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THE BLACK MARKET FOR DOLLARS IN VENEZUELA

SAMUEL MALONE AND ENRIQUE TER HORST

Abstract. In February 2003, the Venezuelan government imposed a strict capital control policy to stem the outflow of dollars. We describe the mechanics and structure of the resulting black market for foreign exchange, present a theoretical model in the stock-flow tradition of Dornbusch et al. (1983), and evaluate the performance of our model against past models from the literature. Our model of the Venezuelan black market premium is parsimonious but achieves the lowest RMSE. We find a significant role for the lagged premium, the rate of depreciation of the black market rate, and changes in foreign reserves.

1. Introduction

In February of 2003, following the *paro petrolero*, or "oil strike", that temporarily paralyzed economic activity in the country, the Venezuelan government decided to impose a strict capital control policy to stem the outflow of US dollars. This policy led naturally to the creation of a black market for dollars. From that point onward, consumers and importers of foreign goods have had to apply to the state bureaucracy, known as CADIVI for its acronym in Spanish, for the dollars that are rationed at the official exchange rate from the government's supply of foreign reserves. The surplus demand for dollars is met by the black market, and the black market premium on dollars has been positive, sometimes well above 100%, since the beginning of the capital control policy.

The recent experience with a black market for foreign currency in Venezuela is not the first for the country. Capital controls have been particularly tempting for policymakers during past periods of falling international reserves, such as 1960-1964, and later during the period 1983-1988, following the collapse of the international price of oil in the early 1980s. In earlier work, Hausmann (1992) discusses past experiences with fixed and floating exchange rate regimes in Venezuela, and presents several macroeconomic models to analyze the adjustment of the economy to external shocks. The recent imposition of capital controls in the country in 2003 occurred immediately following a macroeconomic collapse whose origins were substantially tied to internal political unrest, although the timing of the oil strike during a period of low to moderate oil prices most likely made the specter of capital flight more sinister.

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In the spirit of Hausmann and Rodriguez (2008), who present a variety of perspectives to explain the somewhat puzzling collapse of the country's per-capita GDP since the late 1970s, we aim to contribute to a better understanding of the Venezuelan development experience. Given that black markets for foreign currency have been an intermittent feature of economic life in Venezuela during the past several decades, it is worth understanding in more depth the behavior of the black market premium, and how this behavior compares with the characteristics of the black markets in other countries that have instituted capital controls, in particular during the 1970s and early 1980s, which capital control policies were more common.

To that end, this paper has three specific objectives. First, we describe the mechanics and structure of this market, as gleaned from firsthand experience and interviews with market participants. Second, we present a theoretical model for the determination of black market exchange rates in the stock-flow tradition of Dornbusch et al. (1983). Third, we test alternative empirical models from the literature encompassed by our analytical framework using recent data on the Venezuelan black market premium. We find that a modified version of the Fishelson (1988) model to include changes in international reserves, as suggested by Culbertson (1989), provides the best fit for the dynamics of the black market premium.

It has been common in the literature on black market exchange rates to first lay out a theoretical model, and then adapt a regression based on that model for use in testing black market data from one or many countries. A partial list of articles in this tradition includes Dornbusch et al. (1983), Fishelson (1988), Culbertson (1989), Phylaktis (1992), and Shachmurove (1999). The simple framework we lay out will encompass all of the above approaches. That allows us to test several of the above models on Venezuelan data, as subcases of our framework, and this has the advantage of making our results directly comparable with the parameter estimates of past data. This comparability will allow us to assess the extent to which the black market for dollars in Venezuela differs from past black markets.

The seminal model of black market exchange rates is Dornbusch et al. (1983), who use considerations of stock and flow equilibrium in the black market for dollars to derive an equilibrium black market exchange rate in a system that exhibits saddle-path stability. Dornbusch et al. (1983) use their theoretical model to specify an empirical model in which the black market premium is regressed on the real exchange rate calculated using the official nominal rate, the interest rate differential adjusted for the rate of devaluation of the official exchange rate, and dummy variables to test for seasonal effects. All three of these factors were important determinants of the black market premium in Brazil during time period studied by those authors, from late 1974 to early 1982.

Fishelson (1988) essentially modifies the Dornbusch et al. (1983) to specify a regression model for the black market premium that includes the real exchange rate calculated using the official nominal rate, the interest rate differential adjusted by the actual devaluation of the black market rate, and the lagged black market premium. Fischelson's (1988) model provides a remarkably good fit for most of the 19 developing countries he examines during the 1970-1979 period.

Phylaktis (1992) and Shachmurove (1999) examine Chile and a panel of countries, respectively, and both base their empirical exercises on theoretical models that are essentially variations on the model laid out in Dornbusch et al. (1983). Phylaktis (1992) finds that the real exchange rate, the official depreciation-adjusted interest rate differential, the dollar value of peso assets valued at the official exchange rate, and foreign exchange restrictions are important determinants of the black market premium. Shachmurove (1999) finds similar results in his panel study; in particular, the official depreciation adjusted interest rate differential and the dollar value of domestic currency assets positively influence the premium, while the official exchange rate is found to negatively influence the premium. Also, Shachmurove (1999) finds that the first difference of the black market premium positively influences the premium. This finding is in line with the finding of Fishelson (1988) that the differential rate of expected profits, defined as the interest rate differential adjusted by the rate of depreciation of the black market rate, strongly influences the black market premium. Shachmurove (1999), unlike Fishelson (1988), however does not control for the lagged dependent variable in his study.

