Monetary policy in Argentina: seigniorage and Bailey's curve 2001-2014

Ricardo Luis Descalzi, Ángel Enrique Neder

Ponencia presentada en L Reunión Anual de la Asociación Argentina de Economía Política realizado en 2015. Salta, Argentina

ASOCIACION ARGENTINA
DE ECONOMIA POLITICA

ANALES | ASOCIACION ARGENTINA DE ECONOMIA POLITICA

L Reunión Anual

Noviembre de 2015

ISSN 1852-0022
ISBN 978-987-28590-3-9

Monetary Policy in Argentina: Seigniorage and Bailey's Curve 2001-2014.

Descalzi, Ricardo
Neder, Angel E.

Monetary Policy in Argentina: Seigniorage and Bailey's Curve 2001-2014

DESCALZI, Ricardo Luis
NEDER, Ángel Enrique

National University of Córdoba, Argentina

Abstract

Governments usually do not admit they are causing inflation deliberately. They try to take advantage of this situation, promoting populist actions. They issue money to fund increasing spending on subsidies and transfers, causing strong increases in prices with the consequent welfare loss. Funding fiscal deficits by issuing money (seigniorage) allow us asking ourselves why governments use seigniorage when they know that this action leads to a higher inflation. In trying to find the answer, we should distinguish the role of economic institutions by comparing the Central Bank behavior. The main hypothesis in this paper is that in countries as Argentina, with an inflationary long story, the rate of inflation needed to sustain a given long run fiscal deficit is higher than in developed economies. We analyze the monetary policy in Argentina and stress possible differences with the policy applied in other emerging economies of the European Union, particularly Turkey.

Keywords: Inflation, Central Banks, Government, Monetary System.
JEL classification: E31, E42, E58.

I. Introduction

Many authors have studied the negative effects that inflation provokes on welfare. Cagan (1956) raises two important issues on real balances demand: first, real cash balances depend on the nominal interest rate and therefore on the expected inflation rate, and second how demand responds to that inflation rate, setting that the higher the rate of inflation, the higher the elasticity of the real cash balances demand. Bailey (1956) focuses on the welfare loss provoked by the increase in the inflation rate. As public expects that the inflation rate will increase (because the government announce a hike in money issuing) the nominal interest rate will rise. This diminishes the real cash holdings. When government materializes the increase in money supply, prices grow proportionally and real cash balances remain constant at the new lower level. In the argument of Bailey is highlighted the use of the real cash balances demand to show the changes in welfare (the area under the real cash balances demand curve). Particularly, he displays a methodology in which the cost of collecting the inflation tax (measured as the welfare cost in terms of the raised tax) depends upon the inflation-tax revenue. He concludes that governments tend to get further financing by outrunning public's expectations and by causing damaging distributive effects on population.

Using a public finance approach, Friedman (1969; 2005) explains that interest rate determines seigniorage because government has to choose between two options: either issuing debt or printing money to fund itself. The first policy option implies a cost associated to a positive nominal interest rate, and the second one does not. Therefore, the only way to tempt government not to get seigniorage from public is by setting an interest rate equal to zero. Then, for Friedman is important not only the changes in interest rate, but also its level (which should be zero).[1] Otherwise, Lucas (2000) emphasizes that there exists a welfare gain in reducing inflation rate as well as the interest rate, even though the optimal interest rate is set above zero.

It seems to be that governments do not pay attention to the fact that inflation is a tax, which generates both revenues (for the government) and distortions (for the private sector behavior), but as Bailey (1956) stresses, governments usually do not admit they are causing inflation deliberately. In his view, "they are helpless pawns forced to issue increasing quantities of money in response to price rises generated by forces beyond their control".[2] Moreover, governments do pay attention and they are still trying to take advantage of this situation, promoting (at one end) populist actions. They issue money to fund increasing spending on subsidies and transfers, causing strong increases in prices with the consequent welfare loss. Moreover, governments do know that funding fiscal deficits by issuing money (seigniorage) operates better when there is a large informal sector in the economy –McCandless (2008)-. To reinforce the previous claim, we can ask ourselves why governments use seigniorage when they know that this action leads to a higher inflation.

In trying to find the answer, we should distinguish the role of economic institutions by comparing the Central Bank behavior between developed and developing countries. As Abel et al. (2014) point out, it is more difficult to find developed countries using seigniorage under normal economic conditions, but "heavy reliance on seigniorage usually occurs in war-torn or developing countries, in which military or social conditions dictate levels of government spending well above what the country can raise in taxes or borrow from the public."

Our main hypothesis in this paper is that in countries as Argentina, with an inflationary long story, the rate of inflation needed to sustain a given long run fiscal deficit is higher than in other emerging economies. In these economies, the money issuing has been constrained by monetary rules. For example, in Greece, it is absolutely banned the issue of money because the country is part of the European Union.[3]

Taking into account all the above, the aim of the paper is to analyze seigniorage to test the hypothesis connected to a Cash-in-Advance (CIA) model with seigniorage for Argentina and, as a second step, to stress possible differences with the policy applied in other emerging economies of the European Union.

Our main assumption is that in economies with increasing fiscal deficits, higher government expenditure comes at a high cost, which is the reduction in private consumption. Thus, the public sector gains purchasing power by reducing the amount of real consumption available for families.

---

[1] For more details, see Walsh (2010).

[2] This is a very usual practice in the Argentina's current economic situation, where the blame is put (by the government) on the monopolies who would extract the consumer surplus by rising prices.

[3] At least, at the time this paper was written.

Doing this analysis, some additional research questions emerge: What effects could provoke seigniorage on exchange rate? Is the level of inflation rate in the possible maximum to maximize the seigniorage? Is a good policy measure to use this kind of monetary policy to get a greater growth rate?

