The impact of a political shock on foreign exchange markets in small open economy: A dynamic modeling approach

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Abstract

Background: The aim of this paper is to analyze the dynamics of foreign exchange markets in a country facing political uncertainty that prompt capital outflow from the country. The economic environment under investigation is characterized by dual foreign exchange markets: a formal or official market for foreign exchange with insufficient and volatile foreign exchange flows, and a strong and thriving informal market, with a higher exchange rate. The paper seeks to answer a number of essential questions: Is it possible to stabilize the foreign exchange rates premium under recurring political instability that prompt capital outflow from the country? How possible is it, to sustain unified exchange rate system? Does the informal foreign exchange rate overshoots the sustainable stationary exchange rate? what determines the size of overshooting? And what is the appropriate exchange rate policy that mitigates adverse effect of economic sanctions on the country.

Methods: The paper employs partial equilibrium dynamic modeling approach using optimum control theory to investigate the impact of a shock invoked by political unrest that causes capital outflow from the country.

Results: The findings of the paper indicate a necessary condition for stabilization of the foreign exchange rates is that expected returns from investment should exceed the depreciation rate of the formal foreign exchange rate. The size of overshooting of the informal market rate premium rises as the level of official reserves with the central bank declines. Our finding also indicate that unification of the dual foreign exchange markets can only be achieved when capital outflow remains at insignificant low levels, implying that sustainable unification of exchange rates cannot be achieved in an economy under economic sanctions that prompt capital outflow from the country. However, adoption of flexible exchange rate system that maintains a fixed informal market rate premium can mitigate the adverse effect of economic sanctions on capital outflow.

1 The current model apply to the cases of Iran and Venezuela, after the return of the American sanctions to these two counties. Since early 2018 these two countries have been facing growing political uncertainty and dwindling foreign reserves of central banks, prompting unprecedented rise in informal market premium and increasing capital outflow.

2 In the literature the terms, informal market, black market, and the parallel market used interchangeably.

3 This implies that depreciation of the formal foreign exchange rate (more units of local currency per a unit of US$) represent implicit cost to investors, therefore it must be compensated by higher expected investment returns.
Keywords: dynamic model, foreign exchange markets, political uncertainty, stability analysis, economic sanctions

1- Introduction:
The increasing importance of studying dual foreign exchange markets in some developing countries over the past few years is possibly due to the increasing role of the informal markets for foreign exchange in the economies of these countries, despite, successive attempts by some governments to curb the role of these markets in the economy. It has become apparent to many economists in recent years that a realistic foreign exchange policy should not ignore the role of these markets in the economy. To contain the role of these markets monetary authorities in these countries have resorted to more restrictive foreign exchange policies in the formal market by black listing some import commodities and imposing capital mobility restrictions, as well as adopting more flexible foreign exchange policies in an attempt to stabilize the divergence of the informal market rate from the official market rate (informal market premium).

The role of the informal markets for foreign exchange in the economy of a country depends on the size and the structure of the informal markets, which differ from one country to another. In some countries the informal markets for foreign exchange has a large number of dealers, where the price of foreign exchange is determined according to supply and demand forces for foreign currencies. In other countries these markets are dominated by a small number of dealers who set prices on a daily basis, using their knowledge of supply and demand. Understanding the structure of the informal markets for foreign exchange requires investigating the sources of supply and demand for foreign currencies.

The primary aim of this paper to analyze the dynamics of the informal market rate premium in a country facing political uncertainty that prompt capital outflow from the country. The economic environment in this country as follows: The foreign exchange market characterized by dual markets for foreign exchange, one market is official and managed by the central bank, relies on the inflow and the outflow of foreign currencies via the formal sectors of the economy, whereas the other market is informal market depending on the inflow of foreign currencies, mainly from illegal channels, like smuggling, money laundering, export under-invoicing, and import over-invoicing, to finance demand for foreign currencies that is not financed through the official channels of foreign exchange sources. As a result of political instability (defined as the likelihood of government collapse) and shortage of foreign currency reserves with the central bank, domestic and foreign investors siphoning hard currencies from the country via purchase of foreign currencies from the informal market, and that leaves the central bank’s reserves of foreign currencies in state of continuous deterioration.