We will test most of the above factors from previous studies on Venezuelan data on the black market premium in section IV. Our empirical results for Venezuela can be summed up as follows. The Venezuelan black market premium displays significant autocorrelation, and omitting the lagged dependent variable as in the Dornbusch et al. (1983) model, leads to omitted variable bias. This issue is likely to bias the parameter estimates in other studies, such as Shachmurove (1999), that fail to include the lagged black market premium. The differential rate of expected profits in the black market, as defined by Fishelson (1988), is a key driver of the black market premium, and appears much more important than the official depreciation-adjusted exchange rate. The real official exchange rate is an important determinant of the Venezuelan black market premium, consistent with nearly all previous studies. Additionally, we find the change in international reserves to have a positive and statistically significant effect on the premium, as predicted by Culbertson (1989), after controlling for the factors in the quite successful model of Fishelson (1988).

The Venezuelan black market, therefore, exhibits a behavior in line in most respects with many previous black markets, such as those in Brazil from 1974 to 1982 and Chile from 1975 to 1984. The Venezuelan market, however, does not show any evidence of seasonality, in contrast to the case of Brazil studied by Dornbusch et al. (1983), but in line with the panel data findings of Shachmurove (1999). The importance of changes in reserves is consistent with the status of the government in Venezuela as the principal recipient of petrodollar revenues from the state oil company, PDVSA, during the period concerned, hence a major potential factor in affecting the private supply of black market dollars. Finally, the coefficient estimated on the differential rate of expected profits in running the Fishelson (1988) model on Venezuelan data is greater than the highest estimates obtained for that variable over the 19 countries in his original study. This suggests that speculation may be particularly important in the Venezuelan black market for dollars, and the momentum effects of depreciation of the black market rate carry over strongly to the level of the premium. This is not surprising,

given significant anecdotal evidence among traders that the market is driven primarily by *chismes*, or gossip, and that reliable information on fundamental value is difficult to obtain.

The rest of the paper proceeds as follows. Section II describes the mechanics and structure of the black market for dollars in Venezuela. Section III presents a compact analytical framework for the black market premium based on the supply and demand for black market dollars. Section IV presents our empirical results and compares these to the findings of some previous studies. Section V concludes.

2. The Mechanics and Structure of the Market

Before turning our attention to the empirical properties of the black market exchange rate and the black market exchange rate premium, it is useful to discuss the mechanics of the market and the major sources of supply and demand for black market dollars. The market makers for foreign exchange transactions, both before and after the imposition of capital controls in 2003, are the major *casas de bolsa*, or brokerage houses, headquartered in Caracas. The mechanism used to trade Bolivares for US Dollars on the black market has evolved over time. At the onset of the capital controls regime, the Venezuelan communication company CA Nacional Telefonos de Venezuela, or CANTV for short, was traded on both the Caracas Stock Exchange and the New York Stock Exchange (NYSE), in the latter case as an ADR [1]. For a company or individual wishing to acquire US Dollars in exchange for Venezuelan Bolivares, the procedure was to contact a brokerage house, which would buy CANTV shares in the amount of Bolivares required on the Caracas stock exchange and immediately sell the ADR of CANTV, valued in US Dollars, in New York. The implicit exchange rate from the above transaction was equal to the value in Bolivares required to buy one share of CANTV in Caracas, divided by the value in dollars earned by selling one CANTV ADR.

The black market exchange rate was obtained in this manner until the nationalization of CANTV by the Venezuelan government in January of 2007, at which point the above mechanism ceased to exist [2]. At that point, market makers switched to another method, which involves buying local Venezuelan debt in Bolivares and selling Venezuelan debt in the international markets in US Dollars. That is the method currently in use at the time this article was written. The mechanism works in a manner similar to the earlier method using the ADRs of CANTV. In particular, a business or individual who wishes to purchase US Dollars with Bolivares contacts his broker, who in turn identifies a relatively liquid domestic government bond whose maturity date is approaching. The broker then contacts

[1]For an account of this, see Gallegos, R., Dow Jones International News, 26 January 2007, and later Mander, B., Financial Times, 8 May 2007.

