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Exchange Rate Pressure in Angola

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Abstract

The objective of this work is to develop an operational tool to analyze exchange rate pressure in the context of Angola. The Angolan economy exhibits a number of relevant characteristics: a closed financial account, a partially controlled current account, a highly dollarized economy and exports (oil) price determined in World markets. These features have a direct effect on the demand of foreign currency and motivate their inclusion in the specification of a model for Angola. The model provides the rational for a measure of an exchange market rate pressure (EMP) index that contains exports changes, imports changes, the foreign interest rate and inflation and the change in foreign reserves corrected for a measure dollarization. The empirical performance new measure is comparable (slightly better) to the performance of the EMP indexes obtained in Eichengreen Rose and Wyplosz (1994) and Klassen and Jager (2011).[1]

Introduction

The objective of this work is to develop an operational tool to analyze exchange rate pressure in the context of Angola. Exchange rate pressure is a broad concept that can encompass every deviation of the actual exchange rate from a latent equilibrium exchange rate. Deviations can originate from macroeconomic forces, and are typically labeled misalignments in the international macro literature, or from financial forces, which because of their higher frequency relative to macro forces, (probably) gave rise to the label of pressure. In this work we will use pressure for both types of deviations. By taking this view we can trace back interest in exchange rate pressure and misalignment with the active management of the exchange rate by the monetary authorities. Formal high frequency empirical measures of exchange rate pressure are more recent and started in the late 1970's. The existing literature on this later subject can be divided into two branches.

[1]

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The first branch derives a measure of exchange rate pressure from a model of exchange rate determination. Girton and Roper (1977) are maybe the first example of this approach. More recent examples are Weymark (1997). Their objective is to measure the excess demand for a currency by deriving the gap between the observed exchange rate and a notional exchange rate that would prevail in a pure floating regime conditional on current monetary policy. The vast literature on currency crisis that started with Krugman (1979), Flood and Garber (1984) and then continued with Obstfeld (1994) is closely related. Indeed, most models of speculative attacks derive a "shadow" exchange rate, usually defined as the implicit floating exchange rate that would prevail once reserves are exhausted. While the shadow exchange rate and the notional exchange rate just defined are different, the approach is conceptually similar and both require estimating the structural parameters of the model used in the analysis.

The second strand follows the observation from Meese and Rogoff (1983) that models linking variables like reserve flows and interest rates to the exchange rate appear to be inadequate. A particular set of weights and fundamentals is only as defensible as the theoretical model used to generate it. Eichengreen Rose and Wyplosz (1994) propose an index of exchange rate market pressure model-free. In practice they construct an index using a linear combination of the same variables used in most models but consider a number of different weighting schemes induced by the data. Klassen and Jager (2011) follow a similar approach. First they specify a standard monetary model with an endogenous monetary policy response in the form of Taylor rule and obtain the insight that the policy interest rate should enter in levels and not in differences, then derive a model-free weighting scheme to construct the exchange market pressure measure that now contains the interest rate in level.

Conceptually going back and forth between a model based approach and a data induced analysis is the correct approach. In principle we would like to identify the variables involved in the exchange rate pressure from a sufficiently general class of models and subsequently bring it to the data. However for the exercise to be meaningful, the class of models should be appropriated to describe the economy under investigation. The Angolan economy is characterized by several features that require particular attention in order to infer the correct variables that should be used to measure exchange rate pressure.

The first section of the paper presents two exchange rate pressure measures that exists in the literature. The second section presents some particular aspects of the Angolan economy. The third section presents a stylized model for the Angolan economy to deduce the relevant variables necessary to derive a meaningful exchange rate pressure measure. The fourth section derives the proposed measure and compare it with the existing ones. The fifth section concludes.

The determination of the exchange rate and the derivation of a pressure measure

The level of the exchange rate has proven to be a difficult variable to determine. This difficulty is an issue given the influence of the exchange rate in an integrated World economy and must be considered when evaluating measures of deviations from notional or equilibrium exchange rates. To illustrate the basic insights we will proceed by illustrating a simple benchmark example.

If a currency was only traded spot in a centralized exchange, its relative price would be simply determined by demand and supply. Trades involving a currency can occur because of current account transactions (trade in goods, services, income payments, transfers) or financial account transactions (FDI, Portfolio, Trade credits, Banks deposits, Loans). Let $CA_t = PCA_t - NCA_t$ be the current account which is equal to the difference between positive flows and negative flows. Let $KA_t = \Delta FDA_t - \Delta DFA_t$ the capital-financial account which is equal to the difference between the change in foreign domestic assets and domestic foreign assets. The equilibrium exchange rate E_t^e is such that

$$KA_t\left(E_t^e, z_{KA,t}\right) + CA_t\left(E_t^e, z_{CA,t}\right) = 0,$$

where the z_{CA}, z_{KA} are all the other variables affecting the current and financial accounts. In a World with perfect markets, a pure floating exchange rate would always equal its equilibrium value. The actual exchange rate E_t can differ from the equilibrium exchange rate E_t^e because of imperfections, frictions and defects of the financial markets and/or non-optimal management of the exchange rate by the national monetary authority. The exchange market rate pressure is therefore:

$$EMP_t = E_t - E_t^e.$$

The difficulties begin with the specification of a model. The majority of the literature on EMP uses some variant of a macroeconomic monetary model. In the spirit of Girton and Roper (1977), consider a simple log-linear model with a standard money demand:

$$m_t^d - p_t = \phi y_t - \eta i_t,$$

where m^d is the demand of money, p is the price level, y is the level of income and i is the relevant short term rate. All variables are in natural logarithms except the interest rate. ϕ and η are the respective (semi-)elasticities and are considered structural parameters of the economy. The money supply is

$$m_t^s = r_t + d_t,$$

where r_t are foreign reserves expressed in domestic currency and d_t is domestic credit. Both are expressed in natural logarithms of their ratio to the monetary base. The simplest version of the monetary model determine the exchange rate, denoted e_t, through a purchasing power parity (PPP) condition

$$p_t = p_t^* + e_t.$$

Starred variables denote foreign variables. Solving for the money market equilibrium, using PPP and a symmetric model for foreign imply:

$$e_t + (i_t - i_t^*) - (r_t - r_t^*) = (d_t - d_t^*) - \phi\,(y_t - y_t^*) + (1+\eta)(i_t - i_t^*).$$

The left hand side is an index of exchange rate pressure: if domestic reserves of foreign exchange decline or interest rates rise or the exchange rate depreciates, pressure increases. Sometimes the monetary model is augmented with an uncovered interest parity, see for example Weymark (1997), which changes the exchange rate determination to an asset model. Consider the uncovered interest parity

$$i_t = i_t^* + E_t\left[e_{t+1}\right] - e_t + \psi_t$$

where ψ_t is a risk premium and E_t is the mathematical expectation operator. Solving forward, the exchange rate is determined by:

$$e_t = \frac{1}{1+\eta}\sum_{s=t}^{\infty}\left(\frac{\eta}{1+\eta}\right)^{s-t} E_t\left[r_s + d_s - \phi y_s + \eta i_s^* + \eta\psi_s - p_s^*\right].$$

Modeling or assuming the path of the variables in the right hand side we can solve for the equilibrium exchange rate and construct a measure of of EMP by taking deviations of the actual exchange rate from the model derived exchange rate. One problem with this approach is that the data are not very kind to this monetary model (outside maybe hyper-inflationary environment). A further complication arises because of the necessity of estimating structural parameters. A simple solution is to bypass the estimation of the structural parameters and use a more reduced form approach like in Eichengreen Rose and Wyplosz (1994) intuitive, although arbitrary, proposal to weight the components of the index implied by the monetary model so that their conditional volatilities are equal.

