

# Impacts of foreign exchange auctions on the informal market rate in Myanmar

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**Impacts of foreign exchange auctions  
on the informal market rate in  
Myanmar**

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**Abstract**

Since the abolition of the official peg and the introduction of a managed float in April 2012, the Central Bank of Myanmar has operated the daily two-way auctions of foreign exchange aimed at smoothing exchange rate fluctuations. Despite the reforms to the foreign exchange regime, however, informal trading of foreign exchange remains pervasive. Using the daily informal exchange rate and Central Bank auction data, this study examines the impacts of auctions on the informal market rate. First, a VAR analysis indicates that the official rate did not Granger cause the informal rate. Second, GARCH models indicate that the auctions did not reduce the conditional variance of the informal rate returns. Overall, the auctions have only a quite modest impact on the informal exchange rate.

**Keywords:** Myanmar; foreign exchange auctions; informal market rate; GARCH model

**JEL classification:** E65, F31, O24

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# **Impacts of foreign exchange auctions on the informal market rate in Myanmar**

## **1. Introduction**

The effectiveness of official intervention in foreign exchange markets is a crucial policy issue for authorities in developing countries. As argued by Canales–Kriljenko (2003), official intervention in foreign exchange markets could be more effective in developing countries than in industrialized countries for several reasons. However, empirical studies on foreign exchange interventions in developing countries are rather scant due to the unavailability of high–frequency data on official interventions (Menkhoff 2013). We contribute to this growing body of literature on official foreign exchange intervention in developing countries with a case study on Myanmar.

In April 2012, Myanmar abolished its official peg, which had grossly overvalued the Myanmar kyat for over two decades, and introduced a managed float. In the new regime, the Central Bank of Myanmar (CBM) introduced daily foreign exchange auctions, which now determine the official exchange rate.

Despite such a stark reform, the informal foreign exchange market that developed during the previous exchange rate regime remains pervasive. Prior to the reforms, private exporters and importers traded foreign exchange at mutually negotiated prices irrespective of the official exchange rate. This informal foreign exchange market continues largely as before the reform.

The post–reform foreign exchange auctions are expected to serve as an intervention instrument enabling the CBM to smooth fluctuations in the informal market rate (IMF

2013). However, foreign exchange sales through the auctions conflict with another intermediate target of the CBM, namely to strengthen its international reserves. Considering conflicts in policy targets, it is crucial to ascertain the auctions' effectiveness in smoothing informal exchange rate fluctuations.

Drawing on the literature of official intervention in foreign exchange market, we evaluate the impacts of these auctions on the informal market rate in Myanmar. We measure the volatility of the informal exchange rate returns using generalized autoregressive conditional heteroskedasticity (GARCH) models and evaluate the impact of auctions on the conditional variance of informal exchange rate returns. We use data on the daily auctions and informal market exchange rates for this analysis.

The remainder of the study is organized as follows. Section 2 reviews the literature on foreign exchange auctions and official intervention in foreign exchange market. Section 3 outlines the foreign exchange market in Myanmar, which comprises both official and informal markets. Sections 4 and 5 present empirical analyses by time series econometrics to evaluate the impacts of the auctions on the informal market. In Section 4, we use Granger causality tests in a bi-variate vector autoregression (VAR) model of the informal and official rates to examine whether the official rate impacted the informal rate. In Section 5, we employ GARCH models to evaluate the impacts of auctions on the volatility of informal rate returns. In Section 6, we summarize the analysis and conclude the study.

## **2. Foreign exchange intervention in developing countries**

### **2.1 Foreign exchange auctions**

According to the survey of foreign exchange market organization in developing and transition economies undertaken by the International Monetary Fund (IMF) in 2001, foreign exchange auctions are relatively common in these countries (Canales–Kriljenko 2004). A full 34 percent of the 91 surveyed countries held foreign exchange auctions. These countries usually held their auctions complementarily with the interbank dealer market of foreign exchange; pure auction market structures whereby the central bank periodically auctions surrendered foreign exchange are no longer as common as they were in the 1980s when they were documented by Quirk et al. (1987).

Auctions are conducted in various ways. In one case, the central bank purchases foreign exchange from commercial banks to strengthen its foreign reserves. In another case, the central bank supplies the foreign exchange, which comes from the foreign exchange receipts of the government.

In some cases, foreign exchange auctions serve as an intervention instrument for the central bank to smooth exchange rate fluctuations. For instance, in Turkey, the central bank conducted two–way auctions whereby it called for both bids and offers of foreign exchange (Tuna 2011).

### **2.2 Official intervention**

In terms of the channels through which official interventions in foreign exchange markets might work, the literature indicates the portfolio balance effect and the

signaling effect.<sup>1</sup> In the portfolio balance effect, intervention changes the balance between domestic- and foreign-currency-denominated assets in the markets, which induces the investors to adjust their portfolio, changing the exchange rate. In the signaling effect, in contrast, the information contained in interventions modifies investor expectations regarding the future spot exchange rate, leading to an immediate adjustment to the current exchange rate.