In next section the CIA model with seigniorage is briefly presented. In section III, using a Vector Error Correction model we estimate the theoretical long run relationships that the CIA model states between seigniorage and other endogenous variables. These estimations are performed for Argentina (2004 Q1 – 2014 Q3) and compared with Turkey. Section IV includes the results and in Section V we analyze the results using a theoretical Bailey Curve, and in Section VI we present the conclusions.

II. The Model

The CIA model introduced by Cooley and Hansen (1989) states that economic agents need to hold real balances accumulated in previous periods in order to make purchases (or at least a part of these) in the present period (McCandless -2008-).

The model highlights that families have two members: a worker and a shopper. Given that the family cannot consume the goods they produce (each family's production is sold to the others family´s shoppers), the existence of the money in the model implies that despite being a one-good, model it behaves like one with multiple goods.

In the typical Cooley and Hansen's setting the families are allowed to receive monetary transfers from government (that depend on monetary aggregate supply and on the time *t* gross growth rate of money). In the long run, consumption, capital, labor and aggregate output are negatively associated to the rate of growth of money supply. Given that aggregate real cash balances remain constant in steady state, the rate of growth of aggregate money equals the inflation rate in the long run. In particular, the higher the (steady state) rate of inflation the higher the welfare loss caused by a higher rate of growth of money supply.[4]

The CIA model may also be completed by adding the seigniorage. This entails a different way of leading the monetary policy (although the results remain close to that of the previous model with money transfers). In this case, the government avoids making lump-sum monetary transfers. Instead, it decides to consume goods. To do this, the government runs a fiscal deficit, which is financed by issuing money. The seigniorage,

[4] The CIA model also opens up the possibility of assessing the (short-run) impact of a monetary shock. By taking log-linearization of first order conditions the system can be solved and the corresponding low of motion can be found. Then, the response of the state variables with respect to one-standard-deviation monetary (or any) shock is assessed.

considered as the real value of goods that the government consumes by issuing money, works as a tax on private consumers, which are forced to reduce their purchases.[5]

McCandless (2008) introduces two changes in the CIA model by including a government constraint in which it is assumed that seigniorage is the only way the government can pay for its goods, so that:

$$g_t = \frac{M_t - M_{t-1}}{p_t}$$

where g_t is the amount of government real expenditure in period t. M_t is the money stock at time t . And p_t represents the price level in t. It is also assumed that there no longer exist money transfers to families.

This constraint is inserted in a CIA model. This is a representative-agent economy that considers a continuum of agents indexed by i, where $i = [0,1]$. Families choose the optimal path of the consumption (c_t^i), leisure $(1 - h_t^i)$, capital (k_{t+1}^i), and the amount of money belonging to the agent, it is said family (m_t^i). In the steady state the growth rate of money (φ) is constant and equal to:

$$\varphi = \frac{\beta \bar{w}}{B\bar{g} + \beta \bar{w}}$$

where β is the intertemporal rate of preferences, $\bar{w}$ is the steady state wage level for the competitive market (depending on a scale parameter θ and the depreciation rate δ)[6], B is a parameter which depends on the log of the difference between 1 and the initial level of working hours[7], and $\bar{g}$ is the amount of the average government deficit. The previous equation represents the so called Bailey Curve which shows the long run relationship between the gross growth rate of money issuing and the seigniorage, being this last the public expenditure. It has a positive slope given that in the stationary state a higher inflation rate is needed to sustain a higher level of public expenditure. Thus, the tax on real cash balances tends to reduce private consumption in order to get resources to finance public expenditure.

The previous equation states that when $\bar{g} = -\frac{\beta \bar{w}}{B}$ the growth rate of money (which is also equal to the inflation rate) has reached its maximum. At this point, the steady state

[5] In steady state, seigniorage can be associated to inflationary tax. However, in the short run, government can get an advantage since consumers do not adjust immediately when government issues money. Thus, the seigniorage can be expressed as $\frac{M_t - M_{t-1}}{p_t} = \left[\frac{M}{p}\right]_t - \left[\frac{M}{p}\right]_{t-1} + \frac{\pi_t}{1+\pi_t}\left[\frac{M}{p}\right]_{t-1}$ where M_t is the money stock at time t, p_t represents the price level in t, and the third term of the second member represents the inflationary tax. See Walsh (2010).

[6] In the steady state, $\bar{w} = (1-\theta)\left[\frac{\theta}{\frac{1}{\beta} - (1-\delta)}\right]^{\frac{\theta}{1-\theta}}$.

[7] Being the result a negative number.

seigniorage is maximized and the steady state private aggregate consumption ($\bar{C}$) is zero. In general, the steady state equation for consumption is:

$$\bar{C} = -\frac{\beta\overline{w}}{B} - \bar{g}$$

In the equations to be estimated we will take into account the following theoretical issue: in the steady state the growth rate of money depends on the government expenditure; the higher the government expenditure, the higher the steady state rate of inflation needed to tax the families' cash balances; secondly, given that the real balances remain constant, the growth rate of money equals the inflation rate; finally, the private consumption is negatively associated to government expenditure.