Angola overview

The models in the previous section imply perfect capital and goods mobility. In reality the size or the type of transactions in the current and capital account can be regulated or even prohibited by governments. The Republic of Angola has, according to some measures, the most controlled financial account in the World. The current account as well is subject to controls[2]. There are other aspects of the Angola economy, such as the fact that exports are overwhelmingly oil and gas whose price can be taken a exogenous or that the economy is heavily dollarized that deserve special attention in the specification of a model of exchange rate determination. This sub-section presents rapidly some stylized facts to motivate the modeling assumptions of the next section.

Figure 1 shows the last fifteen years of exchange rate regimes in Angola that started de facto an successful exchange rate management in early 2005. Figure 2 shows the components of the Financial account and the current account from 2005 to 2012. The figure shows the tight management of the financial account through foreign reserve management. Notice that during the last three years of the sample current account surpluses have increasingly financed direct investment. Figure 3 shows the nominal annual effective depreciation of the Angolan currency and the annual effective price differential between the Angolan CPI and its trading partners. Except for the global financial crisis that corresponded to a relatively large 17 percent depreciation of the Angolan currency, the inflation differential appears to play the more important role in the dynamics of the real exchange rate. It is worth noting that the inflation differential was not affected by the depreciation during the crisis. This observation suggests a degree of control of the domestic inflation by the central bank relatively independent of the exchange rate management. The second panel of Figure 3 shows the level of exports in goods together with the price of a barrel of oil in the World market. Given that virtually (98%) of goods exports are oil and gas and that domestic energy production has been peaking in 2008 and then remained flat, changes in the level of export in goods are mostly driven by price changes and are exogenous to Angola. Figure 4 shows the level of foreign reserves, the money supply (M2), the amount of foreign currency deposits and the money multiplier (the ratio of M2 to reserve money). Until 2009 foreign reserves were fully backing the existing supply of M2. Since 2009 M2 has become larger than the Foreign reserves but their ratio has been kept sufficiently stable. A more detailed analysis of this symptom of dollarization requires a more complete set of data. The IMF second post program report provides some information on the amount of foreign currency deposits which approximately still stand at 50% of M2 while the amount of foreign currency credit to the private sector stands at 63.8% in 2009. The important role of the dollar as a medium of exchange and store of value in Angola creates an important source of trade in dollars against kwanzaas that can impact on the exchange rate. Informal currency trade within Angola is also an important source of pressure on the exchange rate. Figure 5 shows the evolution of the informal and official exchange rate against the dollar and the percentage difference between the informal and the official exchange rate. At the peak of the crisis, the informal exchange rate was trading at a 25% lower value than the official rate. Since then the lower informal value appears to have fluctuated within a 5% to 10% corridor. Notice that the post-crisis corridor is sensibly higher (larger discount) than the one prevailing before the crisis which oscillated between -1% and 5%. The higher corridor coincides with the less than complete backing of money by Foreign reserves.

A synthetic narrative that comes from this short description is that oil exports, mostly determined by the world

[2]Today, membership to the IMF requires full liberalization of the current account, and national discretion for what regards the degree of regulation of the financial account.

oil price are the primary source of foreign currency. The shock of the global crisis in 2009 decreased oil price from an average of 100 us dollars in 2008 to an average of 60 us dollars in 2009. The same year, Angola experienced the only episode of current account deficit in the sample which was followed by a sharp depreciation. Angola is also a highly dollarized economy. This characteristic can play an important role in the exchange rate determination by generating pressures originating from domestic credit and financial shocks unknown in countries with a single national domestic tender.

The next section presents a simple model for Angola. The scope is to start the construction of a relevant macroeconomic model for Angola whose features will be incorporated progressively in a series of future works. This is the first of these works and is necessarily incomplete, for example it does incorporate the dollarization of the economy in an extremely reduced form. It also lacks other aspects of the Angolan economy which are likely to be important. Again, in this work, the scope of the model is to identify the relevant variables to be incorporated in the empirical analysis. The non technically oriented reader can skip the section and directly jump to the empirical part.

A benchmark model for Angola

The observations of the previous section motivate a specification of a benchmark model for Angola that features the following key simplifying assumptions:

- the Central Bank (CB) manages the exchange rate through foreign exchange reserves operations,
- the CB controls the short term interest rate to control domestic inflation,
- exports (oil) are exogenous.

The core of the model is a small open economy (SOE) new Keynesian model. Furthermore the benchmark model features the following simplifying technical assumptions (non-crucial):

- unit elasticity of substitution between nontradables and imports
- log utility in consumption
- constant return to scale in production of non tradable.

Extensions of the benchmark should include balance sheet effects of monetary policy foreign reserve interventions through imperfections in financial intermediation and more realistic substitution elasticities between nontradables goods and imports. A further important extension is to incorporate the high degree of dollarization of Angola. We leave these extensions for future work.

We present for simplicity a log-linearized version of the model (See appendix for the non-linear model). Aggregate consumption c_t is a composite index of non-tradable goods $c_{N,t}$, produced domestically, and imported goods $c_{M,t}$:

$$c_t = \omega c_{N,t} + (1-\omega)c_{M,t}$$

where ω is the share of nontradables. Demand for each good is a function of aggregate expenditure and its relative price

$$c_{N,t} = c_t - q_{N,t},$$

$$c_{M,t} = c_t - q_{M,t},$$

where $q_{N,t}$ is the price index for nontradables deflated by the CPI and $q_{M,t}$ is the price of imports deflated by the CPI p_t. The latter depends on the nominal exchange rate e_t and the foreign price of imports $p_{F,t}$ deflated by CPI

$$q_{M,t} = e_t + (p_{F,t} - p_t).$$

Aggregate expenditure depends on the term structure of real interest rates relevant for consumption decisions (Euler equation)

$$c_t = E_t c_{t+1} - E_t\left(i_{D,t} - \pi_{t+1} - \rho\right)$$

where $i_{D,t}$ is the one period nominal interest rate (policy rate) and π_t is the rate of CPI inflation. $\rho = -log(\beta)$ and β is the time discount factor. The labor supply comes from household first order condition

$$(w_t - p_t) = c_t + \phi n_t.$$

The non-tradable sector output $y_{N,t}$ is produced with a constant return to scale in labor input n_t

$$y_{N,t} = a_t + n_t$$

where a_t is labor productivity. Non-tradable producers are price setters subject to nominal price rigidity (a la Calvo with parameter θ) which results in a standard new Keynesian Phillips curve

$$\pi_{N,t} = \beta E\left\{\pi_{N,t+1}\right\} + \lambda mc_t$$

where $\lambda = \frac{(1-\beta\theta)(1-\theta)}{\theta}$ and mc_t is the real marginal cost

$$mc_t = (w_t - p_t) - q_{N,t} - a_t.$$

The non-tradable clearing market condition implies

$$y_{N,t} = c_{N,t}.$$

Importers (price setters or not) face flexible prices so that imported goods inflation is

$$\pi_{M,t} = \Delta e_t + \pi_{F,t}.$$

CPI inflation is

$$\pi_t = \omega \pi_{N,t} + (1-\omega)\,\pi_{M,t}.$$

The national budget constraint is

$$\zeta f_t = \zeta_L \left(f_{t-1} + i_{F,t-1} - \Delta e_t - \pi_{F,t}\right) + \zeta_O y_{O,t} - C_M c_{M,t}$$

where f_t is foreign exchange reserves (in foreign goods). $y_{O,t}$ is the exogenous real exports of oil, $i_{F,t}$ is the exogenous foreign interest rate on foreign reserves and $\pi_{F,t}$ the foreign inflation rate[3].

