



WP/08/199

# IMF Working Paper

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## Efficiency Costs of Myanmar's Multiple Exchange Rate Regime

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**IMF Working Paper**

Asia and Pacific Department

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Authorized for distribution by Nissanke Weerasinghe

August 2008

**Abstract**

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Myanmar's multiple exchange rate system creates various economic distortions. This paper describes the exchange rate practices in Myanmar, develops a model of foreign exchange markets, and presents the efficiency costs imposed by quasi-fiscal operation under the current exchange rate regime. The results of our model-based analyses indicate that the equilibrium exchange rate under the unified market could be at around K 400–500 per U.S. dollar, and using the equilibrium exchange rate (instead of the official exchange rate) as the accounting rate increases trade openness to more than 20 percent from less than 1 percent measured by official statistics. The total efficiency loss caused by the current multiple exchange rate regime is estimated at about 14–17 percent of GDP in 2006/07.

JEL Classification Numbers: F31, H29

Keywords: Multiple Exchange Rate, Exchange Rate Unification, Efficiency Analysis

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<sup>1</sup> We wish to thank Leslie Teo and Sanjay Kalra for their support and many helpful comments. We also thank seminar participants in the context of the IMF Article IV mission to Myanmar in summer 2007 in which a preliminary version of this paper was presented. All remaining errors are our own.

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## I. INTRODUCTION

Myanmar maintains a multiple exchange rate regime consisting of an official exchange rate that coexists with informal parallel market exchange rates. While there has been a greater use of informal exchange rates by private sector agents over the years, the current system is nontransparent, creates various distortions, and imposes high costs on participants. Unification of the multiple rates would allow Myanmar to benefit from more efficient allocation of resources.

Against this background, this paper attempts to develop a model to describe Myanmar's foreign exchange markets, derive the equilibrium exchange rate, quantify the distortions on exports and imports that result from the current multiple exchange rate regime, and re-estimate a few key indicators such as GDP and trade openness based on the estimated equilibrium exchange rate to provide some indications of the size of the distortions.

While several earlier studies have dealt with the consequences of multiple exchange rates on economic efficiency in other countries,<sup>2</sup> their methodologies appear not directly applicable to the case of Myanmar. After describing the multiple exchange rate practices in Myanmar, we extend the model by Rosenberg and Zeeuw (2001) to better reflect features specific to the Myanmar's exchange rate regime, and estimate numerically the size of the net efficiency losses, as well as the level of the equilibrium exchange rate that clears the unified foreign exchange market. We also re-estimate the size of the external sector in the national account statistics using the estimated equilibrium exchange rate to present the size of efficiency losses relative to a re-estimated nominal GDP. Myanmar's GDP is likely to be underestimated due to the undervaluation of international transactions under the multiple exchange rates regime. While the estimates should be taken with some margin, the results of our model analyses indicate that the equilibrium exchange rate to clear the unified market could be around K 400–500 per U.S. dollar. Using the derived equilibrium exchange rate as the accounting rate increases the size of nominal GDP by about 10–12 percent compared to official statistics. Trade openness, defined as the sum of exports and imports divided by nominal GDP, increases to about 20–23 percent from less than 1 percent measured by official statistics. In addition, the total efficiency loss caused by the multiple exchange rate regime in 2006/07 is estimated at about 14–17 percent of GDP.

The paper is organized as follows. Section II describes the multiple exchange rate regime and its practices in Myanmar. Section III develops a model to describe Myanmar's foreign exchange markets. Section IV reports the baseline results of our model-based numerical analyses to quantify the efficiency effects caused by quasi-fiscal operation under the current exchange rate regime. Section V presents results of the sensitivity analyses, and Section VI summarizes the findings of this paper.

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<sup>2</sup> See for example, Tarr (1990), Rosenberg, Ruocco, and Wiegard (1999), and Rosenberg and Zeeuw (2001).

## II. MULTIPLE EXCHANGE RATE REGIME IN MYANMAR

A multiple exchange rate system can be broadly defined as a system in which there are more than one exchange rate to settle foreign exchange transactions and the different rates are used for different types of transaction. The mandatory surrender of foreign exchange proceeds from exports to the authorities at an overvalued official rate and a two-tier exchange rate system with a rate for current account transactions and another rate for capital account transactions are some examples. The multiple exchange rate regime in Myanmar takes the form of dual foreign exchange markets that are effectively segmented for public and private sector external transactions.<sup>3</sup>

In the public sector, the *official exchange rate*, which is exogenously set at far below the market clearing level, is used for accounting purposes and the settlement of external transactions. Public sector exporters, which are obligated to surrender 100 percent of their export proceeds to the government, therefore choose their export volume given the level of the official exchange rate. On the other hand, since the official exchange rate is grossly overvalued, public sector imports demand is much larger than foreign exchange available.<sup>4</sup> Since public sector export earnings are used solely for public sector imports and the accumulation of foreign exchange reserves, and there is no foreign exchange surrender requirement on private sector exporters since the early 1990s, foreign exchanges available for public imports could therefore be treated as the difference between public sector export earnings and the accumulation of international reserves, assuming that capital flows are negligible.<sup>5</sup> Faced with foreign exchange constraint, some public sector agents have procured

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<sup>3</sup> Strictly speaking, the foreign exchange regime in Myanmar consists of multiple rates, that is, an official rate and several unofficial rates (see Box 1 for details). However, most of the unofficial rates are market determined and the differences among the unofficial market-determined rates are negligible as compared to the gap between the official rate and the market-determined rates. Therefore, for simplicity, theoretical and empirical analyses in this paper assume a dual exchange rate system.

<sup>4</sup> Foreign exchange for public imports is rationed by the Foreign Exchange Budget managed by the Ministry of Finance and Revenue. Foreign exchange revenues are obtained from export receipts of exporting State Economic Enterprises (SEEs), export taxes, income tax on inward remittances, utility charges paid by foreign companies for public sector services, and the sales of Foreign Exchange Certificates (FEC). Foreign exchange expenditures consist mainly of import payments of SEEs and for servicing external debt of the public sector.

<sup>5</sup> Capital inflows are limited to direct investment inflows into the gas and energy sectors, and capital outflows are at a very low level given that most external debt obligations are not met and the possession of foreign assets is virtually prohibited for private Myanmar nationals.

### **Box 1: Myanmar's Multiple Exchange Rate System**

Myanmar maintains a multiple exchange rate regime consisting of an official exchange rate that coexists with informal market exchange rates. The official exchange rate, which is used in public sector external transactions, is pegged at K 8.50847 per SDR since 1977, while its valuation is allowed to differ within a margin of +/- 2 percent.

The authorities also issue U.S. dollar equivalent Foreign Exchange Certificates (FEC) which is currently traded at around 1,100 kyat per FEC in informal markets. FEC may be exchanged for kyats also at the official FEC exchange centers, but such transactions are limited as the center rate is set at K 450 per dollar, far below the market-determined rate. FEC are only used by residents as a substitute for U.S. dollar in domestic transactions since the use of foreign currencies in Myanmar is not legal for residents.<sup>1</sup> Nevertheless, the U.S. dollar is widely circulated in informal markets, and the use of FEC in transactions appears to be limited. The FEC are used by residents to pay for large value items such as air tickets, and local employees of international/foreign organizations are usually paid in FEC. Holders of FEC and residents with foreign currency earnings may open foreign currency accounts.<sup>2</sup> Foreign firms are often required to pay for utilities in U.S. dollars or FEC.<sup>3</sup>

U.S. dollars are exchanged with kyats at a premium over the FEC rate in informal parallel markets (at around K 1,120 in March 2008).<sup>4</sup> In addition, the Hundi system of exchange is widely used for settling payments for unrecorded trade, repatriation of profits, and for U.S. dollar cash remittances. The Hundi exchange rate is closely related to the parallel U.S. dollar rate but at a deduction of about 1 percent for commissions. The popularity of the Hundi system is believed to stem from its operation through an extensive informal network and it helps to evade taxes collected at the state-owned banks on export receipts and remittances.<sup>5</sup> The market-determined U.S. dollar exchange rate, together with the Hundi exchange rate, constitutes the main exchange rate for international transactions in the private sector.

The multiple exchange rate system has been supported by various foreign exchange controls to limit the use of foreign exchange. For instance, private imports require a license<sup>6</sup> and are restricted by the availability of export earnings. In addition, Myanmar maintains exchange restrictions that impose a limit on the purchase of foreign exchange by residents for foreign travel, the transfer of the remittable portion of wages by nonresidents, as well as payments relating to invisible and other current international transactions.<sup>7</sup>

<sup>1</sup> FEC were initially issued for the convenient of tourists and to enhance foreign exchange earnings. It was compulsory for foreign travelers holding tourist visa to exchange on arrival a minimum of US\$200/300 into FEC 200/300 units. This compulsory exchange was abolished in August 2003.

<sup>2</sup> Funds from foreign currency accounts could be used in external transactions such as foreign visits and medical treatment abroad with prior approval.

<sup>3</sup> This practice increases the business costs for foreign firms. For example, foreigners are required to pay their telephone bills in dollar terms, for example, US\$189(=1000/5.3), for a charge of K 1,000.

<sup>4</sup> The premium has remained relatively small and stable in recent years, suggesting that there is stable local demand for the FEC, as there is a certain degree of risk for Myanmar nationals to hold foreign currencies under the legal restrictions.

<sup>5</sup> Export earnings are subject to a commercial tax of 8 percent and an income tax of 2 percent.

<sup>6</sup> In the authorities' view, a license could be issued almost automatically upon application in recent years, and it is no longer a barrier to imports.