In the literature that empirically examines the effectiveness of official intervention, one common approach is the GARCH model. In this approach, volatility of exchange rate returns is measured as the conditional variance of the GARCH model, and the impacts, if any, of interventions on conditional variance of exchange rate returns are evaluated econometrically.

The empirical literature concentrates on industrialized countries such as Australia, Germany, and Japan. This is mainly due to the availability of high-frequency data on interventions from these countries. Existing studies on the effectiveness of interventions in industrialized countries have produced mixed results. On the one hand, some studies have found intervention to be effective, including Kim et al. (2000) on Australia and Hoshikawa (2008) on Japan. In contrast, Baillie and Osterberg (1997) and Dominguez (1998), who both examined interventions in Germany and Japan, and Edison et al. (2006) who studied Australia, all found that interventions were associated with higher volatility of exchange rate returns.

There is a growing body of literature on foreign exchange interventions in developing countries. Canales-Kriljenko (2003) lists three structural factors that potentially

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<sup>1</sup>See Sarno and Taylor (2001) for a survey of the literature. They point out international coordination as another channel.

differentiate the effectiveness of official foreign exchange intervention in developing countries from those in industrialized countries. First, official interventions are not always fully sterilized in developing countries, unlike in industrialized countries. Changes in money supply stemming from non—sterilized interventions would reinforce the effect of interventions. Second, given the existence of shallow foreign exchange markets in developing countries, the relative size of interventions is larger in developing countries than in industrialized countries. Considering these two factors, the portfolio balance effect could be more pronounced in developing countries. Third, some central banks in developing countries might be able to use reporting requirements to gain an information advantage in the foreign exchange market over other market participants, a situation less likely to exist in industrialized countries. Overall, foreign exchange interventions in developing countries might be more effective than those in industrialized countries.

Empirical studies on foreign exchange interventions in developing countries are still in a nascent stage. According to the survey by Menkhoff (2013), empirical studies on official interventions in developing countries tend to focus on four Latin American countries (Chile, Colombia, Mexico, and Peru), the Czech Republic, Croatia, and Turkey.<sup>2</sup> Empirical results on the effectiveness of interventions are mixed. Broto (2013) and Menkhoff (2013) argue that the diverse institutional circumstances and policies in developing countries might account for the differences in effectiveness of official interventions.

We contribute to this growing body of literature that empirically analyzes foreign

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<sup>2</sup>Empirical studies on developing countries not covered in Menkhoff (2013) include Shah et al. (2009) on Pakistan and Simwaka and Mkandawire (2012) on Malawi.



exchange interventions in developing countries by testing the effectiveness of official intervention in Myanmar. Due to the lack of monetary policy instruments, interventions are not sterilized in this country.<sup>3</sup> On the other hand, Myanmar has a pervasive informal foreign exchange market. The case study of Myanmar would therefore be a unique addition to this growing field.

### **3. Structure of Myanmar's foreign exchange market**

#### **3.1. Formal market**

Since the abolition of the official peg of the Myanmar kyat in April 2012, the CBM has operated daily two-way foreign exchange auctions. Participants are 14 local banks to whom the CBM granted authorized dealer licenses.<sup>4</sup> In its daily auctions, the CBM calls for sealed bids and offers of US dollars from the banks. The banks then submit their price and quantity bids (offers) to the CBM. The bids and offers must be fully covered by a bank's current account deposits held at the CBM. The CBM sets the cut-off price of US dollars in terms of the Myanmar kyat and accepts the bids (offers) above (below) the cut-off rate. In auction terminology, it is a discriminatory auction where bidders (offerors) are awarded at their bid (offer) prices.<sup>5</sup>

There are two notable points in Myanmar's foreign exchange auctions in comparison

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<sup>3</sup>The sole monetary policy instrument at present is deposit auctions, which have been held only twice per month, whereas foreign exchange auctions are daily.

<sup>4</sup>Eleven banks received these licenses in November 2011. In August 2012, three more banks obtained authorized dealer licenses.

<sup>5</sup>For an explanation of auction terminology, see Feldman and Mehra (1993).

with those held in other developing countries. First, the daily auctions are two-way: the CBM accepts both bids and offers from participating banks. Second, no systematic arrangement exists to transfer the government's foreign exchange receipts, such as export revenues from state enterprises, to the CBM due to the state sector's obsolete foreign exchange administration. Thus, the CBM's supply of foreign exchange is rather limited at present.<sup>6</sup>

The introduction of the auctions was a consequence of the country's shallow and underdeveloped official market for foreign exchange. Until October 2011, banks had not been permitted to engage in foreign exchange trading. Although state banks had been offering international banking services such as current international payments and transfers, they did not sell or buy foreign exchange with customers; buyers and sellers of foreign exchange had to find counterparties outside the banking system (explained in more detail in the following subsection). During the reform process, the private banks who had been newly granted foreign exchange dealer licenses moved ahead of the state banks with respect to money-changing services in October 2011 and customer dealing of foreign exchange in August 2012. Later, in August 2013, the CBM instituted an interbank market for foreign exchange. This series of reforms are still paving the way for the establishment of a two-tier official foreign exchange market: (1) the wholesale segment including the official auctions and the interbank market, and (2) the retail segment including banks' customer dealings and transactions at authorized money changers.<sup>7</sup>

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<sup>6</sup>The transfer of the government's foreign exchange receipts to the CBM is one of the reform agendas in the country (IMF 2013).