III. Estimation strategy

A short description of the applied statistical procedure is made next: given a set of K variables representing the vector $Y_t=(y_{1t},y_{2t},\ldots,y_{Kt})'$, the dynamic interactions between these variables can be captured through a Vector Autoregressive Model of n order, VAR(n), given by:

$$Y_t = A_1Y_{t-1} + \ldots + A_nY_{t-n} + u_t$$

where A_j (j=1,…,n) is a KxK matrix, and u_t is assumed to represent a white noise process, with time-invariant positive definite covariance matrix. If the process has a unit root, some or all variables are said to be integrated. Then, we are interested in analyzing the cointegration relationships that appear explicitly in the Vector Error Correction (VEC) representation of the previous VAR process:

$$\Delta Y_t = \Pi Y_{t-1} + \Gamma_1\Delta Y_{t-1} + \ldots + \Gamma_{n-1}\Delta Y_{t-n+1} + u_t$$

If the VAR process has unit roots, the KxK matrix Π is singular. Assuming that Y_t can be at most I(1), it turns out that ΔY_t does not contain stochastic trends. As a consequence, the term ΠY_{t-1} must also be I(0), being the only one that includes I(1) variables. This term specifies the cointegrating relationships. In particular, the number of cointegrating relationships is given by the rank of Π:

$$rk(\Pi)=r$$

where r is the cointegrating rank. Π can be written as $\Pi=\alpha\beta'$. The Kxr matrix β is called the cointegrating matrix, as the rx1 vector $ec_{t-1}=\beta'Y_{t-1}$ contains the cointegration relations between the time series included in vector Y. Note that $rk(\alpha)=rk(\beta)=r$. α is known as the Kxr loading matrix, that contains the weights attached to the cointegrating relations in the individuals equation of the model. Matrices α and β are no unique if r<K. Therefore, it is necessary to gather non-sample information (associated to the economic theory) to fully identify the cointegrating relationships.

If the cointegrating rank is known, the reduced-rank maximum likelihood estimator (α_e,β_e) is available, which only estimates consistently the cointegrating space. However, to estimate α and β consistently it is necessary to add identifying (uniqueness) restrictions (given that Π is not singular, it is necessary to identify K-r variables using prior information). The most widespread practice in the literature is to assume that the first part of β is an identity matrix, so it takes de form $\beta' = [I_r : \beta'_{k-r}]$, where I_r is an identity matrix of order r, while β'_{k-r} is an rx(K-r) matrix with the coefficients to be identified.[8]

IV. Results

In this section, we test the seigniorage in Argentina in the long run and make a comparison with Turkey as another emergent economy, closely related to the European Union. To do this, we select seven empirical models to adjust different Vector Error Correction models, to identify the corresponding elasticities, and then we choose a couple of them to make the comparisons. The models where built considering the theoretical influences generated by public expenditure (in some cases) and fiscal deficit (in others) on different variables in order to explain seigniorage. In this methodology the order in which variables are included is important, because it defines the strategy used to identify the coefficients. It is important to note that the identification here is chosen according to the economic theory (in this case the CIA model).

IV.A. Estimations for Argentina

IV.A. 1. Model 1: pure seigniorage

We propose to depict the behaviour of an economy with high inflation that is represented by the vector $Y_t = (\pi_t, \varphi_t, g_t)'$. π is (the log of) the gross inflation rate, φ is (the log of) the gross money growth rate, and g is (the log of) public expenditure in real terms. We estimate the cointegration equations represented by $ec_{t-1} = \beta' Y_{t-1}$. The assumption is that the rank(β)=2. Thus:

$$\pi_{t-1} = -\beta_{31} g_{t-1}$$

$$\varphi_{t-1} = -\beta_{32} g_{t-1}$$

It should be noticed that the coefficients $-\beta_{31}$ and $-\beta_{32}$ represent the long run elasticities of π and φ with respect to g, respectively. The first equation indicates the long run relationship between the government expenditure and the inflation rate. In a CIA model with seigniorage it is expected that π reacts positively to a shock in g given that the public expenditure is financed with a tax on real cash balances (i.e. $-\beta_{31}>0$). In particular, the second equation highlights the (positive) relationship between the rate of growth of money and the government expenditure (i.e. $-\beta_{32}>0$). Results are shown in Table 1. Given that in the cointegration equations all the variables are located in the first member, for a right interpretation of the coefficients, the sign of the elasticities of π should be inverted. Besides, given that the null hypothesis of the cointegration rank (which is equal to 2)

[8] See Lütkepohl and Krätzig (2004) for more details.

cannot be rejected, there are two cointegration equations. The first equation in Table 1 shows that the inflation rate responds positively to a shock in government expenditure in the long run, as expected. The second cointegrating equation shows how the (gross) rate of money growth reacts to changes in g. The estimated coefficient is also positive and significantly different from zero, as it was assumed.

Table 1
Coefficients of cointegration relations $\beta' Y_{t-1}$
$Y_t=(\pi_{t-1}, \varphi_{t-1}, g_{t-1})'$

Cointegration Equation	Coefficients of the cointegrating vector β:		
	π_{t-1}	φ_{t-1}	g_{t-1}
$Ec_{1,t-1}$	1.000	0.000	-0.076
	(0.000)	(0.000)	(0.002)
	{0.000}	{0.000}	{0.000}
	[0.000]	[0.000]	[45.362]
$Ec_{2,t-1}$	0.000	1.000	-0.084
	(0.000)	(0.000)	(0.004)
	{0.000}	{0.000}	{0.000}
	[0.000]	[0.000]	[20.698]

(Std. Dev.) {p - Value} [t - Value]*** p<0.01, ** p<0.05, * p<0.1.
The Akaike, Final Prediction Error, Hannan-Quinn and Schwarz Criteria indicated that the optimal VAR lag length is equal to 9. The cointegration test was run using Lütkepohl and Saikkonen (L&S) procedure (including a constant and seasonal dummies). The null hypothesis H0: rank(β^3)=2 cannot be rejected, so that the VEC was specified assuming that the cointegration rank is equal to 2. Remaining VEC's specification details are as follows: deterministic variables: CONS, S1, S2, S3, endogenous lags (in differences): 8, sample range: [2004 Q1, 2014 Q3], T=34, estimation procedure: One stage. Johansen approach. Further estimation details are available upon request.
Source: Own calculations.

