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THE PRICE FORMATION PROCESS IN THE ALBANIAN ECONOMY: A MACRO MODELLING APPROACH

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Note: The views reflected in this paper are of the authors alone and do not represent views or policy stances of the Bank of Albania.

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A more detailed description on the evolution of the MEAM macro econometric model can be found in the Working Paper "Re-estimation of the Macroeconometric Model of the Albanian Economy (MEAM)" (Vika, I et al, 2016). The full model update with the price block described here incorporated is part of a future Project.

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ABSTRACT

This paper provides the modelling framework of the price formation block in the macro econometric Albanian model (MEAM). MEAM is constructed on neo-Keynesian theoretical principles, implying a vertical long-run aggregate supply curve with aggregate demand factors impacting supply in the short-run. The price formation block is composed of a set of equations that estimate the behaviour of key variables including domestic supply prices, import prices, demand deflators and wages. The primary innovations of this block are the estimation of domestic supply prices based on unit labour costs and of the import prices following a pricing to market approach. Demand deflators, derived on the basis of a homogeneity assumption in domestic supply prices and import prices, determine the final behaviour of prices in the economy.

Keywords: prices, wages, macro modelling

INTRODUCTION

This paper is focused on the development of the price formation block, within a larger project framework aimed at developing and improving the MEAM model. The general structure and level of disaggregation of the price formation block is developed with the sole objective to incorporate it within the MEAM model. The latter is constructed on a system of equations used for generating forecasts and simulation analysis. The MEAM model can produce conditional forecasts subject to initial assumptions on the expected economic developments. The transmission mechanisms amongst different economic sectors of the economy should be able to jointly determine and be captured by macroeconomic relationships between variables. Additionally, the relationships have to be stable regardless of the period of time during which they are observed and estimated. As such, the correct specification of short- and long-term dynamics within the price block structure as well as the accurate and efficient estimation of the parametrization that guides variable interrelationships are important in quantifying the effect of domestically generated and foreign shocks to the system.

Transmission mechanisms for different sectors of the economy should be defined and be able to capture macroeconomic interlinkages amongst variables and at the same time, they have to be stable regardless of the time period they are tested. As such, the correct specification of long and short term dynamics in the price block as well as accurate and efficient estimation of parameters guiding these interlinkages helps in quantifying the effects of domestic and foreign shocks on prices.

The re-specification of the price block creates a clear mechanism for creation and transmission of prices in the economy. Domestic inflationary pressures are transmitted in the economy through domestic supply prices and the foreign inflationary pressures through import prices. All other demand prices are expressed as a function of these two variables, restricted to a first order homogeneity that allows for a long-term equilibrium in prices. Domestic supply prices are a function of mark-ups and costs, where the latter is modelled on unit labour costs. The key driver of unit labour costs is average wage for which the minimum wage is selected as a covariate. The Philips curve specification is chosen as a functional form for the minimum wage equation. The specification of the import price equation is similar to the older versions of the MEAM model whereby a "pricing-to-market" behaviour is present.

Primary additions to the price block include: (i) introduction of domestic supply prices as a key determinant of demand deflators; (ii) introduction of an implicit derivation of mark-ups; (iii) endogenisation of aggregate demand prices (deflators); (iv) introduction of the minimum wage modelled through a Philip's curve; (v) specification of the average wage conditional on minimum wage; (vi) introduction of a general equilibrium in the price block.

The price block has been developed according to three principles. Firstly, it needs to be capable to provide a clear image of the price formation mechanism in the economy, hence it should not focus on one single variable or a partial equilibrium. The final goal is the inclusion and modelling of the behaviours of several key variables that can enable an all-encompassing description of economic dynamics. Secondly, it has to be both internally and externally coherent in describing economic processes. Internal cohesion consists in a set of relationships amongst variables, whereas external cohesion has to guarantee the reflection of current macroeconomic processes. Thirdly, it has to allow economists to incorporate external judgment efficiently while using the model taking into account that modelling is subject to parsimonious and aggregated relationships and can partially capture true dynamics. This way, we can also guarantee the necessary cohesion for the trajectories of all variables in the model.

THEORETICAL ASPECTS OF PRICE AND COST SETTING

Domestic supply prices

The construction of the price formation structure consists in the creation of a system of prices whereby domestic inflationary pressures are transmitted to the economy through one single price, domestic supply prices, and foreign inflationary pressures through import prices.

The price formation dynamics is crucial in determining the level of inflation. Relationships between macroeconomic variables define the creation, transmission and the level of inflation. The empirical literature identifying the variables that determine inflation from a macroeconomic aspect is large (Gordon, 1981, 1988; Domberger and Smith, 1982; Carlton, 1989; Hay and Morris, 1991; Layard et al. 1991; Rowlatt, 1992). Some models are constructed upon the basis of a price setting behaviour as a fixed mark up over costs, while others are build upon the purchasing power parity approach. There is a third class of models that assume both approaches are correct and incorporate elements of both.

Macroeconomists have always taken into account determinants of prices (Isard, 1977; Frenkel, 1978; Richardson, 1978; McKinnon, 1979; Bruce and Purvis, 1985; Giovannini, 1988). If domestically produced goods are tradeable and markets are competitive, the law of one price applies and domestic prices are determined by international prices. If domestically produced goods have no substitutes in goods produced abroad and perfect competition is lacking, then domestic prices are determined fully by domestic costs. If these two conditions are not fulfilled, then domestic supply prices are conditional on both costs and foreign prices.

According to the three definitions above McKinnon (1979) and Alogoskoufis et al. (1990) group produced goods in three categories: a) non-tradeables; b) tradeables but imperfect substitutes of goods produced abroad and c) tradeables and perfect substitutes of goods produced abroad. The price of each good is determined according to the group that said good falls into.

a. Non-tradeable goods

Assuming that firms produce non-tradeable goods and operate under monopolistic competition, they set the price of the goods according to marginal costs and profit. The price of the good produced is set as below:

$$p^{NT}=\mu^{NT}+mc^{NT} \tag{1}$$

Where, p^{NT} is the price of the non-tradeable good, $\mu^{NT}$is the mark-up and mc^{NT} is the marginal cost.

b. Tradeables with imperfect substitutes

If these firms also operate under monopolistic competition, their produced good's price is set in a similar way:

$$p^{I}=\mu^{I}+mc^{I} \tag{2}$$

Where, p^{I} is the price of the tradeable good with an imperfect substitute produced abroad, μ^{I} is the mark-up and mc^{I} is the marginal cost. The mark-up does not necessarily have to be constant and can be a function of relative prices, giving exporters a price setting power "*pricing to market*". Since profit has an inverse relationship with the elasticity of demand (Cowling and Waterson, 1976), it can be written as a function of relative prices:

$$\mu^{I}=\mu_0^{\;I}+\mu_1^{\;I}\,(p^{I*}-p^{I}) \tag{3}$$

where, p^{I*} is the price of the tradeable good with an imperfect substitute produced abroad expressed in domestic currency. If in the price equation we substitute the profit magin with its equation, we get:

$$p^{\,I} = \frac{1}{1+\mu_1^I}\,(\mu^{\,I}+mc^{\,I}+\mu_1^{\,I}p^{\,I*}) \tag{4}$$

c. Tradeables with perfect substitutes

The market for these goods is competitive and these goods are traded at the international price:

$$p^{S}=p^{S*} \tag{5}$$

where, p^{S} is the price of the tradeable good with perfect substitutes and p^{S*} is the foreign price expressed in domestic currency.