[2]On Monday, January 8, 2007, Venezuelan President Hugo Chavez announced his intentional to nationalize the electricity industry and the country's largest telecommunications company, CANTV. Earlier that day, the U.S. dollar hit a record high against Venezuela's currency on the black market. The dollar "fetched more than 3,600 bolivars, versus the VEB 2,150 official rate" at that point, and the country's 2027 Global bond dropped USD 13/16 to a bid price of USD 124 7/8, according to R. Gallegos of Dow Jones International News, 8 January 2007.

other brokerage houses to identify a counterparty willing to receive the domestic bond in exchange for a dollar-denominated Venezuelan government bond traded on international markets. The bonds are swapped, the domestic bond is resold into the domestic market, and the internationally traded, dollar-denominated bond is resold into the international market. The buyer of US Dollars receives the proceeds from the sale of the international bond, and the buyer of Bolivares receives proceeds from the sale of the domestic bond [3]. The value in Bolivares received from the sale of the local currency bond divided by the value in US Dollars received from the sale of the international bond in New York is the reference black market exchange rate. The external, dollar-denominated Venezuelan bond commonly used for this operation is known as the *Global 27*. These bonds are registered in the United States and Europe, and are generally known to be the most liquid bonds of their kind and pay a relatively high coupon.

The major buyers of US Dollars in the black market are multinational firms operating in Venezuela, and many large domestic firms, which need to purchase inputs abroad that settle in US Dollars but are rationed in their purchase of dollars at the official exchange rate. Anecdotal evidence indicates that use of the market is also relatively common among individuals in the highest income brackets, who purchase dollar-denominated assets as a way to hedge against high domestic price inflation and the high level of macroeconomic volatility.

The sellers of US Dollars include several groups. First, the non-petroleum sector exporters have the usual incentive to under-invoice and sell some portion of the dollars earned on the unaccounted-for exports in the black market. Second, individuals and businesses able to maintain a significant portion of their liquid assets in dollars need to finance current consumption and expenses. Third, the government, which ultimately receives the significant petrodollar revenue due to oil exports, is naturally the most important supplier of dollars in the economy, and can issue bonds payable in Bolivares that can be sold to international investors for US Dollars.

Officially, of course, government foreign exchange earnings are rationed through CADIVI, the state-bureaucracy that handles requests for dollars to finance the purchase of foreign consumer and capital goods at the official exchange rate [4]. However, the government has also intervened, sometimes significantly, in the black market. Through a series of bond issues in the first half of 2007 and later in early 2008, the government originated several billion dollars worth of debt in the form of "structured notes", which could be purchased domestically in Bolivares but exchanged for dollar-denominated government debt trading in international markets. As noted in the Financial Times on March 31, 2008, "One of the key measures easing pressure on the exchange rate has been the sale over the last two months of almost $1bn in "structured notes" high-risk financial instruments in the state development fund which the government wants to get rid of" (Mander, B., Financial Times, March 31,

[3]This operation is technically equivalent to a currency swap, hence the use of the Spanish term *permuta*, which means "swap", to describe the operation.

[4]Surprisingly, CADIVI approved only $2.2bn for food importers, during the period January to November of 2007, even though the nation battled significant food shortages during that period (Mander, B., Financial Times, January 29, 2008).

2008). An advisor to the finance ministry, cited anonymously, noted at that time to the Financial Times that the government would have to sell between $50m to $100m of reserves each week to main the strong Bolvar in a band of between Bs.F 3 / USD to Bs.F 3.5 / USD on the black market. This level of support amount to an outflow from the reserve stock of between USD 2.6B and USD 5.2B per year, when the international reserves of Venezuela stood at just over USD 34B as of June, 2008 (Banco Central de Venezuela, 2008). The strategy of using reserves to target the black market exchange rate suggests that changes in foreign reserves may be an important driver of the black market premium. In section IV, we show empirically that this is indeed the case.

Typically, local banks, all of which have participated in these debt operations, sell the structured notes to international banks for dollars. The banks are required by the government to sell the dollars back into the local market, and this allows for substantial arbitrage gains when the resale is done at the black market rate. The implicit exchange rate defined by the terms of the bond issues mentioned above, according to their initial offer price in Bolivares and the market price of the dollar denominated bonds at the time, was greater than the official exchange rate but less than the then black market rate. These bond issues were generally heavily oversubscribed, and succeeded in bringing down the black market exchange rate by reducing the the supply of Bolivares available to purchase dollars, while also increasing the potential supply of private sector dollars available to purchase domestic currency. The black market rate affects, to some extent, the domestic price level, and this effect becomes more pronounced as rationing of official dollars becomes more severe and more current account transactions shift to the black market. Because price inflation disproportionately impacts the government's core constituency, the poor, the government will continue to have a clear incentive to intervene in the black market as long as it maintains a policy of capital controls. In fact, an advisor to the finance minister commented to the Financial Times in March of 2008 that Venezuela is preparing to introduce a de facto dual currency in order to ease pressure from a full-blown devaluation and record-high inflation, although at the time of writing such a plan is still in the works (Mander, B., Financial Times, March 31, 2008).

Finally, an important, but notoriously difficult-to-measure, source of black market dollars is arbitrage activities by insiders who have special political connections that allow them privileged access to the stock of foreign exchange. These agents, through over-invoicing of import receipts, private commissions earned from foreign or domestic counterparties in exchange for favorably directing public investment and other public transactions, or outright theft, acquire dollars that can be sold at the black market rate for Bolivares.

3. The Theoretical Framework

This section will lay out a variation of the model of Dornbusch et al. (1983), henceforth the "Dornbusch model". The model is based on a dynamic system in two variables: the black market premium x and the stock of black market dollars B held by the private sector. To derive this dynamic system, we begin with a portfolio equation that defines the demand

for black market dollar denominated assets. This equation, as we will see momentarily, will give us the law of motion for the black market premium x. A separate equation for the flow of black market dollars stipulates the law of motion for B.