<sup>7</sup> Residents (other than government officials) who have been granted an official permit to travel abroad are allowed to buy the equivalent of US\$100-US\$200, on presentation of FEC from their own foreign currency accounts. All payments for invisible transactions and current transfer outside the public sector are subject to approval on a case-by-case basis. The maximum amount that may be remitted against FEC is US\$10,000 per month or its equivalent.

imported goods through private imports and effectively accept the use of the market-determined exchange rate.<sup>6</sup>

In the private sector, while private exporters are allowed to retain all export earnings,<sup>7</sup> there is no legal way for private importers to acquire foreign currencies other than through their own export receipts. However, in practice, foreign exchange demand and supply among private exporters and importers are typically intermediated through “tolerated but illegal brokers” (outside the banking system). The *private market clearing exchange rate*, or simply the market exchange rate is therefore the level at which the private sector’s demand and supply of foreign exchange are cleared in the informal foreign exchange market.

However, in the absence of the market segmentation explained above, the combined demand and supply of foreign exchange from the public and private sectors should clear at the *equilibrium exchange rate*. While the equilibrium exchange rate for kyat is not observable, it lies, by definition, between the *public market clearing exchange rate* and the private market clearing exchange rate, as illustrated in Figure 1. As the private market clearing rate (or the parallel market exchange rate) has depreciated sharply since around 1995 (Figure 2), the official exchange rate at around 5.3 kyat per U.S. dollar is grossly overvalued, with the parallel market premium stood at more than 21,000 percent as of March 2008. Due to the lack of further information, the equilibrium exchange rate is often calculated as the weighted average of the official exchange rate and the parallel market exchange rate.

### III. A MODEL FOR MYANMAR’S FOREIGN EXCHANGE MARKETS

On the basis of our understanding of the multiple exchange rate regime in Myanmar, we develop a model for Myanmar’s foreign exchange markets for our efficiency cost analyses. Under the multiple exchange rate system, government purchases of foreign exchange from public exporters (or state economic enterprises, SEE) at the overvalued official exchange rate serves as implicit taxes, while the sales of foreign exchange to public importers serves as implicit subsidies. Since there is no difference between explicit and implicit taxes and subsidies from the efficiency analytical point of view, earlier studies use standard trade theory to examine the efficiency effects of these implicit taxes and subsidies. We extend the model in earlier studies to incorporate some specific features to better reflect Myanmar’s exchange rate regime. We then use our model to calculate numerically the equilibrium exchange rate and the size of the net efficiency losses in the subsequent sections.

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<sup>6</sup> Strictly speaking, the procurements take place only when the *shadow exchange rate for public imports* is higher than the private market clearing exchange rate.

<sup>7</sup> Until 1988, foreign trade was monopolized by the public sector. Private sector was permitted to engage in foreign trade and retain 60 percent of export earnings from November 1988, and this was further increased to 100 percent from March 1990.



### A. Preliminary Considerations

The efficiency effects of taxes and subsidies are typically examined using the concept of consumer and producer surpluses in a static partial equilibrium model of an open economy. Rosenberg, Ruocco, and Wiegard (1999), and Rosenberg and Zeeuw (2001) applied the model to Uzbekistan's foreign exchange regime in the late 1990s. While their methodology took the standard approach of taking the difference between world market prices at the official rate and at the market clearing exchange rate as the implicit tax/subsidy rate (the gap between the actual equilibrium and the market clearing exchange rate), there are at least four possible extensions that would make the model more relevant for Myanmar's multiple exchange rate regime.

First, Rosenberg et al. omitted the efficiency analyses of markets under the parallel exchange rates due to the lack of data on unofficial/illegal transactions in Uzbekistan. However, in the case of Myanmar, the most significant efficiency loss due to its multiple exchange rate regime is the result of insufficient supply of foreign exchange to finance private sector imports, i.e., there is a large implicit taxation on private imports. To our advantage, statistics on private sector trade for which the parallel market exchange rate applied are available in the case for Myanmar. We could therefore estimate the efficiency effects on private sectors arising from implicit taxation and subsidization due to the overly-depreciated private market clearing exchange rate.

Second, while it is customary for the partial equilibrium efficiency analysis to ignore the interdependence among markets, it is highly unrealistic to assume that public sector importers have unlimited access to foreign exchange at the official exchange rate (and can therefore import as much as they want), especially in the case of Myanmar where the official exchange rate is grossly overvalued. To make our efficiency calculations more realistic, we introduce an explicit foreign exchange supply constraint on public sector importers, assuming that foreign exchange supply is bounded by the foreign exchange proceeds from public sector exports net of reserve accumulation.<sup>8</sup>

Third, it could be argued that an *indicative equilibrium exchange rate* calculated as the trade-volume weighted average of the administratively set official exchange rate and the parallel market exchange rate may well be far from the level of the actual equilibrium exchange rate, which is the key element in efficiency analysis calculations. This problem could be particularly significant for Myanmar with a grossly overvalued official exchange rate. In the following sub-section, we formulate a new methodology to solve numerically the equilibrium

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<sup>8</sup> Even after introducing interdependency, our model is still a static partial equilibrium analysis as it ignores other inter-market dependence, especially the impact of imports on exports, irrespective of imported intermediate inputs used in the production of export goods.

exchange rate that clears the demand and supply of foreign exchange in a unified foreign exchange market.

Lastly, we noticed that the net efficiency loss formulae used in Rosenberg and Zeeuw (2001) appears to have ignored the difference between the observed private market clearing exchange rate and the unobservable equilibrium exchange rate, and as a result probably over or underestimating the effect of tax/subsidy on public sector exporters/importers. As shown below, we derive formulae that keep the private market clearing exchange rate and the equilibrium exchange rate separate and estimate the efficiency effects of the multiple exchange rates system.

## B. Model Description

The net efficiency effects of the dual exchange rate markets can be quantified by using a standard partial equilibrium model. For simplicity, we consider Myanmar as a small open economy, both for exports and imports. We assume a constant elasticity function for the following four trade markets that is, public exports, public imports, private exports, and private imports, respectively.

$$\text{The public export supply function : } P^{X_U} = B_U X_U^{\beta_U} \quad (\beta_U > 0 \text{ and } B_U > 0) \quad (1)$$

$$\text{The public import demand function : } P^{M_U} = A_U M_U^{-\alpha_U} \quad (\alpha_U > 0 \text{ and } A_U > 0) \quad (2)$$

$$\text{The private export supply function : } P^{X_R} = B_R X_R^{\beta_R} \quad (\beta_R > 0 \text{ and } B_R > 0) \quad (3)$$

$$\text{The private import demand function : } P^{M_R} = A_R M_R^{-\alpha_R} \quad (\alpha_R > 0 \text{ and } A_R > 0) \quad (4)$$

As noted in the preliminary considerations, the inclusion of private sector markets, under the parallel exchange rate, is the one key feature of our analysis.  $X$  and  $M$  denote volume of exports and imports, respectively. Subscripts  $U$  and  $R$  denote the public sector and the private sector, respectively. Prices  $P$  are measured in kyat and superscripts  $X$  and  $M$  denote exports and imports, respectively. Parameters  $\alpha$  and  $\beta$  determine the price elasticities, that is, the elasticity of public export supply ( $\varepsilon_p^{X_U} = 1/\beta_U$ ), the elasticity of public import demand ( $\varepsilon_p^{M_U} = -1/\alpha_U$ ), the elasticity of private export supply ( $\varepsilon_p^{X_R} = 1/\beta_R$ ), and the elasticity of private import demand ( $\varepsilon_p^{M_R} = -1/\alpha_R$ ).  $A$  and  $B$  are scaling parameters.

### Public export market

First, we consider the public export market. Let  $P^{\$^{X_U}}$  denote the fixed world market price in U.S. dollars for Myanmar's public sector export,  $E_{MCR}$  the private market clearing exchange rate,  $E_{EQ}$  the equilibrium exchange rate, and  $E_{OF}$  the official exchange rate. Under the small open economy assumption, exchange rates determine the domestic price of goods in kyat terms as follows:  $P_{MCR}^{X_U} = E_{MCR} P^{\$^{X_U}}$  (domestic price under the private market clearing rate),  $P_{EQ}^{X_U} = E_{EQ} P^{\$^{X_U}}$  (under the equilibrium exchange rate), and  $P_{OF}^{X_U} \equiv E_{OF} P^{\$^{X_U}}$  (under the official

exchange rate). By using  $tax$ , we denote the implicit tax rate, which satisfies the relation  $P_{OF}^{X_U} = (1-tax)P_{MCR}^{X_U} \Leftrightarrow E_{OF} = (1-tax)E_{MCR}$ .  $X_{U,MCR}$  is the public export volume that would result under the private market clearing price ( $P_{MCR}^{X_U}$ ),  $X_{U,EQ}$  is the public export volume under the equilibrium price ( $P_{EQ}^{X_U}$ ), and  $X_{U,OF}$  is the public export volume under the official price ( $P_{OF}^{X_U}$ ).