If τ^{NT} and τ^{I} are components of non-tradeable goods and of goods with imperfect substitutes produced abroad, then the price in general terms can be expressed as a weighted average of the three groupings of goods:

$$p=\tau^{NT} p^{N}T+\tau^{I} p^{I}+(1-\tau^{NT}-\tau^{I})p^{S} \tag{6}$$

If in equation (6) the price of each of the goods is substituted with the respective formula, after some mathematical manipulations, we obtain:

$$p =(\tau^{NT}+\mu^{NT}+\tau^{I}\frac{\mu_0^I}{1+\mu_1^I})+\tau^{NT}mc^{NT}+\frac{\tau^I}{1+\mu_1^I}\,mc^{I}+\frac{\tau^I\mu_1^I}{1+\mu_1^I}\,p^{I*}+(1-\tau^{NT}-\tau^{I})p^{S*} \tag{7}$$

Calculating foreign prices of tradeable goods (p^{I*} and p^{S*}) and of marginal costs for non-tradeables and tradeables is difficult, due to the lack of detailed and large datasets and due to the fact that it is never clear-cut which goods should be classified in which category. For this, in the literature authors build upon a set of assumptions to allow for the right theoretical formulation. First, foreign prices of tradeables move in the same direction ($p^{I*}=p^{S*}=p^{*}$), where p^* is the foreign price index of tradeable goods expressed in domestic currency terms.

Secondly, marginal costs for non-tradeable goods and for tradeable goods with imperfect substitutes also move in the same direction ($mc^{NT}=mc^{I}=mc$). As such we can write equation (7) as:

$$p=\tau^{NT} p^{NT}+\tau^{I} p^{I}+(1-\tau^{NT}-\tau^{I})p^{S} \quad (8)^{1}$$

In a general level, domestic supply prices are a weighted average of goods produced domestically and abroad. Since the focus is domestic supply prices (p^{DS}), and import prices are estimated separately, equation (8) takes the following form, where the above indexation ***'DS'*** refers to domestic:

$$p^{DS}=\mu^{DS}+mc^{DS} \quad (9)$$

Hence, despite the theory underlines the importance of setting prices as a mark-up over marginal costs, the large part of empirical studies uses average costs or the "normal cost" (Smith, 1982).

Import Prices

It is imperative to know the form and magnitude of the effect foreign price and exchange rate fluctuations have on domestic supply prices[2]. These two key components are transmitted to domestic prices through the price (deflator) of imports. The imports deflator connects the domestic prices with their foreign counterparts and is determined by both domestic and foreign factors as well as the exchange rate.

Amongst the foreign factors we can identify the trade-weighted export price index according to trade partners and oil prices, for countries who are not intense exporters of it. If there would be solely foreign factors, there would be a full transmission of foreign prices and of exchange rate fluctuations. Limits to full transmission are subject to the degree of competitiveness that goods produced abroad face from domestically produced goods. As such, exporters are forced to price their products according to local market conditions and consequently, the domestic price level is an important determinant of the imports deflator. Other domestic factors of interest are the level of competition and price rigidities in the domestic economy.

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[1] *Where,* $\mu=\tau^{NT}\mu^{NT}+\frac{\tau^{I}\mu_{0}^{I}}{1+\mu_{1}^{I}}$ *dhe* $\tau=\tau^{NT}\mu^{NT}+\frac{\tau^{I}}{1+\mu_{1}^{I}}$

[2] *Some research materials that analyse the exchange rate pass-through to prices in Albania are Istrefi and Semi (2009); Vika et al. (2007) and Peeters (2006).*

Economic theory on small open economies pays little attention to domestic factors' influence on import prices. The imports' price formation is based on the "law of one price (LOP)" assumption, which stresses that tradeable goods are sold at an equal price in domestic currency globally when there is perfect information symmetry between consumers and importers, there is no arbitrage in the market and there is perfect capital mobility. Nevertheless, some studies on small-open economies have provided empiricial evidence that counteracts this key assumption.

Early studies that disagree with the "law of one price" assumption are Isard (1997) and Richardson (1978). Giovannini (1988) concludes that deviation from LOP comes as a result of exchange rate movements. Pippenger (1993) focuses on Switzerland and concludes that this condition holds in the long-term. Pedroni (2001) analyses a panel of countries and refutes the hypothesis of the validity of LOP. Chen and Rogoff (2003) study Australia, Canada and New Zealand and conclude that the hypothesis holds for these countries. Yang et al. (2000) study developed and developing countries and come to the conclusion that the law of one price holds for developed countries but not when a developed country interacts with a developing country.

The empiricial evidence does not have a unified position on this hypothesis and shows that it is not easy to test the theory (Sarno and Taylor, 2002). Foreign producers can adjust prices according to changes in prices and costs in the importing country and may not transmit fully exchange rate fluctuations. This is termed as 'price to market' by Krugman (1987) and is a result of the lack of perfect competition, information asymmetry, arbitrage and barriers to market entry. The act of price setting by foreign exporters is termed as '*pricing to market behaviour*'. Brauer (1999) explains that the primary element behind price setting is the demand elasticity, which is a function of the reservation price and of the product substitution ability.

Supposing that exporting firms operate in a monopolistic competition market, the price setting behaviour for exported products follows the logic as in the paragraph above. From equation 8, import prices (p^M) can be derived as below.

$$p^M = p^*$$ (10)

Demand prices

Every component of the aggregate demand includes products produced domestically as well as imported goods. For this reason, the price indices of aggregate demand components have to include elements of domestic supply prices and import prices. In a macromodel the most important element is the transmission mechanism and the equilibrium condition. Hence, it is general practice that the specification of demand prices follows a long-term homogeneity condition between domestic supply prices and import prices.

This form of functional form for specifying the system of prices is used in the multi-country model in use at the ESCB (Fagan et al., 2001). In the quarterly model of the Bank of Italy (Buligan et al., 2017) aggregate demand prices (delfators) are modelled as a function of import deflators and of value added deflators. In the Slovenian macromodel, (Zummer, 2004) the consumer price index is modelled through a static homogeneity condition between the GDP deflator and the import price deflator[3]. Other papers describing modelling choices falling into the same category include countries like Spain (Willman and Estrada, 2002), France (Boissay and Villetell, 2005), the Netherlands (Angelini, Boissay and Ciccarelli, 2006), Germany (Vetlov and Warmedinger, 2006), Lithuania (Vetlov, 2004) and Greece (Sideris & Zonzilos, 2005).

Fullerton and Tinajero (2001) state that if the production function is homogeneous of degree one, then inflation is the weighted sum of the changes in domestic supply prices and import prices. In the multi-country macromodel of the United Nations, a dynamic homogeneity condition is incorporated in the system of prices in order to ensure a long-term consistency of the model (Alshuler et al. 2016).

[3] *Homogeneity can be static or dynamic conditional on if the restriction is imposed for the long or short term.*

In accordance with the concept that goods and services do not include only domestically produced goods but also imported goods, the domestic demand deflator (p^{DD}) can be expressed as a function of domestic supply prices, the imports deflator and of the indirect effective tax.

$$P^{DD}=f_D\,(P^{DS}, P^M,T) \quad (11)$$

Linearising the logarithm of equation 11 and assuming for a first order homogeneity condition of the domestic demand deflator to the domestic supply prices and the imports deflator, the equilibrium condition of demand prices (p^{DD}) can be expressed as below:

$$p^{DD}=(1+t)\exp(\lambda p^{DS}+(1-\lambda)\,p^M) \quad (12)$$

λ indicates the share of domestically produced goods in domestic demand. This share can be estimated or calibrated through input-output tables.