Past generalizations have relied on expanding the set of factors that the flow of black market dollars can depend upon besides the official real exchange rate, and we adhere to this pattern by proposing the change in foreign reserves as a determinant of the flow supply of black market dollars, in line with Culbertson (1988), since this factor is likely to be particularly important for Venezuela for reasons discussed above.

3.1. **The stock market equilibrium.** First we turn to the stock market for black market dollars. The demand for black market dollars is directly proportional to an increasing function θ of the interest rate differential, adjusted for the rate of depreciation of the black market exchange rate, and wealth, measured in local currency:

$$EB = \theta(i^* + d - i)(C + EB). \tag{1}$$

Here E is the black market exchange rate, B is the stock of black market dollars held in agents' portfolios, C is the amount of domestic currency held in agents' portfolios, i and i^* are the local and foreign currency interest rates, respectively, and $d_t \equiv \frac{d}{dt} \ln E_t$ is rate of depreciation of the black market exchange rate. The higher is $i^* - i$ for a given value of d, the more black market dollars agents are presumed to hold.

Define the black market premium $X = E/\bar{E}$, and the dollar value of local currency assets at the official exchange rate as $\bar{C} = C/\bar{E}$, where $\bar{E}$ is the official nominal exchange rate. Then we can write the stock market equilibrium condition as

$$\frac{xB}{xB + \bar{C}} = \theta(i^* + d - i). \tag{2}$$

Note that the left hand side of the above equation is an increasing function of the ratio $xB/\bar{C}$. Let $\bar{d}$ denote the rate of depreciation of the official exchange rate. The dynamics of the black market premium can then be written as

$$\dot{x}/x = d - \bar{d}. \tag{3}$$

As in the Dornbusch model, we substitute the above relationship into the stock market condition and rearrange to obtain the law of motion for x:

$$\dot{x}/x = G(xB/\bar{C}) - (i^* + \bar{d} - i). \tag{4}$$

Here the function $G(Z) \equiv \theta^{-1}(Z/(1+Z))$, so that $G' > 0$. Equilibrium in the stock market, characterized by $\dot{x} = 0$, is given by the condition

$$G(xB/C) = i^* + \bar{d} - i. \tag{5}$$

This equilibrium condition implicitly defines a locus of the form

$$B = A_1/x; A_1 > 0 \tag{6}$$

in $\{x, B\}$ space. The constant $A_1 \equiv CG^{-1}(i^* + \bar{d} - i)$.

3.2. **The flow market equilibrium.** The flow market equilibrium is derived by first specifying the net rate of increase of the stock B of black market dollars:

$$\dot{B} = F(x, \bar{e}, Y); F_1 > 0, F_2 > 0 \tag{7}$$

Here $\bar{e}$ is the official real exchange rate, and Y is a vector of factors that influence the flow of black market dollars. A higher black market premium increases the flow supply of black market dollars, due to greater overinvoicing of imports, greater underinvoicing of exports, reduced import smuggling, and increased export smuggling. A higher official real exchange rate, which corresponds to a real depreciation, increases the flow supply of black market dollars as Venezuelan good and services become relatively cheaper. Flow market equilibrium is given by the condition $F(x, \bar{e}, Y) = 0$.

Now let us consider some possibilities for the elements of the vector Y and their implications. The original Dornbusch model does not include any explicit arguments to the function F besides $\bar{e}$ and x, but implicitly regards F as depending on seasonal factors. The value of the black market premium x consistent with flow market equilibrium in the Dornbusch model is therefore a constant that depends on $\bar{e}$ and seasonal factors. For a give time of year, the $\dot{B} = 0$ locus is a vertical line in $\{x, B\}$ space.

Phylactis (1992), and later Shachmurove (1999), assume that Y includes total wealth in dollars valued at the official exchange rate, which we can write as $\bar{C} + xB$, and that flow demand for black market dollars is positively related to wealth. The latter assumption implies that the net flow F of black market dollars responds negatively to wealth. Schachmurove (1999) also assumes that Y includes the dollar value of exports, which is exogenous. In this context, the flow market equilibrium condition is given by

$$F(x, \bar{e}, exports, \bar{C} + xB) = 0. \tag{8}$$

Also, Phylaktis (1992) and Schachmurove (1999) implicitly assume that $\partial F/\partial x = F_1 + F_4 B > 0$, where subscripts denote partial derivatives and $F_1 > 0$ and $F_4 < 0$. For this reason, we must have $dB/dx > 0$ to restore flow market equilibrium in response to a rise in x, at least for B sufficiently low. In this context, the flow market equilibrium locus as an upward sloping line in $\{x, B\}$ space, whose location is determined by the official real exchange rate and exports, as opposed to the vertical line in the original Dornbusch model, whose placement is determined by the official real exchange rate alone. The possibility that $\partial F/\partial x < 0$ for B sufficiently large creates the potential for multiple equilibriums in the model, but this is in practice uninteresting, as any equilibrium on the backward-bending segment of the $\dot{B} = 0$ locus would be unstable.