Referring to the graphical presentation in Panel A of Figure 3, the net efficiency loss for Myanmar's public sector exports due to implicit export taxes is:

$$\begin{aligned} NWL(X_U) &= -(P_{MCR}^{X_U} - P_{OF}^{X_U})X_{U,OF} + \left[ P_{EQ}^{X_U} X_{U,EQ} - \int_0^{X_{U,EQ}} B_U X_U^{\beta_U} dX_U \right] - \left[ P_{OF}^{X_U} X_{U,OF} - \int_0^{X_{U,OF}} B_U X_U^{\beta_U} dX_U \right] \\ &= -tax P_{MCR}^{X_U} X_{U,OF} + \frac{\beta_U}{1+\beta_U} P_{EQ}^{X_U} X_{U,EQ} - \frac{\beta_U}{1+\beta_U} P_{OF}^{X_U} X_{U,OF}. \end{aligned} \quad (5)$$

The first term on the right hand side of the equation,  $-(P_{MCR}^{X_U} - P_{OF}^{X_U})X_{U,OF}$ , stands for implicit tax gains for the union government, and the remaining terms are for calculating the loss in exporters' surplus. We divide both sides of the above equation by the value of public export (evaluated at the private market clearing price, that is,  $P_{MCR}^{X_U} X_{U,OF}$ ), to derive the net efficiency loss on public export market relative to public exports.

$$\frac{NWL(X_U)}{P_{MCR}^{X_U} X_{U,OF}} = -tax + \frac{\beta_U}{1+\beta_U} \frac{E_{EQ} X_{U,EQ}}{E_{MCR} X_{U,OF}} - \frac{\beta_U}{1+\beta_U} \frac{E_{OF}}{E_{MCR}} \quad (6)$$

From the constant elasticity public export supply function (1) and the relations between domestic prices and world market prices above, we obtain:

$$\frac{E_{OF}}{E_{MCR}} = \frac{P_{OF}^{X_U}}{P_{MCR}^{X_U}} = \left( \frac{X_{U,OF}}{X_{U,MCR}} \right)^{\beta_U} = (1-tax) \quad (7),$$

$$\frac{E_{EQ} X_{U,EQ}}{E_{MCR} X_{U,OF}} = \frac{E_{EQ}}{E_{MCR}} \left( \frac{P_{EQ}^{X_U}}{P_{OF}^{X_U}} \right)^{1/\beta_U} = \frac{E_{EQ}}{E_{MCR}} \left( \frac{E_{EQ}}{E_{OF}} \right)^{1/\beta_U} = \frac{E_{EQ}}{E_{MCR}} \left( \frac{E_{EQ} E_{MCR}}{E_{MCR} E_{OF}} \right)^{1/\beta_U} = \left( \frac{E_{EQ}}{E_{MCR}} \right)^{\frac{1+\beta_U}{\beta_U}} (1-tax)^{-1/\beta_U} \quad (8).$$

Inserting equations (7) and (8) into equation (6), and factoring out results in

$$\frac{NWL(X_U)}{P_{MCR}^{X_U} X_{U,OF}} = -tax + \frac{\beta_U}{1+\beta_U} \left( \frac{E_{EQ}}{E_{MCR}} \right)^{(1+\beta_U)/\beta_U} (1-tax)^{-1/\beta_U} - \frac{\beta_U}{1+\beta_U} (1-tax) \quad (9).$$

Therefore, the net efficiency losses on public export market (relative to the public export valued at the private market clearing price) can be expressed as a function of the implicit tax

rate, the price elasticity of public export supply, and the equilibrium exchange rate relative to the private market clearing exchange rate.<sup>9</sup>

### Public import market

The calculation of the efficiency effects on the public import market is analogous to that on the public export market shown above. Referring to Panel B of Figure 3, the net efficiency loss for Myanmar's public sector imports due to implicit import subsidies is calculated as:

$$NWL(M_U) = (P_{MCR}^{M_U} - P_{OF}^{M_U})M_{U,Qot} + \left[ \int_0^{M_{U,Qot}} A_U M_U^{-\alpha_U} dM_U - P_{OF}^{M_U} M_{U,Qot} \right] - \left[ \int_0^{M_{U,EQ}} A_U M_U^{-\alpha_U} dM_U - P_{EQ}^{M_U} M_{U,EQ} \right] \quad (10).$$

One important feature that distinguishes this market from other markets is the presence of foreign exchange quotas. The Foreign Exchange Budget determines who may import at the overvalued official exchange rate and by how much.  $M_{U,Qot}$  is the exogenously allocated public import quantity, and appears in the second term. We define the shadow exchange rate for the public import quota by  $E_{Qot} (\equiv P_{Qot}^{M_U} / P\$^{M_U} \equiv A_U M_{U,Qot}^{-\alpha_U} / P\$^{M_U})$ . By using *sub*, we denote the implicit subsidy rate, which satisfies the relation  $P_{OF}^{M_U} = (1 - sub)P_{MCR}^{M_U} \Leftrightarrow E_{OF} = (1 - sub)E_{MCR}$ . Again by expressing as share in the value of public imports, and using relations analogous to equations (7) and (8) in the public export calculation, we obtain

$$\frac{NWL(M_U)}{P_{MCR}^{M_U} M_{U,Qot}} = sub - \left( \frac{1}{1 - \alpha_U} \frac{E_{Qot}}{E_{MCR}} - 1 + sub \right) + \frac{\alpha_U}{1 - \alpha_U} \left( \frac{E_{EQ}}{E_{MCR}} \right)^{-(1-\alpha_U)/\alpha_U} \left( \frac{E_{Qot}}{E_{MCR}} \right)^{1/\alpha_U} \quad (11)$$

The net efficiency losses on public import market (relative to the public import value) can be expressed as a function of the implicit subsidy rate, the price elasticity of public import demand, the equilibrium exchange rate relative to the private market clearing exchange rate, and the public import shadow exchange rate relative to the private market clearing exchange rate.<sup>10</sup>

<sup>9</sup> The presence of this relative exchange rate term differentiates our expressions from those by the earlier studies. If we ignore the difference between  $E_{EQ}$  and  $E_{MCR}$ , equation (9) degenerates to

$$\frac{NWL(X_U)}{P_{MCR}^{X_U} X_{U,OF}} = -tax + \frac{\beta_U}{1 + \beta_U} (1 - tax)^{-1/\beta_U} - \frac{\beta_U}{1 + \beta_U} (1 - tax), \text{ which is equivalent to the expression used by}$$

Rosenberg and others (1999) and also by Rosenberg and Zeeuw (2001).

<sup>10</sup> If we ignore the differences between  $E_{Qot}$  and  $E_{OF}$  as well as between  $E_{EQ}$  and  $E_{MCR}$ , equation (11)

degenerates to  $\frac{NWL(M_U)}{P_{MCR}^{M_U} M_{U,Qot}} = sub - \frac{\alpha_U}{1 - \alpha_U} (1 - sub) + \frac{\alpha_U}{1 - \alpha_U} (1 - sub)^{1/\alpha_U}$ , which is equivalent to the expression

by Rosenberg and others (1999).

## Private export and import markets

While the efficiency effects on the private market are not quantified in the earlier studies, one serious problem of Myanmar's dual exchange rate market is the insufficient supply of foreign exchanges to finance the desired amount of private imports. In other words, there is an implicit subsidization of private exports and an implicit taxation of private imports, which benefit (suffer) from the overly depreciated private market clearing exchange rate. In our model, the net efficiency losses for Myanmar's private sector exports/imports are calculated as follows (Figure 4):

$$NWL(X_R) = - \left\{ \left( P_{MCR}^{X_R} X_{R,MCR} - \int_0^{X_{R,MCR}} B_R X_R^{\beta_R} dX_R \right) - \left( P_{EQ}^{X_R} X_{R,EQ} - \int_0^{X_{R,EQ}} B_R X_R^{\beta_R} dX_R \right) \right\} = - \frac{\beta_R}{1+\beta_R} P_{MCR}^{X_R} X_{R,MCR} + \frac{\beta_R}{1+\beta_R} P_{EQ}^{X_R} X_{R,EQ},$$

$$NWL(M_R) = \left( \int_0^{M_{R,EQ}} A_R M_R^{-\alpha_R} dM_R - P_{EQ}^{M_R} M_{R,EQ} \right) - \left( \int_0^{M_{R,MCR}} A_R M_R^{-\alpha_R} dM_R - P_{MCR}^{M_R} M_{R,MCR} \right) = \frac{\alpha_R}{1-\alpha_R} P_{EQ}^{M_R} M_{R,EQ} - \frac{\alpha_R}{1-\alpha_R} P_{MCR}^{M_R} M_{R,MCR}.$$

The respective share of net efficiency losses relative to respective trade values are:

$$\frac{NWL(X_R)}{P_{MCR}^{X_R} X_{R,MCR}} = - \frac{\beta_R}{1+\beta_R} + \frac{\beta_R}{1+\beta_R} \left( \frac{E_{EQ}}{E_{MCR}} \right)^{(1+\beta_R)/\beta_R} \quad (12)$$

$$\frac{NWL(M_R)}{P_{MCR}^{M_R} M_{R,MCR}} = - \frac{\alpha_R}{1-\alpha_R} + \frac{\alpha_R}{1-\alpha_R} \left( \frac{E_{EQ}}{E_{MCR}} \right)^{-(1-\alpha_R)/\alpha_R} \quad (13)$$

Therefore, the net efficiency losses on private trade markets (relative to trade values) are functions of respective price elasticity, and the equilibrium exchange rate relative to the private market clearing exchange rate).

## The equilibrium exchange rate

Equipped with the formulae to calculate the net efficiency losses, that is, equations (9), (11), (12) and (13), we now turn to the numerical calculations. As both *tax* (in (9)) and *sub* (in (11)) equal  $1 - E_{OF} / E_{MCR}$  by definition, we could estimate the losses numerically, if we know the four elasticities ( $\beta_U$ ,  $\alpha_U$ ,  $\beta_R$  and  $\alpha_R$ ) and four exchange rates ( $E_{OF}$ ,  $E_{MCR}$ ,  $E_{EQ}$  and  $E_{Qot}$ ). Since  $E_{OF}$  and  $E_{MCR}$  are observables, our problem is how we can obtain the fair values of the equilibrium exchange rate ( $E_{EQ}$ ), and the shadow exchange rate for public imports ( $E_{Qot}$ ), as well as the four elasticity variables.