Since every component of the domestic demand deflators can be modelled in a similar way, the share λ can take different values reflecting the need for imported goods each component has. If $\widetilde{p}^{DD}$ is the domestic demand deflator net off taxes, then the dynamic form can take the specification according to equation 13, under the restriction that the parameters sum to unity.

$$\widetilde{p}_t^{DD}=\varrho_0+\varrho_1\widetilde{p}_{t-1}^{DD}+\cdots+\varrho_p\widetilde{p}_{t-1}^{DD}+\varsigma_1 p^{DS}+\varsigma_2 p^M \quad (13)$$

Next, the domestic demand deflator can be adjusted for the level of taxes[4]:

$$p^{DD}=(1+t)\,\tilde{p}^{DD} \quad (14)$$

Wages

[4] *Economic theory suggests that the transmission of an indirect tax change to final prices can be gradual as a result of menu costs. In order to allow for a gradual transmission of indirect tax changes to the domestic demand deflator equation 13 becomes:*

$$\widetilde{p}_t^{DD}=\varrho_0+\varrho_1\widetilde{p}_{t-1}^{DD}+\cdots+\varrho_p\widetilde{p}_{t-p}^{DD}+\varsigma_1 p^M+\varsigma_3\Delta t$$

$$\varsigma_3<0$$

Wage dynamics in Neo-Keynesian models combine elements from real business cycle theory with those of price rigidities and monopolistic competition.The literature on this topic is generally based on the works of Fischer (1997), Taylor (1980), Calvo (1983) and others which underline that wages and prices are determined through individual rational agents optimising their behaviour. Aggregating individual data leads to the link between inflation and real activity based on the Philips curve[5].

Firms have pricing power over the goods they produce, but are price-takers in the capital and labour markets. This implies that firms will optimise their profits conditional on the amount of capital they use, the labour force they employ and the number of products they produce, in a setting where technology is given and the prices of production factors is set by the market. Based on the profit (15) and the Cobb-Douglas production function (16), maximising for profit we can derive the equilibrium condition where the price of production factors in real terms have to be equal to their productivity.

$$\Xi = P\,Y - C \tag{15}$$

$$Y = TFP\,K^{\Upsilon}\,L^{1-\Upsilon} \tag{16}$$

$$\frac{P_W}{P} = (1-\Upsilon)\frac{Y}{L} \quad \& \quad \frac{P_R}{P} = \Upsilon\frac{Y}{K} \tag{17}$$

where Ξ, is profit, Y is the Gross Domestic Product, C are costs, TFP is the total factor productivity, K is capital, L is labour, Υ is the share of capital in the production function, P_W is nominal wage and P_R is rent.

According to the above specifications, in the long-term, wages should equalise labour productivity. In the short-term, wages adjust according to a Philips curve (Calvo, 1983), where wage growth dynamics are dependent on the cyclical position of the economy and the unemployment gap. The latter reflects price rigidities, since if prices were fully flexible, wages would immediately adjust and the labour market would always be in equilibrium.

[5] *Some materials that deal with aggregation issues include Yun (1996), King and Wolman (1996), Woodford (1996), Rotemberg and Woodford (1997a, 1997b), Clarida et al. (1997), McCallum and Nelson (1998), and Bernanke et al. (1998).*

To achieve a stable optimisation of the price system, wages need to have a similar long-term behaviour to inflation. Modelling nominal wages in a symmetrical fashion with prices is described further by Erceg et al. (2000)[6].

The nominal wage can be expressed as a function of developments in productivity, of the cyclical conditions and of inflation:

$$p_{w,t} = o\frac{\Upsilon}{l}_t + \Phi\Delta p_{w,t} - 1 + \Delta p - \Psi\tilde{u}_t \tag{18}$$

where, p_W is the nominal wage, $\frac{\Upsilon}{l}$ is labour productivity, p is inflation and $\tilde{u}$ is the unemployment gap.

MODEL SPECIFICATION AND DATA

Domestic supply prices

The domestic supply price specification is based upon an assumption of the firm operating under monopolistic competition, where firms set their prices on top of a mark-up over costs. As a measure of costs, the average minimum cost (amc) is used. The latter reflects the threshold in which the firm is indifferent between staying in the market or exiting it. Giving the firms the power to influence prices (the θ parameter takes into account this behaviour of firms) equation 19 takes the form below:

$$p^{DS} = \mu^{DS} + \theta amc \tag{19}$$

In the absence of a time series for average minimum costs, we have approximated it with unit labour costs ***(ulc)***. Unit labour costs are calculated as a ratio of compensation per employee to productivity. Compensation per employee should be the sum of wages and social security and health contributions. Since disaggregated data for the latter component are not available, labour compensation per employee is proxied by gross wages

[6] *Later research work include: Smets and Wouters (2003, 2007) and Christiano et al. (2005). For illustrations on macroeconomic modelling some works of interest can be found in Christoffel et al. (2008), Edge et al. (2007), Erceg et al. (2006).*

which partly includes contributions. Leaving out of the series the social and health contributions paid by the employer should not bring major deviations of parameter θ. The inclusion of these variables would only shift upwards the level of the series without affecting the dynamics, unless the shares of the contributions between employer and employee change. Labour productivity is expressed as a 2 year rolling average in order to minimise cyclical fluctuations in the long-term.

Domestic supply prices are calculated from turnover indices according to economic activity. The index of domestic supply prices is derived from the ratio of the value to the volume of turnover indices. We believe this series is an appropriate proxy variable for domestic supply prices. A drawback of this indicator is linked to the inclusion of taxes within the index. Private sector value added deflator would have been a better measure of supply prices but data does not exist.

Since in the long-term firms that operate under monopolistic competition do not generate increasing profits, the latter is expected to affect domestic supply prices only in the short-term. Direct official data for profit do not exist and here we treat it as an unobserved variable. This way, despite the indicator not modelled directly, its behaviour can be implicitly approximated from the developments in domestic and foreign determinants. The output gap captures the cyclical condition of the economy, while oil prices are used as a proxy for commodity prices. Other foreign factors are not included in the model under the assumption that there is no ability to substitute imports in the short-term and demand for imports is relatively inelastic. Relative prices impact domestic supply prices through the model's transmission mechanism.

We use a vector error correction econometric technique to estimate the equation, in line with the general estimation structure of the MEAM macromodel (Dushku, E., et al., 2006). These models assume that the economy moves to a long-term equilibrium condition according to theoretical definitions, but that it can deviate from this trajectory in the short term. The empirical specification of the "vec" technique used to estimate domestic supply prices is expressed as below:

$$\Delta p_t^{DS}=\gamma(p_{t-1}^{DS}-\theta ulc_{t-1}-\alpha)+\rho\Delta p_{t-1}^{DS}+\delta_1\Delta ulc_{t-1}+\delta_2\Delta p_{t-1}^{0}+\delta_3\frac{1}{8}\Sigma_{S=1}^{8}\zeta_{t-s} \quad (20)$$

where, Δ is the first difference, γ estimates the adjustment speed, p^0 is the price of oil in the domestic market and ζ is the output gap.

Import prices

In the model used to estimate import prices we assume an inelastic import demand, where at least in the short-term, domestically produced substitutes are absent. This trait of the economy provides the opportunity for foreign exporters to not be affected by prices in the Albanian economy during the process of price setting and formation of goods they export. The imports deflator is expressed as a function of foreign factos and the exchange rate. Allowing for a "*pricing to market*" effect from equation (10) we get:

$$P^M=\omega(P^F ER) \quad (21)$$

where, P^M is the imports deflator; P^F are foreign prices proxied by the export price index for the Euroarea as the largest chunk of imports comes from there; ER is the exchange rate lek/euro; and ω is the parameter that takes into account the "pricing to market" behaviour of exporters (if ω =1, then there is no "pricing to market" effect).