In the case of Venezuela, oil is the primary export commodity, and oil revenues are the primary source of foreign exchange held by the government. Changes in the reserve stock, as emphasized by Culbertson (1989), are therefore more likely to be a significant contributor to the flow of black market dollars that exports per se, and are available on a monthly basis. Thus to adapt the Dornbusch model for Venezuela, we replace the export measure of Schachmurove (1999) with ΔR, the change in foreign reserves. We expect that a decrease in foreign reserves will increase the flow of private black market dollars, and an increase will

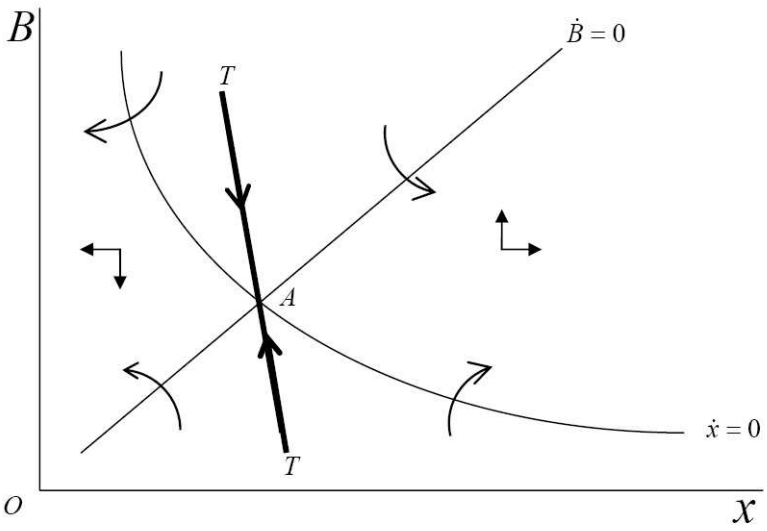

FIGURE 1. Equilibrium in the Black Market

have the opposite effect, so that

$$\dot{B} = F(x, \bar{e}, \Delta R, \bar{C} + xB); F_3 < 0. \tag{9}$$

The solution technique for the model is the same at that for Phylaktis (1992) and Schachmurove (1999). The only difference is that now the change in reserves, rather than exports, determines the location of the flow market equilibrium locus. As is well-known, the equilibrium of the model defined by the intersection of the stock market equilibrium locus with the flow market equilibrium locus is saddle-point stable. We depict the system's equilibrium in Figure 1. The stable eigenvector is denoted by the line segment TT, and the equilibrium by point A. In Figure 2, we show the response of the system to a decrease in the change of foreign reserves, which shifts the flow market equilibrium locus up and to the left, from $\dot{B} = 0$ to $\dot{B}' = 0$. The black market premium immediately jumps downward on impact, from A to A' on the new stable saddle path, and then gradually decreases further as the supply of black market dollars increases and the new equilibrium, A'', is eventually reached. For a detailed analysis of the effects of other shocks on the system, the reader may refer to the papers mentioned above.

To briefly summarize some of those results, a positive shock to the official depreciation adjusted interest rate differential will shift the stock market locus up and to the right, resulting in a positive shock to the black market premium on impact, and an increase in the equilibrium black market premium, with overshooting. A positive shock to the official PPP exchange rate, $\bar{e}$, will shift the flow market equilibrium locus to the left and up, with short and long run effects similar to those depicted in Figure 2.

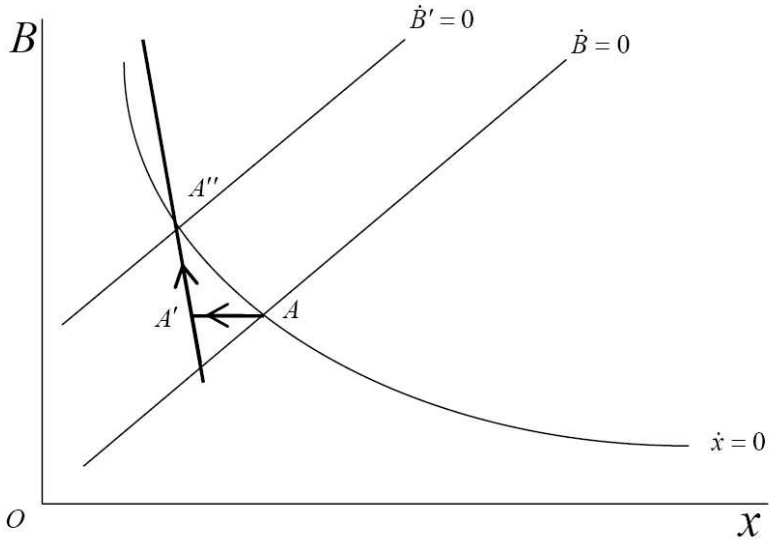

FIGURE 2. Effect of a Decrease in ΔR on the Black Market Premium

4. Empirical Results

Let us turn now to an empirical examination of the black market premium, x_t. Our sample consists of monthly observations, beginning in February of 2003 and ending in August of 2008. For our exchange rate variable, we take the ask rate, in Bolivares, at which banks sell dollars, as recorded on the last day of each month. After the imposition of capital controls, daily information on the bid and ask rates for the purchase and sale of black market dollars has been readily available, on a daily basis, online [5].