The main questions of the paper are as follows: Is it possible to stabilize the foreign exchange rates under such political and economic environment? What is the impact of capital outflow on
the dynamic of the exchange rates? Does the informal market rate approximate steady state equilibrium exchange rate? Is it possible to sustain unified single exchange rate policy?

The remaining parts of the paper are structured as follows. Section two includes literature review. Section three explains the model specification. Section four includes the analysis. The final section concludes the study.

2- Literature review


The current paper follows the second approach, adding distinct contributions to the area of the research. Within partial equilibrium modeling approach embracing optimum control theory, the paper seeks to answer a number of essential questions: Is it possible to stabilize the foreign exchange rates premium under recurring political instability that prompt capital outflow from the country? How possible is, to sustain unified exchange rate system? Does the informal foreign exchange rate overshoots the sustainable stationary exchange rate? And what determines the size of overshooting?

3. The model:

Since the only source of foreign exchange in the foreign exchange markets is the export revenues, and the informal market rate, \( b \), is higher than the formal market rate, \( e \), private firms convert a portion \( 0 < \phi < 1 \) of their export proceeds at the informal rate \( b \), and the remaining part at the formal rate, \( e \). Thus, the revenue side of the income statement of domestic firms consist of revenue from goods from export, and the expenditure side includes imported capital goods.
As a result, firms’ decision rules for all the choices above are found by maximizing their profit function. Households choose between domestic and foreign assets, a portfolio allocation decision. Households’ nominal financial asset portfolio is assumed to consist only of domestic money holdings M, and foreign money holdings F. Since households buy foreign currency F only in the informal market, and therefore value it at the informal exchange rate b, the domestic currency value of households’ nominal wealth, H, can be expressed as H = M + bF.

The government determines much of the context for decisions of other agents in the economy, and also acts as a separate agent. For instance, the government decrees and administers a set of foreign exchange controls which regulate entry into the formal exchange market. In this market the government buys foreign currencies from households at the formal rate e, and allocates it to pay for government imports (G). The government can buy from only one source: private sector export revenue X. We assume that government spending G is entirely on imports, including payment of interest on foreign debt, and that no new foreign debt is incurred. Further, we assume that any of G that is not financed by taxes must be financed by borrowing from the Central Bank.

The current account balance in the formal market (for brevity we will call it official reserves, \( \hat{R} \)) is determined as a fraction of export revenue channeled through the formal exchange market, \((1 - \emptyset(t))x(t)\) less government imports (G) all valued in foreign currency). After determining the official current account, the current account in the informal market, \(\hat{R}\), is determined by subtracting total imports (private sector and government), capital flight, and official reserves, from the total inflow of foreign currency to the economy. Since there is no commonly accepted definition of capital flight in the economic literature (Kant, 2002), in this paper we define capital flight in more broader terms as the outflow of capital from a country to safer heavens as a response to risk and uncertainties in the economic policies of that country. As a result, given declining official reserves, increasing informal market rate premium invoke expectation of collapse of dual exchange rate system and a balance of payment crisis then change in capital flight depends on the deviation of the informal market rate premium from specific benchmark level.

These specifications expressed in the system of the following equations:

\[
\text{Max} \int_{0}^{T} \left[ \emptyset(t)b(t)x(t) + (1 - \emptyset(t))e(t)x(t) - I(b(t)) \right] \exp(-\delta t) \, dt \tag{1}
\]

Subject to:

\[
\frac{dF}{dt} \equiv \dot{F} = x(t) - \left( g(t) + I(b(t)) \right) - c(t) - \hat{R}(t) \tag{2}
\]

\[
\frac{d\hat{R}}{dt} \equiv \dot{\hat{R}} = \left[ (1 - \emptyset(t))x(t) - g(t) \right] \tag{3}
\]

\[
c(t) = a(\theta(t))[m(t) + \pi(t)F(t)] \quad \text{for} \quad a'(\theta) > 0 \tag{4}
\]

\[
\theta(t) = f(\pi(t) - \bar{\pi}) \quad \text{for} \quad f'(\pi) > 0 \tag{5}
\]
F(0), and R(0) given.
Where $\emptyset$ is the proportion of export earning that channel to the informal market, $b$ is the informal market rate, $e$ is the formal exchange rate, which is lower than the informal market rate, $b$, and $x$ is the total export earnings in foreign currencies. $I(b)$ is the private sector imports funded by the informal market rate, $g$ is the government imports. $F$ and $R$ are respectively private foreign currency holdings by private agents, and official reserves held by the central bank, $C$ is the capital flight, which defined here as outflow of capital through the informal market for foreign exchange.