IV.A.2. Model 2: seigniorage and real exchange rate

In this second model, the (log of) gross rate of change of real exchange rate (*rer*) is added to the vector of endogenous variables to test the response of this variable to changes in the government expenditure. This estimation also is thought to gather additional evidence to back up the estimates of coefficients obtained above. The vector of endogenous variables is $Y_t=(rer_{t-1}, \pi_{t-1}, \varphi_{t-1}, g_{t-1})'$. Under the assumption that rank(β)=3, we estimate the cointegration equations $ec_{t-1}=\beta' Y_{t-1}$, so that:

$$rer_{t-1}=-\beta_{41} g_{t-1}$$

$$\pi_{t-1}=-\beta_{42} g_{t-1}$$

$$\varphi_{t-1}=-\beta_{43} g_{t-1}$$

In this scheme, it is expected that $-\beta_{41}$ be negative: if the (long run) inflation rate increases (due to a greater government expenditure financed by issuing new money) the (gross) rate of growth of *rer* diminishes. While the remaining coefficients $-\beta_{42}$ and $-\beta_{43}$ are thought to be positive as in model 1. The estimated coefficients are shown in table 2.

Table 2

Coefficients of cointegration relations $\beta' Y_{t-1}$

$Y_t=(rer_{t-1}, \pi_{t-1}, \varphi_{t-1}, g_{t-1})'$

Cointegration Equation	Coefficients of the cointegrating vector β:			
	rer_{t-1}	π_{t-1}	φ_{t-1}	g_{t-1}
$Ec_{1,t-1}$	1.000	0.000	0.000	0.064
	(0.000)	(0.000)	(0.000)	(0.013)
	{0.000}	{0.000}	{0.000}	{0.000}
	[0.000]	[0.000]	[0.000]	[4.817]
$Ec_{2,t-1}$	0.000	1.000	0.000	-0.084
	(0.000)	(0.000)	(0.000)	(0.005)
	{0.000}	{0.000}	{0.000}	{0.000}
	[0.000]	[0.000]	[0.000]	[-15.709]
$Ec_{3,t-1}$	0.000	0.000	1.000	-0.164
	(0.000)	(0.000)	(0.000)	(0.056)
	{0.000}	{0.000}	{0.000}	{0.003}
	[0.000]	[0.000]	[0.000]	[-2.934]

(Std. Dev.) {p - Value} [t - Value]*** p<0.01, ** p<0.05, * p<0.1.

The Akaike, Final Prediction Error, Hannan-Quinn and Schwarz Criteria indicated that the optimal VAR lag length is equal to 7. The cointegration test was run using the Johansen Trace test (including constant, trend and seasonal dummies). The null hypothesis H0: rank(β^3)=3 cannot be rejected, so that the VEC was specified assuming that the cointegration rank is equal to 3. Remaining VEC's specification details are as follows: deterministic variables: CONST, S1, S2, S3, endogenous lags (in differences): 6, sample range: [2004 Q1, 2014 Q3], T=34, estimation procedure: One stage. Johansen approach. Further estimation details are available upon request.

Source: Own calculations.

As it would be expected, we found three cointegration equations and the estimated coefficient for the response of (the log of) the rate of change of *rer* is found to be positive and significantly different from zero. The greater the seigniorage, the greater the inflation rate, and this implies an acceleration in the real appreciation (a decrease in the rate of change of the real exchange rate). At the same time, this model explains not only that the seigniorage cause inflation but also explains that the change in prices passes through on the real exchange rate. The estimated value of the coefficient that measures the response of π is pretty close to that of the previous model (and significantly different from zero), while the coefficient that capture the response of φ to changes in *g* is lower although it is still positive and significantly different from zero.

IV.A.3. Model 3: seigniorage and real and monetary shocks

In the following model we introduce the distinction between real and monetary shocks to check the robustness of previous results.

We define $Y_t=(bc_{t-1}, rer_{t-1}, pib_{t-1}, \varphi_{t-1})'$, where *bc* represents the difference between (the log of) the exports and (the log of) imports, while *pib* is (the log of) the gross domestic product in real terms. Under the null hypothesis that both, the trade balance and (the log of the gross rate of change in) the real exchange rate, depend on real and monetary shocks (that is, we assume that rank(β)=2) the cointegration equations are expressed as:

$$bc_{t-1}=-\beta_{31}pib_{t-1}-\beta_{41}\varphi_{t-1}$$

$$rer_{t-1}=-\beta_{32}pib_{t-1}-\beta_{42}\varphi_{t-1}$$

In the first equation, $-\beta_{31}$ and $-\beta_{41}$ capture the response of the trade balance to product and monetary shocks, respectively. The theoretical value of $-\beta_{31}$ may differ depending on the selected model. Dynamic non-monetary models usually predict that the response of the trade balance may depend whether the real shock is permanent or transitory or whether it is global or country-specific.[9] Under a Keynesian point of view the coefficient should be negative, given that the trade balance usually depends on income.[10] On the other hand, it is expected that $-\beta_{41}$ be negative as in the CIA model, where an increasing φ tends to cause a real appreciation and a reduction in the trade balance.

The second equation depicts the long run behaviour of the (log of the gross rate of growth) of the real exchange rate. The usual Balassa-Samuelson prediction states that $-\beta_{32}$ is negative, while the stated hypothesis here is that *rer* should react negatively to a monetary shock. Table 3 shows the results.