Figure 3 displays the market exchange rate, since January of 1997 until August of 2008, with the beginning of the period of capital controls delineated by a vertical line. During the period of capital controls, the official exchange rate is depicted for comparison with the black market rate. The government operated a moving band for the exchange rate from early 1997 until February of 2002, a free market regime from March 2002 until January 2003, and a capital control regime thereafter. As can be observed, the black market rate is noticeably more volatile during the period of capital controls.

4.1. **Testing stock-flow models on the data: Dynamic adjustment vs. static equilibrium issues.** It is useful to first clarify a couple of fundamental considerations involved in adapting the theoretical stock-flow framework above into an empirical regression model. The first way to adapt a stock-flow style model is to identify the factors that determine the equilibrium black market premium in the model, and use those to build the regression

[5]We take our information from the webpage http://venezuelafx.blogspot.com/, and supplement this information, which begins in January 2005, with information obtained from economists Gustavo García and José Manuel Puente, whom we thank for this and for many useful discussions pertaining to this paper.

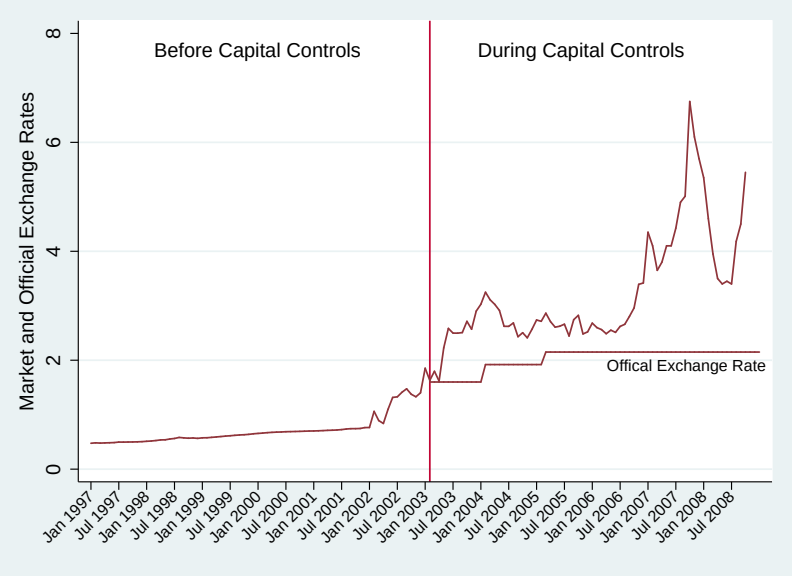

FIGURE 3. The Market Exchange Rate Before and During Capital Controls

model. This view implicitly downplays the importance of dynamics of the system out-of-equilibrium, and places the determinants of the two equilibrium loci, for the stock and flow of black market dollars, respectively, front and center.

The second way to adapt the stock-flow model for empirical testing, of course, is to go to the equations that determine the dynamics of the system out of equilibrium, in particular equations (4) and (9) in section III, discretize them, and identify the factors that influence the contemporaneous black market premium. Since the exchange rate jumps to restore portfolio balance following a shock that shifts one of the equilibrium loci, we need to include equation (2) to this list as well. Finally, it is clear that the list of determinants of the black market premium we obtain from considering the importance of out-of-equilibrium dynamics will include as a subset the group of factors suggested according to the first, equilibrium view.

The following table summarizes the models of several past studies that employ stock-flow style models of the black market premium, for either individual or panels of countries. The factors tested by each model are classified into one of two categories, based on whether they are suggested only from the equilibrium-based method of taking the model to the data, or only by the dynamic method.

The empirical work of Dornbusch et al. (1983) centers on testing the importance of the variables that determine the positions of the stock and flow equilibrium loci, hence the equilibrium black market premium. They neglect dynamic factors, however, such as the lagged premium, the rate of depreciation of the black market rate, or the first difference of the premium.

Study	Static Equilibrium Variables	Dynamic, Out-of-equilibrium Variables
Dornbusch et al. (1983) x_t	$i^* - \bar{d} - i$, $\bar{e}$, Seasonal dummy variables	(none)
Fishelson (1988) x_t	$\bar{e}$	x_{t-1} $(1 + i_t^*)(1 + d_t) - (1 + i_t)$
Phylaktis (1992) Δx_t	$i^* - \bar{d} - i$, $\bar{C}$, $\bar{e}$ Travel allowances Min. maturity on foreign loans Import tariffs Financial crisis dummy	Δx_{t-1}, $\Delta(i^* - \bar{d} - i)_t$ $\Delta\bar{e}_t$, $\Delta\bar{C}_t$ First differences of other exp. vars
Shachmurove (1999) x_t	$i^* - \bar{d} - i$, $\bar{C}$, $\bar{e}$ Seasonal dummy variables, Country dummy variables Yearly dummy variables	Δx_t