For the elasticity variables, we examine a range of elasticities suggested by earlier studies on the trade elasticities in developing countries, as there are no reliable elasticity estimates for Myanmar. Therefore, the remaining issue is the estimation of  $E_{EQ}$  and  $E_{Qot}$ . By definition, the two exchange rates could be derived from the following equations.

The equilibrium exchange rate:<sup>11</sup>

$$X^U + X^R = M^U + M^R \Leftrightarrow \left( \frac{P_{EQ}^{X_U}}{B_U} \right)^{1/\beta_U} + \left( \frac{P_{EQ}^{X_R}}{B_R} \right)^{1/\beta_R} = \left( \frac{P_{EQ}^{M_U}}{A_U} \right)^{1/\alpha_U} + \left( \frac{P_{EQ}^{M_R}}{A_R} \right)^{1/\alpha_R}. \quad (14)$$

The shadow exchange rate for public imports:

$$E_{Qot} = P_{Qot}^{M_U} / P\$^{M_U} \equiv A_U M_{U,Qot}^{-\alpha_U} / P\$^{M_U}. \quad (15)$$

To solve these equations numerically, we need to have the estimates for the four scaling parameters. Assume without loss of generality  $P\$^{X_U} = P\$^{X_R} = P\$^{M_U} = P\$^{M_R} = 1$ , we could calculate three out of the four parameters from directly observed price-quantity (or exchange rate value) combinations from the respective supply and demand functions.

From observed value  $(P_{OF}^{X_U}, X_{U,OF})$  and the public sector export supply function:

$$B_U = \frac{P_{OF}^{X_U}}{X_{U,OF}^{\beta_U}} = \frac{P_{OF}^{X_U^{1+\beta_U}}}{(P_{OF}^{X_U} X_{U,OF})^{\beta_U}} = \frac{(E_{OF} P\$^{X_U})^{1+\beta_U}}{(P_{OF}^{X_U} X_{U,OF})^{\beta_U}} = \frac{E_{OF}^{1+\beta_U}}{(P_{OF}^{X_U} X_{U,OF})^{\beta_U}}. \quad (16)$$

From observed value  $(P_{MCR}^{X_R}, X_{R,MCR})$  and the private sector export supply function:

$$B_R = \frac{P_{MCR}^{X_R}}{X_{R,MCR}^{\beta_R}} = \frac{P_{MCR}^{X_R^{1+\beta_R}}}{(P_{MCR}^{X_R} X_{R,MCR})^{\beta_R}} = \frac{(E_{MCR} P\$^{X_R})^{1+\beta_R}}{(P_{MCR}^{X_R} X_{R,MCR})^{\beta_R}} = \frac{E_{MCR}^{1+\beta_R}}{(P_{MCR}^{X_R} X_{R,MCR})^{\beta_R}}. \quad (17)$$

From observed value  $(P_{MCR}^{M_R}, M_{R,MCR})$  and the private sector import demand function:

$$A_R = P_{MCR}^{M_R} M_{R,MCR}^{\alpha_R} = P_{MCR}^{M_R^{1-\alpha_R}} (P_{MCR}^{M_R} M_{R,MCR})^{\alpha_R} = (E_{MCR} P\$^{M_R})^{1-\alpha_R} (P_{MCR}^{M_R} M_{R,MCR})^{\alpha_R} = E_{MCR}^{1-\alpha_R} (P_{MCR}^{M_R} M_{R,MCR})^{\alpha_R}. \quad (18)$$

However, we could not use the public sector import demand function to derive  $A_U$ , since no price-quantity combination on it is actually observed. In the absence of a directly observable value, we expediently assumed that  $A_U$  is a value that satisfies the condition  $M_{R,MCR} = \phi M_{U,MCR}$ , where  $\phi = (\text{Private Sector Share in GDP} / \text{Public Sector Share in GDP})$ .<sup>12</sup> In other words, we assume that, under the private market clearing price level, the private import demand is  $\phi$  times larger than the public import demand, reflecting the size of economic activities represented by their

<sup>11</sup> Strictly speaking, the unified market clearing condition should be  $X^U + X^R + \text{Others} = M^U + M^R$ , where *Others* is defined as net capital inflows minus net increase in international reserves.

<sup>12</sup> As discussed later, since the share of the public/private sector in GDP from the official statistics could not be used here, we estimate the respective shares and solved the equations iteratively.

respective shares in GDP.<sup>13</sup> Based on the assumption of constant elasticity import demand function, we can derive  $A_U$  from

$$\left(\frac{P_{MCR}^{M_R}}{A_R}\right)^{-1/\alpha_R} = \phi \left(\frac{P_{MCR}^{M_U}}{A_U}\right)^{-1/\alpha_U} \Leftrightarrow A_U = \phi^{-\alpha_U} A_R^{\alpha_U/\alpha_R} E_{MCR}^{1-\alpha_U/\alpha_R}. \quad (19)$$

Once we obtain the estimates for the four scaling parameters, we can then solve the equilibrium condition (14) numerically

$$\left(\frac{P_{EQ}^{X_U}}{B_U}\right)^{1/\beta_U} + \left(\frac{P_{EQ}^{X_R}}{B_R}\right)^{1/\beta_R} = \left(\frac{P_{EQ}^{M_U}}{A_U}\right)^{1/\alpha_U} + \left(\frac{P_{EQ}^{M_R}}{A_R}\right)^{1/\alpha_R} \Leftrightarrow \left(\frac{E_{EQ}}{B_U}\right)^{1/\beta_U} + \left(\frac{E_{EQ}}{B_R}\right)^{1/\beta_R} = \left(\frac{E_{EQ}}{A_U}\right)^{1/\alpha_U} + \left(\frac{E_{EQ}}{A_R}\right)^{1/\alpha_R} \quad (14')$$

for the equilibrium exchange rate ( $E_{EQ}$ ), and the equation (15)

$$E_{Qot} = A_U M_{U,Qot}^{-\alpha_U} / P\$^{M_U} = \phi^{-\alpha_U} A_R^{\alpha_U/\alpha_R} E_{MCR}^{1-\alpha_U/\alpha_R} M_{U,Qot}^{-\alpha_U} = E_{MCR} \left( M_{R,MCR} / \phi M_{U,Qot} \right)^{\alpha_U} \quad (15')$$

for the shadow exchange rate ( $E_{Qot}$ ). These values, together with the elasticity assumptions, could then be used to calculate the efficiency effects of the dual exchange rate system.

### Net efficiency loss relative to GDP

For those not familiar with the Myanmar economy, the net efficiency losses as a percent of GDP is perhaps a better indicator to intuitively understand the size of the efficiency losses from the dual exchange rate system. However, the dual exchange rate (or the use of the official exchange rate for accounting in the official statistics) also results in the undervaluation of international transactions and an overall underestimation of GDP. Therefore, we need to re-estimate nominal GDP using a realistic exchange rates ( $E_{adj}$ , instead of the official rate  $E_{OF}$ ) for accounting.

Based on limited available information, we can obtain adjusted GDP from nominal GDP in the official statistics as follows:

$$\begin{aligned} \text{Adjusted GDP} &= \text{Domestic Demand for Domestically Produced Goods} \\ &+ \{\text{Adjusted Imports} - \text{Adjusted Intermediate Imports}\} \\ &+ \text{Adjusted Exports} - \text{Adjusted Imports} \end{aligned}$$

where Adjusted Exports = Exports in official statistics  $\div E_{OF} \times E_{adj}$ ,

Adjusted Imports = Imports in official statistics  $\div E_{OF} \times E_{adj}$ , and

<sup>13</sup> To make sure that this assumption is not deriving our main findings, we examined an alternative value of  $\phi$  in the sensitivity analysis.

Adjusted Intermediate Imports = Intermediate Imports in official statistics  $\div E_{Of} \times E_{adj}$ .

We use our estimated equilibrium exchange rate ( $E_{EQ}$ ) as  $E_{adj}$  for our empirical calculations. As a comparison, we also report the results using the private market clearing rate ( $E_{MCR}$ ) as  $E_{adj}$ .

Distortions caused by the use of the overvalued official exchange rate in the official statistics are not confined to the value of nominal GDP. It distorts all statistics that involved using the value of international transactions, such as measurement of trade openness and the share of public/private sector in nominal GDP. The measure of trade openness in the official statistics is obviously underestimated as there is no reason to believe that the following relation holds between the official statistics and our adjusted estimates:

$$(\text{Exports} + \text{Imports})/\text{GDP} = (\text{Adjusted Exports} + \text{Adjusted Imports})/\text{Adjusted GDP}.$$

The public/private sector share in GDP varies as the shares of international transactions are different among the economic agents (private vs. public). As we have already re-estimated nominal GDP (i.e., adjusted GDP) above, we can estimate GDP by sector by allotting the total adjustment to the respective sectors as follows:

$$\begin{aligned} \text{Adjusted GDP by public sector} &= \text{GDP by public sector in official statistics} \\ &+ \{ \text{Adjusted Imports} - \text{Imports} - \text{Adjusted Intermediate Imports} + \text{Intermediate Imports} \} \\ &* \text{Public sector share in imports} \\ &+ (\text{Adjusted Exports} - \text{Exports}) * \text{Public sector share in exports} \\ &- (\text{Adjusted Imports} - \text{Imports}) * \text{Public sector share in imports} \\ \text{Adjusted GDP by private sector} &= \text{Adjusted GDP} - \text{Adjusted GDP by public sector}. \end{aligned}$$

In our numerical analyses, we need to use a tentative  $\phi$  to derive  $E_{EQ}$  in our first-round calculation. Then we use that estimated  $E_{EQ}$  to calculate the adjusted statistics above as well as  $\phi$  to derive the second round  $E_{EQ}$ . Reported in the following section are results we obtained after repeating this procedure until we reach the convergence in  $\phi$  value. As we have already derived the equations to estimate the net efficiency losses relative to the value of trade flows in the previous subsection, it is straightforward to calculate the net efficiency losses as percent of GDP, once we obtain the adjusted estimates of GDP and trade flows (in kyat terms).