Finally policy consists in choosing a path for $\bar{e}_t$ by managing foreign reserves and setting the domestic interest rate $i_{D,t}$. From a simplified Central Bank balance sheet, define $\chi_t = ln\left(\frac{E_t F_t}{M_t}\mu_t\right)$ where M is money and μ the money multiplier. Levels in χ_t signal the capacity of the Central Bank to face domestic demand of foreign currency. Changes in χ_t can be seen as an index of sterilization ($\Delta\chi_t = 0$, implies full sterilization).

Empirical Analysis

The above model provides the rational for a measure of an exchange rate pressure index that contains exports changes, imports changes, the foreign interest rate and inflation and the change in foreign reserves corrected by our measure χ_t. Following Eichengreen Rose and Wyplosz (1994) the weights of the components of the index are set so that their conditional volatilities are equal. A second measure is obtained by selecting a subset of the above variables by eliminating those that are statistically insignificant in predicting one month ahead a devaluation of 2 percent (annual rate). The 2 percent threshold corresponds to the band defined by the monetary authority within the exchange rate is managed. Finally the two measures of EMP are compared with the EMP indexes obtained in Eichengreen Rose and Wyplosz (1994) and Klassen and Jager (2011). All the data used in the analysis are presented

[3] $\zeta = \left(F + \rho_F(F)\frac{F}{Q_M}\right), \zeta_L = \frac{(1+i_F)F}{\Delta Q_M \Pi}, \zeta_O = \frac{P_O Y_O}{P_F}$,where capital letters without time subscript indicate steady state values and ρ_F is the derivative of the adjustment cost of changing reserves.

in Figure 6:

- the exchange rate monthly depreciation rate Δe_t,
- a binary index of devaluation that takes the value of 1 if the exchange rate depreciates more than 2% on an annual basis,
- the percentage monthly rate of change in exports denominated in dollars Δx_t,
- the percentage monthly rate of change in imports denominated in dollars Δm_t,
- the US 3-month T-bill $i_{F,t}$,
- the Angola 3 month deposit rate $i_{D,t}$,
- the US annual inflation rate $\pi_{F,t}$,
- the Angola annual inflation rate $\pi_{A,t}$,
- the percentage change in oil prices (Brent),
- the monthly percentage change in foreign reserves f_t,
- and the index χ_t which is the ratio of Foreign reserves denominated in domestic currency to the money in circulation (M2) times the money multiplier (demeaned).

The sample starts in 2005. The EMP measure that follows from the model of the previous section is:

$$EMP_{theory} = \Delta e_t + \alpha_{\Delta f}\Delta f_t + \alpha_{i_F} i_{F,t-1} - \alpha_{\pi_F}\pi_{F,t} - \alpha_{\Delta x}\Delta x_t + \alpha_{\Delta m}\Delta m_t - \alpha_\chi \chi_t$$

where the $\alpha_y = \frac{stdev(\Delta e_t)}{stdev(y_t)}$. The second suggested measure of EMP is derived by keeping in the index only the variables suggested by the model that significantly predict one month ahead a devaluation of more than 2% percent at an annual rate. Table 1 presents the probit regressions where the dependent variable is devaluation and the explanatory variables are the one month lagged variables.

The EMP measure that follows the model and the statistical approach is:

$$EMP_{empirical} = \Delta e_t + \alpha_{i_F} i_{F,t-1} - \alpha_{\Delta x}\Delta x_t - \alpha_\chi \chi_t.$$

For comparison we report the index of Eichengreen Rose and Wyplosz (1994) based on the arbitrary same weighting scheme and on monetary model:

$$EMP_{ERW} = \Delta e_t - \alpha_f f_t + \alpha_{\Delta(i_F - i_D)}\Delta\left(i_{F,t} - i_{D,t}\right)$$

and the Klassen and Jager (2011) index based on a modified monetary model that endogenizes monetary policy with an interest rate rule, define the notional exchange rate the exchange rate that would have prevailed without intervention and use the same weighting scheme:

$$EMP_{KJ} = \Delta e_t - \alpha_{fm} fm_t + \alpha_{(i_F - i_D)} \left(i_{F,t} - i_{D,t}\right),$$

where $fm_t = \frac{\Delta F_t E_{t-1}}{M_{t-1}}$. Figure 7 shows the four different measures. Finally, Table 2 compares the predictive power of the four measures in anticipating a devaluation by one month regressing the variable devaluation on the four lagged EMP indexes. For each index three models are estimated: OLS, Probit and Logit. The reason for the probit and logit models is that the dependent variable is a discrete variable that takes the value 1 in the event of the depreciation greater than 2 percent (yearly rate) and 0 in the event of no depreciation (or smaller than 2 percent). Formally, let $y_t \in [0, 1], t = 1, ..., T$. Let $\theta_t = Pr[y_t = 1]$, which is a function on the exchange market rate pressure via

$$h(\theta_t) = y_t^* = \beta EMP_{it-1} + u_{it},$$

where i indexes the different EMP measure and y_t^* is the depreciation rate. Therefore

$$y_t = \begin{cases} 0 & , y_t^* < 2\% \\ 1 & , y_t^* \geq 2\% \end{cases}$$

For probit, u_{it} is $N(0, 1)$, while for logit u_{it} is drawn from a logistic distribution, also normalized to have unit variance. The log-likelihood function is easy to construct in the case of independent[4] y_t. For comparison the OLS results are reported as well. The estimates from the three models tell a consistent story. The signs of the coefficients are the same across the models, and the exchange market pressure measures are statistically significant in each model. The three models are estimated with robust standard errors. The four EMP measures have predictive power. Overall the ranking is $EMP_{empirical} \succ EMP_{KJ} \succ EMP_{theory} \succ EMP_{ERW}$. EMP_{theory} has a performance comparable (slightly better) with EMP_{ERW} while $EMP_{empirical}$ has a performance comparable (slightly better) with EMP_{KJ}. Consider the results for the probit model using $EMP_{empirical}$ as an explanatory variable:

$$y_t^* = -.7256997 + 0.312683 EMP_{it-1},$$

[4]Absence of independence across time of the dependent variables is potentially problematic and can substantially complicate the estimation. The simplest test is to assume a transitional model in which correlation among the discrete responses arises because past responses explicitly influence the present outcome. Past realizations of the discrete response help determine the current response, and so enter the model as additional predictor variables. Assuming a Markov chain to form the basis of a transitional model, Diggle, Liang and Zeger (1994, 135) show the model:

$$h(\theta_t) = \beta_0 EMP_{it-1} + \alpha EMP_{it-1} y_{t-1} + u_{it},$$

Tests of the null hypothesis $\alpha = 0$ tap whether the effects of EMP are constant irrespective of the previous state of the binary process. α always results statistically non different from zero in the regressions of Table2. Results are not reported.

where both the constant and the coefficient are highly significant. The interpretation is that in the monthly sample (2005-2013) if $EMP_{emprical} = 0$ then the probability of a devaluation greater than 2% is equal to 0.23 ($\Phi(-0.72)$, where Φ is the cdf of a $N(0,1)$) while if $EMP_{empirical}$ is equal to the sample average (-1.203529) the probability becomes 0.13 ($\Phi(-0.72 + 0.31 \times (-1.22))$). Compare these results with the logit model:

$$y_t^* = -1.256036 + 0.5484EMP_{it-1}.$$

When $EMP_{emprical} = 0$ then the probability of a devaluation greater than 2% is equal to 0.22 ($\Lambda(-1.25)$, where Λ is the cdf of a standard logistic) while if $EMP_{empirical}$ is equal to the sample average the probability becomes 0.128 ($\Lambda(-1.25+0.55 \times (-1.22))$). Finally as it is already clear from the previous two examples the marginal effects in the probit or logit models are not constant and depend on the value of the explanatory variable. For example at the 90 percentile of $EMP_{empirical} = 1.89$ the probability of a devaluation greater than 2 percent next month is 0.445.

