Theoretical and Applied Economics
Volume XXI (2014), No. 11(600), pp. 85-94

A mark-up model of inflation for Morocco

Hicham BENNOUNA
University Mohammed V, Rabat-Agdal, Morroco
hicham.bennouna1@gmail.com

Abstract. *We follow Brouwer and Ericsson (1998) approach in order to estimate a mark-up model of price over unit costs in Morocco from 1997q1 to 2013q2. This kind of models assumes that the equilibrium price level is set as a markup on some combination of input prices. Therefore, by estimating the short-run and long-run price elasticities with respect to unit labor costs and import prices, it's possible to calculate the impact of supply shocks related to production costs. This treatment of price dynamics is at the heart of the modern approach to modelling inflation, both for forecasting and for policy analysis. The mark-up model identified in this paper highlight the fact that unit labor costs and import prices are key factors in the price setting strategy of the Moroccan firms.*

Keywords: mark-up, inflation, import prices, production costs, price setting.

JEL Classification: E50, E52, E58.
REL Classification: 8F.

1. Introduction

The mark-up over marginal costs is a key factor in many macroeconomic models. Indeed, Rotemberg and Woodford (1999) conclude that the mark-up is rather countercyclical in the sense that it tends to decrease at the end of the upswing. Similarly, under the new Keynesian models, stating price rigidity and the marginal costs procyclicality, an expansionary monetary policy or a government positive spending shocks would weakened the mark-up (Goodfriend and King (1997). This result has been empirically verified by several empirical research: Smets and Wouters (2003, 2007) and Christiano et al. (2005). However, Christopher and Ramey (2010) found that most measures of the markup are procyclic1al or acyclical. In addition, the authors found that the mark-up increases in response to positive monetary shocks and is unresponsive to government spending shocks.

Based on empirical studies, the consensus about the mark-up cyclicality isn't obvious, although, several empirical studies agree with the fact that there is a negative relationship between the mark-up and inflation. Indeed, Bénabou (1992) argues within a price-taking model that higher inflation leads to greater competition and therefore a lower markup. Similarly, De Bandt et al. (2004) conclude that competition improves when the inflation rate is in very high levels, as companies decide to reduce their monopoly power to keep their market share.

The paper is organized as follows. In Section 2 we will set out the theoretical framework that we follow, the empirical results are discussed in section 3.

2. A framework for modelling inflation

2.1. Definition of mark-up

The theory of cost-push inflation assumes that the price level is set as a combination of the production costs (unit labor cost and imported prices) plus a mark-up set by firms operating in an imperfect competitive market. Indeed, Banerjee et al. (2001) defined the mark-up as $mu = p - \sum_{i=1}^{k} \psi_i c_i$ where p is the logarithm of prices, the c_i's are the logarithm of the various costs of production and $\sum_{i=1}^{k} \psi_i = 1$.

In order to investigate the behavior of the mark-up over the cycle and its contribution to inflation movements in the Euro Area, Bruneau et al. (2004)

defined the mark-up as $mu_{2t} = p_t - \frac{1}{1+\rho}(w_t - \pi_t) - \frac{\rho}{1+\rho} IPI_t$, in the Layard, Nickell and Jackman (1992) tradition, where w_t, π_t, p_t, IPI_t are wages, labour productivity, the price level and the imported price level, respectively.

2.2. Derivation of the mark-up equation

According to Célérier (2009), the mark-up equation was derived by considering firms operating in an imperfect competitive environment, in which the firm *i* determines its market share Y_i / Y by setting its price P_i relatively to the average price of its competitors price P on the basis of the demand function it faces:

$P_i = P.(\frac{Y}{Y_i})^{\frac{1}{\varepsilon}}$, where ε is the price elasticity ($\varepsilon \succ 1$).

The profit maximizing condition implies that, in equilibrium, the marginal revenue equals the marginal costs mc_i. The firm's revenue being $R_i = P_i.Y_i$, its marginal revenue is:

$$\frac{dR_i}{dY_i} = \frac{dP_i}{dY_i}.Y_i + P_i = P_i.(1 - \frac{1}{\varepsilon})$$

The equilibrium condition for the firm can hence be written:

$$P_i = (1 + \frac{1}{\varepsilon - 1}).mc_i$$

In the symmetric equilibrium ($P_i = P$ et $mc_i = mc$), this leads in the aggregate to the fundamental equation:

$$P = (1 + \frac{1}{\varepsilon - 1}).mc$$

The price level is thus defined by a mark-up ($\mu = \frac{1}{\varepsilon - 1}$) over the marginal cost.