#### IV. QUANTITATIVE ANALYSES

This section quantifies the net efficiency effects of implicit taxation and subsidization in Myanmar's four trade markets, that is, public sector export market, public sector import market, private sector export market, and private sector import market, respectively. As shown in the previous section, by assuming constant elasticity export supply and/or import



demand functions and after a number of manipulations, the efficiency effects in the four markets (by type of agents) can be expressed as functions of implicit tax/subsidy rate, price elasticity of the respective four markets, and relative values of the equilibrium exchange rate and the shadow exchange rate for public imports to the private sector market clearing rate (Table 1).

Implicit tax and subsidy rates (*tax* and *sub*) are obtained directly from the difference between the official exchange rate and the private market clearing rate, since both of these variables are observable. We are not aware of any estimates of exports/imports price elasticity for Myanmar. However, several earlier studies suggest that long-run elasticity in resource-rich developing countries is around unity (Table 2). In the absence of established estimates for Myanmar, we assume unit elasticity for all but the public export market in our baseline efficiency analysis calculation.<sup>14</sup> For public sector exports, we assume an elasticity of 0.2, smaller than the elasticities in other markets, on the basis that Myanmar's SEEs are likely to be less responsive to price changes since they are obligated to surrender all export profits to the union government. It is normal to assume positive public export price elasticity, irrespective of the price insensitivity of the SEEs, since the elasticity is also affected by domestic demands for SEEs' products by private agents.

### **Baseline results**

Table 3 shows the estimated efficiency effects under our baseline assumptions in the period 2004/2005 to 2006/07 relative to the respective trade values. It also reports the value of three conceptual exchange rates calculated from the estimated demand and supply for foreign exchange. The equilibrium exchange rate is estimated to lie between K 350–450 per U.S. dollar, sizably lower than the observed private market clearing exchange rate owing to excess supply of foreign exchange at the private market clearing rate in the public sector market. Due to the abundant supply of foreign exchange in the public sector, particularly from gas exports, the public sector market clearing exchange rate is estimated to lie between K 75–95 per U.S. dollar. The shadow exchange rate for public imports is estimated at about K 130–200 kyat per U.S. dollar, roughly two times higher than the market clearing rate level in the public sector market.

The net efficiency effect of the multiple exchange rate regime on public sector export is positive at around 20–35 percent of the total public export value. This suggests net efficiency gains as the tax revenue of the union government is larger than the efficiency loss of the exporting SEEs. However, the above positive finding runs contrary to results from previous studies. The net efficiency loss estimated for public exports in earlier studies resulted from ignoring the difference between the observed private market clearing exchange rate and the

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<sup>14</sup> To check the sensitivity of our results to the elasticity assumptions, we examine a range of elasticity in the next section.

equilibrium exchange rate which is estimated to be considerably lower in our analysis. As the implicit tax rate on the public exports is close to 100 percent, reflecting the widening parallel market premium over the official exchange rate, tax revenue to the union government is close to the total value of public sector exports. On the other hand, efficiency loss for the public sector exporters is smaller than the tax revenue gain, at around 65–80 percent of the trade value, since the equilibrium exchange rate used to calculate the efficiency loss is considerably lower than the private market clearing exchange rate (see Panel A of Figure 3).

The net efficiency effects of the multiple exchange rate regime on public sector imports is negative at around 70–73 percent of the total public import value because the subsidy expenditure of the union government, which is close to 100 percent of the public import value, is always larger than efficiency gain of the importing SEEs (see Panel B of Figure 3). While it is not correct to simply add up the estimated efficiency gains or losses expressed in monetary terms in a static partial equilibrium analysis, a comparison of the size of the efficiency gains and losses in the public sector trade markets appears to indicate that the efficiency gain in the public sector export market is more than offset by the efficiency losses in the public sector import market. The above results suggested that while the multiple exchange rate regime in Myanmar is designed to benefit the public sector, in practice, the public sector also incurred net efficiency losses from the segmented foreign exchange markets.

Next, we examine the efficiency effects for the private sector trade markets using the parallel exchange rate, which have so far omitted in the earlier studies (Figure 4). While private sector exporters reaped efficiency gain by about 42–45 percent of the total private export value from the undervalued private sector market clearing exchange rate, on the other hand, the private sector importers suffered efficiency loss of about 92–110 percent of the total private import value. In sum, the private sector appears to incur net efficiency losses, as the efficiency loss in the private sector import market is always larger than the efficiency gain in the private sector export market. In addition, the above results estimated based on our baseline parameter assumptions show that the private sector incurs larger net efficiency losses than the public sector.

### **Efficiency effects measured relative to GDP**

While the findings in the previous subsection provide some indications of the cost of the multiple exchange rate regime in terms of efficiency gains/losses relative to trade values or their absolute values in kyat terms, these may not be sufficiently intuitive. To present our findings more intuitively, this subsection provides estimates of efficiency effects relative to nominal GDP.

However, to calculate the efficiency costs relative to the size of the economy, we need to re-estimate the size of the external sector in the national accounts, since the use of the grossly overvalued official exchange rate in compiling the official statistics has the effects of

underestimating the size of Myanmar's external transactions and nominal GDP. Therefore, we first estimate Myanmar's nominal GDP, trade openness, and the share of public sector in GDP using the estimated equilibrium exchange rate, instead of the official exchange rate, as the accounting rate. After obtaining these values, we calculate the efficiency loss relative to GDP using efficiency loss estimates in kyat terms shown in Table 3. Estimated efficiency effect relative to GDP and estimated GDP, sector share and trade openness measure are presented in Table 4. Results using the official exchange rate and the private market clearing exchange rate respectively as accounting rates are also presented together for comparison.

Our estimates indicate that using the equilibrium exchange rate as the accounting rate increases nominal GDP by about 11–12 percent as compared to the official GDP figures. Trade openness measure, defined as the sum of exports and imports divided by nominal GDP, increases to about 21–23 percent from less than 1 percent measured using official statistics. As the public sector has a larger share in external trade than the private sector, the above adjustment also increases the public sector share in GDP to 12–13 percent from 7–8 percent indicated by official statistics.<sup>15</sup>

Net efficiency losses appear to have been relatively constant during the period 2004/05 to 2006/07 at around 16–18 percent of nominal GDP using GDP estimates based on the equilibrium exchange rate.<sup>16</sup> In comparison, net efficiency loss estimates would be slightly smaller but still at around 14–15 percent of nominal GDP using GDP estimates based on the directly observable private market clearing exchange rate. .

## V. SENSITIVITY ANALYSIS

The baseline results presented above, of course, depend on our parameter assumptions. This section presents results of our sensitivity analysis to assess how robust the results are to assumptions of the parameters used (Table 5). First to see the sensitivity to parameter changes, we checked the results by allowing one of the five basic parameters to take a higher or lower value than that in our baseline calculation.

The results from varying the private sector import elasticity ( $1/\alpha_R$ ) indicate that higher private sector import elasticity (i.e., higher demand for foreign exchange in the private sector

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<sup>15</sup> For comparison, the effects of the adjustments would be much larger if we use the undervalued private market clearing exchange rate as the accounting rate. Broadly speaking, it will increase nominal GDP by about 30 percent, the trade openness measure to 50 percent, and the public sector share in GDP to 20 percent.

<sup>16</sup> This figure is a simple aggregate of the effects on the four separate markets. While we understand that we cannot simply add up the efficiency effects from partial equilibrium analyses as distortions in the separate markets may partly overlap with each other, the aggregate figure is only intended to provide a ballpark estimate of the overall efficiency impact of the multiple exchange rate regime in Myanmar. Precise evaluations of each of the four markets are shown in Table 4.

market at the equilibrium exchange rate) leads to a higher or more depreciated equilibrium exchange rate. A higher equilibrium exchange rate would result in a smaller efficiency gain in public sector exports as the size of the efficiency losses of the exporting SEEs becomes larger relative to export tax revenue of the union government (see Panel A in Figure 3 or the formula in Table 1). As the above effect of a smaller efficiency gain in public sector export market more than offset the smaller efficiency losses in the public and private import markets, total net efficiency losses would increase with higher private sector import elasticity.<sup>17</sup>

A higher public sector import elasticity ( $1/\alpha_U$ ) would also lead to more depreciated equilibrium exchange rate, although the impact is smaller than that in the case of a higher private sector import elasticity. However, the impact is more noticeable on the shadow exchange rate for public importers and the public sector market clearing exchange rate. A more depreciated shadow exchange rate therefore leads to a larger efficiency gain to the SEE importers, which lowers efficiency losses in public imports, as well as smaller efficiency losses in private imports, which the combined lower efficiency losses more than offset the decrease in efficiency gain in the public sector exports. In sum, total net efficiency losses decrease slightly with higher public sector import elasticity.

Total net efficiency loss increases with a higher private export elasticity ( $1/\beta_R$ ). While a slightly higher equilibrium exchange rate again partly accounts for this effect, a smaller efficiency gain for the public sector exports (as suggested in Panel A of Figure 4 and the third row in Table 1) is the major factor contributing to a larger net efficiency loss under a higher private export elasticity.

On the other hand, a higher public sector export elasticity ( $1/\beta_U$ ) would lead to a lower or more appreciated equilibrium exchange rate. As the resulting increase in efficiency losses in private sector imports (as suggested in Panel B of Figure 4) dominates the effects in other markets, total net efficiency losses increase with a higher public sector export elasticity.