Equation (1) defines discounted net revenue function of private firms that export domestic products and convert $\emptyset$ portion of export earnings via the informal market and the rest $(1 - \emptyset)$ through the formal foreign exchange market, minus the cost of imported inputs, $I(b)$, which is a function of the informal market rate, $b$. Equation (2) defines the foreign currency portfolio held by the private sector as the difference between total foreign currency inflows of export revenues minus total imports (government plus private imports), minus capital flight and official reserves held by the central bank. Equation (3) stipulates that official foreign currency reserves as the difference between the export proceeds of the formal market minus the government imports, $g$.

Equation (4) defines the capital flight as a proportion of private wealth $[m + \pi F]$ which combines domestic assets denominated in foreign currencies and stock of foreign currencies, where $\pi$ is the informal market premium, which is $b/e$. The proportion of capital flight, $a(\theta)$, depends on political instability of the country, $\theta$, which indicated by divergence of informal market rate premium from benchmark level of the premium, as defined in equation (5).

Substituting equations (3) – (5) into equation (2) and rewriting it, the problem can be reduced to:

$$\max \int_0^T \left[ \emptyset(t)b(t)x(t) + (1 - \emptyset(t))e(t)x(t) - I(b(t)) \right] \exp(-\delta t) \, dt \quad \text{(7)}$$

Subject to:

$$\dot{F} = [\emptyset(t)x(t) - I(b(t)) - a(\theta)(m + \pi F)] \
F(0), \text{ and } R(0) \text{ given .}$$

The problem as defined in (7) and (8) is an optimum control problem, with $\emptyset$ is the control variable, and $F$ is the state variable. The current value Hamiltonian can be stated as:

$$H = \left[ \emptyset(t)b(t)x(t) + (1 - \emptyset(t))e(t)x(t) - I(b(t)) \right] + 
\mu\left[\emptyset(t)x(t) - I(b(t)) - a(\theta)(m + \pi F)\right] \quad \text{(9)}$$
Where μ is a costate variable. The first-order conditions can be derived as:

$$\frac{\partial H}{\partial \phi} = bx - ex + \mu x = 0 \quad (10)$$

$$\mu - \delta \mu = -\frac{\partial H}{\partial F} = -a(\theta)\pi \quad (11)$$

Equation (10) can be rearranged into:

$$e(1 - \pi) = \mu \quad (12)$$

Differentiating equation (12) and substituting it into equation (11) we get:

$$\dot{\pi} = (1 - \pi)(\hat{e} - \delta) + \frac{a(\theta)\pi}{e} \quad (13)$$

where \( \hat{e} = \dot{e}/e \)

From equation (13) we can deduce that \( \dot{\pi} = 0, \) only if \( \pi = 1, \) and \( a(\theta) \approx 0. \)

The dynamic system of the model represented in the differential equations (8) and (13). In the following section we analyze the stability of the system.

4. The analysis:

For ease of exposition we repeat the two differential equations of the system:

$$\dot{F} = [\theta(t) x(t) - l(b(t)) - a(\theta)(m + \pi F)] \quad (8)$$

$$\dot{\pi} = (1 - \pi)(\hat{e} - \delta) + \frac{a(\theta)\pi}{e} \quad (13)$$

Proposition (1):

A necessary condition for existence of a saddle point solution for the system of equations (8), and (13) is that depreciation in the formal foreign exchange rate, \( \hat{e}, \) should be less than the discount rate that reveals time value of money, \( \delta. \)

Proof:

Analysis of the characteristic polynomial of the linear approximation of the equations (8), (13), shows that the dynamic model has one positive and a negative root if \( \delta > \hat{e}. \) That is, the steady state discussed above is a saddle-point solution, therefore the economy can (re-)converge to the steady state from a distance away. If this condition is not satisfied there is no guarantee for existence of sustainable unique solution for the system of the equations (8) and (13).