Taking logarithms (small letters indicate values in logarithmic form) and assuming that exporters do not react uniformly to changes in production costs in their economies as opposed to fluctuations in the exchange rate, equation (21) takes the form below:

$$p^M=\omega_1 p^F+\omega_2 er \quad (22)$$

According to the "vec" technique, the functional form to be estimated looks like the equation below:

$$\Delta p_t^M=\Omega^i(\lambda^i p_{t-1}^{DS}+(1-\lambda^i)p_{t-1}^M-\Phi^i)+\eta^i_1\Delta p^i_{t-1}+\eta^i_2\Delta p_{t-1}^{DS}+\eta^i_3\Delta p_{t-1}^M \quad (23)$$

Demand prices

The specification of demand deflators (excluding imports) in the model is based on equation (12). According to this equation deflators need to be net of indirect taxes for every component of aggregate demand and supply prices. While for the imports deflator this condition is fulfilled, for the other indicators data is not available. Turnover indices on which domestic supply prices are calculated include taxes. For this reason, the specification of demand deflators is done by including indirect taxes[7]. According to the "vec" technique the general functional form of demand deflators to be estimated is shown in equation (24).

A static homogeneity condition is included in the long-term component of the "vec" in relative price terms (Fagan et al., 2001).

$$\Delta p^{i}_{t-1}=\Omega^{i}(\lambda^{i}p^{DS}_{t-1}+(1-\lambda^{i})p^{M}_{t-1}-\Phi^{i})+\eta^{i}_{1}\Delta p^{i}_{t-1}+\eta^{i}_{2}\Delta p^{DS}_{t-1}+\eta^{i}_{3}\Delta p^{M}_{t-1} \qquad (24)$$

where the index 'i' represents the component of aggregate demand, more specifically, the household consumption deflator, the public consumption deflator, the investment deflator, the goods and services exports deflators. Weights are deflator specific and are calibrated according to input-output tables. At the same time, we have run empirical tests to certify the validity of such calibration. The speed of convergence in the long-term (Ω) and the short-term relationship is estimated.

The domestic demand deflator is calculated as a weighted-average of its components:

$$P_t = \Sigma^{i} w^{i}_{t} P^{i}_{t} \qquad (25)$$

Where, w^i is the share of the components. Shares are allowed to change in time in reflection of the evolving structure of the economy.

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[7] *Firstly, we constructed a net effective indirect tax series for the whole economy through alternative methods. Thereafter, domestic demand deflators net of taxes where obtained according to the transformation below: p˜ DD=pDD/(1+t).*
In the equations where deflators were specified without the level of indirect taxes we could not find a stable relationship.

The consumer price index (P^{CPI}) is expressed as a linear function of the household consumption deflator (P^{CP}) and a dynamic adjustment parameter (Π).

$$P_t^{CPI} = \Pi_t P_t^{CP} \quad (26)$$

Wages

The specification of wages follows equation (18). Owing to the structural breaks labour market indicators exhibit, it was not possible to estimate a stable relationship between average wage, labour productivity, unemployment gap and inflation. Meanwhile, initial analysis indicated a strong correlation between average wage and minimum wage.

Consequently, the specification of wage equations assumes that authorities set the minimum wage conditional on accumulated inflation and the cyclical position of the economy. As such, the minimum wage is modelled to follow a Philip's curve specification. This implies that authorities have more room to increase the minimum wage in cases where the economy operates above potential (the unemployment gap is negative) and vice versa. In the long run, productivity growth is assumed to be constant. In addition, the average wage is assumed to adjust fully to the inflation of the previous year. In an analytical form, the minimum wage can be expressed as below:

$$p_{wm,t} = o + \Phi \Delta p_{wm,t-1} + \Delta p_{t-1} - \Psi \tilde{u}_t \quad (27)$$

where, p_{wm}, p and $\tilde{u}$ represent respectively the 4 quarter moving average of the minimum wage, the 4 quarter moving average of the consumer price index and the unemployment gap. The unemployment gap is expressed as a difference between the actual unemployment rate and the natural unemployment rate[8].

The minimum wage acts as a determinant of the average wage level in the economy. Any change in the minimum wage by the

[8] *The natural unemployment rate is generated according to Çela and Skufi (2014).*

authorities is transmitted directly as a shift in the average nominal wage level. Consequently, the average wage is expressed as a linear function of the minimum wage with unit elasticity. The minimum wage is imposed at lag 4, which means that it takes about 1 year that average wages reflect fully changes in the minimum wage. Similarly, rigidities are captured by the autoregressive coefficient (parameter Φ takes values within the interval]-1; 0[). Assuming that employees paid at the minimum wage rate have a lower productivity, in the specification of the average wage, we have included a productivity term (ϖ) as a constant growth rate in time[9]. The analytical form of the average wage is expressed as below:

$$p_{w,t} = \varpi + \pi \Delta p_{w,t-1} + \Delta p_{wm,t-4} \quad (28)$$

[9] *The specification with two levels of productivity would be obsolete if productivity was not expressed as constants.*

PRICE BLOCK MODEL RESULTS

The system of equations included in the price block structure provides a clear and consistent picture of the price formation process in the economy. The reaction of key variables to specific identifiable shocks on the economy needs to reflect both economic theory and the distinct characteristics of the Albanian economy. The parameters of every behaviour equation have been estimated independently following the vector error correction technique. Beyond the correct identification of the direction and magnitude of the reaction of variables of interest to specific shocks, the price block can be used to conduct forecasts independently or integrated within the overall MEAM framework. In order to evaluate the price formation block's accuracy, stability and concordance with economic theory, a procedure of econometric tests has been developed to show the pattern of reaction of the price block and its forecasting capability.

Econometric tests focus on two crucial aspects that encompass the overall evaluation of forecasting performance through simulation processes of the price block. Impulse response function (IRFs) analyses explore model dynamic responses to unit shocks of exogenous (or exogenised) variables. To evaluate the forecasting performance of the price formation block, we have conducted a range of iterative in-sample forecasts. The time dimension of the database has been exploited to carry out this procedure, whereby forecasting results have been compared to actual available historical data. Furthermore, we have constructed probability distributions of forecast around central outcomes based on relevant moments of the stochastic process. Results are shown through "fan-charts"[10].

Parametrisation

The price block's parameters are largely estimated in individual equations through a "vector error-correction" technique. Parameter values on the speed of adjustment and on specific variables' long-term elasticities in the estimated equations are included in Table 1.

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[10] *The "fan-chart" graphical representation of point forecasts was firstly introduced by the Bank of England in 1996 in order to illustrate confidence intervals around point forecasts of headline inflation (Britton et al., 1998).*

Domestic supply prices and import prices exhibit a rather slow adjustment to fluctuations of costs and prices. Estimations for these parameters indicate that 20% of the deviation from the long-term equilibrium adjusts in one quarter for domestic supply prices and 25% for the imports deflator. The slower adjustment of domestic supply process reflects the slow movement of wages in time. The other aggregate demand deflators adjust relatively fast to changes in domestic supply prices and in the imports deflator. The household consumption deflator, the investments deflator and the goods exports deflator move back to their equilibrium relationship within six months. In the labour market, adjustment is slower owing to wage rigidities in the short-term. The minimum wage, as specified in the price block, adjusts within four quarters to fluctuations of inflation. Similarly, the average wage adjusts within four quarters to movements of the minimum wage.

The sign and magnitude of parameters is in line with prior expectations and with the idiosyncrasies of the Albanian economy. In the domestic supply price equation, an increase of labour costs with 1% in the long-term is associated with an increase of prices by 0.5%. A below 1 elasticity indicates the importance other costs have on price formation in the long-term. Estimates on the behaviour of the imports deflator support the presence of "pricing to market" effects. In the long term, parameters before foreign prices and the exchange rate are estimated to be different from 1, respectively 1.66 and 0.83. Above 1 elasticity of foreign prices suggests that transmission is amplified and generally perceived of a longer term nature and persistent. Fluctuations of the exchange rate are not fully transmitted to the imports deflator indicating a perception of it being a shorter-term phenomenon. These results are generally in line with the limited competition to imported goods and services in the economy.