Conclusion

The Angolan economy exhibits a number of relevant characteristics. Angola has a closed financial account, a partially controlled current account, a highly dollarized economy and exports (oil) price determined in World markets. All of these features are likely to have an impact on the demand of foreign currency. This paper wants to help the policy maker by providing an EMP suitable for the Angolan economy. In a broader picture the paper is also a first step in the construction of a relevant macroeconomic model that incorporates those features to provide meaningful insights on the Angolan economy. The proposed EMP measure appears to perform slightly better than existing empirical measures. Future extensions that model in a more careful way the domestic credit market and its interactions with the demand of foreign currency should be the next item on the agenda.

Figures

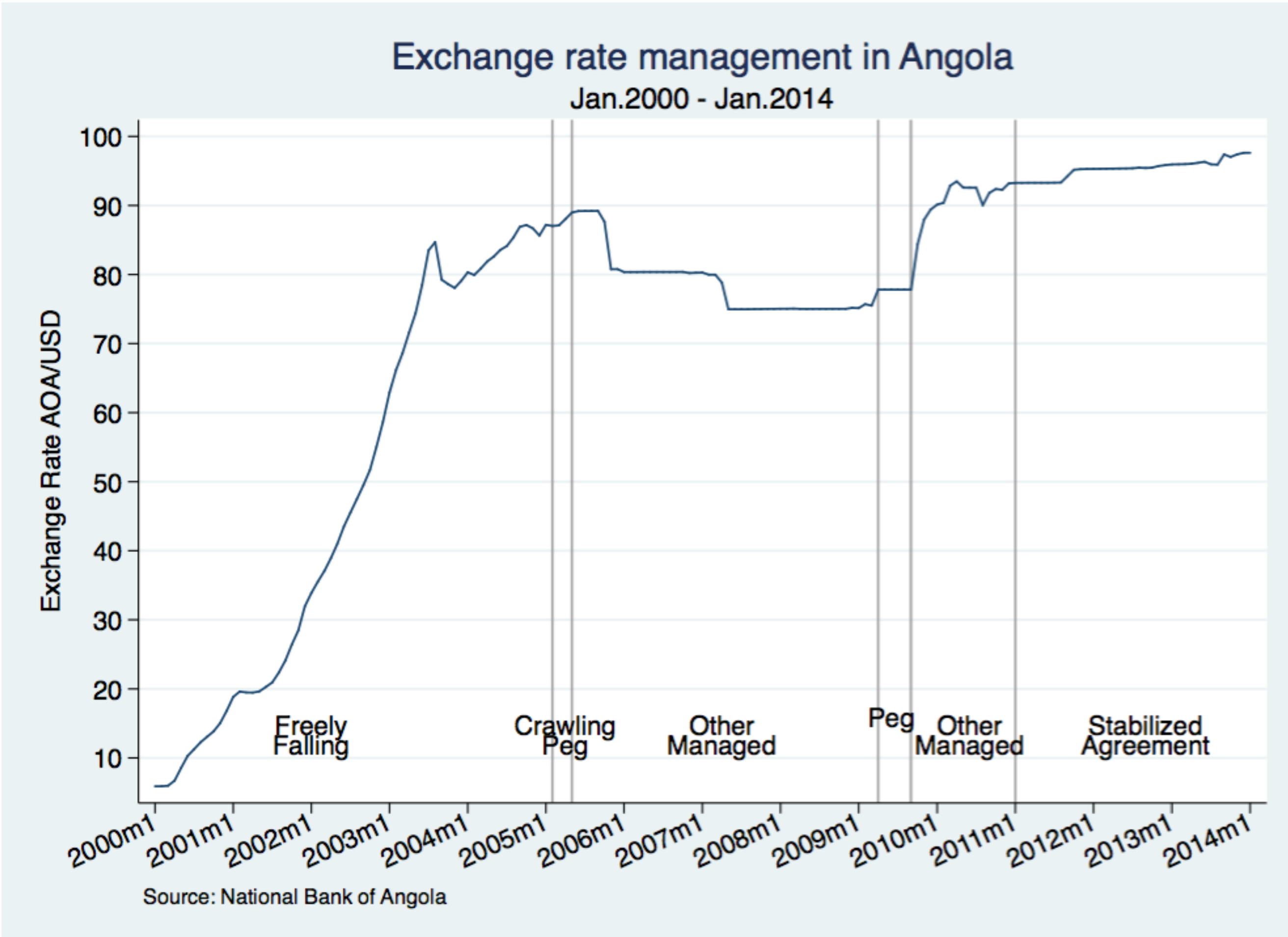

Figure 1: The Exchange rate in Angola 2000-2014

Tables

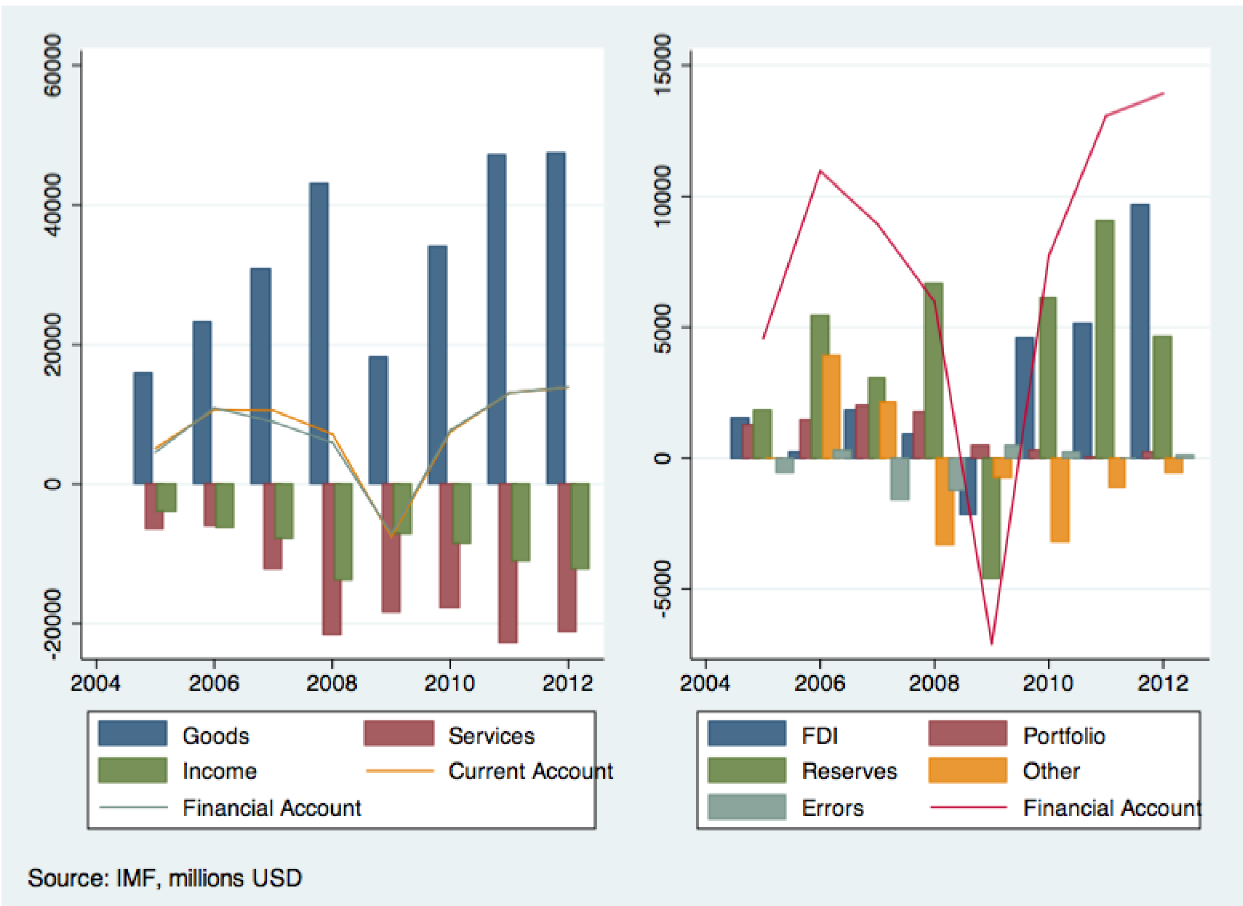

Figure 2: The current and financial account in Angola.

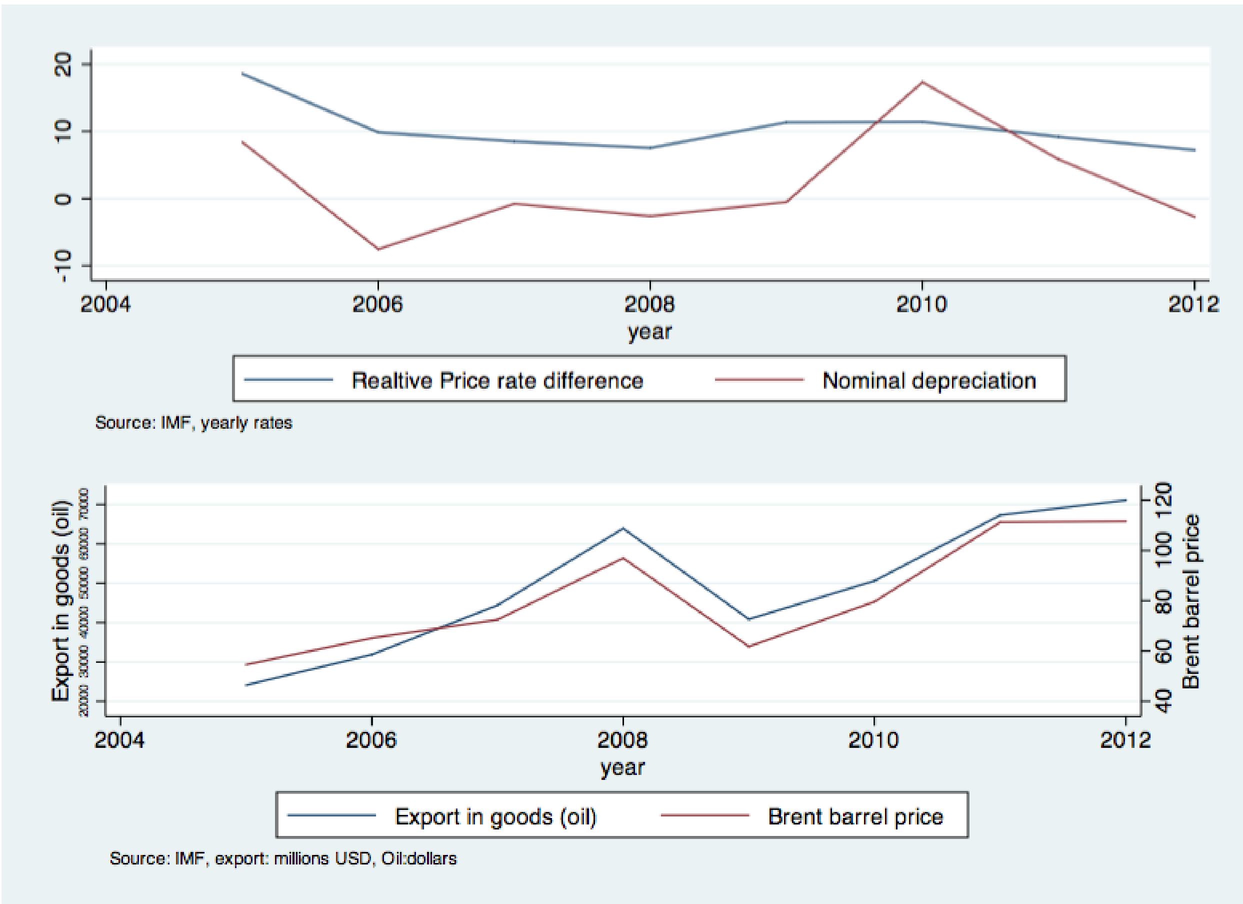

Figure 3: The real exchange rate and exports in Angola.

