4)	outputde oil	outputde oil
Slovakia	3 (98Q1 – 12Q2)	4 (98Q1 – 12Q2)	outputde(1) oil	outputde(1) oil(1)

Source: my own estimation

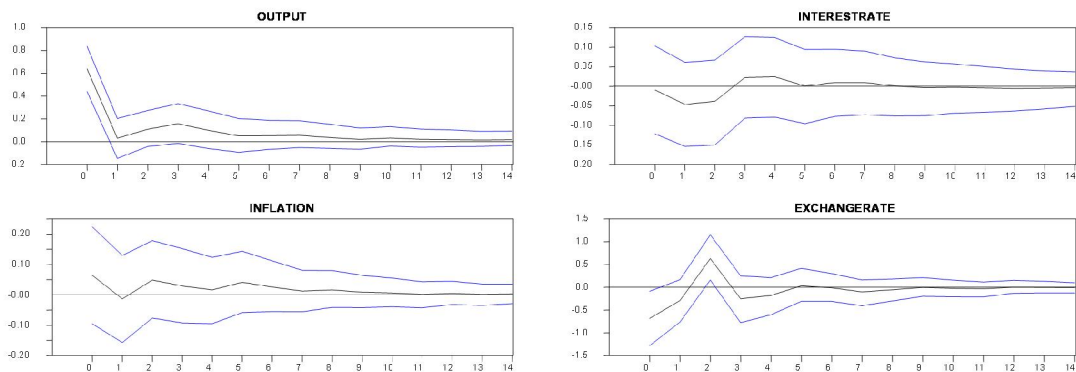
Notes: VAR1 stands for model with real GDP and VAR2 uses real unit labor costs. Sample is given in parentheses for each VAR. OUTPUTDE stands for real GDP of German economy and OIL represents nominal prices of Brent oil in US dollars. Lag of exogenous variables if any is given in parentheses.

2 Responses to an Exogenous Demand Shock

The first part of the analysis rests on an impulse-response exercise based on a one-standard-deviation positive shock to the output of the German economy, which may be interpreted as a positive external demand shock. Due to the lack of space I give the results for the Czech

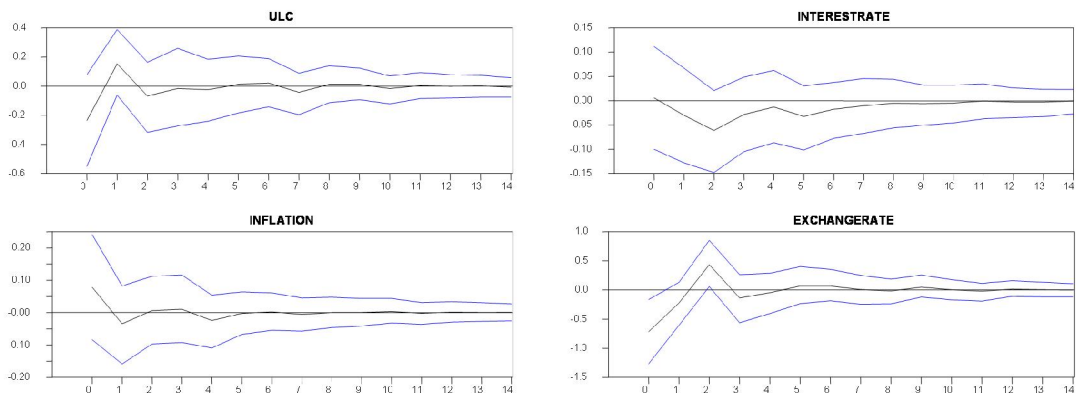
economy only. I provide a brief comment on the rest of the economies below. The results are at disposal on request.

Fig. 1: Czech Republic – VAR with Real GDP



Source: my own estimation (bands constructed at 5 % significance level)

Fig. 2: Czech Republic – VAR with Real Unit Labor Costs



Source: my own estimation (bands constructed at 5 % significance level)

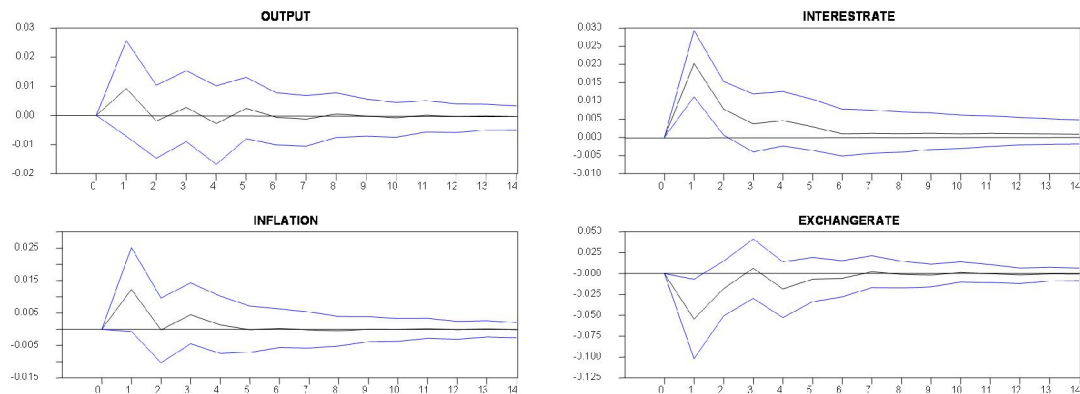
The results show a strong positive reaction of GDP to the shock accompanied by nominal appreciation. The responses of inflation and interest rate are insignificant. The appreciation is followed by depreciation with a lag of two quarters. Initially, real unit labor costs decline, which means that the real positive effect of the shock prevails. However, this is followed by an increase in unit wages and real unit labor costs rise. The results show that the relationship between real GDP and real unit labor costs is statistically significant. Very similar results were found for Lithuania. Real exchange rate was used in this case, and the positive external demand shock was followed by an immediate real depreciation reversed to real appreciation with a delay of one quarter.