Parameters on the rest of aggregate demand deflators are estimated according to a static homogeneity condition, whereby in the long-term the sum of parameters before domestic supply prices and import prices is restricted to 1. The results indicate that household consumption, public consumption, private and public investments and exports of goods are generally composed of domestic products. Exception to the rule here is services exports. This result is nevertheless to be expected as a large chunk of service exports includes imports of manufacturing services on physical inputs owned by others destined for re-exporting[11].

The transmission of accumulated inflation on the minimum wage and the transmission of changes to the minimum wage onto average wage are supposed to be full, hence parameters are calibrated to 1. Impact of labour productivity growth on the average wage is estimated to be twice as big as in the minimum wage, largely in line with respective wage levels. The autoregressive term in the wage equation, which should fall within an interval of [-1; 0] in order to reflect wage rigidities, is estimated at 0.58. In contrast, this parameter is positive in the minimum wage equation. This counter-intuitive result is underpinned by the fact that authorities have always increased the minimum wage.

[11] *Textile industry, which is an important sub-category of services, is classified in here.*

Table 1. Price block's parametrisation

DOMESTIC SUPPLY PRICES		
Adjustment speed	γ	-.18
Elasticity to labour costs	θ	.52
Growth rate of other costs	α	1.52
Elasticity to oil prices in the domestic market	δ_2	.04
Elasticity to cyclical conditions of the economy	δ_3	.22
IMPORT DEFLATOR		
Adjustment speed	ϑ	-.25
''Pricing to market'' effect to cost fluctuations	ω_1	1.66
''Pricing to market'' effect to exchange rate fluctuations	ω_2	.83
Growth rate of other costs	υ	7.15
OTHER AGGREGATE DEMAND DEFLATORS		
Adjustment speed	Ω^{i*}	-.71; -.15; -.85; -.58; -.21
Share of the product produced domestically in the aggregate demand equation	λ^{i*}	.6; .65; .7; .7; .45
WAGES		
Growth rate of labour productivity in the minimum wage	o	.3
Lag in reviewing the minimum wage	Φ	.36
Elasticity to unemployment gap	Ψ	-1.13
Growth rate of labour productivity in the average wage	ϖ	.6
Average wage persistence	π	-.58

$^*i$ includes the household consumption deflator, the public consumption deflator, the investments deflator, the goods exports deflator and the services exports deflator.
Source: Authors' calculations.

Impulse Response Functions

The price formation process follows a backward-looking Neo-Keynesian Philip's curve specification. Beyond price rigidities captured by the autoregressive term, price dynamics are a function of demand and supply shocks. Demand shocks are of a more short-term nature originating from unemployment or output gaps. Supply shocks can be of foreign or domestic origin. Foreign supply shocks are transmitted through import prices, whereas domestic shocks are approximated through unit labour costs. Other price variables (demand deflators and other prices) are modelled as functions of domestic supply prices and import prices. The average nominal wage is modelled as a linear function of the minimum wage, where the latter is captured by accumulated inflation, labour productivity and deviation of the unemployment rate from its natural rate. To help the interpretation of impulse response functions to specific exogenous shocks, the full transmission mechanism of the price block is included below (Chart 1).

To illustrate the dynamic behaviour of the price block, we have included the system in the full MEAM model and simulated two shocks in order to analyse the IRFs and identify the propagation of the shocks in the economy throughout the transmission mechanism. The shock simulations include firstly a domestic shock in the form of an increase of domestic supply prices by 1 percent for 4 consecutive quarters and a foreign shock for the second simulation. The model results shown take the form of deviations from the unique baseline solution of the system. The results of the simulation are included in Chart 2.

In the first scenario, we find shock unit labour costs for four quarters. In the first stage of the shock's propagation throughout the system, domestic supply prices start to increase but at a lower magnitude than the original shocks. This comes as a result of price stickiness which forces firms to partly absorb the shock internally and reduce mark-ups. Higher domestic supply prices leads to higher export prices and consequently a deterioration of the competitiveness of the economy. Household consumption and private investments increase slightly as a result of more stimulative real interest rate, leading to higher imports according to sectoral demand need for imports. The total effect on GDP growth is neutral as a result of the deteriorating external balance. In the second stage of the shock propagation in the economy, price variables stabilise whereas prices in the real sector of the economy are subject to second round effects. The continuous deterioration of external competitiveness leads to a deceleration of GDP and lower private investments. The economy goes through a cyclical deterioration which implies a fall in labour demand and an increase of the unemployment gap. The latter cushions wage pressures resulting in a deceleration of the minimum wage and of the average wage at the end of the period. The deceleration of wages has a small negative impact on household consumption.

In the second scenario, we shock foreign export prices for 4 quarters. In the first stage of the shock propagation, import prices start to increase faster than the magnitude of the original shock. This illustrates the "pricing-to-market" behaviour in the price bllock. Similarly, inflation starts to increase where in this case, despite firms absorbing part of the shock, transmission to final prices is higher. Goods and services export price indices increase and deteriorate foreign competitiveness of the exports. However, imports become relatively more expensive and dominate the overall effect in relative prices. For this reason, the external position of the economy improves and the impact on GDP is positive. Higher activity supports more private investments, while the cyclical improvement combined with higher inflation contribute to increased pressure for higher wages. In the second stage of the shock propagation within the economy, the average wage starts an upwards tendency which leads to higher domestic supply prices and inflation. Paralelly, goods and services export prices start to increase and instigate a deterioration of foreign competitiveness. Higher production costs domestically and higher inflation make imports cheaper in relative terms. Improved incomes from higher wages generate an increase in household consumption but also a rise in the now cheaper imports in relative terms. As a result, the foreign competitiveness of the economy deteriorates and dominates the overall negative effect on GDP.