As the parameter for public import opportunities ( $\varphi$ ) increases (recall equilibrium exchange rate determined in Section III.B.) relative to the private import opportunities, net efficiency losses decrease as higher public import opportunities mean a smaller waste of foreign exchange resources.

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<sup>17</sup> While it seems counter-intuitive to find a decrease in the efficiency losses in the private sector imports as their elasticity increases, this is because the increasing effect on efficiency loss owing to the higher import elasticity is more than offset by the decreasing effect on efficiency loss from the higher equilibrium exchange rate.

Finally, to check the robustness of our findings under alternative parameter assumptions, we set intervals for our five basic parameters, that is,  $\alpha_R, \alpha_U, \beta_R, \beta_U$  and  $\varphi$ , respectively as follows:

$$1/\alpha_R \in [0.5, 1.5]; 1/\alpha_U \in [0.5, 1.5]; 1/\beta_R \in [0.5, 1.5]; 1/\beta_U \in [0.1, 0.3]; \text{ and } \varphi \in [7/3, 7].$$

We then calculated all  $32 (= 2^5)$  combinations of lower limit and upper limit values in those intervals for 2006/2007. The average (or median) of all combinations is not very different from our baseline results, with the equilibrium exchange rate estimated at around K 470 per U.S. dollar, nominal GDP at 12 percent higher than the official statistics, trade openness at roughly 23 percent of GDP, and the share of public sector at 14 percent of GDP. As efficiency gains in the export markets are smaller than efficiency losses in the import markets, total net efficiency losses are estimated at about 13–16 percent of GDP.

In sum, while the estimated total efficiency loss relative to GDP is contingent on the parameter assumptions—with the estimated net efficiency loss ranging from 6 percent to 33 percent of GDP in 32 combinations of our parameters, we can conclude that the efficiency costs of the multiple exchange rates regime are fairly large.<sup>18</sup>

## VI. SUMMARY OF FINDINGS

This paper first described the multiple exchange rate practices in Myanmar, and then developed a model to describe Myanmar's foreign exchange markets. We used the model to calculate numerically the equilibrium exchange rate, to re-estimate the size of external sectors, and to present efficiency analyses on effects caused by quasi-fiscal operation under the current exchange rate regime.

The multiple exchange rates regime in Myanmar takes the form of dual foreign exchange markets that are effectively segmented for public and private sector external transactions. Our baseline analyses indicate that the equilibrium exchange rate to clear the unified market could be about K 450 per U.S. dollar, and that using the derived equilibrium exchange rate for accounting increases nominal GDP by about 10–12 percent as compared in the official statistics. Trade openness increases to about 20–23 percent from less than 1 percent in measured in official statistics. The total efficiency loss caused by the implicit tax and subsidy

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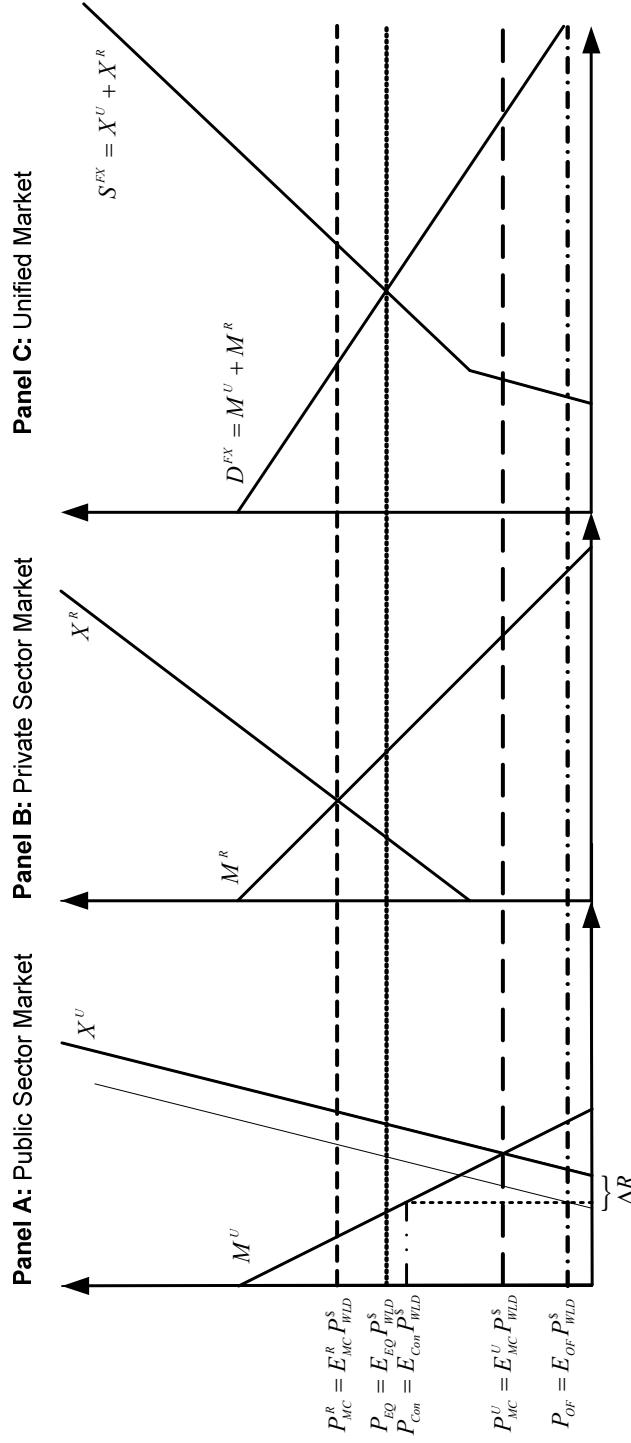
<sup>18</sup> Of course, factors that are not taken into account in our analysis could work to decrease or increase the net efficiency loss estimates. For example, if tax evasion is prevalent, the implicit tax and subsidy rates would effectively be lower and it would have the effect of reducing net efficiency losses. On the other hand, our estimate may have underestimated the efficiency loss, since our static analysis ignores the dynamics through which trade and capital inflows bring new goods and technology into the Myanmar economy. Romer (1994) provides an illustration of the importance of new goods brought by international trade. In his numerical example, the cost of an ad valorem tax of 25 percent is 47 percent of GDP in his model with new goods, as compared to 6 percent of GDP in the standard model without new goods.

is about 14–17 percent of GDP in 2006/07, mainly hurting private importers. While the robustness analysis suggests that the estimate should be taken with a wide margin, actual efficiency loss is probably larger since distortions from unrecorded trade and the dynamic effects of distortions are omitted in our calculation.

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**Figure 1. Segmented Foreign Exchange Markets and Conceptual Foreign Exchange Rates**



**Notation:**  $X^U$  and  $M^U$  are exports and imports of public sectors;  $X^R$  and  $M^R$  are those of private sectors.  $\Delta R$  is reserve accumulation.

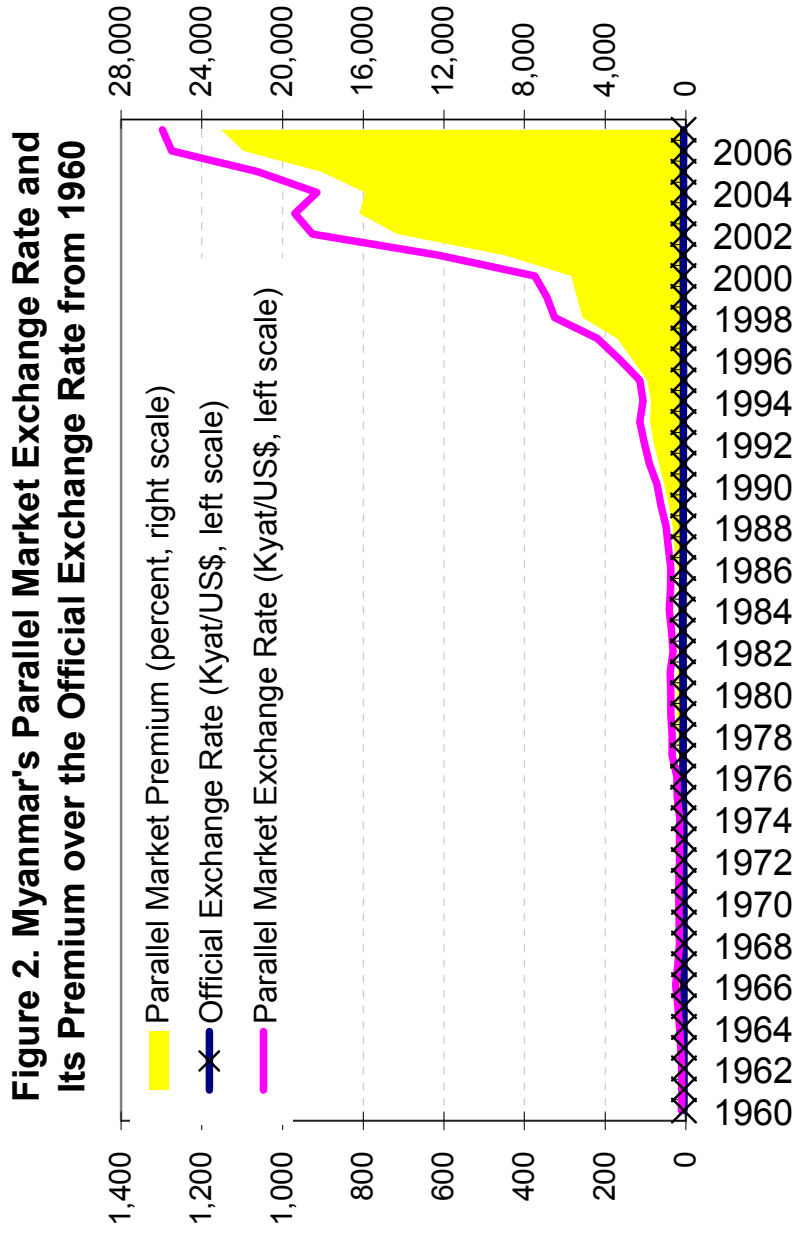
$S^{FX}$  and  $D^{FX}$  are the supply and demand of foreign exchanges in the unified markets.

