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Exchange Rate and Balance of Payment Risks in the Global Development Finance Architecture

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- Characterization of SDG-compatible investments
- Business Models
- Governance
- Financial regulation
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Exchange rate and balance of payment risks in the global development finance architecture

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Abstract
We analyze the exchange rate and balance of payment crisis risks when MDBs lend, in hard currency, to NDBs, for NDBs to onlend to investment projects. Investment projects maybe “export-enhancing” (EXIPs), which generate hard currency (for example, building a port or developing export agriculture), or “domestic-oriented” (DOIPs), which don’t generate hard currency (for example, a solar farm or a sewage system). If MDBs want to increase the proportion of onlending to DOIPs, they need to increase their refinancing to NDBs, and allow more time to pay back the loans. Further, MDBs need to reduce the interest rate charged on NDBs.

Keywords
Inequality, Climate variability, Indonesia, Vietnam

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Résumé
Nous analysons les risques de taux de change et de crise de la balance des paiements lorsque les BMD prêtent, en période de forte conjoncture, aux BND, pour que ces dernières prêtent ensuite à des projets d'investissement. Les projets d'investissement peuvent être des projets "d'amélioration des exportations" (EXIP), qui génèrent des devises fortes (par exemple, la construction d'un port ou le développement de l'agriculture d'export), ou des projets "à vocation nationale" (DOIP), qui ne génèrent pas de devises fortes (par exemple, une ferme solaire ou un système d'égouts). Si les BMD veulent augmenter la proportion des prêts accordés aux DOIP, elles doivent augmenter leur refinancement aux NDB et leur accorder plus de temps pour rembourser les prêts. En outre, les BMD doivent réduire le taux d'intérêt appliqué aux NDB.

Mots-clés
Inégalité, Variabilité climatique, Indonésie, Vietnam

Introduction

In recent times there has been a renewed impulse to the idea of using Development Finance Institutions (DFIs) as a tool for economic growth and development (United Nations, 2015, 2019, 2020). This new impulse, however, is given in a new international context with a world that is not only more commercially integrated but also more financially integrated in comparison to the past. Collaboration between multilateral development banks (MDBs) and national development banks (NDBs), through on-lending arrangements, can help enhance the complementarity of international resources and local market knowledge. Unfortunately, the access to hard currency by NDBs through MDBs loans not only generates exchange rate and balance of payment crisis risks for the particular financial actors involved, but also for the financial system as a whole. Note that hard currency is needed to pay back the loan from the MDB to the NDB.

In the past six decade, the collaboration between MDBs and NDBs has experienced the rise, decline and renaissance. In the wake of the World War II, the World Bank assisted developing country governments to establish NDBs and then used NDBs as a conduit for on-lending to developing countries. Yet the momentum stalled since the 1980s when NDBs were criticized for their poor governance and mismanagement. Recently especially after climate change and the Sustainable Development Goals top the agenda in international development, MDBs have renewed their interest in deploying NDBs to finance green energy projects or other development projects which are small in scale but generate positive externalities.

The objective of this research paper is to analyse the exchange rate and balance of payment crisis risks involved when a MDB finances itself in the international bond market to lend US Dollars to a NDB for it to do on-lending to investment projects in its country (host country). Investment projects maybe "export-enhancing" (EXIPs), which generate hard currency (for example, building a port or developing export agriculture), or "domestic-oriented" (DOIPs), which don't generate hard currency (for example, a solar farm or a sewage system). The main argument is that when the financing goes to export-enhancing or import-substitution investment projects in line with latent comparative advantages of the host country, which improve the future current account balance, the exchange rate and balance of payment risks are reduced for the different financial actors involved, but also for the financial system as a whole. Oppositely, if the investment projects that are financed are domestic-oriented (non-export-enhancing or non-import-substitution projects), the exchange rate and balance of payment risks increase.[1]

Regarding the related literature, there is quite a consensus that current account deficits is a problematic macroeconomic and financial issue (see, for example, Edwards (2002); Obstfeld (2012); Ocampo

1 Domestic-oriented projects may generate positive externalities and development impact such as small and medium-sized enterprises and green finance. So here we are not analyzing these positive aspects of domestic-oriented projects, but focusing on the exchange rate and balance of payment risks associated with its funding in US dollars.

(2016); Prebisch (1950); Thirlwall (2011)). Even if the complete-markets hypothesis states that current account fluctuations that are due to households and firms optimal behavior should not be of concern because global financial trades allow countries to pool their risks to the maximum feasible extent, Obstfeld (2012) argues that there is very little empirical evidence in favor of this complete-markets hypothesis. Furthermore, the, so called, Lawson Doctrine states that only those current-account deficits that arise because of excessive government deficits should be of concern. However, already Diaz-Alejandro (1985); Velasco (1987) discussed that the balance of payment crisis of 1980' in Latin America, especially clearly in Chile, happened even without the presence of important fiscal deficits. Furthermore, (Prasad et al., 2007) even find a robust positive relationship between current account surpluses and growth for developing countries.

What is less clear in the literature, is why, when and how the current account deficits are problematic. The problem is that the empirical evidence, for example for Australia, show that there are countries that suffer long-run current account deficits without facing balance of payment crises (Belkar et al., 2008). Some authors, such as Calvo (2000); Calvo et al. (2004); Edwards (2002), claim that it is large current account deficits that are problematic because they are prone to current account reversals and sudden stops. Furthermore, there are several studies that claim that foreign indebtedness, especially if it is short-term, plays a key role in causing financial fragility (Chang and Velasco, 1998; Chui et al., 2018; Jeanne, 2000; Krugman, 1999). Other theoretical studies analyzing foreign indebtedness, include among other, Acharya et al. (2020); Giavazzi and Spaventa (2011); Korinek (2011).

In this paper, we first make a theoretical analysis of the above-mentioned issues, following the "money view" theory of Mehrling (2011, 2012); Mehrling et al. (2015) and Schclarek et al. (2019). Specifically, we model the different monetary transactions that are involved when a MDB funds itself in the international market in order to lend to a NDB, which lends, in turn, to an investment project in its country (host country). Further, we model the monetary transactions involved when the investment project produces its monetary proceeds and all the loans have to be paid back, distinguishing two special cases. The first case is when the investment project has been export-enhancing and increased the availability of foreign currency in the host country's banking system. Here the monetary transactions involved in the repayment of the loans are executed without significantly affecting the foreign exchange market. In the second case, we analyze the case when the investment project is domestically-oriented (non-exportenhancing or non-import-substitution projects) and has not helped the domestic banking system to increase its foreign currency assets. In this case, in order to avoid a balance of payment crisis, the MDB has to refinance the NDB (capital and interests) but also has to refinance its liabilities (bond issuance). Alternatively, the NDB could get the US Dollars generated by other export-oriented investment projects or by having access to the foreign reserves at the central bank.

Secondly, we present a theoretical model, following Brei and Schclarek (2015); Giavazzi and Spaventa (2011); Schclarek et al. (2019), where NDBs need to optimally choose the proportion of onlending that goes to EXIPs and DOIPs. We analyze three different scenarios depending on the availability of USD liquidity in the foreign exchange market of the developing country: a first case with abundant USD liquidity, a second case with normal USD liquidity, and a third case with scarce USD liquidity. In the case with abundant USD liquidity, the NDB may freely choose the proportion of lending between the two types of investment projects, without any need to consider how this decision affect the foreign exchange market. In the scenario with normal USD liquidity, the NDB needs to consider how his decision affects the foreign exchange market, but needs not worry about balance of payment problems. The NDB can lend a certain proportion to DOIPs, but has to lend a certain proportion to EXIPs, so as to increase in the future the supply of USD in the local foreign exchange market and avoid a large depreciation of the local currency. In the scenario with scarce USD liquidity, the NDB is bound by the foreign exchange market and balance of payment constraints. Now, the NDB has to choose a higher proportion of EXIPs, and a lower proportion of DOIPs, than the cases with abundant and normal USD liquidity.