According to this equation, if the mark-up is zero, we are in a perfect competition environment, however, if the mark-up is equal to unity, we are faced to monopoly.

In a Cobb-Douglas framework, the price function becomes:

$\ln(P) = \ln(1 + \mu) + \beta.\ln(\rho) + (1 - \beta).\ln(\frac{\varpi}{\Gamma}) + a$, where ω, ρ, Γ, μ are wages, cost of capital per unit, labour productivity and the mark-up, respectively.

In the case where firms use imported inputs in their production process, the new form of the mark-up equation becomes:

$\ln(P) = \theta_0 \ln(1+\mu) + \theta_1.\ln(\rho) + \theta_2.\ln(\frac{\varpi}{\Gamma}) + \theta_3.\ln(P_M) + \theta$, where P_M is the import price level.

2.3. The cyclicality of the mark-up

The mark-up over marginal costs is a key factor in several macroeconomic models. Indeed, Rotemberg and Woodford (1999) conclude that the mark-up is rather countercyclical in the sense that it tends to decrease at the end of the upswing. According to the authors, since the marginal costs (MC) rise faster than prices (P) in periods of economic expansion, this implies that the real marginal costs (MC/P) are procyclical. Therefore, the mark-up, which is the inverse of real marginal costs (P/Cm), is countercyclical. Similarly, under the new Keynesian models, stating price rigidity and the marginal costs procyclicality, an expansionary monetary policy or a government positive spending shocks would weakened the mark-up (Goodfriend and King (1997). This result has been empirically verified by several empirical research: Smets and Wouters (2003, 2007) and Christiano et al. (2005). However, Christopher and Ramey (2010) found that most measures of the markup are procyclic1al or acyclical. In addition, the authors found that the mark-up increases in response to positive monetary shocks and is unresponsive to government spending shocks.

Otherwise, several empirical studies have focused to understand the negative relationship that may exist between inflation and mark-up. The question is to understand the real effects of inflation in imperfectly competitive markets. Especially, if inflationary episodes times, when consumers are confused about real price, leads to raise monopoly power or to enhance competition.

Indeed, Banerjee and Russell (2001) found that higher inflation is associated with a lower mark-up in the long run. Particularly, the mark-up decrease as inflation increases and vice versa. This relationship was verified for the G7 economies and Australia. Therefore, according to the authors, one explanation of the negative long-run relationship in the data is that the 1970s were a period when supply shocks from the energy and labor market were very prevalent. The low mark-up, therefore, simply reflects the lags in price adjustment following the shocks.

Similarly, Bénabou (1992) showed that in the United States, periods of high inflation are associated with a low mark-up. Indeed, a very high inflation rate leads to greater competition and therefore a lower mark-up. In contrast, Russell, Evans and Preston (1997) focus on the difficulties that price-setting firms face when adjusting prices in an inflationary environment where there is missing information. The authors found out that in this case, the lower mark-up with higher inflation is interpreted as higher cost of overcoming the missing information with higher inflation because firms would lose their market share if they set prices inappropriately.

3. Empirical results for Morocco

3.1. Stationarity tests

Before modeling the CPI, it is useful to determine the orders of integration for the variables considered. Table 1 lists the results of the augmented Dickey-Fuller (ADF(4)) and the Phillips-Perron (PP) tests for the CPI, the import price index (IPI) and the unit labor cost (ULC) from 1997Q1 to 2013Q2. Empirically, all variables appears to be I(1).

Table 1. *Results of ADF and PP tests from 1997q1 to 2013q2*

	Variable		
	CPI	IPI	ULC
ADF	I(1)+c	I(1)	I(1)
PP	I(1)+c	I(1)	I(1)+c+t

Figure 1. *The consumer price index, unit labor costs and the import price index*