$P^S_{WLD}$  is the world market price in U.S. dollars.

$E_{EQ}$ ,  $E_{OF}$ ,  $E^R_{MC}$ ,  $E^U_{MC}$ , and  $E_{Com}$  are the equilibrium exchange rate, the official exchange rate, the private market clearing exchange rate, the public sector market clearing exchange rate, and the shadow exchange rate for public imports.

$P_{EQ}$ ,  $P_{OF}$ ,  $P^R_{MC}$ ,  $P^U_{MC}$ , and  $P_{Com}$  are kyat prices evaluated at the corresponding exchange rates.

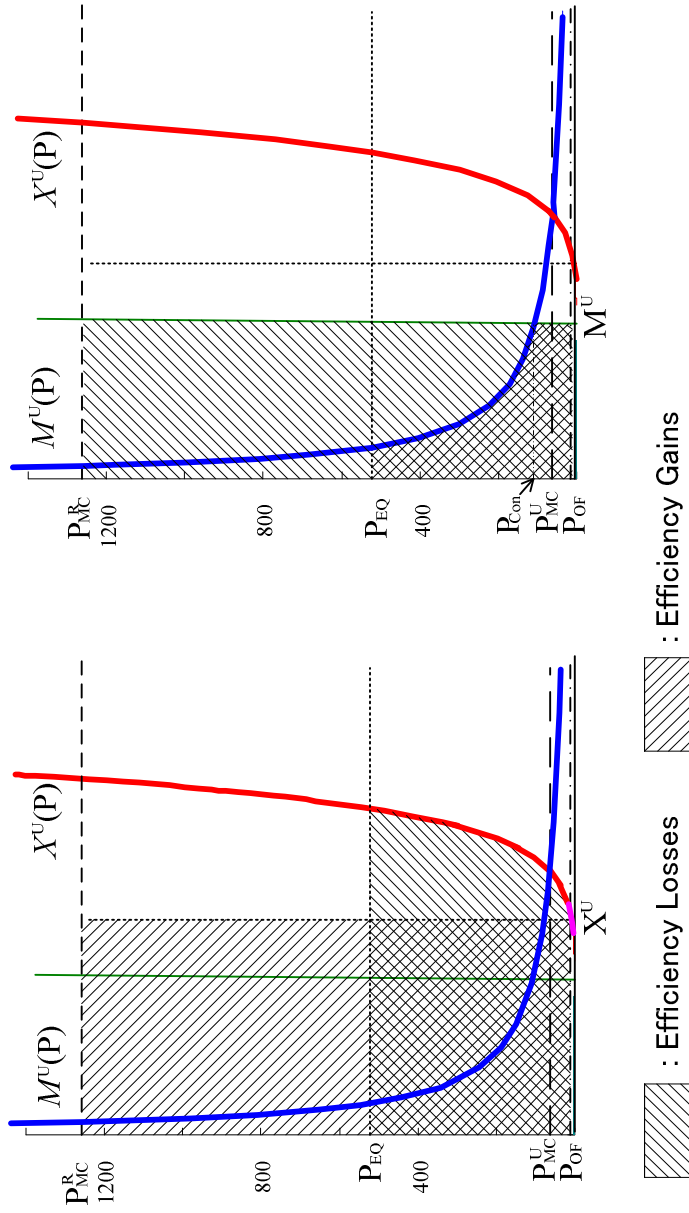




**Figure 3. Efficiency Effects in the Public Sector Trade**

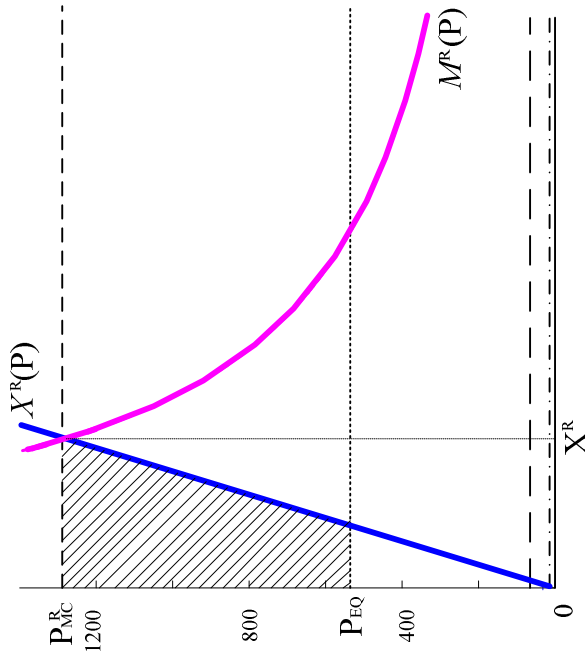
**Panel A:** Efficiency Effects of the Public Sector Exports

**Panel B:** Efficiency Effects of the Public Sector Imports

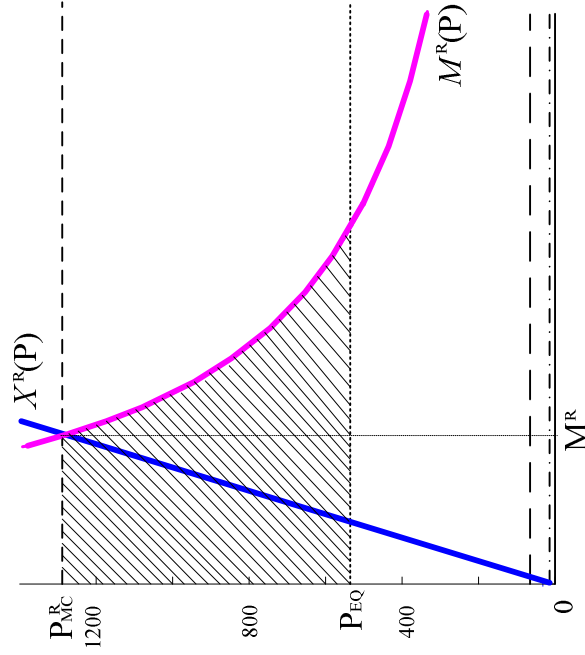


**Figure 4. Efficiency Effects in the Private Sector Trade**

**Panel A: Efficiency Effects of the Private Sector Exports**



**Panel B: Efficiency Effects of the Private Sector Imports**



 : Efficiency Losses
  : Efficiency Gains

Table 1. Net Efficiency Losses Relative to the Value of Trade Flows

Agents Trade Flows	Union Government	State Economic Enterprises	Private Traders
Public Sector Exports	$- tax$	$\frac{\beta_U \left( \frac{E_{EQ}}{E_{MCR}} \right)^{\frac{1+\beta_U}{\beta_U}}}{1+\beta_U} (1-tax)^{-1/\beta_U} - \frac{\beta_U}{1+\beta_U} (1-tax)$	
Public Sector Imports	$sub$	$\left( 1-sub - \frac{1}{1-\alpha_U} \frac{E_{com}}{E_{MCR}} + \frac{\alpha_U}{1-\alpha_U} \left( \frac{E_{EQ}}{E_{MCR}} \right)^{\frac{1}{\alpha_U}} \left( \frac{E_{com}}{E} \right)^{\frac{1}{\alpha_U}} \right)$	
Private Sector Exports			$\frac{\beta_R}{1+\beta_R} \left\{ \left( \frac{E_{EQ}}{E} \right)^{\frac{1+\beta_R}{\beta_R}} - 1 \right\}$
Private Sector Imports			$\frac{\alpha_R}{1-\alpha_R} \left\{ \left( \frac{E_{EQ}}{E_{MCR}} \right)^{\frac{\alpha_R-1}{\alpha_R}} - 1 \right\}$

Notes:  $\beta_U$  is price elasticity of the public exports;  $\alpha_U$  is price elasticity of the public imports;  $\beta_R$  is price elasticity of the private exports; and  $\alpha_R$  is price elasticity of the private imports.  $E_{EQ}$  is the equilibrium exchange rate (the rate that would emerge in the absence of the market segmentation);  $E_{MCR}$  is the market exchange rate (the rate that clears the private sector market);  $E_{com}$  is the shadow exchange rate for public imports; and  $E_{of}$  is the official exchange rate.  $tax(\equiv 1 - E_{of}/E_{MCR})$  is the implicit tax rate on public exports; and  $sub(\equiv 1 - E_{of})/E_{MCR}$  is the implicit subsidy rate on public imports.

Table 2. Estimated Price Elasticities of Trade Flows in the Earlier Studies

	Coverage	1/ countries	Elasticities						
			Exports			Imports			
			Average-All Countries	Average- Developing Countries	0.2-quartile in Developing Countries	0.8-quartile in Developing Countries	Average-All Countries	Average- Developing Countries	0.2-quartile in Developing Countries
Reinhart (1995)	12 (12) countries	0.3	0.3	0.6	0.0	0.6	0.6	1.3	0.3
Senhadji (1998)	66 (47) countries	na	na	na	na	1.1	1.1	1.6	0.3
Senhadji and Montenegro (1999)	53 (36) countries	1.1	1.1	1.8	0.3	na	na	na	na
Caporate and Chui (1999)	21 (2) countries	0.9	0.7	na	na	0.5	0.4	na	na
Sinha (2001)	5 (4) countries	1.2	1.2	na	na	0.5	0.3	na	na
Bahmani-Oskooee and Kara (2005)	28 (7) countries	1.0	0.4	na	na	1.2	0.5	na	na
Tarr (1990)	Assumed							0.3-1.0	
Rosenberg and Zeeuw (2001)	Assumed							0.5-2.0	

Note: 1/ Numbers in parentheses are the number of developing countries.