Linearizing equations (8) and (13) around the steady state values \( \bar{F} \) and \( \bar{\pi} \) yield the following matrix equation:

$$\begin{bmatrix} \dot{F} \\ \dot{\pi} \end{bmatrix} = \begin{bmatrix} \dot{F}_F & \dot{F}_{\bar{\pi}} \\ \dot{\pi}_F & \dot{\pi}_{\bar{\pi}} \end{bmatrix} \begin{bmatrix} F - \bar{F} \\ \pi - \bar{\pi} \end{bmatrix} \quad (14)$$

Where the first term on the right-hand side of equation (14) is the Jacobian matrix.
The values of the partial derivatives in the Jacobian matrix can be determined as follows:

\[
\begin{align*}
    \frac{\partial \hat{F}}{\partial F} &= -a(\theta)\pi < 0, \\
    \frac{\partial \hat{F}}{\partial \pi} &= -a'(\theta)F < 0, \\
    \frac{\partial \hat{\pi}}{\partial F} &= 0, \\
    \frac{\partial \hat{\pi}}{\partial \pi} &= \left[-(\hat{e} - \delta) + \frac{a(\theta) + a'(\theta)\pi}{e}\right] > 0 \text{ for } \delta > \hat{e}
\end{align*}
\]

A necessary condition for a saddle-point solution is that the determinant of the Jacobian matrix should be negative and the sign of the trace of the Jacobian matrix is positive, negative or zero. This is the case as can be verified by substituting the above stated partial derivatives in the Jacobian matrix to get negative determinant:

\[
|J| = \left| \hat{F}_{\pi} \hat{\pi}_{\pi} F_{\pi} \right| = \left| \begin{array}{cc} -a(\theta)\pi & -a'(\theta)F \\ 0 & \left[-(\hat{e} - \delta) + \frac{a(\theta) + a'(\theta)\pi}{e}\right] \end{array} \right| < 0, \text{ for } \delta > \hat{e}
\]

**Proposition (2):**
Sustainable unification of the dual foreign exchange markets, \((\bar{\pi} \rightarrow 1)\), can only be achieved when, \(a(\theta) \rightarrow 0\).

Prove of the proposition can be reached by setting \(\hat{\pi} = 0\), in equation (13) and solving for steady state premium level, \(\bar{\pi} = \frac{\hat{e} - \delta}{(\hat{e} - \delta) - \frac{a(\theta)}{e}}\) to show that \(\bar{\pi} \rightarrow 1\) only when \(a(\theta) \rightarrow 0\).

**Proposition (3):**
Under flexible exchange rate system that maintains a fixed exchange rate premium at \(\bar{\pi} = \eta \) (for \(\eta > 1\)) economic sanctions trigger capital outflow from the country.

**Prove:** To prove this proposition we need to show a positive association between change in export and capital outflow. To do so, from equation (8) we solve for stationary capital outflow \((\bar{F})\), and then differentiate it with respect to export, that is \(\frac{\partial \bar{F}}{\partial X} = \frac{\hat{\phi}(\tau)}{a(\theta)\bar{\pi}} > 0\) (for \(\bar{\pi} > 1\), since \(\bar{\pi} = 1\), imply \(a(\theta) = 0\)).
Figure (1) indicates the dynamic path of steady states of the informal market premium and the private foreign currency holdings. As the solution of the equations (8) and (13) indicates a saddle point solution, then if the system, some how, placed in quadrants I and III, there is a chance to slide towards the steady state equilibrium point A, as indicated in the figure. However, if the system placed at the quadrants II and IV, it diverge away from the steady state equilibrium point. When political and economic environment becomes unfavorable in a country, more frequent demands for dollars for capital transfer from the country follows, and as a consequence the rising informal market premium, depletes official reserves held by the central bank to lower levels. When foreign exchange reserves become insufficient to cover the loss of reserves that takes place during capital flight the public will anticipate a balance of payment crisis that requires discrete devaluation of the formal market rate. The adjustment process in this case explained in figure (2). As a result of a sudden capital flight, the \( \hat{F} = 0 \) schedule shift to \( \hat{F}_1 = 0 \) schedule, which in turn causes shift in the \( \hat{\pi} = 0 \) schedule upward to \( \hat{\pi}_1 = 0 \). As a consequence of sharp drop in the official foreign currency reserves, the public anticipation of future devaluation of the formal rate, generate speculative attacks on foreign currency and that causes further upward shift in the informal rate premium from A to B. At point B the exchange rate depreciation contributes in reserve loss, which instigate further anticipation of the formal rate devaluation, and that in turn will push the informal market rate premium at the point, C. When official reserves reach a minimum level at C, the government resort to a devaluation of the formal rate and that bring the system to point D. During the adjustment process from points C to D, along the saddle path some of the reserves previously lost replenished. It is important to realize that, under insufficient reserves the recovery process from a shock is more costly in terms of time period required for convergence of the system to the new steady state point at D. However, the adverse effect of the economic sanctions on capital outflow is mitigated under flexible exchange rate system that maintains a fixed level of informal market rate premium. In figure (2) indicated that if the government adopt a policy of foreign exchange system that fix the premium level at \( \hat{\pi} \), the outflow of capital moves from \( \hat{F} \) to \( \hat{F}_2 \) instead of \( \hat{F}_1 \) in the case of fixed formal exchange rate system\(^4\). The difference between these two levels of capital outflow, \( F_2 \) and \( F_1 \), is that \( F_1 \) correspond to the level of capital flight due to the joint adverse effect of the economic sanctions and depreciation of the informal market rate at the informal market premium rate \( \hat{\pi}_1 \).