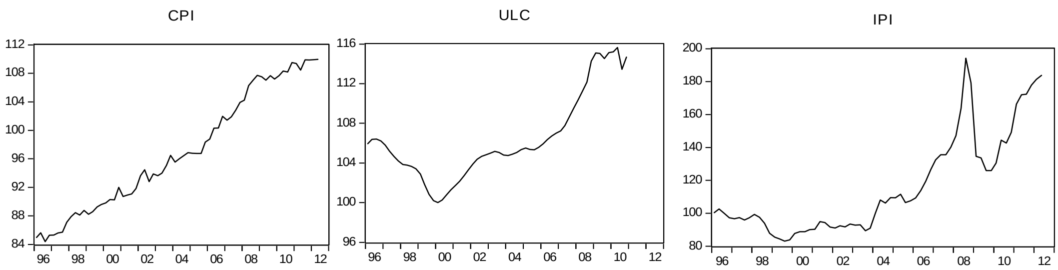
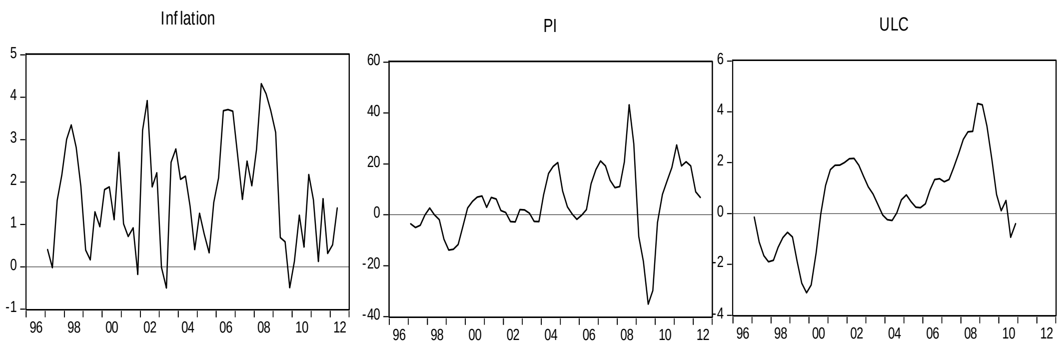


Figure 2. *Year over year quarterly growth rate for the consumer price index, unit labor costs and the import price index*



3.2. Cointegration tests

Cointegration analysis helps clarify the long-run relationships between integrated variables. Johansen's (1988, 1991) procedure is maximum likelihood for finite-order VAR is used here from 1997Q1 to 2013Q2. Table 2 reports the maximum eigenvalue and trace eigenvalue statistics. The latter reject the null of no cointegration in favour of at least one cointegrating relationship.

Table 2. *Cointegration analysis conducted from 1997q1 to 2013q2*

	No cointegration	At least one cointegrating relationship
Trace statistics	31.54	8.11
95% critical value	24.27	12.32
Maximum eigenvalue statistics	23.44	6.12
95% critical value	17.80	11.22

The long-un relationship identified through the Johansen's procedure from 1997Q1 to 2013Q2 is as follows:

$$\log(CPI_t) = 0.24 * \log(IPI_t) + 0.75 * \log(ULC_t) + \varepsilon_t \quad (1)$$

Numerically, the long-run price elasticities with respect to unit labor cost and import price are statistically significant, positive and less than unity. In addition, the coefficient related to ULC is higher than the one associated to IPI, showing that wages and import price are key factors for firms in their price setting strategy. Also, the sum of coefficients in (1) is equal to unity, and statistically the restriction of long-run unit homogeneity cannot be rejected.

3.3. Selected model

We used the Engle and Granger's approach for estimating a two steps cointegration model. In the first step, we estimate the long-run relationship between CPI, ULC and IPI from 1997Q1 to 2013Q2. We found out that the latter is quite similar to the one found by Johansen's (1988, 1991) procedure (equation 1):

$$\log(CPI_t) = 0.19 * \log(IPI_t) + 0.78 * \log(ULC_t) + \xi_t \quad (2)$$

The ADF test (Table 3) indicates that the residuals related to equation (2) are stationary. Also, the restriction of long-run unit homogeneity cannot be rejected.