Chart 1. The system of demand and supply price formation and transmission

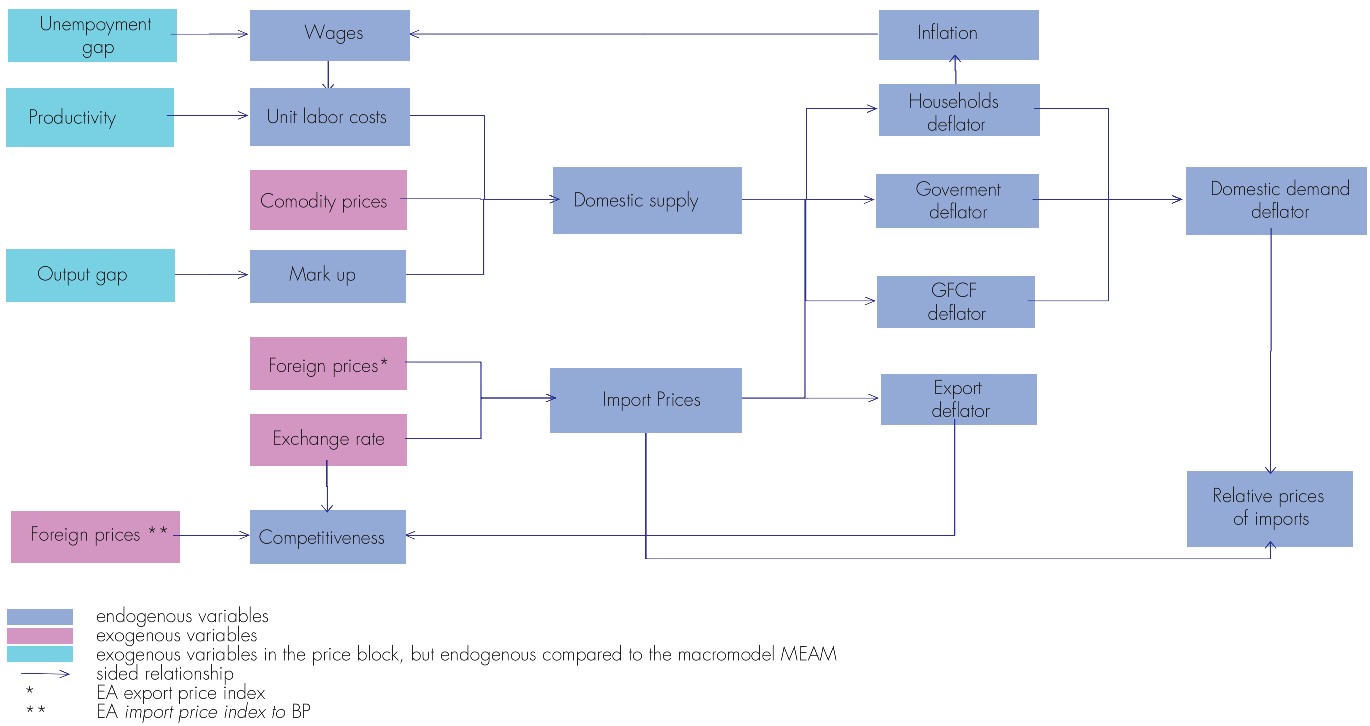
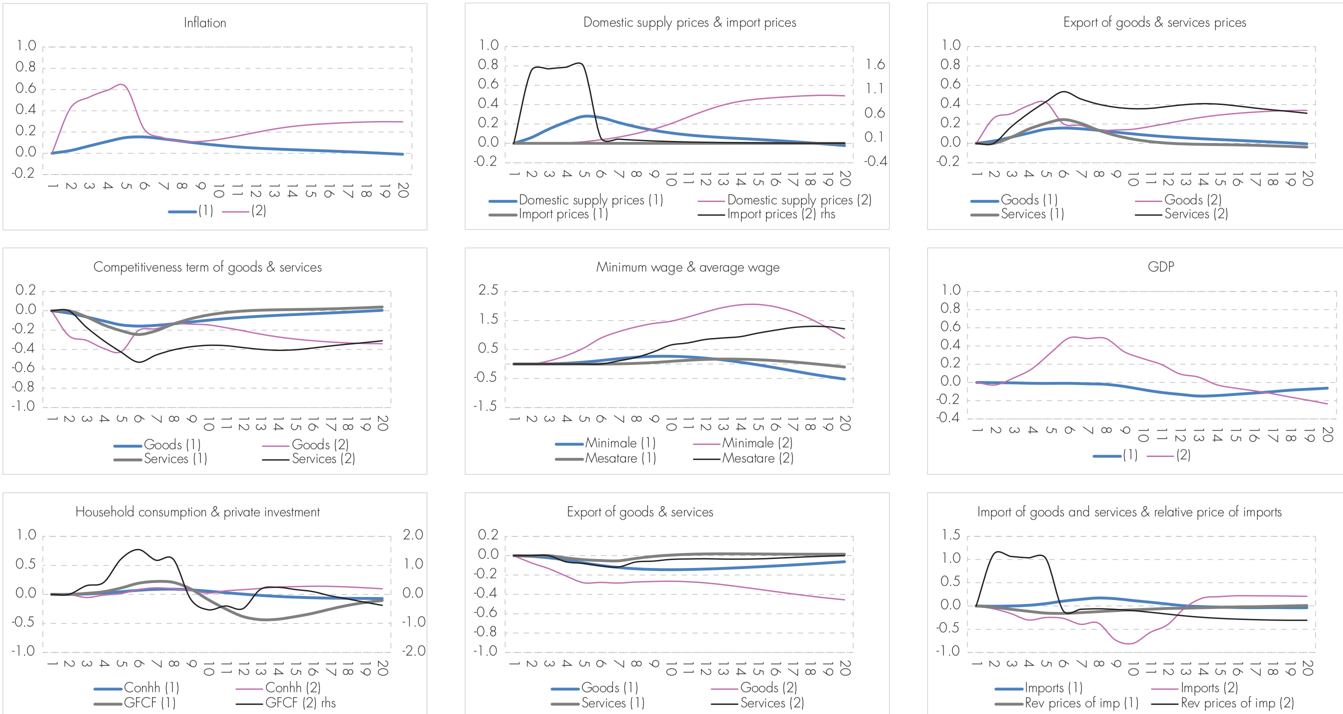


Chart 2. Indicators' response to supply shocks

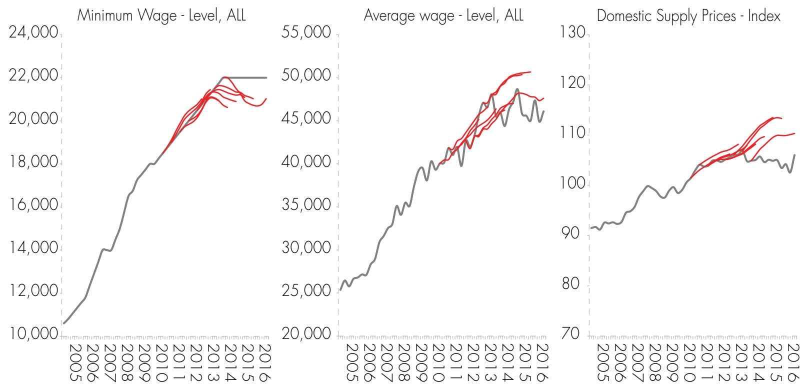


Source: Authors' calculations

In-sample simulations

The in-sample simulation process is designed to evaluate the forecasting performance of the price block at different points in time. For this 8 pure forecasts have been carried out[12] with a forecasting horizon of 8 quarters. The first simulation starts in the first quarter of 2013 and ends in the last quarter of 2014. The final 8th simulation ends in the last quarter of 2016. For every simulation, we assume that actual values of endogenous variables do not exist and thereafter forecast results are compared to actual values. The evolution of exogenous variables in time is known for every period and for the whole forecasting horizon. Results shown cover the key variables in the price block.

Chart 3. Simulation results for the minimum wage, average wage and for domestic supply prices.



Source: Authors' calculations

Simulation results for the minimum wage replicate well its historical development at least until 2014. Beyond 2014, the simulation slightly underestimates the minimum wage level due to an expanding unemployment gap and a lower accumulated inflation. The latter has a negative short-term impact on the minimum wage. The model suggests a decrease of the minimum wage level owing to

[12] *Pure forecasts in this case are carried out through updating exogenous variables with actual data for the whole forecast horizon and generating the model consistent values of endogenous variables.*

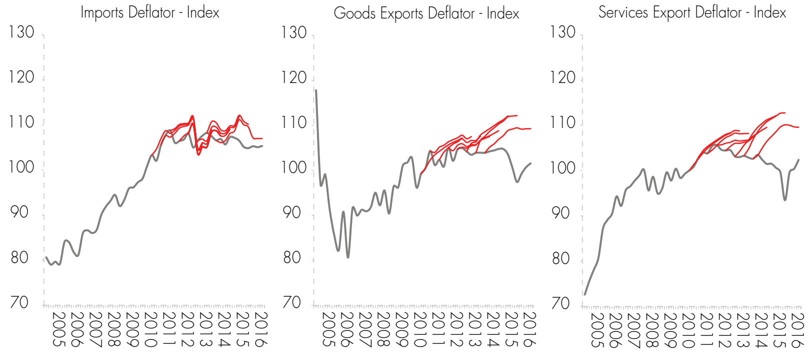
deteriorating cyclical conditions during 2014-2015. Nevertheless, bearing in mind that determining the level of the minimum wage is ultimately a discretionary policy choice and lowering it can be politically sensitive, the stochastic behaviour of the variable is rather nonlinear and is subject to a lower zero limit on the change of the minimum wage level. For this period, the actual value has remained unchanged reflecting reduced scope to increase the nominal wage.