The rest of the paper is organized as follows. In section 1, we graphically analyze the balance sheets of the different agents and the financial and monetary effects and consequences of their behavior. Understanding these monetary mechanisms, in particular the currency mismatch, will make it easier to understand the mathematical model in section 2. Specifically, in section 2, we study how the optimal lending policy by the MDBs and NDBs are affected by exchange rate and balance of payment crisis risks. Finally, in the last section, we present our conclusions.

1. Balance-Sheet Presentation

In this section, we graphically analyze the different payments and settlements, in particular interbank payments, that arise between the involved agents. We explicitly model these transactions by analyzing, at each point in time, the balance sheets of the agents using T-accounts: that is, assets on the left-hand side and liabilities on the righthand side, following the "money view" monetary theory, presented in Mehrling (2011, 2012); Mehrling et al. (2015).

First, in subsection 1.1, we analyze the process in which a MDB obtains financing by issuing bonds in the international bond market and finances a NDB for doing on-lending. Second, in subsection 1.2, we analyze the process of on-lending whereby the NDB lends to an investment project (IP), in domestic currency denominated debt. Finally, in subsections 1.3 and 1.4, we analyze the repayment process of the IP, the NDB and the MDB, distinguishing between export-enhancing and domestic-oriented IPs.

1.1. MDB obtains financing in the international capital market and grants a USD loan to the NDB

In this subsection, we analyze the financial and monetary mechanism by which a MDB obtains financing by issuing a bond in the international capital market and uses those funds to finance a NDB. Figure 1 depicts this process. Note that each account has a subscript, which refers to the agent for which that account represent an asset, and a superscript, which refers to the agent for which that account represents a liability. Note also that the currency denomination of each account is explicitly indicated.

In the initial period (T=0), agents have neither assets nor liabilities. In period 1 (T=1), the MDB issues a bond in the international capital market (*USDBondMDBICB*), which in this case is acquired by an International Commercial Bank (from now on ICB). The ICB just debits the corresponding amount into the MDB's bank account. This operation is represented in the second line of T=1. When T=2, the MDB grants a loan to the NDB and transfers its deposits in the ICB to the NDB.

In the final situation (F), each agent has expanded its balance sheet on both sides. The NDB, with the assistance of the MDB, has obtained USD funds (*USDDepICBND*) and possesses a USD liability with the MDB (*USDLoanNDBMDB*). The MDB in turn, possesses in the asset-side a USD loan granted to the NDB, and in the liability-side the USD bonds it issued in T=1.

1.2. NDB finances an IP in local currency

In this subsection, we analyze the financial and monetary mechanism by which the NDB finances an IP. This operation is carried out in local currency. Figure 2 depicts this process, where the starting point is the final line (F) of figure 1.[2]

T	Int Com Bank Assets	Int Com Bank Liabilities	Mult Dev Bank Assets	Mult Dev Bank Liabilities	Nat Dev Bank Assets	Nat Dev Bank Liabilities
0						
1	$+USD\ Bond^{MDB}_{ICB}$			$+USD\ Bond^{MDB}_{ICB}$		
		$+USD\ Dep^{ICB}_{MDB}$	$+USD\ Dep^{ICB}_{MDB}$			
2			$+USD\ Loan^{NDB}_{MDB}$			$+USD\ Loan^{NDB}_{MDB}$
		$-USD\ Dep^{ICB}_{MDB}$	$-USD\ Dep^{ICB}_{MDB}$			
		$+USD\ Dep^{ICB}_{NDB}$			$+USD\ Dep^{ICB}_{NDB}$	
F	$USD\ Bond^{MDB}_{ICB}$	$USD\ Dep^{ICB}_{NDB}$	$USD\ Loan^{NDB}_{MDB}$	$USD\ Bond^{MDB}_{ICB}$	$USD\ Dep^{ICB}_{NDB}$	$USD\ Loan^{NDB}_{MDB}$

Figure 1: MDB funds the NDB by issuing bonds in the international bond market

Since the NDB is lending in local currency and it maintains US Dollar deposits, it needs to exchange them. In T=1 the NDB buys local currency deposits to a Local Commercial Bank (LCB). In the first and second lines the NDB asks the ICB to debit the corresponding amount from its bank account and debit it into the bank account of the LCB in the ICB. In the third line, the LCB creates local currency deposits by just crediting them into the NDB's bank account. In T=2, the NDB grants a loan to the IP (*$LocDepIPNDB*), and transfers its local currency deposits to it.

The final situation is depicted in line T=F. The balance sheet of the ICB did not suffer a major modification: the asset-side remains changeless, while its liabilities are now in possession of the LCB (*USDDepICBLCB*). The NDB in turn faces a currency mismatch: while its liabilities are denominated in US Dollar (recall *USDDepNDBMDB* from figure 1), its assets are now denominated in local currency (*$LocDepLCBNDB*). The balance sheet of the LCB throughout this process has been increased on both sides: on the asset-side by *USDDepICBLCB*, and on the liability-side by *$LocDepLCBIP*. Finally, the IP has acquired the necessary funds to finance and develop an investment project and maintains a liability denominated in local currency.

2 The balance sheet of the MDB and the loan granted by the MDB to the NDB has been omitted for simplicity reasons and to enhance clarity in the exposition.

1.3. Export-enhancing investment project

In this subsection we analyze the financial and monetary mechanism by which each liability is cancelled considering the scenario where the IP is export-enhancing and produce USD proceeds. First, the IP obtains US Dollar deposits as a result of the project developed, and uses them to cancel its liability with the NDB. Second, the NDB uses these deposits to meet its commitment with the MDB, which in turn settles its debt with the ICB.

Figure 3 depicts this process. The initial period corresponds to the final line (F) of figure 2. Note that in figure 3 the IP, as a result of the investment project, has tradable goods. In period 1 (T=1), the IP exports these goods to a firm. The latter pays those goods by asking the ICB where it maintains US Dollar deposits to transfer them to the IP (second and third rows of figure 3).

The second period of figure 3 (T=2) shows the process by which the IP cancels its liability with the NDB (i.e. *$LocDLoanIPNDB*), using the US Dollar it obtained in T=1. This transaction, of paying a local currency debt with USD, is similar to exchanging the USD for local currency and then cancelling the local currency debt with the NDB. When (T=3), the NDB uses its US Dollar deposits to cancel its liability with the MDB (i.e. *USDLoanNDBMDB*). Finally, when (T=4), the MDB cancels its liabilities with the ICB (*USDBondMDBICB*).

Note that at the end of the process all commitments have been cancelled without problems. This is a direct consequence of the fact that the IP, as a result of the investment project it developed, acquired US Dollar deposits. The US Dollar proceeds of the IP resulted in a benefit not only for the IP, but also for the NDB and the MDB.