<sup>7</sup>The CBM has also issued money changer licenses to non-bank firms since December 2012, but these money changers are not permitted to participate in the auctions.

In the face of the underdeveloped interbank foreign exchange market, the auctions enable the CBM to obtain a market-based official exchange rate. The CBM publicly announces the daily auction's cut-off rate as the "official reference rate" and uses it to regulate exchange rates in official wholesale and retail markets. The buying and selling rates at authorized dealer banks and money changers are restricted to within a range of  $\pm 0.8$  percent of the "official reference rate," which the CBM updates each working day. The reference rate itself is discretely determined in the auctions, and there is no band on it.

Furthermore, the auctions equip the CBM with an intervention instrument in the foreign exchange market. The IMF (2013: 7) concludes that the CBM has sought to smooth exchange rate fluctuations without targeting a specific level or range. Figure 1 summarizes the auction's daily records for the period April 2012–September 2013, along with the trends in the "official reference rate" and prevalent informal rate. As shown in this figure, when the informal rate appreciated (depreciated) sharply, the CBM purchased (sold) dollars with a more depreciated (appreciated) exchange rate, implying attempts by the CBM to adjust the informal market rate.

Figure 1

However, one of the auction's important negative impacts is the resulting foreign reserve outflows. As the foreign exchange auctions are two-way, they can lead to either accumulation or dissipation of foreign reserves. For example, in March 2013, the monthly sales and purchases of foreign exchange were USD 145.3 million and USD 5.5 million, respectively. This net outflow of USD 139.8 million amounted to 4.7 percent of

the foreign reserves.<sup>8</sup> Thus, official interventions to defend the Myanmar kyat against depreciation conflicted with the accumulation of foreign reserves.

### **3.2. Informal market**

Despite Myanmar's foreign exchange policy reforms, the informal market remains pervasive, a legacy of the country's previous peculiar exchange rate regime. Prior to the April 2012 introduction of a managed float, the Myanmar kyat had been officially pegged to the special drawing right (SDR) of the IMF at 8.50847 kyat per SDR; the official rate had not been adjusted for over three decades. However, this official rate had been applied only to transactions in the public sector for fiscal accounting. For the private sector, there had been, in principle, no allocation of foreign exchange or surrender requirement on foreign exchange earners (IMF 2012).

Under the previous fixed exchange rate regime, private exporters and importers were relegated to the informal market where they traded foreign exchange competitively. As for the proceeds from formal exports, foreign exchange regulations restricted private exporters to only being able to deposit them in the state banks in foreign currency deposit (FCD) accounts. However, this was different from a surrender requirement. By regulation, the banks could not accept conversion of FCD into the Myanmar kyat or withdrawal in foreign currencies, whereas they tolerated domestic account transfers of FCD. Domestic account transfers of FCD thus fostered private exporters' ability to sell FCD to importers by transferring FCD to importers' accounts in exchange for side payments in Myanmar kyat. In this way, buyers and sellers traded FCD at bilaterally

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<sup>8</sup>According to IMF (2014: 22), the Central Bank's foreign reserves as of the end of March 2013 were USD 3,062 million.

negotiated prices. Sometimes brokers acted as middlemen and their quoted prices of FCD (i.e., informal exchange rates) were widely circulated in the private sector.<sup>9</sup>

It is worthwhile mentioning that informally traded FCD could be used for imports in the formal channel. In addition to FCD, informally held foreign exchange such as proceeds from smuggling exports were traded in the informal market. The regulations differentiated informally held foreign exchange from the FCD, and did not approve the former's use for formal imports.

The practice of informal foreign exchange trading in the private sector remains largely the same even after the ongoing reforms were first enacted. We can infer the informal market's turnover in relation to the formal market's turnover. Since August 2012, private exporters have had two choices for disposal of export revenues: banks (the official market) and the informal market. When banks deal with customers, banks buy foreign exchange from exporters and sell it to importers. Thus, if the customer dealing of the banks were substantially small compared with exports, it would signal the informal market transactions between the private exporters and importers.<sup>10</sup>

Table 1 compares turnover of the official foreign exchange market with private exports. We use private sector exports as a yardstick since the state sector does not sell foreign exchange to banks or in the informal market under the state budget system's administrative controls.<sup>11</sup> The turnover of the banks' customer dealing includes both

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<sup>9</sup>Major brokers disseminated their quotes via the short message service (SMS) of mobile phones.

<sup>10</sup>Some exporters import as well, and they use export revenues for their own imports. A part of the disparity between the exports and customer dealing of the banks is attributable to such export-import firms.

<sup>11</sup>Kubo (2013) offers an account of the controls on foreign exchange in the state sector. In principle, export revenues of the state sector are maintained as the FCD of the state and they are disbursed only to the state sector.

sales and purchases of foreign exchange by the banks. If all private exporters had sold their export revenues to the banks, who in turn had sold the entire sum received to private importers, the ratio of the banks' customer dealing to private exports would be 2 : 1.<sup>12</sup> The actual ratio is as low as 0.27 : 1. On the assumption that the banks have accurately reported their customer dealings, this low ratio implies a considerable scale of informal foreign exchange trading occurring between private exporters and importers.