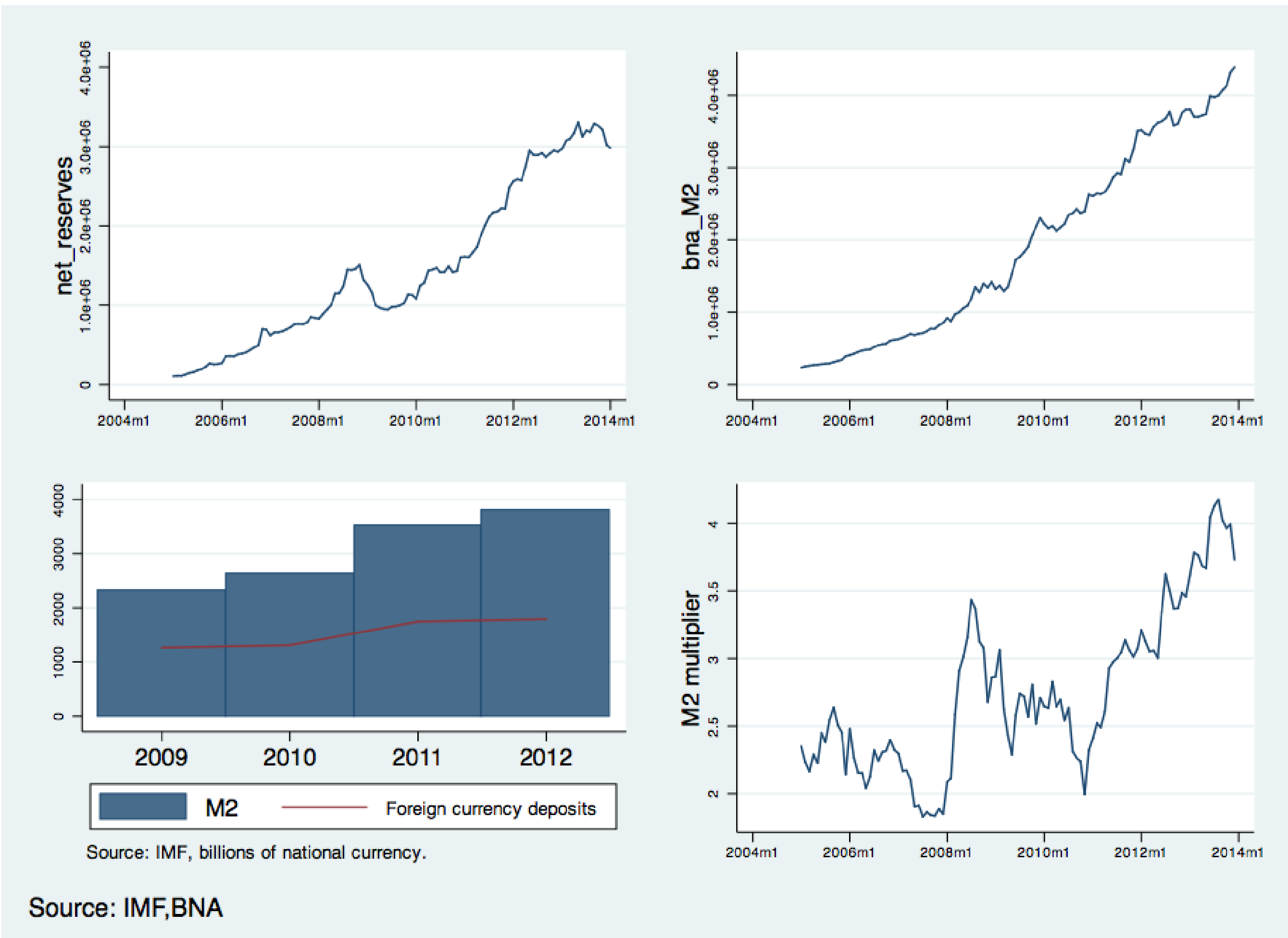

Figure 4: Monetary aggregates in Angola.