Table 3
Coefficients of cointegration relations $\beta' Y_{t-1}$
$Y_t=(bc_{t-1}, rer_{t-1}, pib_{t-1}, \varphi_{t-1})'$

Cointegration Equation	Coefficients of the cointegrating vector φ:				
	bc_{t-1}	rer_{t-1}	pib_{t-1}	φ_{t-1}	$TREND_{(t-1)}$
Ec1,t-1	1.000	0.000	1.206	0.300	0.003
	(0.000)	(0.000)	(0.132)	(0.227)	(0.002)
	{0.000}	{0.000}	{0.000}	{0.185}	{0.042}
	[0.000]	[0.000]	[9.123]	[1.325]	[2.031]
Ec2,t-1	0.000	1.000	0.987	0.074	-0.012
	(0.000)	(0.000)	(0.065)	(0.111)	(0.001)
	{0.000}	{0.000}	{0.000}	{0.507}	{0.000}
	[0.000]	[0.000]	[15.210]	[0.663]	[-16.623]

(Std. Dev.) {p - Value} [t - Value]*** p<0.01, ** p<0.05, * p<0.1.
The Final Prediction Error Criterion indicated that the optimal VAR lag length is equal to 6. The cointegration test was run using Johansen (L&S) procedure (including constant, trend and seasonal dummies). The null hypothesis H0: rank(β^3)=3 cannot be rejected, using the Johansen trace test, so that the VEC was specified assuming that the cointegration rank is equal to 3. Remaining VEC's specification details are as follows: deterministic variables: CONST, S1, S2, S3, TREND, endogenous lags (in differences): 5, sample range: [2004 Q1, 2014 Q3], T=34, estimation procedure: One stage. Johansen approach. Further estimation details are available upon request.
Source: Own calculations.

[9] See Glick and Rogoff (1995) for more details.
[10] If the chosen response variable was the current account, the predicted response would be positive under a Keynesian setting, and the Harberger-Laursen-Metzler effect would follow.

The estimated value of $-\beta_{31}$ is negative and highly significant as expected. However, the estimated value of $-\beta_{41}$ although with the expected negative sign is not significantly different from zero. The estimated coefficients of the second equation also stress the impact of the real shock given that $-\beta_{32}$ is negative (that is, the Balassa-Samuelson effect operates), while the estimated value of $-\beta_{41}$ is not significantly different from zero (although it is still positive). The lack of significance of the coefficients associated to the monetary shocks may well be associated to the fact that in the CIA model there is a direct link between the growth of money, the inflation and the (change) in the real exchange rate, so that the *rer* may be redundant in the presented model.

IV.A.4. Model 4: seigniorage (as a *proxy* of real exchange rate) and trade balance

Since *rer* is entirely reflected by φ, in what follows we present a simplified version of our VEC model with real and monetary shocks. In this case we maintain the trade balance as being a proxy of (the log of) the *rer* change caused by the seigniorage. The vector to apply the VECM analysis is $Y_t=(bc_{t-1}, pib_{t-1}, \varphi_{t-1})'$, while it is assumed that the cointegration rank equals 1, so that the trade balance depend on real as well as monetary shocks. The equation to be estimated is

$$bc_{t-1}=-\beta_{21} pib_{t-1}-\beta_{31}\varphi_{t-1}$$

As before, $-\beta_{21}$ represents the impact on real (product) shocks on the balances, whereas $-\beta_{31}$ indicates how the seigniorage affects the trade balance via changes in the real exchange rate. The stated assumption is that $-\beta_{31}$ is negative.

Table 4 reports the estimates for these coefficients. The estimated value of $-\beta_{21}$ remains quite close to that of the previous regression, as it was expected. The estimated value for the coefficient of the seigniorage is negative as expected and significantly different from zero at a 10% level. Therefore, with the obtained results we are not able to reject the null hypothesis that the seigniorage is the responsible of the deterioration in the trade balance through a real appreciation.

Table 4
Coefficients of cointegration relations $\beta' Y_{t-1}$
$Y_t=(bc_{t-1}, pib_{t-1}, \varphi_{t-1})'$

Cointegration Equation	Coefficients of the cointegrating vector β:		
	bc_{t-1}	pib_{t-1}	φ_{t-1}
	1.000	1.375	0.726
$Ec_{1,t-1}$	(0.000)	(0.010)	(0.071)
	{0.000}	{0.000}	{0.000}
	[0.000]	[132.287]	[10.281]

(Std. Dev.) {p - Value} [t - Value]*** p<0.01, ** p<0.05, * p<0.1.
The Akaike, Final Prediction Error, Hannan-Quinn and Schwarz Criteria indicated that the optimal VAR lag length is equal to 9. The cointegration test was run using the Lütkepohl and Saikkonen (L&S) procedure (including a constant and seasonal dummies). The null hypothesis H0: rank(β^3)=1 cannot be rejected, so that the VEC was specified assuming that the cointegration rank is equal to 1. Remaining VEC's specification details are as follows: deterministic variables: CONST, S1, S2, S3, endogenous lags (in differences): 8, sample range: [2004 Q1, 2014 Q3], T=34, estimation procedure: One stage. Johansen approach. Further estimation details are available upon request.
Source: Own calculations.

IV.A.5. Model 5: simplified model of seigniorage and real and monetary shocks

In what follows the trade balance is replaced by (the log of) the *rer* change in the vector of endogenous variables. The aim is to reinforce the view that in a CIA model with seigniorage the changes in the trade balance are also connected to shocks in government expending. The vector of endogenous variables is $Y_t=(rer_{t-1}, pib_{t-1}, \varphi_{t-1})'$; under the assumption that the cointegration rank is 1, we have the following equation:

$$rer_{t-1}=-\beta_{21}pib_{t-1}-\beta_{31}\varphi_{t-1}$$

where the coefficient $-\beta_{31}$ is expected to be negative. The following table report the results. First, the hypothesis that rank(β)=1 cannot be rejected, so the changes in the real exchange rate can be represented as function of shocks to product and money (seigniorage). Second, it can be seen that in this representation the coefficient of the monetary shock ($-\beta_{31}$) is negative as expected and it is significantly different from zero. Finally, the estimated value for the coefficient is positive and significantly different from zero, although its value is quite small.