Table 1

#### **4. Relationship between official and informal exchange rates**

We examine the relationship between the Central Bank rate (official reference rate) and the prevalent informal market rate since the introduction of a managed float in April 2012. If the auctions exert an influence on the informal market, a rise in the official reference rate would be accompanied by a rise in the informal market rate. We examine the relationship of the two rates by the Granger causality test.

The data used in this study are as follows. For the informal rate, we use the broker buying price of US dollars in the informal market at the closing of the market in the afternoon, disseminated by a private market information service company.<sup>13</sup> The official rate is the daily auction cut-off rate, which is publicly announced at around 10:00AM

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<sup>12</sup>Similarly, the turnover of the central bank auctions includes both sales and purchases of foreign exchange by the CBM.

<sup>13</sup>e-Trade Myanmar Co. Ltd. (<http://etrademyanmar.net/newetm/home>)

the same day as the auction. The official rate is posted on the CBM's website.<sup>14</sup> The sample period spans from April 2, 2012, to September 30, 2013. The total number of observations is 360. We use variables in logarithms and denote the informal market rate and official reference rate as  $\ln(BLK_t)$  and  $\ln(CBM_t)$ , respectively.

Initially, we examine the data's time series properties. First, we check the stationarity of the two time series using the Augmented Dickey–Fuller test. The test statistics indicate that both  $\ln(BLK_t)$  and  $\ln(CBM_t)$  are non-stationary in their level but stationary in their first difference at the 1 percent significance level. Thus, we judge they are I(1) variables. Second, we test if two variables are co-integrated in their level. The Maximum Eigenvalue test indicates that the null hypothesis of no co-integration cannot be rejected at the 5 percent significance level.<sup>15</sup>

Accordingly, we estimate a bi-variate vector autoregression (VAR) model in their first difference as follows:

$$\Delta \ln(CBM_t) = \alpha_1 + A_{11}(L)\Delta \ln(CBM_{t-1}) + A_{12}(L)\Delta \ln(BLK_{t-1}) + \varepsilon_{1t}, \quad (1)$$

$$\Delta \ln(BLK_t) = \alpha_2 + A_{21}(L)\Delta \ln(CBM_{t-1}) + A_{22}(L)\Delta \ln(BLK_{t-1}) + \varepsilon_{2t}, \quad (2)$$

where  $A_{ij}$  are the polynomials in the lag operator  $L$ ;  $\varepsilon_{1t}$  and  $\varepsilon_{2t}$  are independently distributed disturbance terms. We test the null hypothesis that  $A_{21}(L) = 0$ . Rejecting the null hypothesis implies that the CBM could exert an influence on the informal market rate.

As to the empirical model, the lag length is pared to 3 from 20 by both the Akaike Information Criterion and Schwarz Information Criterion. As to the model diagnostics,

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<sup>14</sup>Central Bank of Myanmar (<http://www.cbm.gov.mm/>)

<sup>15</sup>For evaluation of co-integration relationship, we include 20 lags of  $\Delta \ln CBM$  and  $\Delta \ln BLK$ , where  $\Delta$  refers to the first difference.

the Lagrange multiplier test indicates that the null hypothesis of no serial correlation of residuals for lag order one cannot be rejected at the 10 percent significance level. Thus, it is appropriate to proceed to the Granger causality tests with this VAR model.

Table 2 summarizes the results of the Granger causality tests. The null hypothesis that  $\Delta \ln(CBM)$  does not Granger cause  $\Delta \ln(BLK)$  cannot be rejected at the 10 percent significance level. On the other hand, the null hypothesis that  $\Delta \ln(BLK)$  does not Granger cause  $\Delta \ln(CBM)$  can be rejected at the 1 percent significance level.

Table 2

We can interpret these results in two ways. In one interpretation, the CBM can be seen as trying to follow the informal exchange rate rather than guiding it. A policy target of the CBM has been to dissolve the multiple currency practices (MCP) and align the official reference rate with the informal market rate, containing the gap between the informal and official exchange rate in the 2 percent range.<sup>16</sup> If this is the case, we cannot judge precisely the CBM's ability to influence the informal exchange rate.

In the other interpretation, the CBM did seek to influence the informal exchange rate occasionally, but did not succeed. As shown in Figure 1, the gap between official and informal market rates sometimes widened and persisted, implying that the CBM did attempt to adjust the informal market rate. If so, the empirical result could be interpreted as an indication of the CBM's limited ability to influence the informal market.

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<sup>16</sup>If the auction rate differs from another prevalent market rate by 2 percent, it is regarded as MCP, which requires approval from the IMF (Canales–Kriljenko 2004: 18).



## 5. Effect of foreign exchange auctions on the informal rate's volatility

### 5.1. Data

We evaluate the impact of auctions on the volatility as well as the level of the informal market rate return. When changes in the informal market rate have a time-varying conditional variance structure of errors, we can capture it through a GARCH model. We then analyze the impacts of auctions on the conditional variance of informal rate returns in the GARCH model.