\(^4\) To verify an adverse effect of economic sanctions on capital outflow, we can solve for the steady state \( \hat{F} \) from equation (8) and differentiate it with respect to exogenously determined variable X (export) to show a positive association, that is \( \frac{d\hat{F}}{dx} > 0 \).
Figure (1): Saddle point solution

\[ \pi = \bar{\pi} \]

\[ \dot{F} = 0 \]

\[ \pi = \pi \]

\[ F = 0 \]

Figure (2): Unexpected shock

\[ \dot{\pi}_1 = 0 \]

\[ \dot{F} = 0 \]

\[ \pi = \pi \]

\[ \pi_1 = 0 \]

\[ F = 0 \]
5-Conclusions:
The paper employs partial equilibrium dynamic model to assess the impact of unexpected shock causing capital outflow from a country. The economy in the model is characterized by dual foreign exchange markets, including a formal market for foreign exchange with inadequate and volatile official foreign exchange inflows, and a strong and thriving informal market with higher exchange rate. The paper attempts to answer the following questions: What is the necessary condition needed to stabilize the foreign exchange rates under such dual foreign exchange system? What is the impact of a sudden capital outflow on the dynamics of the exchange rates? Does the informal market rate approximates steady state equilibrium exchange rate? Is it possible to sustain unified single exchange rate system?

With regard to the first question, the finding in the paper shows that a necessary condition for stability of the foreign exchange premium is that investment returns in the economy should exceed the depreciation rate of the formal foreign exchange rate. This implies that depreciation of the formal foreign exchange rate represent implicit cost to investors, therefore it must be compensated by higher expected investment returns. It should be realized that stability of the foreign exchange rates is more difficult to achieve, under insufficient official reserves, as the recovery process from a shock becomes more costly in terms of time period needed for the adjustment process to complete, even when stability requirement stated above is satisfied. It is important to realize that such stabilization condition has not stipulated investment returns to exceed the informal market rate, because the informal rate encompasses implicit extra cost including risk of trading in the informal illegal market for foreign exchange. On the question of the impact of capital flight on the exchange rates dynamics, our finding indicate when political and economic environment become unfavorable in a country, more frequent demands for dollars for capital flight from the country follows, and as a consequence the rising informal market premium, depletes official reserves held by the central bank. When existing official foreign exchange reserves are insufficient to cover the loss of reserves that takes place during capital flight, the public will anticipate a balance of payment crisis and that prompts periodic devaluations of the formal market rate. As to the question of the informal market rate approximation to steady state equilibrium exchange rate, it is indicated in the paper that the informal market premium overshoots the sustainable equilibrium exchange rates premium. The
size of overshooting of the informal market rate premium rises as the level of official reserves with the central bank declines. In other words, the ability and the effectiveness of the central bank’s intervention in the foreign exchange market can reduce the overshooting distance of the informal market premium from its steady state equilibrium level. Our finding also indicate that unification of the dual foreign exchange markets can only be achieved when capital outflow remains at insignificant low levels, implying that sustainable unification of exchange rates cannot be achieved in an economy under economic sanctions and characterized by political instability that prompt capital outflow. However, adoption of flexible exchange rate system that maintains a fixed informal market rate premium can reduce capital outflow from the country.

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