T	Int Com Bank		Nat Dev Bank		Loc Com Bank		Investment Project	
	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
0		$USD\,Dep^{ICB}_{NDB}$	$USD\,Dep^{ICB}_{NDB}$					
		$-USD\,Dep^{ICB}_{NDB}$	$-USD\,Dep^{ICB}_{NDB}$					
1		$+USD\,Dep^{ICB}_{LCB}$			$+USD\,Dep^{ICB}_{LCB}$			
			$+\$Loc\,Dep^{LCB}_{NDB}$			$+\$Loc\,Dep^{LCB}_{NDB}$		
			$+\$Loc\,Loan^{IP}_{NDB}$					$+\$Loc\,Loan^{IP}_{NDB}$
2			$-\$Loc\,Dep^{LCB}_{NDB}$			$-\$Loc\,Dep^{LCB}_{NDB}$		
						$+\$Loc\,Dep^{LCB}_{IP}$	$+\$Loc\,Dep^{LCB}_{IP}$	
F		$USD\,Dep^{ICB}_{LCB}$	$\$Loc\,Loan^{IP}_{NDB}$		$USD\,Dep^{ICB}_{LCB}$	$\$Loc\,Dep^{IP}_{LCB}$	$\$Loc\,Dep^{LCB}_{IP}$	$\$Loc\,Loan^{IP}_{NDB}$

Figure 2: NDB finances an IP in local currency

1.4. Domestically-oriented investment project

In this subsection we analyze the financial and monetary mechanism by which each liability is canceled considering the scenario where the NDB has granted a local currency loan to the IP. First, in figure 4, we show the process by which an IP develops a domestic-oriented project (i.e. produces goods or services that are sold within the domestic market), obtains local currency proceeds, and uses them to pay back its liability with the NDB. Second, in figure 5, we explain the difficulties that arise as a direct consequence of financing a domestic-oriented project when the NDB has financed itself in USD.

The initial period of figure 4 corresponds to the final line of figure 2. Note that in figure 4 the IP, as a result of the investment project, has non-tradable goods. In period 1 (T=1), the IP sells these goods to a local firm. The latter pays for those goods by asking the LCB where it maintains its local currency deposits to debit from its bank account and credit the corresponding amount into the IP's bank account (second and third rows of T=1). The second period of figure 4 (T=2) shows the process by which the IP cancels its liability with the NDB (i.e. *$LocLoanIPNDB*), using the local currency deposits it acquired in T=1.

Unlike the previous subsection, the NDB may have problems to pay back its liabilities with the MDB (i.e. *USDLoanNDBMDB*) since it possesses local currency assets and USD liabilities. Note that even when the MDB has lent in US Dollars, it too may have problems to meet its liabilities with the ICB if the NDB cannot pay back its debt to the MDB. The point to emphasize is that, when the project developed is domestic-oriented, not only the IP (or the NDB), but also the MDB may have problems to meet their USD liabilities.

For the NDB to meet its commitments with the MDB, it would be necessary to obtain USD from another actor in the economy that is willing to accept local currency in exchange (this could even be the Central Bank by using its foreign reserves). Alternatively, another solution would be to obtain a refinancing of the loan to the MDB. However, this would also require that the MDB, in turn, obtain a refinancing of its liabilities with the ICB.

Figure 5 depicts this alternative mechanism of cancelling the original loans from the MDB to the NDB and from the ICB to the MDB by refinancing the loans. When T=0, the NDB possesses a local currency asset (deposits in the local comercial bank) and a USD liability (a loan granted by the MDB). Periods 1 and 2 (T=1, T=2) of figure 5 show these processes of refinancing debts. In period 3 (T=3), the NDB uses the US Dollar deposits it acquired in the previous operations to cancel the first loan granted by the MDB (*USDLoanNDBMDB*). In period 4 (T=4), the MDB cancels its debt to the ICB (*USDBondMDBICB)*.

At the end of the process both, the NDB as well as the MDB has refinanced its debts, even when the project was successfully developed and the IP met its liabilities. The explanation is straightforward. Since the funds raised by this mechanism were used to finance a domestic-oriented project the IP did not generate USD. Even when the IP successfully met its liabilities with the NDB, the latter needed USD deposits to fulfill its commitments.

T	Int Com Bank		Mult Dev Bank		Nat Dev Bank		Investment Project		Foreign Firm	
	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
0	$USD\,Bond^{MDB}_{ICB}$	$USD\,Dep^{ICB}_{firm}$	$USD\,Loan^{NDB}_{MDB}$	$USD\,Bond^{MDB}_{ICB}$	$USD\,Loan^{IP}_{NDB}$	$USD\,Loan^{NDB}_{MDB}$	$TradGood$	$USD\,Loan^{IP}_{NDB}$	$USD\,Dep^{ICB}_{firm}$	
							$-TradGood$		$+TradGood$	
1		$-USD\,Dep^{ICB}_{firm}$							$-USD\,Dep^{ICB}_{firm}$	
		$+USD\,Dep^{ICB}_{IP}$					$+USD\,Dep^{ICB}_{IP}$			
		$-USD\,Dep^{ICB}_{IP}$					$-USD\,Dep^{ICB}_{IP}$			
2		$+USD\,Dep^{ICB}_{NDB}$			$+USD\,Dep^{ICB}_{NDB}$					
					$-USD\,Loan^{IP}_{NDB}$			$-USD\,Loan^{IP}_{NDB}$		
		$-USD\,Dep^{ICB}_{NDB}$			$-USD\,Dep^{ICB}_{NDB}$					
3		$+USD\,Dep^{ICB}_{MDB}$	$+USD\,Dep^{ICB}_{MDB}$							
			$-USD\,Loan^{NDB}_{MDB}$			$-USD\,Loan^{NDB}_{MDB}$				
		$-USD\,Dep^{ICB}_{MDB}$	$-USD\,Dep^{ICB}_{MDB}$							
4	$-USD\,Bond^{MDB}_{ICB}$			$-USD\,Bond^{MDB}_{ICB}$						
F									$TradGood$	

Figure 3: Repayments of loans and bonds when investment project is export-enhancing

T	Local Commercial Bank		Investment Project		Local Firm		Nat Dev Bank	
	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
0		$\$Loc\,Dep^{LCB}_{firm}$	$NTrad\,Good$	$\$Loc\,Loan^{IP}_{NDB}$	$\$Loc\,Dep^{LCB}_{firm}$		$\$Loc\,Loan^{IP}_{NDB}$	
			$-NTrad\,Good$		$-NTrad\,Good$			
1		$-\$Loc\,Dep^{LCB}_{firm}$			$-\$Loc\,Dep^{LCB}_{firm}$			
		$+\$Loc\,Dep^{LCB}_{IP}$	$+\$Loc\,Dep^{LCB}_{IP}$					
		$-\$Loc\,Dep^{LCB}_{IP}$	$-\$Loc\,Dep^{LCB}_{IP}$					
2		$+\$Loc\,Dep^{LCB}_{NDB}$					$+\$Loc\,Dep^{LCB}_{NDB}$	
				$-\$Loc\,Loan^{IP}_{NDB}$			$-\$Loc\,Loan^{IP}_{NDB}$	
F		$\$Loc\,Dep^{LCB}_{NDB}$	$\$Loc\,Dep^{LCB}_{IP}$		$NTrad\,Good$		$\$Loc\,Dep^{LCB}_{NDB}$	

Figure 4: Repayments of loans and bonds when investment project is domestically-oriented - first operations

T	Int Com Bank		Mult Dev Bank		Nat Dev Bank	
	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
0	$USD\ Bond^{MDB}_{ICB}$		$USD\ Loan^{NDB}_{MDB}$	$USD\ Bond^{MDB}_{ICB}$	$\$Loc\ Dep^{LCB}_{NDB}$	$USD\ Loan^{NDB}_{MDB}$
1	$+USD\ Bond2^{MDB}_{ICB}$			$+USD\ Bond2^{MDB}_{ICB}$		
		$+USD\ Dep^{ICB}_{MDB}$	$+USD\ Dep^{ICB}_{MDB}$			
2			$+USD\ Loan2^{NDB}_{MDB}$			$+USD\ Loan2^{NDB}_{MDB}$
		$-USD\ Dep^{ICB}_{MDB}$	$-USD\ Dep^{ICB}_{MDB}$			
		$+USD\ Dep^{ICB}_{NDB}$			$+USD\ Dep^{ICB}_{NDB}$	
3		$-USD\ Dep^{ICB}_{NDB}$			$-USD\ Dep^{ICB}_{NDB}$	
		$+USD\ Dep^{ICB}_{MDB}$	$+USD\ Dep^{ICB}_{MDB}$			
			$-USD\ Loan^{NDB}_{MDB}$			$-USD\ Loan^{NDB}_{MDB}$
4		$-USD\ Dep^{ICB}_{MDB}$	$-USD\ Dep^{ICB}_{MDB}$			
	$-USD\ Bond^{MDB}_{ICB}$			$-USD\ Bond^{MDB}_{ICB}$		
F	$USD\ Bond2^{MDB}_{ICB}$		$USD\ Loan2^{NDB}_{MDB}$	$USD\ Bond2^{MDB}_{ICB}$	$\$Loc\ Dep^{LCB}_{NDB}$	$USD\ Loan2^{NDB}_{MDB}$