The variables we utilize in this analysis are the informal market rate and daily foreign exchange sales and purchases by the CBM through the auctions. The CBM releases the daily auction results to participating banks. The sample period spans from April 2, 2012, to September 30, 2013. For the informal market rate, we define the daily return of the US dollar against Myanmar kyat as follows:

$$r_t \equiv 100 \times [\ln(BLK_t) - \ln(BLK_{t-1})], \quad (3)$$

which is proximate to the percentage change in the informal market rate. A positive  $r_t$  value indicates depreciation of the kyat against the US dollar. Figure 2 depicts the daily return of the US dollar. As is common for financial variables, volatility clustering is observable; large changes of the informal rate were followed by large changes, and small changes by small changes. The figure clearly indicates that the daily return of the informal market rate has a time-varying conditional variance structure of errors.

Figure 2

Table 3 summarizes the variables' descriptive statistics. In this table, except for the exchange rate return ( $r_t$ ),  $I_t$  stands for the CBM's net foreign exchange sales. A negative value for this term indicates the CBM's purchases of foreign exchange. Furthermore,  $I_t^+$  and  $I_t^-$  refer to disaggregated sales and purchases of foreign exchange by the CBM, respectively. As for the exchange rate return, the Ljung–Box  $Q$ -statistics for serial correlation reveal that the null hypothesis of no serial correlation of the squared standardized residuals up to 20 lags is rejected at the 1 percent significance level. This suggests the presence of conditional heteroskedasticity of the exchange rate return and the GARCH method's suitability to model its variance.

Table 3

Turning to the disaggregated data of the CBM's sales and purchases, out of 360 working days, the CBM sold foreign exchange on 164 days and purchased on 256 days. On several days, the CBM accepted both bids and offers. Foreign exchange purchases are more varied in size than foreign exchange sales.

Two types of banks participate in the auctions.<sup>17</sup> The first type is private banks that arbitrage between the auctions and the informal market. When the informal market rate is higher than the official rate, arbitrage banks buy foreign exchange in the auctions and sell it to customers. Similarly, when the informal rate is lower than the official rate, they buy foreign exchange from customers and sell it in the auctions. The second type of participant is the state banks, who mostly sell foreign exchange in the auctions whenever they are in need of local currency liquidity. They may not be connected to the

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<sup>17</sup>Turnell (2014) offers a comprehensive overview of Myanmar's banking sector.

informal market.

The CBM's pattern of foreign exchange sales and purchases might reflect the above-mentioned heterogeneity of banks participating in the auctions. Figure 3 contrasts the auction net sales with the gap between informal and official rates. As expected from the private banks' arbitrage, the CBM's sales (purchases) concentrated on days when the official rate was lower (higher) than the informal rate. On the other hand, there were some lumpy purchases of foreign exchange by the CBM irrespective of the gap between the official and informal rates, which might be associated with foreign exchange sales by state banks to the CBM. In the following analysis, we consider the asymmetric characteristics of the CBM's sales and purchases of foreign exchange.

Figure 3

## 5.2. Empirical model

Following Baillie and Bollerslev (1989), Dominguez (1998), and Edison et al. (2006) among others, we analyze the impacts of the foreign exchange auctions on the informal market rate returns using a GARCH model. As the baseline model, we add the CBM's net sales of foreign exchange in the daily auctions in both the conditional mean and conditional variance equations. In particular, the specification of the baseline model is as follows:

$$r_t = \varphi_0 + \varphi_1 r_{t-1} + \varphi_2 I_t + \varepsilon_t, \quad (4)$$

$$\varepsilon_t | \Omega_{t-1} \sim t(0, v, \sigma_t^2), \quad (5)$$

$$\sigma_t^2 = \delta_0 + \delta_1 |I_t| + \alpha \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2, \quad (6)$$

where  $r_t$  is the daily exchange return,  $I_t$  is the CBM's net sales of foreign exchange, and  $|I_t|$  is its absolute value. Equation (5) shows our assumption that the error terms have a conditional variance that has the Student's t density with mean zero, degree of freedom  $\nu$ , and variance  $\sigma_t^2$ . In Equation (6),  $\alpha$  and  $\beta$  represent the ARCH effect and GARCH effect, respectively. To address small number of observations, we estimate the integrated GARCH model that presumes *a priori* that  $\delta_0 = 0$  and  $\alpha + \beta = 1$ .

When incorporating the intervention variables into the conditional mean and variance equations, some studies, such as Baillie and Osterberg (1997) and Broto (2013), used lagged intervention variables in consideration of simultaneous bias. For the case of the foreign exchange auctions in Myanmar, the results of the auctions are announced to the market around 10:00AM. Data on the informal market rate are the market's afternoon closing price. Therefore, endogeneity is less of a concern compared with the cases in the above-mentioned studies.<sup>18</sup>

The parameters of interest are  $\varphi_2$ , which measures the impact of the foreign exchange auction on the level of the informal market rate return, and  $\delta_1$ , which measures the impact on the variance of changes in the informal market rate return. We expect  $\varphi_2 < 0$  as CBM's foreign exchange sales would lead to appreciation of the Myanmar kyat vis-à-vis the US dollar. Regarding the informal market rate's volatility, if the auctions as official intervention dampen informal market rate fluctuations, then the sign on  $\delta_1$  would be negative.