This tendency is captured from the model simulation. The unemployment gap has a closing trajectory during 2016 and pushes the estimation of the expected development in the minimum wage towards its actual level. In-sample simulations on the average wage level are generally in line with its historical development, albeit not able to capture the drop in the average wage in 2014.

The latter is estimated to be a divergence linked to a large labour market formalisation push, which are interpreted as short-term shocks from the equation block and cannot be replicated by the simulation. The difficulty in replicating the history for this period imposes a slight upward bias in the results, which is evident in the simulation of domestic supply prices. Simulations for the latter overestimate actual values at least from the start of 2014. This result is conditional on the overestimation of unit labour costs for this period. Actual results indicate rapid employment growth which in terms of cyclical economic conditions would imply tighter labour market conditions, drop in labour supply and consequently higher wage growth pressures.

Since this registered rapid employment growth is linked directly to labour market formalisation processes and average wage does not change, productivity in the economy falls and unit labour costs increase rapidly. The latter indicator is a key driver of forecast results above actual results beyond 2014.

Chart 4. Simulation results for import prices and goods and service export prices

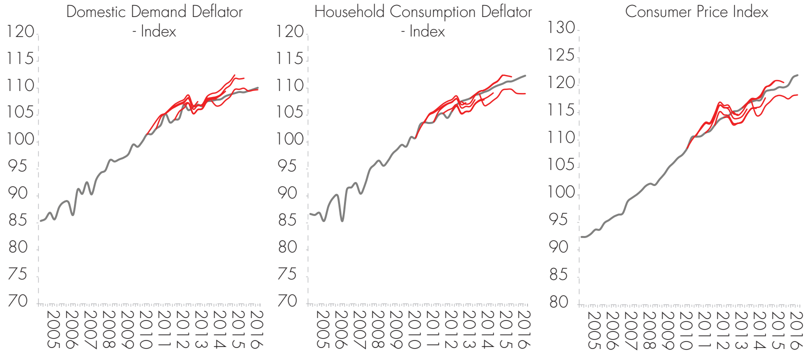


Source: Authors' calculations

Domestic supply prices are an important element in guiding the behaviour of the price of goods and services exports in time. As a result, the simulation for the latter variable overestimates actual values for 2014 and 2015 and the indices stabilise in higher levels compared to actual values. Similarly, the simulation cannot replicate the sharp drop in export prices of goods and services during the first half of 2015 and the beginning of 2016. This actual development in export prices is attributed to a large fall in oil and metal commodity prices in international markets. Short-term supply shocks originating in international markets cannot be anticipated and as such they cannot be captured by the simulation. On the other hand, simulation results for import prices follow closely actual outcomes of this variable for the large part of simulation exercise.

However, it has to be noted that the simulation underestimates slightly the actual import price data during 2013 and 2014. This variable's dynamic is subject to foreign export prices that have experienced a rapid drop during the period but that they have not been fully transmitted to actual import prices. The latter indicator is the second most important driver of goods and services export prices after domestic supply prices.

Chart 5. Simulation results for the domestic demand deflator, the household consumption deflator and the consumer price index.



Source: Authors' calculations

The domestic demand deflator is composed by the public and private investment deflators, the public consumption deflator and the household consumption deflator. In order to illustrate in a more clear-cut form the interpretation of the simulation results, we have included only the final indicator that aggregates domestic demand prices and not its components. Exception to the rule here is the household consumption deflator as its behaviour is important in defining the evolution of the consumer price index in time. In-sample simulations for the domestic demand deflator can replicate well its actual evolution in time. The simulation exhibits heightened volatility around the actual values around the simulation period 2014-2015 and manages to replicate correctly the historical development of the domestic demand deflator at the end of the sample. Historical simulations for the household consumption deflator and the consumer price index are largely identical since the former is the sole behavioural determinant of the latter. All simulation results follow closely actual variable outcomes. The exception here is the first two simulation exercises. During this period, the simulation outcome for lower import prices compared to actual variable outcomes dictates an underestimation of the household consumption deflator. This slight divergence is similarly reflected in the initial in-sample simulations of the consumer price index.

The consumer price index is the most crucial element of the price block's transmission mechanism. Its volatility in time initially affects the behaviour of wages in the economy, which thereafter are transmitted on to all the other segments of the price formation channel and end up again in the consumer price index to close the whole transmission loop. For this reason, identifying correctly and efficiently the behaviour of the consumer price index in time is paramount in tracking the movement of specific impulses within the transmission mechanism.

Graphical simulation of probability distributions around point forecasts ("fan-charts")

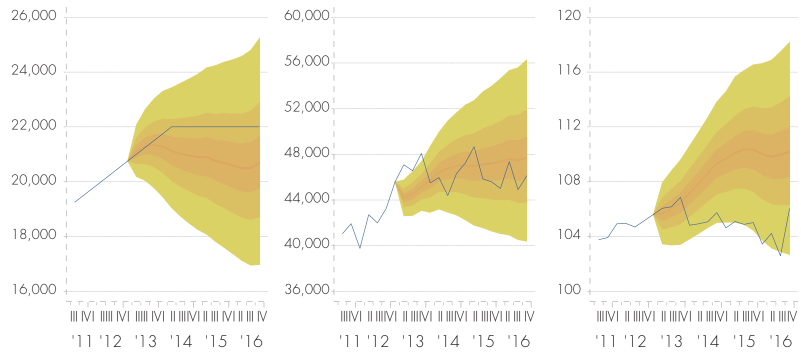
The generation of probability distributions around central point forecasts for specific indicators and its graphical representation constitutes an efficient illustrative method to evaluate the forecasting power of the model. This simulation method is different from the in-sample approach in concept, construct as well as in the interpretation of results. The graphical representation is done through "fan-charts" which helps in illustrating more transparently the uncertainty around the central forecast.

The database of the price block's model on which probability distributions are constructed ends in 2012. Forecasts for variables of interest are carried out for the next 4 years, until 2016, for which actual values of variables are available and the forecast can be compared to actual data. Since the structure of the price block models long-term relationships of variables allowing at the same time for short-term deviations, 4 year ahead out-of-sample simulations conditional on exogenous variables are possible. It has to be noted that the exact time when forecasts are initialised have implications on the actual simulation results, but to conserve parsimony of illustration and to enable the comparison of results, the forecasting period is kept constant[13].

[13] *Some research materials dealing with the importance that the correct approximation of economic behaviour at the start of the forecast and the actual forecast starting point have on forecast results are Benes et al. (2010), Turner (2016), Gallo et al. (2010), and Chen et al. (2009).*

To construct probability distributions around the central forecast some important parameters of the structure of the price block have been made use of. To generate normally distributed random numbers following a "Monte Carlo"[14] technique we have used the standard deviations of innovations in specific variables' behavioural equations. Confidence intervals selected for the "fan-charts" are set at 1%, 30%, 60% and 90% of the probability distribution around the central forecast. The variables selected are the same ones analysed during the in-sample simulation exercise.

Chart 6. Probability distribution around the central forecast of the minimum wage, average wage and domestic supply prices.