Table 3. Net Efficiency Loss Estimates under the Baseline Parameters (2004/05-2006/07)

Assumed Parameters	$1/\alpha(R)$	$1/\alpha(U)$	$1/\beta(R)$	$1/\beta(U)$	$\phi$	Value in billions of kyat									
	1.0	1.0	1.0	0.2	6.5	Relative to Trade Values					Equilibrium Exchange Rate (kyat/US\$)				
	Union Government	State Economic Enterprise	Private Traders	Total	Trade Value (in billions of kyat)	Union Government	State Economic Enterprise	Private Traders	Total	Equilibrium Exchange Rate (kyat/US\$)	Public Sector Market Clearing Rate (kyat/US\$)	Shadow Exchange Rate for Public Imports			
<b>2004/05 (Private Sector Market Clearing Exchange Rate=921.4, Official Exchange Rate=5.7)</b>															
Public Sector Exports	-0.994	0.742	0.000	-0.251	1,800	-1,789	1,336	0	-453						
Public Sector Imports	0.994	-0.278	0.000	0.716	1,864	1,852	-519	0	1,334						
Private Sector Exports	0.000	0.000	-0.423	-0.423	1,590	0	0	-673	-673						
Private Sector Imports	0.000	0.000	0.938	0.938	1,692	0	0	1,587	1,587						
Total	-	-	-	-	6,945	64	818	914	1,795	361	76	129			
<b>2005/06 (Private Sector Market Clearing Exchange Rate=1104.1, Official Exchange Rate=5.8)</b>															
Public Sector Exports	-0.995	0.785	0.000	-0.210	2,170	-2,159	1,703	0	-456						
Public Sector Imports	0.995	-0.294	0.000	0.701	2,214	2,202	-650	0	1,552						
Private Sector Exports	0.000	0.000	-0.420	-0.420	2,059	0	0	-866	-866						
Private Sector Imports	0.000	0.000	0.919	0.919	2,179	0	0	2,003	2,003						
Total	-	-	-	-	8,622	43	1,053	1,137	2,233	440	93	168			
<b>2006/07 (Private Sector Market Clearing Exchange Rate=1279.9, Official Exchange Rate=5.7)</b>															
Public Sector Exports	-0.996	0.649	0.000	-0.346	4,089	-4,071	2,655	0	-1,416						
Public Sector Imports	0.996	-0.266	0.000	0.729	3,277	3,263	-873	0	2,390						
Private Sector Exports	0.000	0.000	-0.445	-0.445	3,081	0	0	-1,371	-1,371						
Private Sector Imports	0.000	0.000	1.104	1.104	3,226	0	0	3,563	3,563						
Total	-	-	-	-	13,674	-808	1,782	2,191	3,165	424	86	195			

Source: IMF staff estimates.

**Table 4. Net Efficiency Loss Estimates under the Baseline Parameters (2004/05-2006/07)**  
(Relative to Estimated Nominal GDP)

Assumed Parameters	Relative to Estimated GDP				Exchange Rate (Kyat/US\$)	Nominal GDP (in billion kyat)	Openness Measure	Share of Public Sector in GDP
	1/α(R) 1.0	1/α(U) 1.0	1/β(R) 1.0	1/β(U) 0.2				
<b>2004/05</b>								
Equilibrium Rate (total)	0.6	8.1	9.0	17.7	361	10,135	22.6	12.3
Public Sector Exports	-17.6	13.2	0.0	-4.5				
Public Sector Imports	18.3	-5.1	0.0	13.2				
Private Sector Exports	0.0	0.0	-6.6	-6.6				
Private Sector Imports	0.0	0.0	15.7	15.7				
Official Rate (total)	0.7	9.0	10.1	19.8	5.7	9,079	0.3	7.0
Market Rate (total)								
(Private Sector Clearing Rate)	0.5	6.9	7.7	15.2	921	11,801	49.6	18.7
<b>2005/06</b>								
Equilibrium Rate (total)	0.3	7.7	8.4	16.4	440	13,599	21.3	11.8
Public Sector Exports	-15.9	12.5	0.0	-3.4				
Public Sector Imports	16.2	-4.8	0.0	11.4				
Private Sector Exports	0.0	0.0	-6.4	-6.4				
Private Sector Imports	0.0	0.0	14.7	14.7				
Official Rate (total)	0.4	8.6	9.3	18.2	5.8	12,287	0.3	7.0
Market Rate (total)								
(Private Sector Clearing Rate)	0.3	6.7	7.3	14.3	1104	15,608	46.5	17.6
<b>2006/07</b>								
Equilibrium Rate (total)	-4.4	9.6	11.9	17.1	424	18,490	21.2	13.4
Public Sector Exports	-22.0	14.4	0.0	-7.7				
Public Sector Imports	17.6	-4.7	0.0	12.9				
Private Sector Exports	0.0	0.0	-7.4	-7.4				
Private Sector Imports	0.0	0.0	19.3	19.3				
Official Rate (total)	-4.8	10.7	13.1	18.9	5.7	16,716	0.3	8.0
Market Rate (total)								
(Private Sector Clearing Rate)	-3.7	8.1	9.9	14.3	1280	22,125	53.4	21.8

Source: IMF staff estimates.

Table 5. Sensitivity of Estimated Net Efficiency Losses to Assumed Parameters (2006/07)

Assumed Parameters		Net Efficiency Losses (Relative to Trade Values)				Net Efficiency Losses (Percent in Estimated Nominal GDP)				Equilibrium Exchange Rate (kyat/US\$)	Public Sector Market Clearing Rate (kyat/US\$)	Shadow Exchange Rate for Public Imports	Nominal GDP (relative to Official Statistics)	Openness Measure	Share of Public Sector in GDP				
$1/\alpha(U)$	$1/\beta(U)$	Public Exports	Private Imports	Public Imports	Private Exports	Public Exports	Private Imports	Public Imports	Private Exports	Total									
$1/\alpha(R)$	$1/\beta(R)$	$\psi$																	
<b>Baseline Case</b>																			
1.0	1.0	1.0	0.2	6.5	-0.35	0.73	-0.45	1.10	-7.7	12.9	-7.4	19.3	17.1	424	86	195	1.11	21.2	13.4
<b>Sensitivity Analyses</b>																			
Private Import Elasticity ( $1/\alpha(R)$ )																			
0.5	1.0	1.0	0.2	6.5	-0.65	0.81	-0.48	1.11	-14.9	14.9	-8.4	20.3	11.9	252	86	196	1.06	13.1	11.3
1.5	1.0	1.0	0.2	6.5	-0.08	0.69	-0.40	1.02	-1.8	11.8	-6.5	17.1	20.7	563	86	194	1.14	27.3	15.0
Public Import Elasticity ( $1/\alpha(U)$ )																			
1.0	0.5	1.0	0.2	6.5	-0.38	0.85	-0.45	1.15	-8.5	15.2	-7.5	20.2	19.3	404	12	30	1.10	20.3	13.2
1.0	1.5	1.0	0.2	6.5	-0.29	0.66	-0.44	1.04	-6.4	11.6	-7.2	17.9	15.9	454	191	365	1.11	22.5	13.8
Private Export Elasticity ( $1/\beta(R)$ )																			
1.0	1.0	0.5	0.2	6.5	-0.39	0.74	-0.55	1.16	-8.6	13.1	-9.2	20.3	15.6	403	86	195	1.10	20.2	13.2
1.0	1.0	1.5	0.2	6.5	-0.32	0.72	-0.37	1.07	-7.1	12.8	-6.2	18.7	18.2	437	86	195	1.11	21.8	13.6
Public Export Elasticity ( $1/\beta(U)$ )																			
1.0	1.0	1.0	0.1	6.5	-0.36	0.69	-0.40	0.82	-7.8	11.8	-6.5	13.7	11.3	566	108	194	1.14	27.4	15.0
1.0	1.0	1.0	0.3	6.5	-0.36	0.77	-0.47	1.39	-8.1	14.0	-8.0	24.9	22.7	319	71	196	1.08	16.4	12.2
Public Sector Potential Import ( $\psi$ )																			
1.0	1.0	1.0	0.2	2.2	-0.18	0.61	-0.42	0.92	-4.0	10.5	-6.9	15.7	15.4	510	216	583	1.13	25.0	14.4
<b>Robustness Check (summary)</b>																			
Average																			
					-0.28	0.71	-0.43	0.98	-6.4	12.5	-7.2	17.1	16.0	475	163	354	1.12	23.1	13.9
Median																			
					-0.22	0.67	-0.40	0.95	-4.7	11.9	-6.6	16.9	12.8	463	122	317	1.12	22.9	13.9
Maximum NWL case																			
1.5	0.5	1.5	0.3	6.5	0.00	0.84	-0.37	1.37	0.0	14.9	-6.1	23.8	32.6	450	11	30	1.11	22.3	13.7
Minimum NWL case																			
0.5	1.5	0.5	0.1	6.5	-0.56	0.69	-0.55	0.88	-12.4	12.2	-9.2	15.3	5.9	405	235	365	1.10	20.3	13.2

Source: IMF staff estimates.