We also estimate an alternative specification of the baseline model by replacing the net sales terms in Equations (4) and (6) with the terms for disaggregated sales and

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<sup>18</sup>We also estimated the GARCH models with lagged intervention variables but they did not yield significantly different results from those presented in the main text.

purchases of foreign exchange by the CBM as follows:

$$r_t = \varphi_0 + \varphi_1 r_{t-1} + \varphi_3 I_t^+ + \varphi_4 I_t^- + \varepsilon_t, \quad (7)$$

$$\sigma_t^2 = \delta_2 I_t^+ + \delta_3 |I_t^-| + \alpha \varepsilon_{t-1}^2 + \beta \sigma_{t-1}^2. \quad (8)$$

This specification is based on the hypothesis that CBM purchases of foreign exchange include the lumpy purchases from the state banks that are not linked to the informal market. With this alternative model, we perform the Wald test for the null hypothesis of symmetric effects of CBM sales and purchases in the auctions, where  $H_0: \varphi_3 = -\varphi_4$  and  $\delta_2 = \delta_3$ .

### 5.3. Empirical results

Table 4 reports the results of estimation. Model (1) is without intervention (auctions) variables. Model (2) is the baseline model with the CBM's net sales of foreign exchange included in the conditional mean and conditional variance equations. Model (3) is the alternative specification replacing the CBM's net sales with disaggregated sales and purchases. For the diagnostics of standardized residuals, in all three models, the Ljung–Box  $Q$ –statistic tests for high–order serial correlation indicate that the null hypothesis of no serial correlation in squared standardized residuals cannot be rejected. These diagnostic tests indicate that the GARCH models correct the heteroskedasticity.

Table 4

We now examine the impacts of the auctions on the conditional mean and variance of exchange rate change in the informal market. For Model (2), the coefficient on the

CBM's net sales in the conditional mean equation is negative but statistically insignificant. The coefficient on net sales in the conditional variance equation is positive and significant at the 5 percent significance level. This implies that the CBM intervention was associated with higher informal rate volatility.

For Model (3), which differentiates the impacts of CBM foreign exchange sales and purchases upon the informal rate, the result does not indicate any effectiveness of such interventions. In the conditional mean equation, the coefficient on the CBM sales is positive and significant at the 1 percent significance level. This implies that the CBM's sales of foreign exchange via auctions were associated with depreciation of the Myanmar kyat against the US dollar, rather than appreciation. The coefficient on the CBM's foreign exchange purchases is insignificant. In the conditional variance equation, coefficients on both sales and purchases are positive, whereas only the coefficient on sales is significant at the 10 percent significance level. Furthermore, the Wald test rejects the null hypothesis that the coefficients on sales and purchases are symmetric in the mean equation at the 10 percent significance level, whereas it cannot reject the null hypothesis that the coefficients on  $I_t^+$  and  $|I_t^-|$  are the same in the variance equation at the 10 percent significance level.

The overall results should not be interpreted as indicating that the auctions raised the volatility of the informal market rate return. To the contrary, causality might run the other way such that the CBM has intervened more in the market when the informal market rate has showed abrupt changes. In other words, we consider that the CBM's stance has been one of "leaning against the wind".

Furthermore, whereas the CBM's intervention in the foreign exchange market is positively associated with higher conditional variance, its impact is quite modest. Using

the estimates of the baseline model (2) in Table 4, we can calculate the contemporaneous impact of the intervention on the conditional variance,  $\delta_1|I_t|/\sigma_t^2$ . On average, the intervention accounts for 5.88 percent of the conditional variance. Such a result is similar to Edison et al. (2006).

Regardless of the auction's modest impact on the informal market rate, their cost is not necessarily small. First, the CBM's sales of foreign exchange sometimes led to considerable outflows of foreign reserves, as shown in Section 3. Second, the auctions provide windfall gains to the banks that arbitrage between the auctions and the informal market. As shown in Figure 3 in this section, the CBM's sales (purchases) of foreign exchange were largely concentrated on the days when the official rate was lower (higher) than the informal market rate. Therefore, the foreign exchange auctions should be regarded as a transitory arrangement and the CBM should be encouraged to put more emphasis on accumulation of its foreign reserves.

## **6. Conclusion**

Since the abolition of the official peg and the introduction of a managed float in April 2012, the Central Bank of Myanmar has operated daily foreign exchange auctions. These auctions have had three functions: (1) providing the CBM with a market-determined exchange rate apart from the informal rate, (2) supplying or absorbing foreign exchange liquidity in the context of an underdeveloped interbank market, and (3) serving as a policy instrument to intervene in the foreign exchange market.

Using daily data on auctions and exchange rates for the period April 2012–September

2013, we analyze the auctions' impacts on the informal market. First, the exchange rates' bi-variate VAR indicates that the official reference rate did not Granger cause the informal market rate, whereas the latter did so for the former. Second, the GARCH models incorporating the auction variables indicate that the CBM's net sales of the US dollar did not reduce the conditional variance of changes in the informal rate.