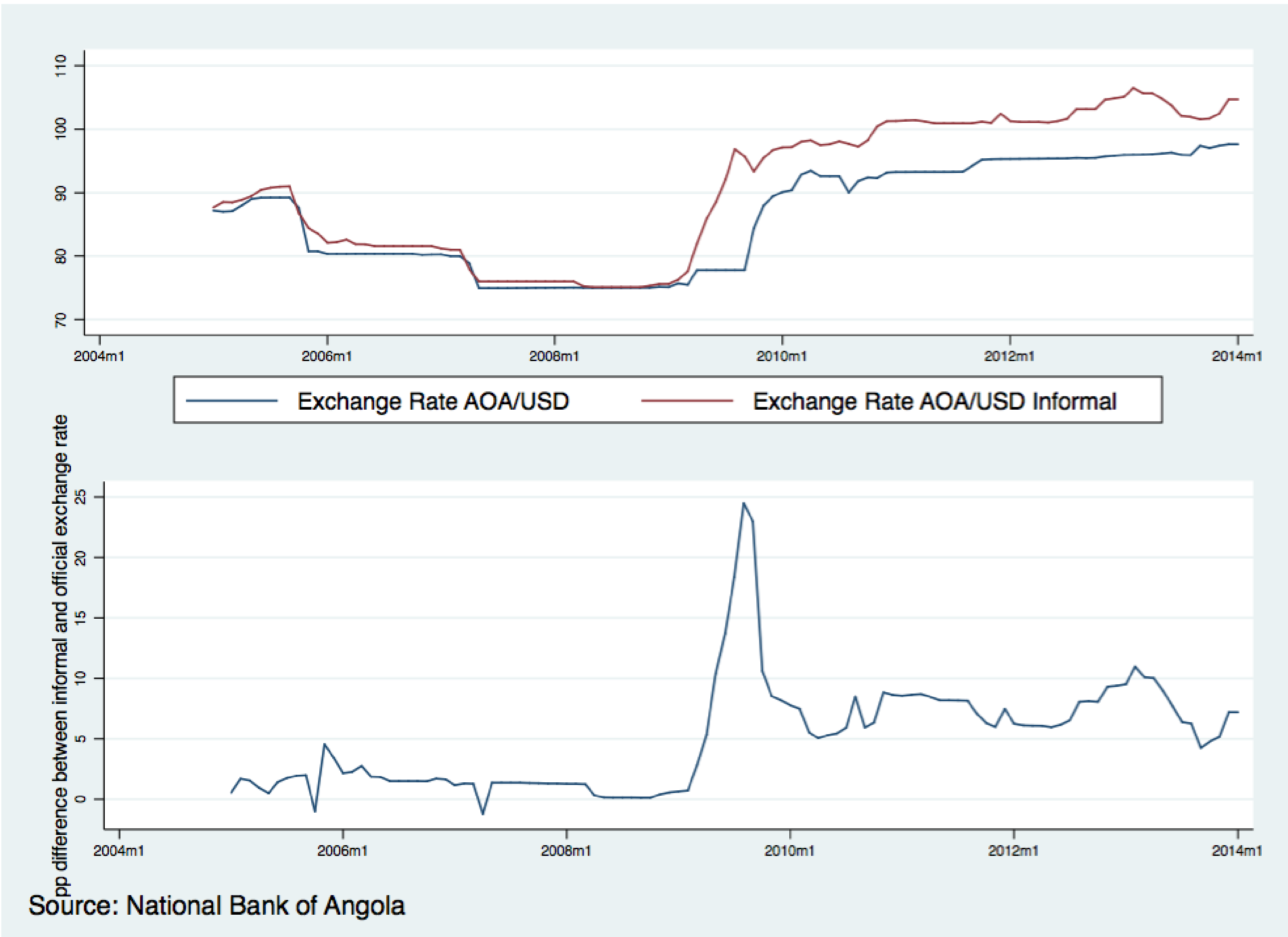

Figure 5: Informal currency trade in Angola

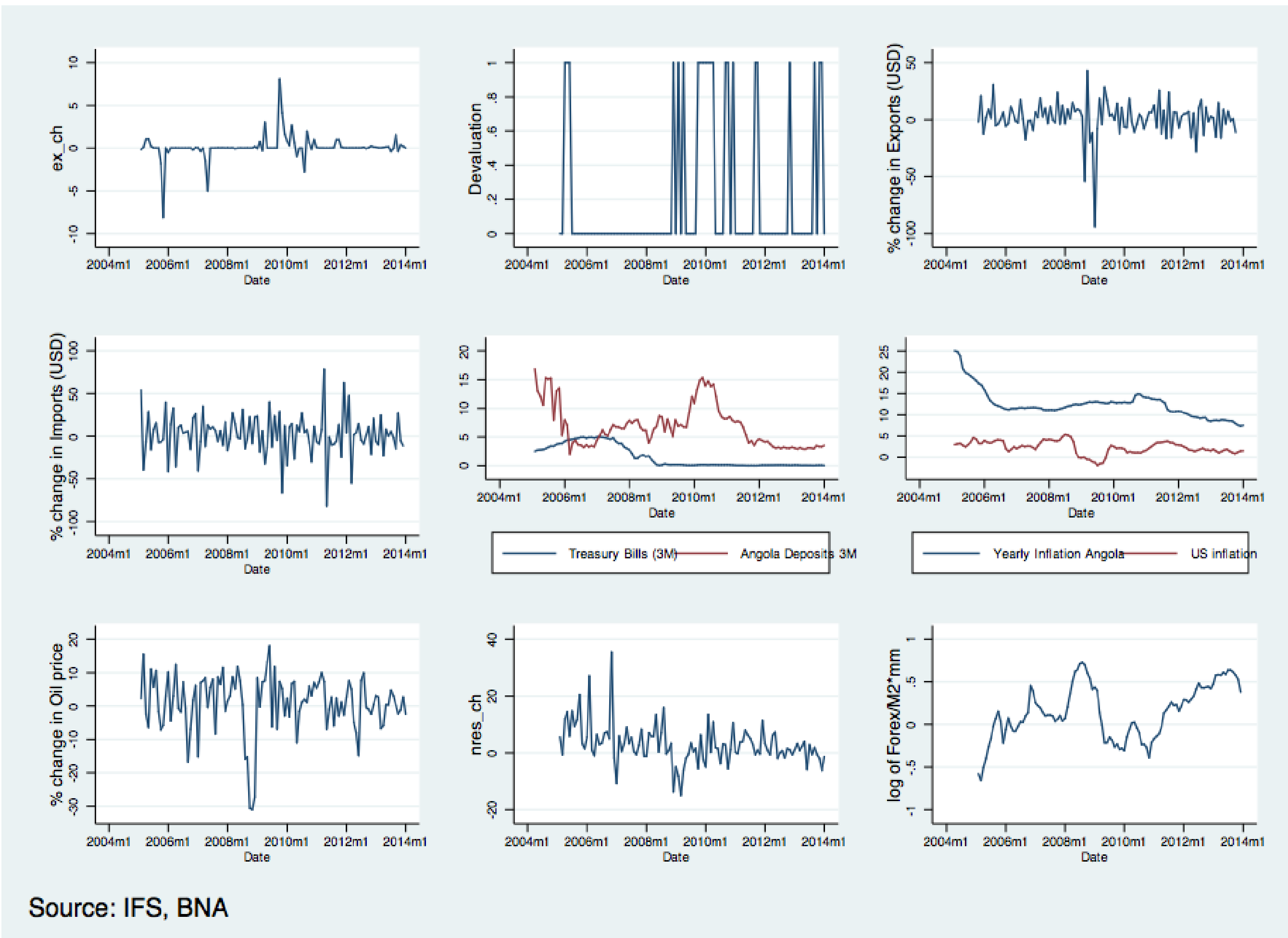

Figure 6: Data

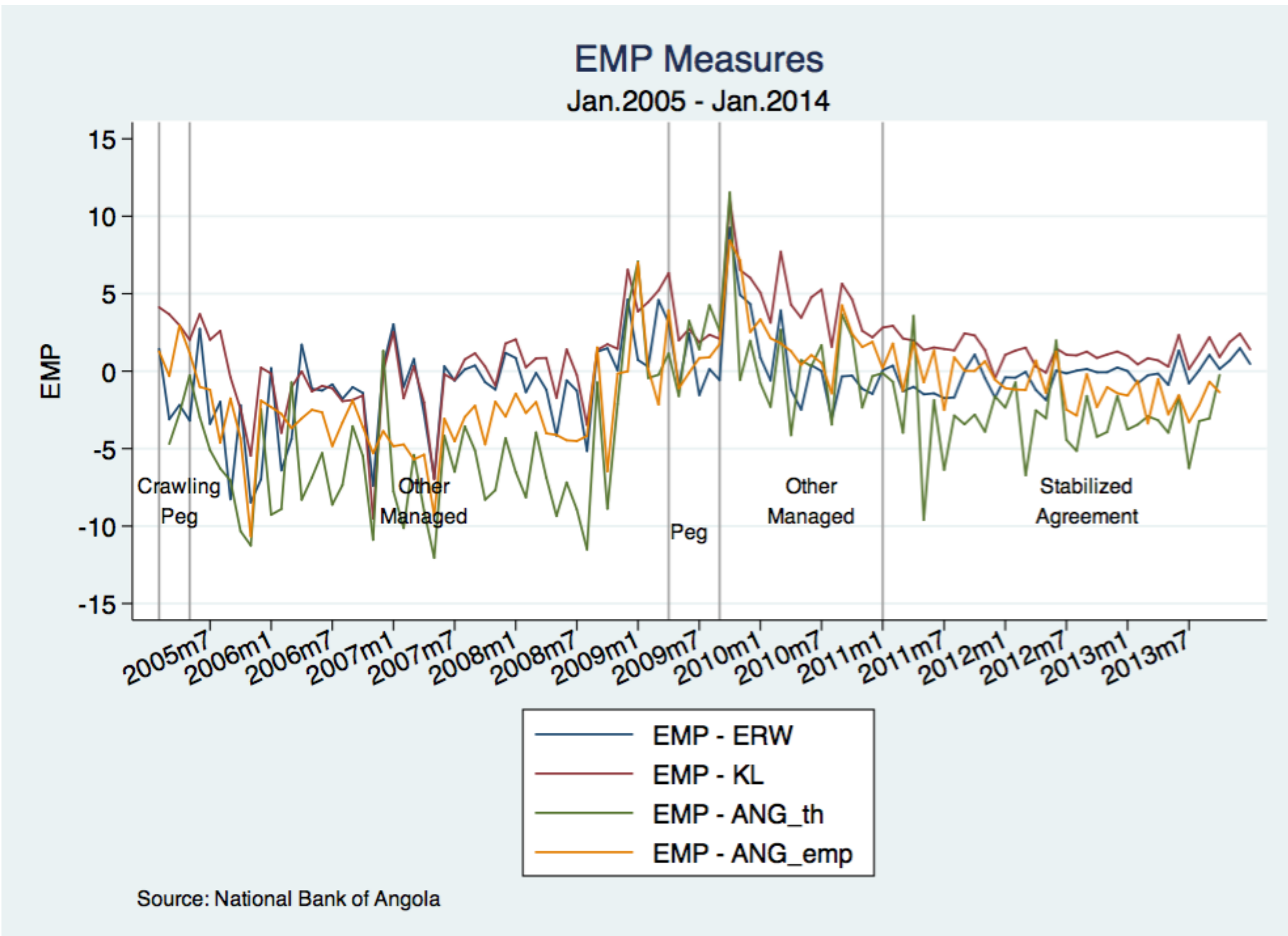

Figure 7: The EMP indexes, 2005-2014.

TABLE 1

EQUATION	VARIABLES	(1) exports	(2) imports	(3) US rates	(4) US inflation	(5) Oil price	(6) Reserves	(7) F/M2*mu	(8) Angola 3m	(9) Angola inflatior	(10) All	(11) Significant
devaluation	L.export_ch	-0.0128									-0.0165	-0.0199*
		(0.00860)									(0.0101)	(0.0103)
	L.import_ch		-0.00416								-0.00198	
			(0.00574)								(0.00632)	
	L.tb3ms			-0.316***							-0.460**	-0.422***
				(0.109)							(0.208)	(0.143)
	L.infl_u_y				-0.226**						-0.000225	
					(0.0947)						(0.136)	
	L.doil					-0.00882					-0.0244	
						(0.0156)					(0.0211)	
	L.nres_ch						-0.0268				-0.0128	
							(0.0212)				(0.0300)	
	L.lrel							-1.005**			-1.787*	-1.875***
								(0.430)			(1.018)	(0.527)
	L.ang_3m								0.0827**		0.00385	
									(0.0357)		(0.0638)	
	L.infl_ang_y									0.0457	0.0357	
										(0.0367)	(0.0886)	
	Constant	-0.844***	-0.826***	-0.485***	-0.349	-0.822***	-0.766***	-0.726***	-1.445***	-1.417***	-0.693	-0.251
		(0.140)	(0.137)	(0.168)	(0.237)	(0.137)	(0.145)	(0.145)	(0.308)	(0.496)	(1.117)	(0.194)
	Observations	106	108	108	108	108	108	108	108	108	106	106