Similar results were further obtained in the cases of Hungary and Slovakia with the exception of the reaction of the exchange rate, which was not statistically significant in either case. The responses of both output and real unit labor costs were not significant in Poland, which points to the fact that the Polish economy is relatively closed as compared to the others. The only significant effect was nominal appreciation. The results for Estonia and Latvia showed a significant increase in domestic output but an insignificant reaction of real unit labor costs. In Estonia a statistically significant real appreciation was present.

3 Responses to an Exogenous Supply Shock

In the second part of the analysis an analogous exercise was performed, this time based on a one-standard-deviation increase in oil price, which may be interpreted as a negative supply shock. Only the results for the Czech economy are presented in Figures 3 and 4; I give a brief comment on the other economies below.

Fig. 3: Czech Republic – VAR with Real GDP



Source: my own estimation (bands constructed at 5 % significance level)

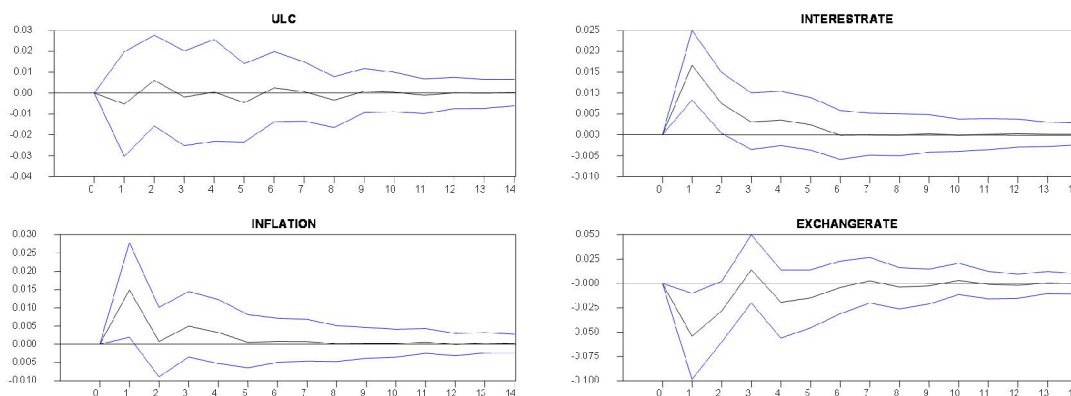
Obviously, no significant responses of real activity were estimated. There is a positive impact on inflation and interest rate. The exchange rate appreciates, probably due to the increase in the interest rate.

In most other cases: Estonia, Latvia, Lithuania, Poland and Slovakia, output responded with an increase, statistically significant changes in real unit labor costs were found in the cases of Estonia and Latvia. This finding further blurs the relationship between the two measures of real activity.

Statistically significant increases in inflation were estimated in all the cases except for Slovakia. The behavior of the interest rate varies across the sample: it responded by an

increase in Estonia, Lithuania and Poland while there was a decrease in Hungary and Latvia. The exchange rate reacted by appreciation in Hungary, Lithuania and Poland in nominal terms and in Estonia in real terms.

Fig. 4: Czech Republic – VAR with Real Unit Labor Costs



Source: my own estimation (bands constructed at 5 % significance level)

Conclusion

The analysis was based on an impulse-response exercise within VAR models with the aim of assessing the relationship between real output and real unit labor costs. Both the variables are used as a proxy for real marginal costs within the New Keynesian Phillips Curve model with mixed empirical results.

The analysis showed that a statistical significant relationship between the two variables may be considered in the cases of the Czech economy, Hungary, Latvia, Lithuania and Slovakia. In the rest of the sample, Estonia and Poland, the results show the relationship between the real output and real marginal costs is much less clear. Furthermore, the results tend to vary according to the shock to the VARs.

The results are important when considering the estimation of the New Keynesian Phillips Curve model as it shows it might be wrong to use real GDP or real unit labor costs as proxies for the real marginal costs. To avoid this problem a direct derivation of real marginal costs should be made based on plausible assumptions. The mixed results of the empirical studies presented in the paper show that reliance on published data, which may be used as proxies for real marginal costs, may seriously alter the results of the estimations.

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Contact

Vít Pošta
Economic University, Prague
W. Churchill sq. 4, 130 67, Prague
vit.posta@vse.cz