The empirical results imply that the auctions' ability to function as a means of intervention has been rather modest, whereas they have incurred substantial costs for the CBM in terms of eroding the official foreign reserves. Thus, foreign exchange auctions should be recognized as a transitory arrangement that should operate only until the interbank foreign exchange market is developed.



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Table 1. Formal trading of foreign exchange and private sector international trade,  
January 2014–December 2014

	Monthly average US dollar, million	Ratio to private exports
Wholesale		
Auction turnover 1/	165.3	0.41
Interbank dealing turnover	17.5	0.04
Retail		
Customer dealing turnover	110.2	0.27
Private exports	401.5	1.00

Sources: Central Bank of Myanmar website; *Selected Monthly Economic Indicators*, Central Statistical Organization (CSO), Myanmar.

Notes:

1/: Monthly average for January 2013–September 2013.

Table 2. Granger causality between the official and informal rates

Null Hypothesis	$\Delta \ln CBM$ does not Granger-causes $\Delta \ln BLK$	$\Delta \ln BLK$ does not Granger-causes $\Delta \ln CBM$
Test Statistics ( $\chi^2(3)$ )	5.8951	107.0716
P-value that null hypothesis holds	0.116	0.000

Source: Author's calculation.

Table 3. Descriptive statistics

	$r_t$ Exchange rate return	$I_t$ Auction CBM net sales	$I_t^+$ Auction CBM sales	$ I_t^- $ Auction CBM purchases
Mean	0.0492	-0.2554	5.3754	3.8027
Maximum	2.0225	21.5000	21.5000	44.7500
Minimum	-1.5125	-44.7500	0.0100	0.0100
Std. Dev.	0.3905	7.2595	4.6742	6.4527
Observation	359	360	164	256
$Q(20)$	23.121			
$Q^2(20)$	88.056 ***			

Source: Author's calculation.

Notes:  $Q(20)$  and  $Q^2(20)$  denote the Ljung–Box  $Q$ -statistic with 20 lags for the standardized residuals and squared standardized residuals. \*\*\* indicates that the null hypothesis of no serial correlations of the standardized residuals (squared standardized residuals) is rejected at the 1 percent significance level.

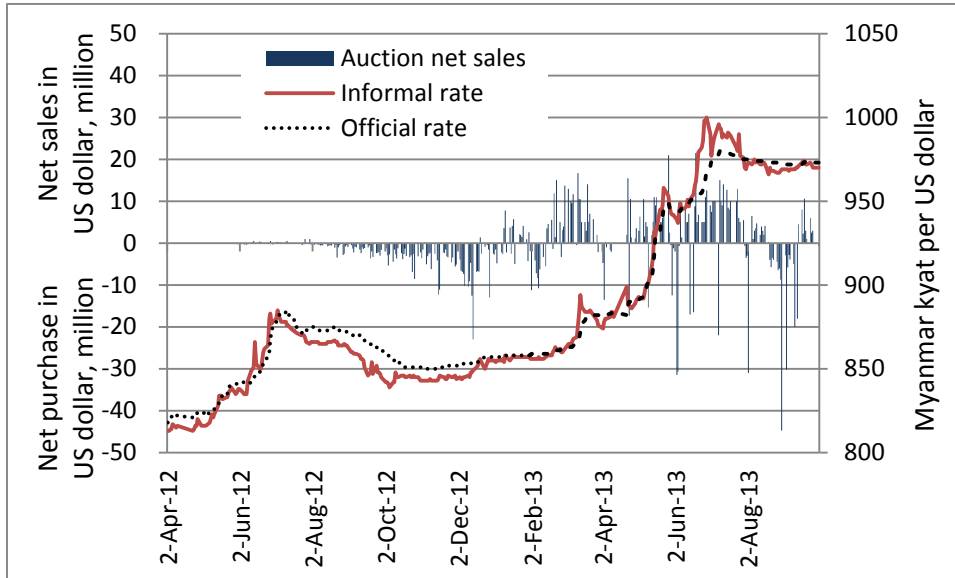
Table 4. Daily exchange rate return GARCH models

Model	(1)	(2)	(3)
Mean Equation			
Constant	0.0006 (0.933)	-0.0018 (0.838)	-0.0195 (0.070)
$r_{t-1}$	-0.0439 (0.350)	-0.0413 (0.417)	-0.0786 (0.120)
$I_t$		-0.0004 (0.840)	
$I_t^+$			0.0098 *** (0.002)
$I_t^-$			-0.0030 (0.159)
Variance Equation			
$\varepsilon_{t-1}^2$	0.2280 *** (0.000)	0.2853 *** (0.000)	0.2859 *** (0.000)
$\sigma_{t-1}^2$	0.7720 *** (0.000)	0.7147 *** (0.000)	0.7142 *** (0.000)
$ I_t $		0.0007 ** (0.036)	
$I_t^+$			0.0014 * (0.081)
$ I_t^- $			0.0004 (0.148)
Diagnostics for standardized residuals			
Q(20)	24.250 (0.232)	27.561 (0.120)	22.693 (0.304)
$Q^2(20)$	13.325 (0.863)	11.054 (0.945)	9.881 (0.970)
Log likelihood	-50.7060	-41.4274	-35.5877
Observations	358	358	358

Notes: \*\*\*, \*\*, and \* indicate statistical significance at the 1, 5, and 10 percent level, respectively. Numbers in brackets are p-values.  $Q(20)$  and  $Q^2(20)$  denote the Ljung-Box  $Q$ -statistic with 20 lags for the residuals and squared residuals. The p-value for  $Q$ -statistic is the probability that the null hypothesis of no serial correlations of the residuals (squared residuals) is accepted.