Table 5
Coefficients of cointegration relations $\beta'Y_{t-1}$
$Y_t=(rer_{t-1}, pib_{t-1}, \varphi_{t-1})'$

Cointegration Equation	Coefficients of the cointegrating vector β:					
	rer_{t-1}	pib_{t-1}	φ_{t-1}	S1(t-1)	S2(t-1)	S3(t-1)
$Ec_{1,t-1}$	1.000	-0.001	0.260	-0.717	0.045	-0.647
	(0.000)	(0.000)	(0.027)	(0.028)	(0.005)	(0.029)
	{0.000}	{0.000}	{0.000}	{0.000}	{0.000}	{0.000}
	[0.000]	[-6.429]	[9.767]	[-26.058]	[9.777]	[-22.538]

(Std. Dev.) {p - Value} [t - Value]*** p<0.01, ** p<0.05, * p<0.1.
The Akaike, Final Prediction Error, Hannan-Quinn and Schwarz Criteria indicated that the optimal VAR lag length is equal to 7. The cointegration test was run using the Johansen trace test (including a constant, trend and dummy). The null hypothesis H0: rank(β^3)=1 cannot be rejected, so that the VEC was specified assuming that the cointegration rank is equal to 1. Remaining VEC's specification details are as follows: deterministic variables: CONS, endogenous lags (in differences): 7, sample range: [2007 Q4, 2015 Q1], T = 30, estimation procedure: One stage. Johansen approach. Further estimation details are available upon request.
Source: Own calculations.

IV.A.6. Model 6: simplified model of seigniorage and fiscal deficit

Since the model of seigniorage represents an extreme case because government not only grants transfers but also collects taxes, both elements have played a major role in determining the need of funding. Therefore, in this new estimation we use fiscal deficit as a proxy for the tax burden on the real balances held by economic agents.

Consequently, the vector of endogenous variables is represented now by $Y_t=(\pi_t, \varphi_t, def_t)'$, in a similar way to that used in Model 1. One difference is that we have changed the variable public expenditure by fiscal deficit, where *def* is the difference between the (log of the) government negative cash flows (that include transfers as well) and the (log of the) government revenues mainly represented by taxes.

Under the assumption that the cointegration rank is 2, we have the following equations:

$$\pi_{t-1}=-\beta_{31}def_{t-1}$$

$$\varphi_{t-1}=-\beta_{32}def_{t-1}$$

Again, the coefficients $-\beta_{31}$ and $-\beta_{32}$ represent the long run elasticities of π and φ now with respect to *def*, respectively. The first equation indicates the long run relationship between the fiscal deficit and the inflation rate. In a CIA model with seigniorage, one should expect that π reacts positively to a shock in *def* given that the fiscal deficit is financed taxing real cash balances (i.e. $-\beta_{31}>0$). The second equation highlights the (positive) relationship between the growth rate of money and the fiscal deficit (i.e. $-\beta_{32}>0$). Results are shown in the following table.

Table 6
Coefficients of cointegration relations $\beta' Y_{t-1}$
$Y_t=(\pi_t, \varphi_t, def_t)'$

Cointegration Equation	Coefficients of the cointegrating vector β:		
	π_{t-1}	φ_{t-1}	def_{t-1}
$Ec_{1,t-1}$	1.000	0.000	-0.165
	(0.000)	(0.000)	(0.021)
	{0.000}	{0.000}	{0.000}
	[0.000]	[0.000]	[7.709]
$Ec_{2,t-1}$	0.000	1.000	-0.136
	(0.000)	(0.000)	(0.053)
	{0.000}	{0.000}	{0.011}
	[0.000]	[0.000]	[2.556]

(Std. Dev.) {p - Value} [t - Value]*** p<0.01, ** p<0.05, * p<0.1.
The Akaike, Final Prediction Error, Hannan-Quinn and Schwarz Criteria indicated that the optimal VAR lag length is equal to 6. The cointegration test was run using the Johansen trace test (including a constant, trend and seasonal dummies). The null hypothesis H0: rank(β^3)=2 cannot be rejected, so that the VEC was specified assuming that the cointegration rank is equal to 2. Remaining VEC's specification details are as follows: deterministic variables: CONST, S1, S2, S3, endogenous lags (in differences): 5, sample range: [2005 Q3, 2014 Q3], T = 37, estimation procedure: One stage. Johansen approach. Further estimation details are available upon request.
Source: Own calculations.

The first equation in Table 6 shows that the inflation rate responds positively to a shock in fiscal deficit in the long run, as expected. Furthermore, it doubles the coefficient obtained in model 1, when the government expenditure was used. The second cointegrating equation shows how the (gross) rate of money growth reacts to changes in *def*. The estimated coefficient is also positive and significantly different from zero, as it was assumed.

IV.A.7. Model 7: seigniorage and real exchange rate depending on fiscal deficit

The vector of endogenous variables is $Y_t=(rer_t, \pi_t, \varphi_t, def_t)'$. Under the assumption that rank(β)=3, we estimate the cointegration equations $ec_{t-1}=\beta' Y_{t-1}$, so that:

$$rer_{t-1}=-\beta_{41} def_{t-1}$$

$$\pi_{t-1}=-\beta_{42} def_{t-1}$$

$$\varphi_{t-1}=-\beta_{43} def_{t-1}$$

As before, it is expected that $-\beta_{41}$ be negative: if the (long run) inflation rate increases (due to a greater fiscal deficit financed by issuing new money), the (gross) rate of growth of *rer* diminishes. While the remaining coefficients $-\beta_{42}$ and $-\beta_{43}$ are thought to be positive as in model 6. The estimated coefficients are shown in table 7.