Table 3. *ADF test for the residuals of equation 2*

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.54	0.01
Test critical values:	1% level	-2.60	
	5% level	-1.94	
	10% level	-1.61	

In the second step of Engle and Granger's procedure, we estimate the short-run relationship over 1997Q1-2013Q2. To do so, we based our selection procedure by using step-wise method. Indeed, we first started by a more general model of lag 5, and then we removed the non significant parameters, until we found a final model where all parameters are significant and relevant to economic theory. Therefore, the selected model has the following form:

$$d(\log(CPI_t)) = -0.06 * \xi_{t-1} - 0.29 * d(\log(CPI_{t-1})) - 0.20 * d(\log(CPI_{t-5})) + 0.3 * d(\log(ULC_t)) + 0.03 * d(\log(IPI_t)) + \upsilon_t \quad (3)$$

Numerically, the parameters of equation (3) are statistically significant; the Durbin Watson statistic is close to 1.99. However, this statistic is not significant in the context of dynamic models. Therefore, the Breusch-Godfrey test was conducted and shows that residuals of equation (3) are not autocorrelated (p-value = 0.20). Also, the heteroskedasticity (Breusch-Pagan-Godfrey) test shows that the variance of the residuals is constant over time, which means that the errors are not heteroscedastic.

Empirically, the feedback effect of the lagged disequilibrium in the cointegrating relation onto the inflation rate is statistically significant and negative (-0.06), which implied that an excess mark-up induces a greater price rigidities. In addition, the short-run price elasticities with respect to unit labor cost and import price are 30% and 3%, respectively.

4. Conclusions

Following de Brouwer and Ericsson's (1998) approach for modelling Australian inflation, this paper investigates the short-run and long-run effects of production costs onto inflation rate in Morocco by estimating a mark-up model of price over unit costs. The latter shows that unit labor costs and import price are key factors for firms in their price setting strategy.

In fact, the importance of imported inflation comes mainly from: the fixed exchange rate regime, the structure of the consumption basket and the degree of economic openness. In addition, the unit labor costs play a major role for explaining inflation dynamics in Morocco. This result is confirmed by Mohanty and Klau (2001) analyses over 14 emerging economies during the 80s and 90s, which suggest that wages, exchange rate and inflation persistence affect both inflation and its volatility.

References

Banerjee, A., Russell, B. (2001). “The Relationship between the Markup and Inflation in the G7 Economies and Australia”, *The Review of Economics and Statistics*, Vol. 83, No. 2, May, pp. 377-384

Banerjee, A., Russell, B. (2005). “Inflation and Measures of the Markup”, *Journal of Macroeconomics*, Vol. 27, Issue 2, June, pp. 289-306

Bénabou, R. (1992). “Inflation and markups”. MIT, Cambridge, MA 02139, USA and NBER. *European Economic Review,* 36, pp. 566-574, North-Holland

Bils, M. (1987). “The Cyclical Behavior of Marginal Cost and Price”, *The American Economic Review*, Vol. 77, No. 5, Decembre, pp. 838-855

Bowdler, C., Jansen, E.S. (2004). “A markup model of inflation for the euro area”, European Central Bank, *Working paper series*, No. 306, February

Brouwer de, G., Ericsson, N.R. (1995). “Modelling inflation in Australia”, *International Finance Discussion Papers*, No. 530, November

Bruneau, C., De Bandt, O. Flageollet, A. (2004). “Inflation and the mark-up in the euro area”, Banque de France, Notes d’études et de recherché, NER, No. 114, Septembre

Célérier, C. (2009). “Forecasting inflation in France”, Banque de France, Document de travail, No. 262, Décembre

Ericsson, N.R. (2009). “Constructive data mining: modeling Australian inflation”, *Federal Reserve Board*, Under revision: June 14

GarcésDíaz, D.G. (2001). “Determinación del nivel de precios y la dinámica inflacionaria en México”, Monetaria, Centro De Estudios Monetarios Latinoamericanos, Vol. XXIV, No. 3, Julio-Septiembre De

Goodfriend, M., “A framework for the analysis of Moderate Inflations”, *Federal Reserve Bank of Richmond*, WP 97-04

Loranger, J.G., Halévi, J. (1986). “La théorie du markup comme explication de l’inflation: une critique kaleckienne de certains post-keynésiens”, *L'Actualité économique*, Vol. 62, No. 3, pp. 385-408

Nekarda, C.J., Ramey, V.A. (2010). “The Cyclical Behavior of the Price-Cost Markup”, University of California, San Diego

Rotemberg, J.J., Woodford, M. (1991). “Markups and the Business Cycle”, *NBER Macroeconomics Annual 1991*, Vol. 6

Rotemberg, J.J., Woodford, M. (1999). “The cyclical behavior of prices and costs”, NBER *Working paper series*, W6909