Figure 5: Repayments of loans and bonds when investment project is domestically-oriented - second operations

2. Model of the MDB lending to the NDB for onlending

2.1. Basic model

In this section we present a model to analyze an MDB that lends USD to an NDB for it to do onlending to real investment projects. The NDB needs to optimally choose which proportions of its onlending goes to export-enhancing (or import-substitution) real investment projects (EXIPs) and domestically-oriented (non-export-enhancing or non-import-substitution projects) real investment projects (DOIPs). The EXIPs produce financial proceeds in USD and the DOIPs produce financial proceeds in the local currency Loc$. We analyze three different cases in terms of the availability of USD liquidity. In the first case with abundant USD liquidity, the NDB may choose the optimal proportions of onlending to EXIPs and DOIPs without being constrained by exchange rate or balance of payment considerations. In the second case with normal USD liquidity, when deciding its optimal behavior, the NDB needs to consider how his choice affects the foreign exchange market, but need not worry about balance of payment problems, i.e. lack of USD liquidity. In the third case with scarce USD liquidity, the NDB is bound by balance of payment problems, i.e. lack of USD liquidity.

Following Allen and Gale (1998), Brei and Schclarek (2015) and Holmstrom and Tirole (1998), among others, the economy is characterized by a simple two period model in which decisions are made in the initial period 0; and all the uncertainty is revealed in the final period 1, and all the payoffs are settled. In period 0, the MDB lends a fixed amount I_{USD} of USD to the NDB at an interest rate i_{MDB} with the loan maturing in the final period 1. For simplicity reasons, we assume that both the principal and interests are paid at maturity, so in period 1, the NDB has to pay $I_{USD}{\cdot}(1{+}i_{MDB})$ of USD to the MDB.

Also, in the initial period 0, the NDB invest the proceeds of the loan by the MDB I_{USD} into onlending to real investment projects that maybe export-enhancing (or import-substitution) or domestically-oriented (non-export-enhancing or non-import-substitution projects). The NDB needs to optimally choose the proportion of lending α that goes to the EXIPs and the proportion of lending $(1\text{-}\alpha)$ that goes to the DOIPs. Further, we assume that the NDB grants all its loans to real investment projects in local currency Loc$. By doing so, the NDB incurs into a currency mismatch on its balance sheet and exchange rate risk. Further, this assumption implies that the NDB needs to exchange the USD received by the MDB to get local currency Loc$. We assume that there is an economic agent, that could be the central bank, that is willing to exchange the USD for Loc$ at an exchange rate of S_0 in the initial period 0.[3] Below we discuss more about this economic agent and the exchange rate. Thus, in the initial period 0, the NDB have $I_{Loc\$} = I_{USD} \cdot S_0$ to lend to real investment projects, charging a fixed interest rate of i_{NDB}, and loans maturing in the final period 1. Note that in our model, we assume that all interest rates are fixed and that $i_{NDB} \geq i_{MDB}$. Thus, the

3 cWe use the convention that the exchange rate represents the price in local currency Loc$ of a unit of USD.

EXIPs and DOIPs receive lending equivalent to $\alpha \cdot I_{Loc\$}$ and $(1 - \alpha) \cdot I_{Loc\$}$, respectively. With these funds, the investment projects pay, in the initial period 0, all the necessary expenses of the real investment projects, such as materials, machinery, workforce, and other supplies.

In the final period 1, real investment projects produce stochastic proceeds, given by the stochastic rate of return *r*, which is different for EXIPs and DOIPs. The expected rate of return of the EXIPs in the initial period 0 is $E_0(r_{EXIP})$, and for DOIPs it is $E_0(r_{DOIP})$ in the initial period 0. Furthermore, the EXIPs obtain these proceeds in USD and the DOIPs obtain the proceeds in the local currency Loc\$. Then, in the final period 1, the total proceeds in USD of the EXIPs is $(1+r_{EXIP}) \cdot \alpha \cdot I_{USD}$ and the total proceeds in local currency Loc\$ of the DOIPs is $(1 + r_{DOIP}) \cdot (1 - \alpha) \cdot I_{Loc\$}$. We assume that EXIPs exchange the total proceeds in USD for local currency Loc\$, at an exchange rate of S_1, obtaining $(1+r_{EXIP}) \cdot \alpha \cdot S_1 \cdot I_{USD}$. EXIPs use, all or part, of these local currency Loc\$ funds to pay back the loan and interests to the NDB, which amounts to $(1+i_{NDB}) \cdot \alpha \cdot I_{Loc\$}$. Thus, for the EXIPs to be able to payback the loans and interests to the NDB, it is necessary that $(1+ r_{EXIP}) \cdot \alpha \cdot S_1 \cdot I_{Loc\$} / S_0 \geq (1+i_{NDB}) \cdot \alpha \cdot I_{Loc\$}$. In the case of the DOIPs, they directly use, all or part, of the total proceeds in the local currency Loc\$ to pay back the loan and interests to the NDB, which amounts to $(1+i_{NDB}) \cdot (1-\alpha) \cdot I_{Loc\$}$. Thus, for DOIPs to be able to payback the loans and interests to the NDB, it is necessary that $(1+r_{DOIP}) \cdot (1-\alpha) \cdot I_{Loc\$} \geq (1+i_{NDB}) \cdot (1-\alpha) \cdot I_{Loc\$}$. Accordingly, for the NDB to have incentives to lend to the real investment projects without making expected losses, we assume that in the initial period 0, the expected exchange rate of the final period 1 $E_0(S_1)$, and the expected rate of returns $E_0(r_{EXIP})$) and $E_0(r_{DOIP})$ are such that $(1+E_0(r_{EXIP}))) \cdot E_0(S_1)/S_0 \geq (1+i_{NDB})$ and $(1+ E_0(r_{DOIP})) \geq (1+i_{NDB})$.

Also, in the final period 1, the NDB has to payback the principal and interests of the loan granted by the MDB in USD. Therefore, the NDB needs to exchange into USD, all or part, of the funds received in local currency Loc\$ from its loans to the real investment projects. Then, to payback its debts, the NDB needs to exchange sufficient local currency Loc\$ funds into USD, at an exchange rate of S_1, so that $(1+i_{MDB}) \cdot I_{USD} = D_{Loc\$}/S_1$, where $D_{Loc\$}$ are the exchanged local currency Loc\$ funds. Note that a higher exchange rate S_1, i.e. a more depreciated currency, implies that the NDB needs to exchange a larger amount of local currency Loc\$ funds into USD because its USD demand is fixed and given, if it wants to honour its debt to the MDB. Accordingly, for the MDB to have incentives to lend to the NDB without making expected losses, we assume that in the initial period 0, the following holds:

$(1+i_{MDB}) \cdot I_{USD} \leq (1+i_{NDB}) \cdot I_{Loc\$}/E_0(S_1)$. Note that this last condition implies that the NDB is exchanging into USD all the received funds from the NDB loans to the real investment projects, i.e. $D_{Loc\$} = (1+i_{NDB}) \cdot I_{Loc\$}$. Further, using the fact that $I_{Loc\$} = I_{USD} \cdot S_0$, we get that the above condition becomes: $(1+i_{MDB}) \leq (1+i_{NDB}) \cdot S_0/E_0(S_1)$.