Source: Author's calculation.

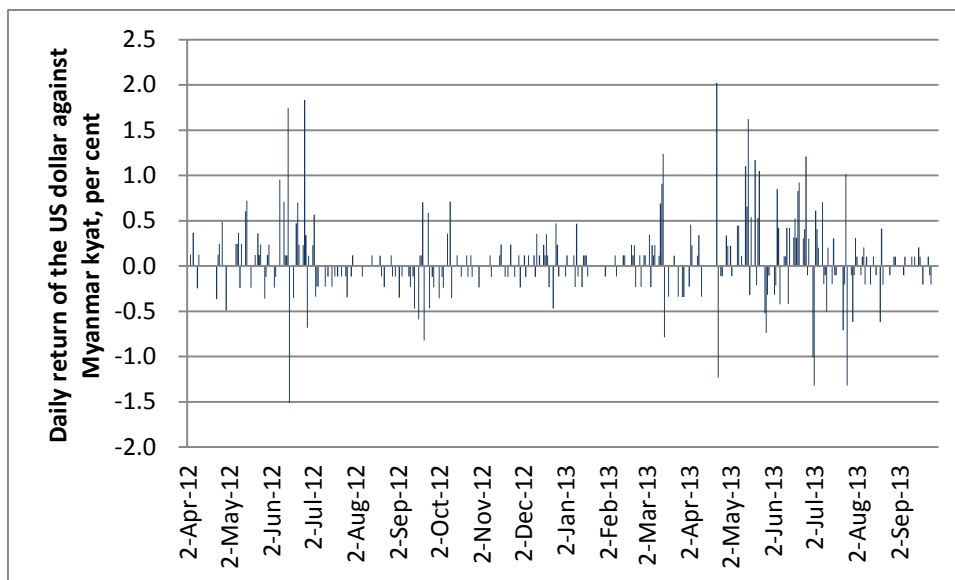
Figure 1. Auction net sales and exchange rate levels,  
April 2012–September 2013



Sources: Central Bank of Myanmar and the informal market survey.



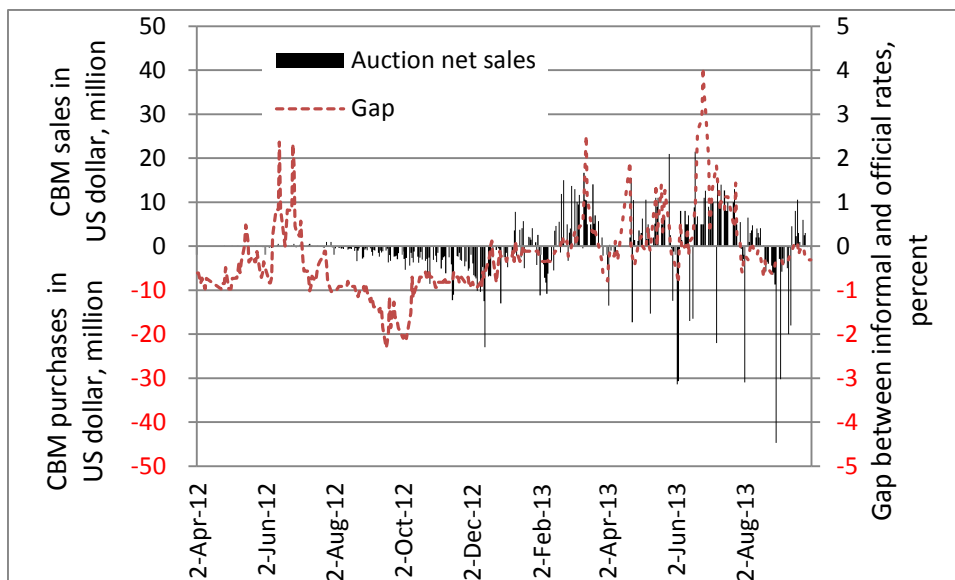
Figure 2. Daily return of the US dollar against Myanmar kyat in the informal market, April 2012–September 2013



Sources: Central Bank of Myanmar and the informal market survey.

Notes: The daily return is calculated as  $100 \times [\ln(BLK_t) - \ln(BLK_{t-1})]$ , where  $\ln(BLK_t)$  is the informal rate on date  $t$  in logarithm form.

Figure 3. Auction net sales and gap between informal and official rates, April 2012–September 2013



Sources: Central Bank of Myanmar and the informal market survey.

Note: The gap between the informal and official rates is calculated as  $100 \times [BLK_t - CBM_t]/CBM_t$ .