Russell, B., Evans, J., Preston, B. (2002). “The impact of inflation and uncertainty on the optimum makrup set by firms”, *European University Institute working paper*, No. 02

Appendix

Figure 3. *Adjustment of equation 2*

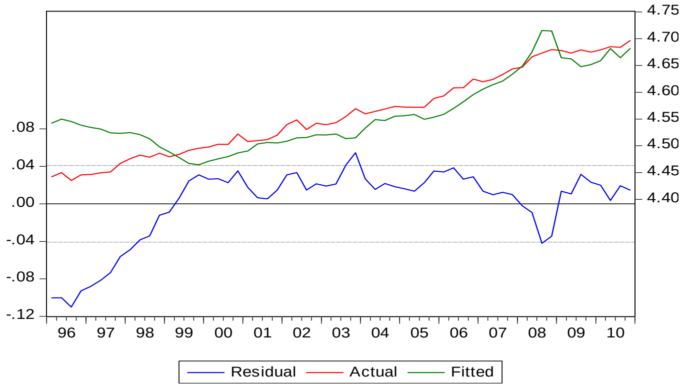


Figure 4. *Adjustment of equation 3*

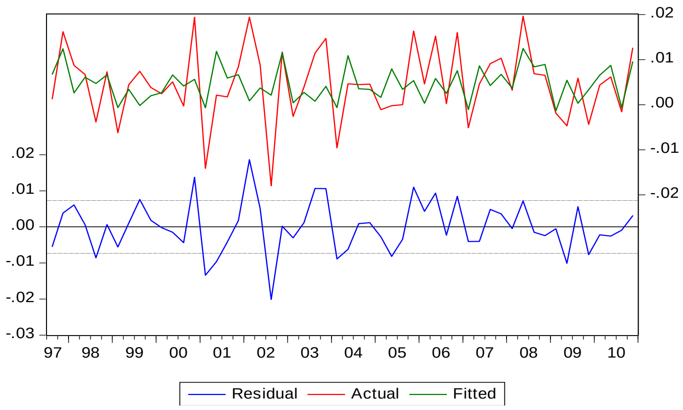


Figure 5. *Residual correlogram of equation 3*

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.006	-0.006	0.0020	0.964
		2	-0.228	-0.228	3.0189	0.221
		3	-0.195	-0.209	5.2701	0.153
		4	-0.182	-0.271	7.2696	0.122
		5	0.150	0.025	8.6663	0.123
		6	0.185	0.054	10.825	0.094
		7	-0.134	-0.182	11.979	0.101
		8	0.014	0.047	11.991	0.152
		9	-0.125	-0.129	13.046	0.161
		10	0.082	0.088	13.508	0.197
		11	0.182	0.087	15.847	0.147
		12	-0.024	0.022	15.888	0.196
		13	-0.267	-0.235	21.129	0.070
		14	-0.199	-0.226	24.125	0.044
		15	0.056	-0.023	24.370	0.059
		16	0.310	0.086	32.005	0.010
		17	0.058	-0.077	32.275	0.014
		18	-0.099	-0.071	33.095	0.016
		19	-0.047	0.116	33.285	0.022
		20	0.007	0.104	33.289	0.031
		21	-0.119	-0.243	34.584	0.031
		22	0.060	-0.064	34.925	0.039
		23	-0.043	-0.066	35.101	0.051
		24	0.066	0.110	35.537	0.061

Figure 6. *The CUSUM test related to of equation 3*

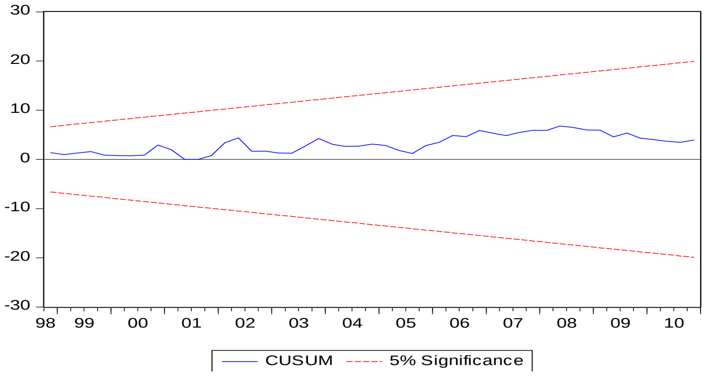


Figure 7. *Recursive estimates for the coefficients in equation 3*