* Confidence intervals starting from the darkest shade are 1%, 30%, 60% and 90%

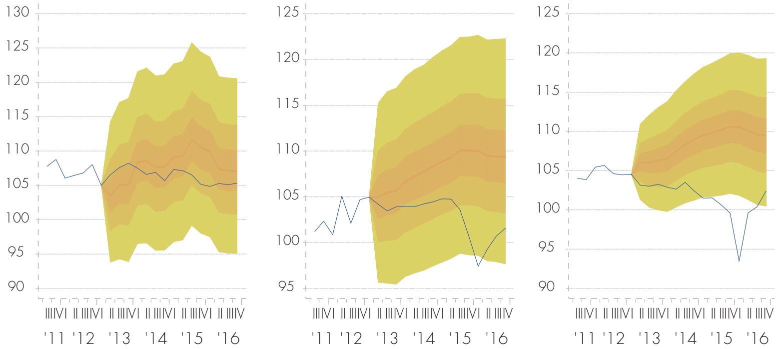
Source: Authors' calculations

Actual results on the evolution of the minimum wage for the period 2013-2016 are within confidence intervals around the central forecast. In the first year of the simulation, the forecast for the minimum wage is more accurate and actual values are within the 30% confidence band. Forecasting performance deteriorates slightly in the next 3 years. Nevertheless, actual values falls within the 60% confidence interval at all times. The simulation of the average wage cannot pin down correctly the actual behaviour of the indicator in the short-term. Actual data for this period are affected by an income tax policy change at the beginning of 2013, where the taxable lower threshold was increased from ALL 10000 to ALL

[14] *A similar technique has been adopted by Simionescu (2014) e Sugiyama (2007). A more broad-based illustration of the stochastic simulation uncertainties generated by the MEAM model through Monte-Carlo procedures can be found in Ceca et al. (2012).*

30000[15]. The legal change on the tax system is estimated to have fuelled the reporting of a higher wage level in 2013 and it is impossible to be captured by the model without imposing an expert judgment. In a more medium-term horizon starting from the second year of the simulation, the projection performance improves and actual data fall within the 30% confidence band around the central forecast. Simulation results for the domestic supply prices provide a similar picture to in-sample results. In addition, the forecasting performance is slightly worse when compared to the previous two indicators. The simulation can project accurately the actual values of domestic supply prices for the first year of the forecasting exercise but thereafter performance deteriorates. Actual results remain within the lower limit of the probability distribution and within the 90% confidence interval.

Chart 7. Probability distribution around the central forecast of import prices and goods and services export prices.



* Confidence intervals starting from the darkest shade are 1%, 30%, 60% and 90%

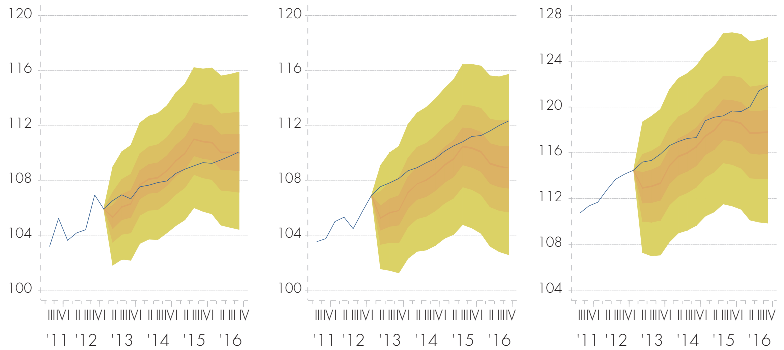
Source: Authors' calculations

The simulated probability distribution of the evolution of import prices in time indicates a good performance in approximating actual historical results of this indicator. Actual outcomes fall within the 30% confidence interval around the central forecast. Here, the probability distribution of the forecast for the first half of 2015 and beginning of 2016 is an exception and actual import price data fall in the 60% confidence interval. Similar to the in-sample exercise,

[15] *For more detailed information, see law nr. 107/2013: http://www.qbz.gov.al/botime/fletore_zyrtare/2013/PDF-2013/53-2013.pdf*

goods and services export price forecasts perform slightly worse when compared to actual data for these indicators. The probability distribution of the export price index forecast indicates a higher uncertainty when compared to other indicators' forecasts in the price block. Actual values of this indicator generally fall within the 90% confidence interval around the central forecast for the larger part of the forecast horizon and fall outside of confidence bands during the first quarter of 2016. We obtain a similar result when we simulate the probability distribution of the services' export price forecast. Despite a smaller overall uncertainty in the forecast and narrower confidence bands, forecasting performance for a 4 year horizon is slightly weaker. Actual results generally fall within the 90% confidence interval around the central forecast and fall below the confidence bands for the whole of 2015 and for the first half of 2016. Both these indicators were subject to short-term shocks which a 4-year simulation of the price block is not expected to anticipate or to identify.

Chart 8. Probability distribution around the central forecast of the domestic demand deflator, of the household consumption deflator and of the consumer price index.



* Confidence intervals starting from the darkest shade are 1%, 30%, 60% and 90%

Source: Authors' calculations

For the last three indicators of interest, the domestic demand deflator, the household consumption deflator and for the consumer price index, the simulated probability distributions around the central forecasts indicate a highly accurate forecasting power of the price block. Actual values for these indicators remain around the central forecast and fall below the 60% confidence interval for the whole forecasting period. The accuracy of the forecasts for the household consumption deflator and for the consumer price index deteriorates slightly during the last year of the simulation. Actual data for these indicators fall within the 60% confidence in the last year of the simulation moving from the 30% band for the first 3 years. Nevertheless, the forecast uncertainty for these indicators is lower when compared to the previous indicators and the simulation results are closer to actual historical values.

CONCLUSIONS

In this material, we introduce the theoretical principles and empirical results behind a price formation block developed to be incorporated in the MEAM model. The correct specification of the price formation process and the accurate identification of economic factors behind price fluctuations in time are important in informing the monetary policy decision making process. At the same time, this block constitutes a valuable extra instrument in the medium term forecasting toolkit.

The price block is constructed according to the theoretical principles of Neo-Keynesian theory, reflecting a clear and detailed transmission mechanism of price formation in the economy and allowing for a "pricing-to-market" behaviour to final prices. The building blocks of price formation in the country are import prices and domestic supply prices. The first element is specified through a standard combination of exchange rate and foreign price fluctuations. The second, reflects not only the cyclical position of the economy but also the evolution of wages in the economy conditional on the minimum wage. The latter approximates the discrete behaviour of the bureaucracy in setting the change in minimum wage while factoring in accumulated inflation in time. Import prices and domestic supply prices are the primary components of demand price formation in the economy.

The behavioural parameters' matrix in the price block is largely estimated through a stochastic process and is calibrated for some parameters on which there is sufficient economic information on their likely value. Dynamic characteristics of the price block are illustrated through impulse response functions to unit shocks on exogenous variables, through in-sample forecasts and through stochastic simulations for several years ahead and comparison of probability distributions of central forecasts to actual values. Results indicate an economic behaviour coherent with macroeconomic principles in case of exogenous shocks, a sufficient capacity in replicating historical behaviour and a high level of forecast accuracy in a medium term perspective.

Future improvements on the price block are closely intertwined with detailed data availability which could require a different specification of its functional form. The behaviour of some variables of interest needs to be better captured in order to be fully in line with theoretical principles. As such, domestic supply prices would be more reflective of price developments if they were modelled on the private sector's value added deflator. Furthermore, compensation per employee needs to include health and social insurance outlays and domestic demand deflators need to be net of indirect taxes. Similarly, the foreign price index should be further detailed to reflect closely export prices of our trading partners. In a more methodological perspective, the specification of domestic supply prices before and after tax would be a great addition to the specification of the price block.

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