Regarding the exchange rate determination, we assume that there is a dealer in the foreign exchange market, that could be the central bank, who buy and sell USD and local currency Loc\$ (Mehrling, 2011, 2012, 2013; Treynor, 1987). We analyze three extreme cases. In the first case, with abundant USD liquidity, in the final period 1, the dealer is willing to exchange an infinite amount of local currency Loc\$ for USD at a fixed exchange rate, given by $S_1 = S_0$. Note that we are assuming that the exchange rate is fixed between the initial period 0 and the final period 1, independent of the demand for USD by the NDB ($(1+i_{MDB}) \cdot I_{USD}$)

and the supply of USD by the EXIPs ($(1+r_{EXIP})\cdot\alpha\cdot l_{USD}$) in the final period 1. This means that $E_0(S_1)=S_0$. This case represent a situation where the dealer has abundant access to USD liquidity and is willing to expand its exposure to the local currency Loc$, without demanding a higher exchange rate for this increased exposure.

In the second case, with normal USD liquidity, in the final period 1, the dealer is willing to exchange any amount of local currency Loc$ for USD but at a variable exchange rate. We assume that the exchange rate S_1 is positively related to the net demand for USD by the NDB and the EXIPs, given by $ND_{USD} =(1+i_{MDB})\cdot l_{USD} -(1+r_{EXIP})\cdot\alpha\cdot l_{USD}$. Thus, we assume that $S_1=S_0+b\cdot ND_{USD}$, where b is a fixed positive coefficient. This means that $E_0(S_1)=S_0+b\cdot ND_{USD}$. This case represent a situation where the dealer has normal access to USD liquidity and is willing to expand its exposure to the local currency Loc$, but demanding a higher exchange rate for this increased exposure.

For the third case, with scarce USD liquidity, in the final period 1, the dealer is willing to offer an exchange rate $S_1 = S_0$ if the net demand for USD by the NDB and the EXIPs is less or equal to zero, i.e. $ND_{USD} \leq 0$, which requires $(1+i_{MDB})\leq(1+r_{EXIP})\cdot\alpha$. If the net demand for USD by the NDB and the EXIPs is greater than zero, i.e. $ND_{USD} >0$, the offered exchange rate tends to infinity ($S_1 \rightarrow \infty$). This case represent a situation where the dealer has hit position limits, beyond which it is not prepared to expand its exposure to the local currency Loc$ further. If $ND_{USD} >0$, then the dealer stops making markets and the payments system threatens to break down and a balance of payment crisis ensues.

For simplicity reasons, we assume that the maximization problem for the MDB is to maximize its profits from the lending to the NDB, given that it has USD funds equivalent to l_{USD}. Thus, the optimal behavior of the MDB in the initial period 0 is to lend l_{USD} to the NDB, but without making expected losses. This last condition implies that for the MDB to lend to the NDB the following must hold:

$$(1 + i_{MDB}) \leq (1 + i_{NDB}) \cdot S_0/E_0(S_1). \qquad (1)$$

In the case of the NDB, also for simplicity reasons, we assume that the maximization problem for the NDB is to maximize the proportion ($1-\alpha$) of onlending that goes to DOIPs. Note that we have assumed that the NDB charges the same interest rate to EXIPs and DOIPs, so the profit maximization condition cannot tell us much about the optimal proportions of lending to EXIPs and DOIPs. Still, the NDB needs to choose the proportions α and ($1 - \alpha$) so that condition 1 holds. Further, it will only lend to the real infrastructure projects if the following conditions hold:

$$(1+E_0(r_{EXIP})))\cdot E_0(S_1)/S_0 \geq(1+i_{NDB}) \qquad (2)$$

$$(1+E_0(r_{DOIP}))\geq(1+i_{NDB}). \qquad (3)$$

Then, the optimal behavior of the NDB in the initial period 0 is dependent on the value of the expected exchange rate in the final period 1 $E_0(S_1)$. Thus, we will have three cases depending on the USD liquidity situation and the behavior of the dealer in the foreign exchange market.

In the first case with abundant USD liquidity, the NDB may choose the optimal proportion *(1 - $\alpha*$)* of onlending that goes to DOIPs in the initial period 0 without being constrained by the exchange rate or balance of payment problems. In the final period 1, if the demand for USD by the NDB is greater than the supply of USD by the EXIPs, i.e. $(1+i_{MDB})\cdot I_{USD} > (1+r_{EXIP})\cdot\alpha\cdot I_{USD}$, there is always enough supply of USD at a fixed exchange rate S_0 to meet this net demand of USD. Also, condition 1 is met because $E_0(S_1)=S_0$, and we have assumed that $i_{NDB}>i_{MDB}$. Thus, if conditions 2 and 3 hold, the NDB will choose the optimal proportions $\alpha* = 0$ and $(1-\alpha*)=1$ of the lending to EXIPs and DOIPs, respectively. The dealer's abundant USD liquidity access allows the NDB to obtain its maximum utility and lend all the funds $I_{Loc\$}$ to DOIPs. No EXIPs will be funded. Note that neither the MDB nor the NDB face any exchange rate risks and balance of payment crisis risks because the dealer has abundant access to USD liquidity and sets a fixed exchange rate.

In the second case with normal USD liquidity, in the initial period 0, when the NDB chooses the optimal proportion $(1-\alpha*)$ of onlending to DOIPs, the NDB needs to consider how this decision affect the foreign exchange market, but need not worry about balance of payment problems, i.e. lack of USD liquidity. In the final period 1, if the demand for USD by the NDB is greater than the supply of USD by the EXIPs, i.e. $(1+i_{MDB})\cdot I_{USD} > (1+r_{EXIP})\cdot\alpha\cdot I_{USD}$, there is always enough supply of USD to meet this net demand of USD but at a variable exchange rate $S_1=S_0+b\cdot ND_{USD}$, which is increasing in the net demand of USD. This means that the NDB needs to consider how its decision on $\alpha*$ and $(1-\alpha*)$ affects the net demand of USD and, thus, the exchange rate. A lower proportion of EXIPs and a higher proportion of DOIPs reduces the supply of USD, increases the net demand for USD, and implies a more depreciated exchange rate (a higher S_1). A more depreciated exchange rate (a higher S_1) implies that the USD value of the local currency Loc$ funds received by the NDB from its loans and interests to EXIPs and DOIPs ($(1+ i_{NDB})\cdot I_{Loc\$}/S_1$) is reduced. Thus, for condition 1 to hold, the NDB have to consider how choosing $\alpha*$ and $(1-\alpha*)$ affect the exchange rate S_1 and the USD value of its incomes in local currency Loc$. The NDB have to choose $\alpha*$ and $(1-\alpha*)$ so that the following condition holds

$$\alpha \geq \frac{b\cdot(1+i_{MDB})^2\cdot I_{USD} - S_0\cdot(i_{NDB}-i_{MDB})}{I_{USD}\cdot b\cdot(1+i_{MDB})\cdot(1+r_{EXIP})}. \qquad (4)$$

Clearly, from condition 4, the optimal behavior of the NDB is to to choose the following proportions

$$\alpha^* = \frac{b\cdot(1+i_{MDB})^2\cdot I_{USD} - S_0\cdot(i_{NDB}-i_{MDB})}{I_{USD}\cdot b\cdot(1+i_{MDB})\cdot(1+r_{EXIP})}; \qquad (5)$$

$$(1-\alpha^*) = 1 - \frac{b\cdot(1+i_{MDB})^2\cdot I_{USD} - S_0\cdot(i_{NDB}-i_{MDB})}{I_{USD}\cdot b\cdot(1+i_{MDB})\cdot(1+r_{EXIP})}. \qquad (6)$$