TABLE 1. A comparison of the variables used in past studies based on the stock-flow framework

Fishelson (1988) is one of the first papers to incorporate dynamic factors in explaining the black market premium. To do this, he modified the Dornbusch et al. (1983) regression by replacing $i^* - \bar{d} - i$ with $(1+i_t^*)(1+d_t)-(1+i_t)$, the differential rate of expected profits, and adding the lagged premium, x_{t-1}. In his study of 19 countries, the regression on Brazilian black market data achieves an R^2 of 0.97, versus an R^2 of only 0.74 for the Dornbusch et al. (1983) regression for a partially overlapping period. It is clear that dynamic factors were important in explaining the Brazilian black market premium. While Schachmurove (1999) does not include the lagged premium or the factor $i^* - d - i$ in his study [6], he does include the first order difference in the black market premium to partially control for dynamic effects. The coefficient on the variable $x_t - x_{t-1}$ in his panel data study is estimated at approximately 0.33, and is significant at the 1% level.

In what follows, we test the models of Dornbusch et al. (1983), Fishelson (1988), and Shachmurove (1999) on Venezuelan data. We also test a modified version of Fishelson (1988) that includes the changes in log foreign reserves. The empirical specification of Phylaktis (1992) tests an error correction model, which regresses Δx_t, rather than x_t, on the explanatory variables and their first differences. We do not report results for the error correction model, since the interpretation of the coefficients on the factors determining x_t

[6] He uses $\bar{d}$ instead of d in the interest rate differential.

has to do with long-run equilibrium, but the results of running the Phylaktis (1992) style error correction model on our data are available upon request. The notation used for our variables is consistent with that used in section III, but a table of variable definitions is included in Appendix A for convenience.

Variable	Auto-correlation	Dornbusch et al. (1983)	Fishelson (1988)	Modified Fishelson	Shachmurove (1999)
x_{t-1}	.913837***	—	.9410114***	.9412432***	—
	(.06879)	(—)	(.0502376)	(.0507168)	(—)
Official RER	—	-237.042***	-20.17892	-21.32414	-32.43665
	(—)	(44.10573)	(13.849)	(13.37958)	(148.5453)
$i^* + \bar{d} - i$	—	60.10696	—	—	337.9633
	(—)	(93.38374)	(—)	(—)	(267.1978)
DREP	—	—	147.2771***	146.6***	—
	(—)	(—)	(20.15335)	(19.80174)	(—)
$\Delta \ln R_t$	—	—	—	36.08288**	—
	(—)	(—)	(—)	(14.06466)	(—)
$\bar{C}$	—	—	—	—	.0049231***
	(—)	(—)	(—)	(—)	(.0015778)
2003 Dummy	—	—	—	—	275.1515***
	(—)	(—)	(—)	(—)	(75.64264)
2004 Dummy	—	—	—	—	236.8589***
	(—)	(—)	(—)	(—)	(70.29681)
2005 Dummy	—	—	—	—	173.8006***
	(—)	(—)	(—)	(—)	(64.07384)
2006 Dummy	—	—	—	—	88.1651*
	(—)	(—)	(—)	(—)	(51.89722)
2007 Dummy	—	—	—	—	85.72011**
	(—)	(—)	(—)	(—)	(35.44592)
Constant	15.168	386.1202***	38.389**	143.8908**	-119.5806
	(9.688)	(54.42994)	(17.226)	(26.59363)	(193.5161)
No. Observations:	67	67	66	66	66
R^2	0.8389	0.4822	0.9652	0.9669	0.8043
F-test	176.48***	3.68***	447.25***	321.52***	8.79***
Root MSE	17.526	34.873	8.2543	8.1146	22.973
Ramsey RESET	1.48	4.46***	.96	.67	9.33***

TABLE 2. Regression Models of the Venezuelan Black Market Premium

4.2. **A comparison of alternative models on Venezuelan data.** Our primary empirical results are reported in Table 2. Column 1 reports the results of the regression of the black market premium on its lagged value and a constant:

$$x_t = \alpha + \rho x_{t-1} + \epsilon_t \tag{10}$$

A t-test of the null hypothesis $H_0 : \rho = 1$ against the alternative $H_1 : \rho < 1$ in the above regression, with $N - 1 = 66$ degrees of freedom, yields a t-statistic of -1.25, so that a one-sided test cannot reject the null hypothesis of a unit root at the 10% level (Sims and Uhlig, 1991). The R^2 for the regression of the premium on its lagged value is relatively high, and equal to 0.8389. The RMSE is approximately 17.5. This result serves as a useful benchmark for comparison with other models, and is consistent with past findings that black market exchange rates pass conventional tests of efficiency, as in Culbertson (1989).

Columns 2-5 report the results of running alternative regression models from the literature on the Venezuelan data. All regressions are reported with robust standard errors. Column 2 reports the results of running the original Dornbusch et al. (1983) regression, which produces an R^2 of 0.4822 and an RMSE of 34.9. We control for monthly dummy variables in regression 2, following the Dornbusch et al. (1983) regression, but find scant evidence these are significant for Venezuela, in line with our priors. For this reason, the results of the other regressions reported do not control for seasonal effects. All other variables included in the regressions are listed explicitly in the left hand column of Table 2.