Table 7
Coefficients of cointegration relations $\beta' Y_{t-1}$
$Y_t=(rer_t, \pi_t, \varphi_t, def_t)'$

Cointegration Equation	Coefficients of the cointegrating vector β:			
	rer_{t-1}	π_{t-1}	φ_{t-1}	def_{t-1}
$Ec_{1,t-1}$	1.000	0.000	0.000	0.115
	(0.000)	(0.000)	(0.000)	(0.032)
	{0.000}	{0.000}	{0.000}	{0.000}
	[0.000]	[0.000]	[0.000]	[-3.542]
$Ec_{2,t-1}$	0.000	1.000	0.000	-0.211
	(0.000)	(0.000)	(0.000)	(0.022)
	{0.000}	{0.000}	{0.000}	{0.000}
	[0.000]	[0.000]	[0.000]	[9.479]
$Ec_{3,t-1}$	0.000	0.000	1.000	-0.206
	(0.000)	(0.000)	(0.000)	(0.012)
	{0.000}	{0.000}	{0.000}	{0.000}
	[0.000]	[0.000]	[0.000]	[16.989]

(Std. Dev.) {p - Value} [t - Value]*** p<0.01, ** p<0.05, * p<0.1.
The Akaike, Final Prediction Error, Hannan-Quinn and Schwarz Criteria indicated that the optimal VAR lag length is equal to 7. The cointegration test was run using the Johansen trace test (including a constant and seasonal dummies). The null hypothesis H0: rank(β^3)=3 cannot be rejected, so that the VEC was specified assuming that the cointegration rank is equal to 3. Remaining VEC's specification details are as follows: deterministic variables: CONST S1 S2 S3, endogenous lags (in differences): 6, sample range: [2005 Q4, 2014 Q3], T = 36, estimation procedure: One stage. Johansen approach. Further estimation details are available upon request.
Source: Own calculations.

The estimated coefficient for the response of (the log of) the rate of change of *rer* is found to be positive and significantly different from zero. Comparing with the model in which was used the government expenditure (Model 2) the estimated values of the coefficients that measures the response of *rer*, π, and φ to changes in *def* are higher. This strengthens the role of the fiscal irresponsibility of government, which derives in a higher long run inflation rate. Additionally, the coefficient which reflects the relationship between fiscal deficit and inflation is higher than that obtained previously, reinforcing the hypothesis of the existence of seigniorage.

IV.B. Estimations for Turkey

In this section we estimate the model for Turkey and make a comparison with Argentina, using the Model 6. The interest in analyzing these two economies is based on the aspect that, despite the fact that both economies are considered emergent ones, both of them followed different patterns of monetary policy. In the case of Argentina, after abandoning the Convertibility, and particularly during the time of analysis of this paper, the main goal of monetary policy was a monetary expansion oriented to finance fiscal deficit, generating a high inflation rate. Turkey, meanwhile, despite implementing an inflation targeting policy[11] does not present too different results from those of Argentina, despite their close relationship with the European Union. Results for Turkey using Model 6 with $Y_t=(\pi_t, \varphi_t, def_t)'$ are shown in table 8.

Table 8
Coefficients of cointegration relations $\beta' Y_{t-1}$
$Y_t=(\pi_t, \varphi_t, def_t)'$

Cointegration Equation	Coefficients of the cointegrating vector β:		
	π_{t-1}	φ_{t-1}	def_{t-1}
$Ec_{1,t-1}$	1.000	0.000	-0.163
	(0.000)	(0.000)	(0.025)
	{0.000}	{0.000}	{0.000}
	[0.000]	[0.000]	[-6.604]
$Ec_{2,t-1}$	0.000	1.000	-0.193
	(0.000)	(0.000)	(0.061)
	{0.000}	{0.000}	{0.002}
	[0.000]	[0.000]	[-3.161]

(Std. Dev.) {p - Value} [t - Value]*** p<0.01, ** p<0.05, * p<0.1.
The Akaike, Final Prediction Error, Hannan-Quinn and Schwarz Criteria indicated that the optimal VAR lag length is equal to 7. The cointegration test was run using the Johansen trace test (including a constant and seasonal dummies). The null hypothesis H0: rank(b3)=2 cannot be rejected, so that the VEC was specified assuming that the cointegration rank is equal to 2. Remaining VEC's specification details are as follows: deterministic variables: CONST S1 S2 S3, endogenous lags (in differences): 6, sample range: [2005 Q4, 2014 Q3], T = 36, estimation procedure: One stage. Johansen approach. Further estimation details are available upon request.
Source: Own calculations.

The coefficient that shows the long run relationship between fiscal deficit and inflation is very similar to that obtained for Argentina, while in the case of the long run influence on the growth rate of money is even greater, revealing that people do not run away from domestic currency as much as in Argentina.

[11] It can be seen in the goals of both Central Banks in their webpages.

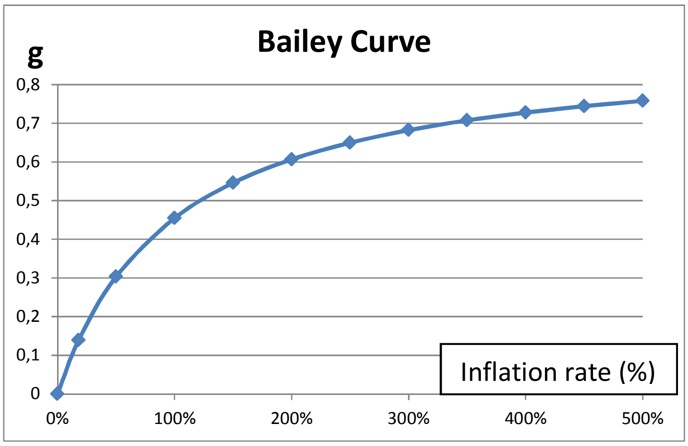
V. Theoretical Bailey Curve and analysis of the estimated coefficients

In this section, we try to analyse the results comparing them with the average obtained in certain variables for the span under analysis. We take a textbook example as a benchmark and we use it to interpret the elasticity coefficients obtained from the estimations, in order to get the theoretical associated long run inflation rate.