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 8: Table1

TABLE 2

EQUATION	VARIABLES	OLS EMP_ERW	OLS EMP_KJ	OLS EMP_Theory	OLS EMP_Empirica	Probit EMP_ERW	Probit EMP_KJ	Probit EMP_Theory	Probit EMP_Empirica	Logit EMP_ERW	Logit EMP_KJ	Logit EMP_Theory	Logit EMP_Empirical
devaluation	L.EMP_ERW	0.0360**				0.141**				0.252**			
		(0.0137)				(0.0592)				(0.106)			
	L.EMP_KL		0.0595***				0.307***				0.513***		
			(0.0128)				(0.0661)				(0.116)		
	L.EMP_ANG_th			0.0359***				0.152***				0.251***	
				(0.00745)				(0.0320)				(0.0555)	
	L.EMP_ANG_emp				0.0644***				0.313***				0.548***
					(0.0108)				(0.0627)				(0.122)
	Constant	0.222***	0.119***	0.324***	0.277***	-0.803***	-1.485***	-0.473***	-0.726***	-1.343***	-2.495***	-0.803***	-1.256***
		(0.0410)	(0.0325)	(0.0561)	(0.0420)	(0.143)	(0.208)	(0.172)	(0.162)	(0.254)	(0.390)	(0.293)	(0.293)
	Observations	105	105	104	105	105	105	104	105	105	105	104	105
	R-squared	0.055	0.172	0.144	0.231								

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Figure 9: Table 2

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Appendix Complete Model

Households

Households maximize the following standard utility,

$$\sum_{s=0}^{\infty} \beta^s E_t \left\{ U\left(C_{t+s}\right) - V\left(N_{t+s}\right) \right\},$$

subject to a sequence of budget constraints of the form

$$P_t C_t + P_t D_t + P_t B_t \leq \left(1 + i_{D,t-1}\right) P_{t-1} D_{t-1} + W_t N_t + \Pi_t + T_t$$

Foc:

$$\frac{V'\left(N_t\right)}{U'\left(C_t\right)} = \frac{W_t}{P_t}$$

$$\left(1 + \rho_{D,t}\left(D_t\right)\right) = \beta \frac{U'(C_{t+1})}{U'(C_t)} \frac{P_t}{P_{t+1}} \left(1 + i_t^d\right)$$

where C_t is an index composed of non tradable goods and imported goods.

Firms

The economy is composed of an oil exporting sector, an importing sector and a non-tradable sector.

Non tradable

There is a continuum of firms indexed by $j \in [0, 1]$, each of which produces a differentiated good with the following technology

$$Y_{N,t}(j) = A_t N_t(j)$$

where $Y_{N,t}(j)$ denotes the output of good j, A_t is an exogenous technology parameter, and $N_t(j)$ is labor input used by firm i. Finally each firm may reset its price with probability $1 - \theta$ in any given period independently of the time elapsed since the last adjustment. Those firms that get to reset their price choose a reset price $P^r_{N,t}(j)$ to solve

$$\sum_{k=0}^{\infty} \theta^k \Psi_{t,t+k} \left\{ P^r_{N,t}(j) Y_{N,t+k|t}(j) - W_{t+k} N_{t+k}(j) \right\}$$

subject to the technology constraint, the demand constraint $Y_{N,t+k|t}(j) = \left(\frac{P^r_{N,t}(j)}{P_{N,t+k}}\right)^{-\epsilon} Y_{N,t+k}$, $\Psi_{t,t}$ is the stochastic discount factor. The foc is

$$\frac{P^r_{N,t}(j)}{P_{N,t-1}} = \frac{\epsilon}{\epsilon - 1} \frac{\sum_{k=0}^{\infty} \theta^k Q \Psi_{t,t+k} \frac{P_{N,t+k}}{P_{N,t-1}} mc_{t+k}(j) Y_{N,t+k|t}(j)}{\sum_{k=0}^{\infty} \theta^k \Psi_{t,t+k} Y_{N,t+k|t}(j)}$$

$$mc_{t+k} = \frac{W_{t+k}}{P_{N,t+k}} \frac{1}{A_{t+k}}$$

Importers

Importers are price setters with a markup on the exogenous foreign price $P_{F,t}$. Their price, $P_{M,t} = \mu E_t P_{F,t}$, is assumed to be flexible. E_t is the nominal exchange rate.

Oil

The oil sector is simply assumed to produce exogenous oil revenues $E_t P_{O,t} Y_{O,t}$ where $Y_{O,t}$ is the number of barrels produced and $P_{O,t}$ is the price per barrel in foreign currency.

Financial intermediaries

Maximize

$$D_t - R_t - L_t$$

subject to

$$(1 + i_{D,t}) D_t = (1 + i_{L,t}) L_t + (1 + i_{R,t}) R_t$$

Government

The government budget constraint is

$$P_t B^g_t = (1 + i_{G,t-1}) P_{t-1} B^g_{t-1} + P_t T_t$$

Central Bank

Central Bank balance sheet

$$P_t B^{cb}_t + E_t P_{F,t} F_t = P_t R_t$$

Bonds market clearing

$$P_t B^g_t = P_t B^{cb}_t$$

Central Bank Cash flow

$$CF_t^{cb} = P_t R_t - P_{t-1} R_{t-1} \left(1 + i_{R,t-1}\right) - \left[P_t B_t^{cb} - P_{t-1} B_{t-1}^{cb} \left(1 + i_{G,t-1}\right)\right] - \left[E_t P_{F,t} F_t - E_{t-1} P_{F,t-1} F_{t-1} \left(1 + i_{F,t-1}\right)\right]$$

Financial sector cash flows

$$CF_t^{fs} = P_t D_t - \left(1 + i_{D,t-1}\right) P_t D_{t-1} - \left[P_t R_t - \left(1 + i_{R,t-1}\right) P_t R_{t-1}\right] - \left[P_t L_t - \left(1 + i_{L,t}\right) P_t L_t\right]$$

National Budget constraint

$$E_t P_{F,t} F_t = E_{t-1} P_{F,t-1} F_{t-1} \left(1 + i_{F,t-1}\right) + E_t P_{O,t} Y_{O,t} - P_{M,t} C_{M,t}$$

Monetary Policy

Chooses E_t by selling and buying F_t and set the interest rate on reserves $i_{R,t}$.

Functional forms

We will consider the following functional forms

$$U = log(C_t) - \frac{N_t^{1+\phi}}{1+\phi}$$

$$C_t \equiv \left[\omega^{\frac{1}{\eta}} C_{N,t}^{\frac{\eta-1}{\eta}} + (1-\omega)^{\frac{1}{\eta}} C_{M,t}^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}},$$

$$C_{N,t} \equiv \left(\int_0^1 C_{N,t}(j)^{\frac{\epsilon-1}{\epsilon}} dj\right)^{\frac{\epsilon}{\epsilon-1}}$$

foc

$$C_{N,t}(j) = \left(\frac{P_{N,t}(j)}{P_{N,t}}\right)^{-\epsilon} C_{N,t}$$

and $P_{N,t} \equiv \left(\int_0^1 P_{N,t}(j)^{1-\epsilon} dj\right)^{\frac{1}{1-\epsilon}}$ and

$$C_{N,t} = \omega \left(\frac{P_{N,t}}{P_t}\right)^{-\eta} C_t; C_{M,t} = (1-\omega) \left(\frac{P_{M,t}}{P_t}\right)^{-\eta} C_t$$

and $P_t \equiv \left[\omega P_{N,t}^{1-\eta} + (1-\omega) P_{M,t}^{1-\eta}\right]^{\frac{1}{1-\eta}}$

Benchmark

The benchmark model is obtained asusming a unitary elasticity of substitution between C_M and C_N

$$\eta = 1$$