Column 3 reports the results of running the original regression of Fishelson (1988), and this produces a much better R^2, of 0.9652. The RMSE for the Fischelson (1988) model run on the Venezuelan data is 8.25. Column 4 reports the results of running a modified version of the Fishelson (1988) regression, in which we add the change in the logarithm of foreign reserves to the original Fishelson (1988) specification. Column 4 is our preferred regression, and achieves the best R^2, equal to 0.9669, and the lowest RMSE, at 8.11. Finally, column 5 displays the results of running the regression model of Shachmurove (1999). This model has an R^2 of 0.8043, which is slightly less than the R^2 achieved by regression 1, which contained only the lagged dependent variable. The F-test of joint significance is significant at the 1% level for all five of the regression models considered.

Several important points emerge from a comparison of our five models. First, inclusion of the lagged dependent variable alone is able to explain a significant portion of the variation in the black market premium, and models that fail to include the lagged dependent variable are likely to be misspecified. To test this hypothesis, we ran a Ramsey RESET test, which is distributed as an F-statistic, on each regression to test for the possible presence of omitted variables. We are unable to reject the null hypothesis of no omitted variables at conventional significance levels in the case of regressions 1, 3, and 4, which include the lagged dependent variable, but we reject the null hypothesis of no omitted variables at the 1% level in the case of regressions 2 and 5, due to Dornbusch et al. (1983) and Shachmurove (1999), which do not include the lagged premium.

Focusing in on our preferred model, it is clear from our analysis in the previous section that it would be sensible to include the variable $\bar{C}$, which measures the value in dollars of $M2$,

or broad money, at the official exchange rate, since this variable influences the equilibrium exchange rate in the stock-flow model. We choose to exclude that variable, however, since it has a highly negative correlation, of -0.9465, in the sample with the official real exchange rate variable. The official real exchange rate has the correct sign in regression 4, but just falls short of significance at the 10% level. The differential rate of expected profits variable of Fishelson (1988), however, is positive and significant at the 1% level, and the magnitude of this variable for Venezuela, equal to 146.6, is higher than the highest value of this coefficient estimated by Fishelson (1988) over the 19 countries in his original study, of 133.81, for Sri Lanka during the period 1970 to 1979. This suggests that portfolio demand for black market dollars is very sensitive to changes in the differential rate of expected profits from purchasing black market dollars.

5. Conclusion

Following the economic crisis in the oil sector of the country during the last half of 2002 and early 2003, Venezuela instituted a capital control policy to reduce the outflow of dollars. In this paper, we describe the mechanics and structure of the black market for dollars in Venezuela. We present a stock-flow style model of the black market along the lines of Dornbusch et al. (1983), and discuss several previous models that build on this tradition. We test five models on monthly data for the Venezuelan black market premium during the period spanning from February 2003 until August 2008. We find that the model of Fishelson (1988) modified to include the change in the logarithm of foreign reserves provides the best fit to the data. The magnitude of the effect of the interest rate differential adjusted for the rate of depreciation of the black market exchange rate on the black market premium is greater than the value taken by any of the countries in the original Fishelson (1988) study. This suggests that speculative motives may be particularly important in the Venezuelan black market for dollars. Increases in international reserves tend to raise the black market premium, in line with the explanation of Culbertson (1989) that such increases are likely to reduce the private supply of black market dollars.

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6. Appendix A: Variable Definitions

Variable	Definition
x_t	The black market premium x at time t is defined as $E_t/\bar{E}_t$, where E_t is the black market ask rate and $\bar{E}_t$ is the official exchange rate. Sources: The black market rate is taken from dealers notes before January 2005, and after that date from the public source http://venezuelafx.blogspot.com/. The official rate is taken from the Banco Central de Venezuela
Official RER	The official real exchange rate is calculated as $\bar{E}P^*/P$, where $\bar{E}$ is the official exchange rate in Bs.F/USD, P^* is the CPI for the United States, and P is the CPI for Venezuela. Sources: The CPI data is taken from the IMF International Financial Statistics data source, available on Bloomberg.
$i^* + \bar{d} - i$	i^* is the interest rate on 1-year yield on US Treasury bonds, i is the average rate paid to depositors in Venezuelan banks, and $\bar{d}$ is defined as $\ln(\bar{E}_t/\bar{E_{t-1}})$. Sources: The US Treasury rate data is taken from Bloomberg, and the deposit rate in Venezuela is taken from the Banco Central de Venezuela.
DREP	The differential rate of expected profits is defined as $(1 + i_t^*)(1 + d_t) - (1 + i_t)$, where $d \equiv \ln(E_t/E_{t-1})$.
$\Delta \ln R_t$	R_t is the stock of foreign currency reserves of Venezuela. Source: Banco Central de Venezuela.
$\bar{C}$	This variable is computed by dividing the M2 definition of the money supply in Venezuela by the official exchange rate. Source: Banco Central de Venezuela.

TABLE 3. Variable Definitions