Thus, when there is normal USD liquidity, the NDB has to lend a certain positive proportion to EXIPs ($\alpha*$), so as to increase the supply of USD ($(1+r_{EXIP})\cdot\alpha*I_{USD}$) and avoid a large depreciation of the local currency Loc$ (S_1). The case with normal USD liquidity implies that the proportion of lending to DOIPs $(1-\alpha*)$ is lower in comparison to the case with abundant

USD liquidity. Moreover, as is clear from figure 6, that the higher the rate of return of EXIPs (r_{EXIP}), meaning a higher supply of USD, allows a higher proportion of lending to DOIPs (1-α∗). Further, as figure 7 shows, the lower the interest rate that the MDB charges the NDB (i_{MDB}), the higher the proportion of lending to DOIPs. The reason is that a lower interest rate i_{MDB} implies a lower demand for USD. In addition, as figure 8 shows, a higher interest rate charged by the NDB (i_{NDB}) implies a higher proportion of lending to DOIPs because, as the NDB has more local currency Loc$ funds, it can support a higher depreciation (S_1). Finally, note that the larger the interest rate differential i_{NDB}-i_{MDB}, the higher the proportion of lending to DOIPs.

In the third case with scarce USD liquidity, in the initial period 0, when the NDB chooses the optimal proportion (1-α∗) of onlending to DOIPs, the NDB is bound by the foreign exchange market and balance of payment problems, i.e. lack of USD liquidity. In the final period 1, if the demand for USD by the NDB is greater than the supply of USD by the EXIPs, i.e.

$(1+i_{MDB})\cdot l_{USD} > (1+r_{EXIP})\cdot\alpha\cdot l_{USD}$, there is no available supply of USD to meet this net demand of USD and the exchange rate tends to infinity ($S_1 \rightarrow \infty$). This means that the USD value of the local currency Loc$ funds held by the NDB ($(1+i_{NDB})\cdot l_{Loc\$}/S_1$) tends to zero,

Figure 6. Proportion of lending to EXIPs in relation to the rate of return of EXIPs

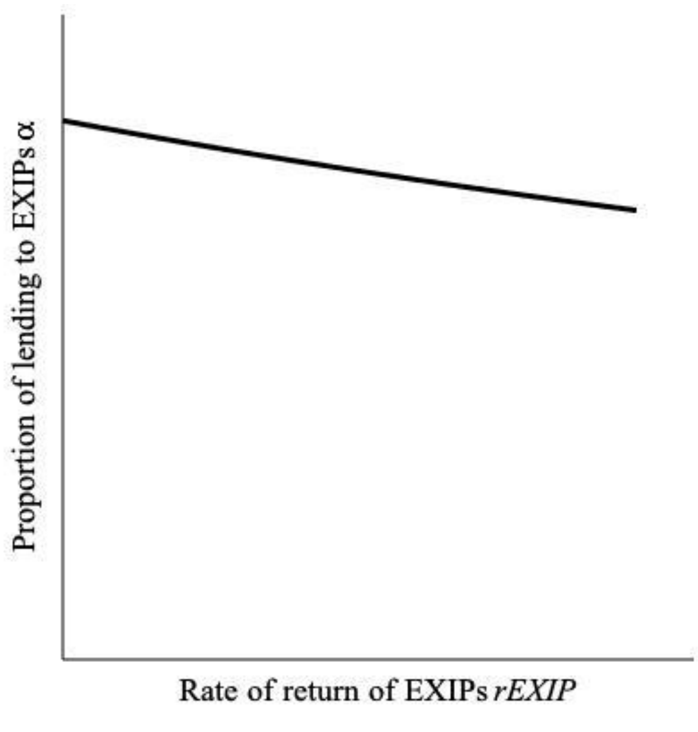


Figure 7. Proportion of lending to EXIPs in relation to the interest rate charged by the MDB

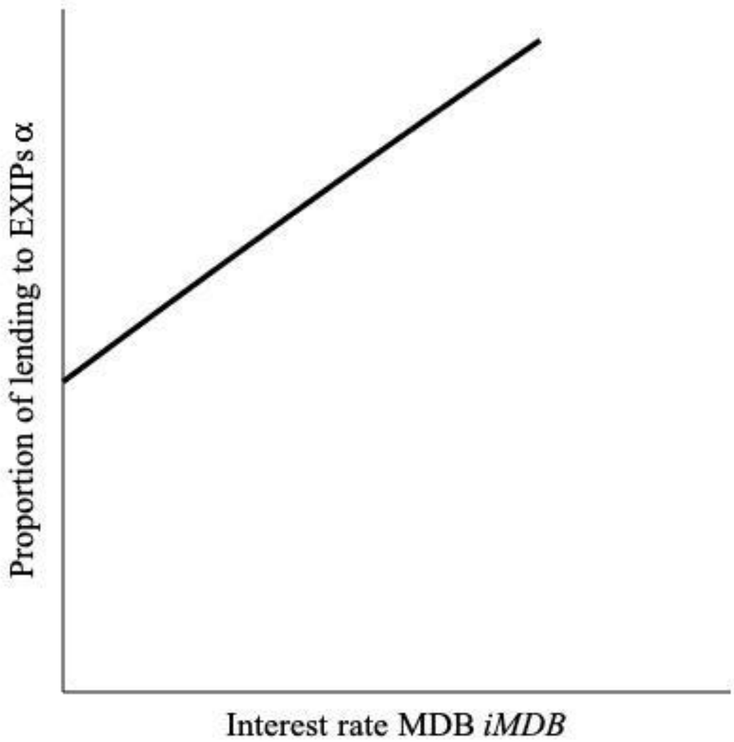
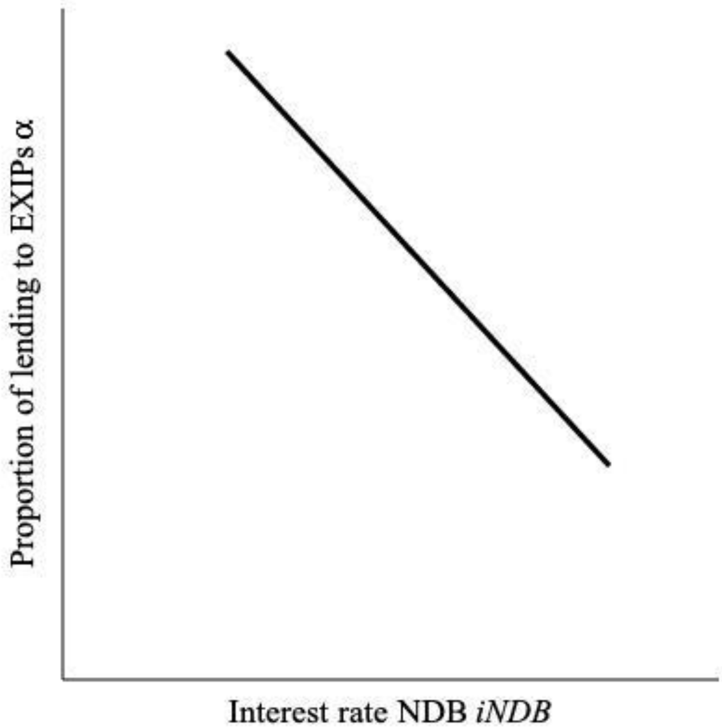