Following McCandless (2008), we replicate the Bailey Curve (presented previously) using some values that are standard in this type of models.

β	0,99
δ	0,03
θ	0,36
B	-2,58
$\overline{w}$	2,37
Maximum seigniorage	0,91
Maximum consumption	0,91

Therefore, using different inflation rates we calibrate the Bailey Curve, which is showed next:



The Bailey Curve shows different steady-state inflation rates needed to finance alternative levels of government expenditure (or fiscal deficit, according the variable that it is being used in the estimation). The slope of the curve decreases as the inflation rate grows. The VEC estimations obtained previously refer to just a point of the Curve. To know which is that point, we take natural log of the variables gross inflation rate ($\bar{\pi}$) and log of public expenditure ($\bar{g}$) in the figures, and we calculate the ratio between them, getting the elasticity.

It can be seen that the estimated coefficient of the elasticity of inflation rate with respect to fiscal deficit in Model 7 was 0.21. In order to get the long run inflation rate that the CIA model predicts for this value, we have to look for the theoretical elasticity and fetch the corresponding long run elasticity value. And this value is 21%.[12] Thus, for Argentina the long run inflation rate would be 21%. In the case of Turkey, using the corresponding model, the long run inflation rate seems to be as high as that for Argentina.

VI. Conclusions

In this paper we have evaluated the prediction of the CIA model with seigniorage, doing estimations of elasticities of inflation with respect to seigniorage (representing this by public expenditure or fiscal deficit) for Argentina and Turkey. Using a Bailey Curve we interpreted the behavior of inflation rate in the long run. The Bailey Curve also helped us to understand the real exchange rate dynamics in economies that experience high inflation rates. The higher the inflation rate, the lower the real exchange rate and the economy tends to reach its maximum rate of seigniorage. If this assumption is not rejected, the implications for political economy are relevant. Efforts aimed at maintaining a nominal anchor (i.e. a high real exchange rate at the very beginning of the stabilization program) may be futile. This is due to the behavior that agents can adopt when government tends to get resources by using more seigniorage as much as possible while them avoid the use of money and flight to other assets (i.e. in Argentina, could have a run against the domestic currency).

The main findings tend to show a long run relationship between inflation, money issuing, and fiscal deficit. In particular, the estimated elasticity of inflation rate with respect to changes in Argentina government imbalances is between 0.16 and 0.21 (which is quite close to the estimated long-run relationship between fiscal deficit and the rate of money creation). Finally, the estimated coefficients of the estimated error-correction term also show that the monetary shocks (which are associated to seigniorage in the Argentinean economy) tend to cause a reduction in the long run growth rate of the real exchange rate. In the case of Turkey the results were similar, experiencing high long run inflation rate.

---

[12] Since the elasticity indicates the marginal rate of inflation at which new nominal balances are taxed, then in the steady-state inflation matches with the elasticity of inflation relative to seigniorage. At steady state, a marginal increase in public expenditure (or fiscal deficit) should not change the long run equilibrium, as new nominal balances to be issued, if they are demanded by economic agents, will allow raising the same level of seigniorage as before in real terms since they are affected by an inflation rate equal to the current one. If the growth in public expenditure required greater funding seigniorage, an increase in inflation would be generated and the steady state would change, and another point of the Bailey Curve would be reached.

References

ABEL, Andrew B., Ben S. BERNANKE, and Dean CROUSHORE (2014). *Macroeconomics*. Pearson.

BAILEY, Martin J. (1956). "The Welfare Cost of Inflationary Finance". *The Journal of Political Economy*. Volume LXIV, Number 2, April.

CAGAN, Philip (1956). "The Monetary Dynamics of Hyperinflation." In *Studies in the Quantity Theory of Money*, ed. Milton Friedman, 25-117. Chicago, University Press.

COOLEY, Thomas F. and Gary HANSEN (1989). "The Inflation Tax in a Real Business Cycle Model". *American Economic Review*, American Economic Association, vol. 79(4), pages 733-48, September.

FRIEDMAN, Milton (1969). *The Optimum Quantity of Money and Other Essays*. Chicago: Aldine.

FRIEDMAN, Milton (2005). "Federal Reserve: How not to stop inflation," *Econ Focus*, Federal Reserve Bank of Richmond, issue Sum, pages 2-7. http://www.richmondfed.org/publications/research/region_focus/2005/summer/pdf/federal_reserve.pdf

GLICK, Reuven and Kenneth ROGOFF (1995). "Global versus country-specific productivity shocks and the current account". *Journal of Monetary Economics*, Elsevier, vol. 35(1), pages 159-192, February.

LUCAS, Robert E. (2000). "Inflation and Welfare." *Econometrica*, Vol. 68, No. 2, March, pp 247-274.

LÜTKEPOHL, Helmut and Markus KRÄTZIG (2004). *Applied Time Series Econometrics*. Cambridge University Press.

McCANDLESS, George (2008). *The ABCs of RBCs. An Introduction to Dynamic Macroeconomic Models.* Harvard University Press. Cambridge, Massachusetts, and London, England.

WALSH, Carl E. (2010). *Monetary Theory and Policy*. The MIT Press. Cambridge, Massachusetts. Third Edition.