Figure 8. Proportion of lending to EXIPs in relation to the interest rate charged by the NDB



and condition 1 is not met. Only when the net demand of USD is zero or negative (meaning that the supply is higher than the demand of USD), will the exchange rate be $S_1 = S_0$. In this case, condition 1 is met. Thus, the NDB needs to choose $\alpha*$ and $(1 - \alpha*)$ so that the net demand of USD is equal or lower to zero, which implies that the optimal proportions are

$$\alpha^* = \frac{(1 + i_{MDB})}{(1 + r_{EXIP})}; \qquad (7)$$

$$(1 - \alpha^*) = 1 - \frac{(1 + i_{MDB})}{(1 + r_{EXIP})}. \qquad (8)$$

Thus, when there is scarce USD liquidity, the NDB needs to lend a sufficient proportion to EXIPs ($\alpha*$), so that the supply of USD $((1+r_{EXIP})\cdot\alpha*\cdot l_{USD})$ is sufficient to meet the demand for USD $((1+i_{MDB})\cdot l_{USD})$, and avoid a large depreciation of the local currency Loc\$ (S_1). Clearly, a higher rate of return of EXIPs (r_{EXIP}), means higher supply of USD, and allows a higher proportion of lending to DOIPs ($1-\alpha*$). Further, a lower interest rate charged by the MDB (i_{MDB}), implies a higher proportion of lending to DOIPs. The reason is that a lower interest rate i_{MDB} implies a lower demand for USD. Note that the interest rate charged by the NDB (i_{NDB}) does not affect the optimal behavior of the NDB, as it did in the case of normal USD liquidity, because in this case with scarce USD liquidity having more local currency Loc\$ funds does not help you to buy more USD. Finally, note that the case with scarce USD liquidity implies that the proportion of lending to DOIPs ($1-\alpha*$) is lower in comparison to the cases with normal and abundant USD liquidity.

2.2. MDB refinancing to the NDB

In this subsection, we deepen the analyzes by adding an intermediate period where the MDB may refinance the NDB. Thus, we now have 3 periods, where decisions are made in the initial period 0; some of the uncertainty is revealed in the intermediate period 1, and part of the MDB loan is refinanced; and the rest of the uncertainty is revealed and the final payoffs are settled in the final period 2.

The model setup follows the basic model from subsection 2.1. Still, in period 0, the MDB lends a fixed amount l_{USD} of USD to the NDB with the loan maturing in the intermediate period 1. Note that all the different loans in this subsection have a maturity of one period. Also, in the initial period 0, the NDB exchanges the USD received by the MDB to get local currency Loc\$ for onlending to EXIPs and DOIPs, with the loans and real investment projects also maturing in the intermediate period 1. Now, however, the MDB is willing to refinance $\gamma\cdot l_{USD}$, where $\gamma \leq 1$, to the NDB in the intermediate period 1, at the same interest rate i_{MDB}.

This USD denominated refinancing allows the NDB to postpone the payment of a certain amount of USD to the final period 2. Thus, the NDB will also end up having some spare local currency Loc\$ funds in the intermediate period 1, which were received from the repayment of the loans by the EXIPS and DOIPs, but were not exchanged into USD due to the refinancing by the MDB. The spare local currency Loc\$ funds in the intermediate period 1 are $L_{Loc\$}=(1+i_{NDB})\cdot l_{Loc\$}-(1+i_{MDB}-\gamma)\cdot l_{USD}\cdot S_1$. These disposable local currency Loc$ funds $L_{Loc\$}$ are lent to new EXIPs and DOIPs with maturity in the final period 2 and at the interest rate i_{NDB}. For the NDB to have incentives to lend to these new EXIPs and DOIPs, we assume that in the intermediate period 1, the expected exchange rate of the final period 2 $E_1(S_2)$, and the expected rate of returns $E_1(r_{EXIP})$ and $E_1(r_{DOIP})$ are such that $(1+E_1(r_{EXIP}))\cdot E_1(S_2)/S_1\geq(1+i_{NDB})$ and $(1+E_1(r_{DOIP}))\geq(1+i_{NDB})$.

In the final period 2, for the NDB to pay back $(1+i_{MDB})\cdot\gamma\cdot l_{USD}$ to the MDB, the NDB needs to exchange sufficient funds into USD at an exchange rate of S_2. For the MDB to have incentives to refinance the NDB in the intermediate period 1 without making expected losses, we assume that in the intermediate period 1, the following condition holds:

$$(1+i_{MDB})\cdot\gamma\cdot l_{USD}\leq(1+i_{NDB})\cdot L_{Loc\$}/E_1(S_2). \qquad (9)$$

Further, as in subsection 2.1, it is necessary that in the initial period 0, the following condition holds:

$$(1+i_{MDB}-\gamma)\leq(1+i_{NDB})\cdot S_0/E_0(S_1). \qquad (10)$$

In this new model setup, the NDB needs to choose the optimal proportions of lending to EXIPs and DOIPs not only in the initial period 0 (α_0^* and $(1-\alpha_0^*)$), but also the optimal proportions of new lending to EXIPs and DOIPs in the intermediate period 1 1 (α_1^* and $(1-\alpha_1^*)$).

For simplicity reasons, we keep on assuming that the optimal behavior of the MDB in the initial period 0 is to lend l_{USD} to the NDB, but without making expected losses in the intermediate period 1 and the final period 2. Also, we assume that the maximization problem for the NDB is to maximize the proportions $(1-\alpha_0)$ and $(1-\alpha_1)$ of onlending that goes to DOIPs in the initial period 0 and in the intermediate period 1, respectively. Again, as in subsection 2.1, the optimal behavior of the NDB in the initial period 0 and in the intermediate period 1 is dependent on the values of the expected exchange rates, so we will have three cases depending on the USD liquidity situation.

In the first case, with abundant USD liquidity, both in the intermediate period 1 and the final period 2, the dealer is willing to exchange an infinite amount of local currency Loc$ for USD at a fixed exchange rate, given by $S_2=S_1=S_0$. This means that $E_1(S_2)=E_0(S_1)=S_0$. In the second case, with normal USD liquidity, the dealer is willing to exchange any amount of local currency Loc$ for USD but at a variable exchange rate that is positively related to the net demand for USD by the NDB and the EXIPs in each period. Accordingly, we assume that, in the intermediate period 1, the exchange rate $S_1=S_0+b\cdot((1+i_{MDB}-\gamma)\cdot l_{USD}-(1+r_{EXIP})\cdot\alpha_0\cdot l_{USD})$, and that, in the final period 2, $S_2=S_1+b\cdot((1+i_{MDB})\cdot\gamma\cdot l_{USD}-(1+r_{EXIP})\cdot\alpha_1\cdot L_{Loc\$}/S_1$. This means that $E_0(S_1)=S_0+b\cdot((1+i_{MDB}-\gamma)\cdot l_{USD}-(1+r_{EXIP})\cdot\alpha_0\cdot l_{USD})$ and that $E_0(S_2)=E_0(S_1)+b\cdot((1+i_{MDB})\cdot\gamma\cdot l_{USD}-(1+r_{EXIP})\cdot\alpha_1\cdot L_{Loc\$}/E_0(S_1))$. For the third case, with scarce USD liquidity, in both the intermediate period 1 and the final period 2, the exchange rate is $S_2 = S_1 = S_0$ if the net demand for USD by the NDB and the EXIPs is less or equal to zero, which requires $(1+i_{MDB}-\gamma)\leq(1+r_{EXIP})\cdot\alpha_1$ in the intermediate period 1 and $(1+i_{MDB})\cdot\gamma\leq(1+r_{EXIP})\cdot\alpha_2\cdot(1+i_{NDB})-(1+i_{MDB}-\gamma)$ in the final period 2. Again, if the net demand for USD by the NDB and the EXIPs is greater than zero in any period, the offered exchange rate tends to infinity ($S_1\rightarrow\infty$).

In the first case with abundant USD liquidity, the NDB may choose the optimal proportions $(1-\alpha_0^*)$ and $(1-\alpha_1^*)$ of onlending that goes to DOIPs in the initial period 0 and in the intermediate period 1, respectively, without being constrained by the exchange rate or balance of payment problems. Thus, the NDB will optimally choose to lend all the available funds in the initial period 0 and the intermediate period 1 to DOIPs $(1-\alpha_0^* = 1$, and $1-\alpha_1^* = 1)$ and no funds to EXIPs ($\alpha_0^* = 0$, and $\alpha_1^* = 0$).

In the second case with normal USD liquidity, when the NDB chooses the optimal proportions $(1-\alpha_0^*)$ and $(1-\alpha_1^*)$ of onlending to DOIPs, the NDB needs to consider how these decisions affect the foreign exchange rate in the intermediate period 1 and the final period 2.

In the intermediate period 1, the NDB needs to choose the maximal $(1-\alpha_1^*)$, given that the condition 9 holds. This means that the chosen α_1 and $(1-\alpha_1)$ need to respect the following condition:

$$\alpha_1 \geq \frac{S_1 \cdot (I_{USD}^2 \cdot b \cdot \gamma^2 \cdot (1+i_{MDB})^2 + I_{USD} \cdot S_1 \cdot \gamma \cdot (1+i_{MDB}) - L_{Loc\$} \cdot (1+i_{NDB}))}{L_{Loc\$} \cdot I_{USD} \cdot b \cdot \gamma \cdot (1+r_{EXIP}) \cdot (1+i_{MDB})}. \quad (11)$$

Clearly, from condition 11, the optimal behavior of the NDB in the intermediate period 1 is to to choose the following proportions

$$\alpha_1^* = \frac{S_1 \cdot (I_{USD}^2 \cdot b \cdot \gamma^2 \cdot (1+i_{MDB})^2 + I_{USD} \cdot S_1 \cdot \gamma \cdot (1+i_{MDB}) - L_{Loc\$} \cdot (1+i_{NDB}))}{L_{Loc\$} \cdot I_{USD} \cdot b \cdot \gamma \cdot (1+r_{EXIP}) \cdot (1+i_{MDB})}. \quad (12)$$

$$1-\alpha_1^* = 1 - \frac{S_1 \cdot (I_{USD}^2 \cdot b \cdot \gamma^2 \cdot (1+i_{MDB})^2 + I_{USD} \cdot S_1 \cdot \gamma \cdot (1+i_{MDB}) - L_{Loc\$} \cdot (1+i_{NDB}))}{L_{Loc\$} \cdot I_{USD} \cdot b \cdot \gamma \cdot (1+r_{EXIP}) \cdot (1+i_{MDB})} \quad (13)$$

In the initial period 0, the NDB needs to choose the maximal $(1-\alpha_0^*)$, given that the condition 10 holds. This means that the chosen α_0 and $(1-\alpha_0)$ need to respect the following condition:

$$\alpha_0 \geq \frac{b \cdot (1+i_{MDB}-\gamma)^2 \cdot I_{USD} - S_0 \cdot (i_{NDB}+\gamma-i_{MDB})}{I_{USD} \cdot b \cdot (1+i_{MDB}-\gamma) \cdot (1+r_{EXIP})} \quad (14)$$

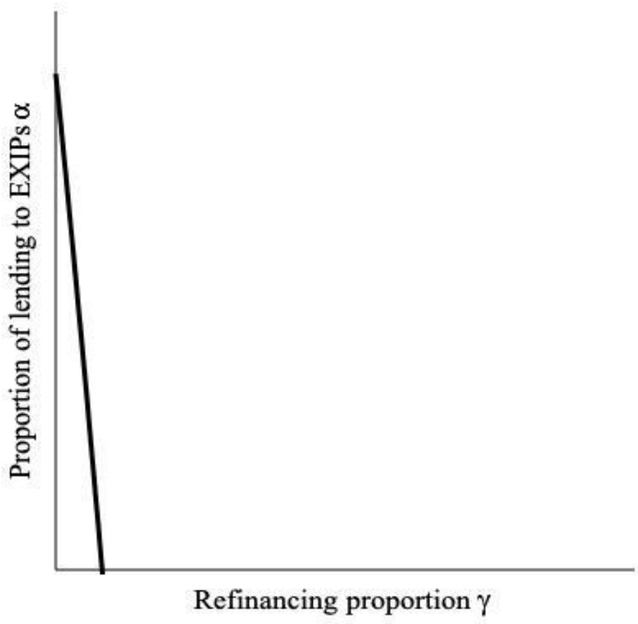
Clearly, from condition 14, the optimal behavior of the NDB in the intermediate period 1 is to choose the following proportions

$$\alpha_0^* = \frac{b \cdot (1+i_{MDB}-\gamma)^2 \cdot I_{USD} - S_0 \cdot (i_{NDB}+\gamma-i_{MDB})}{I_{USD} \cdot b \cdot (1+i_{MDB}-\gamma) \cdot (1+r_{EXIP})} \quad (15)$$

$$1-\alpha_0^* = 1 - \frac{b \cdot (1+i_{MDB}-\gamma)^2 \cdot I_{USD} - S_0 \cdot (i_{NDB}+\gamma-i_{MDB})}{I_{USD} \cdot b \cdot (1+i_{MDB}-\gamma) \cdot (1+r_{EXIP})} \quad (16)$$

Clearly, there is a positive relationship between γ, the proportion of refinancing by the MDB, and the proportion $(1-\alpha_0^*)$ of onlending to DOIPs. Inversely, as figure 9 shows, there is a negative relationship between γ and the proportion α_0^* of onlending to EXIPs. Moreover, when the proportion of refinancing is large enough, the NDB may lend all its funds in the initial period 0 to DOIPs $(1-\alpha_0^*=1)$.

Figure 9. Proportion of lending to EXIPs in relation to the proportion of refinancing by the MDB



Comparing this case with refinancing (equation 16) with the normal USD liquidity case without refinancing (equation 6), analyzed in subsection 2.1, we get that the proportion of lending to DOIPs $(1-\alpha_0^*)$ in the initial period 0 for this case with refinancing is higher, i.e. $(1-\alpha_0^*) > (1-\alpha^*)$. Note that the refinancing of the NDB allows the NDB to finance a larger proportion of DOIPs in the initial period 0 because now the NDB has an extra period to repay the USD loans to the MDB.

In the third case with scarce USD liquidity, in the initial period 0, when the NDB chooses the optimal proportion $(1-\alpha*)$ of onlending to DOIPs, the NDB is bound by the lack of USD liquidity and has to secure that the net demand of USD is zero or negative. Accordingly, the NDB needs to choose α_0^* and $(1-\alpha_0^*)$ so that the net demand of USD is equal or lower to zero, which implies that the optimal proportions are

$$\alpha_0^* = \frac{(1+i_{MDB}-\gamma)}{(1+r_{EXIP})}; \quad (17)$$

$$(1-\alpha_0^*) = 1 - \frac{(1+i_{MDB}-\gamma)}{(1+r_{EXIP})}. \quad (18)$$

Thus, when there is scarce USD liquidity, the proportion of refinancing by the MDB (γ) positively affects the proportion ($1 - \alpha_0^*$) of onlending to DOIPs in the initial period 0. Inversely, there is a negative relationship between γ and the proportion of onlending to EXIPs in the initial period 0. Again, the case with scarce USD liquidity has a lower proportion of lending to DOIPs ($1 - \alpha_0^*$) in comparison to the cases with normal and abundant USD liquidity.

Conclusions

In this paper we present a theoretical model where NDBs need to optimally choose the proportion of onlending that goes to EXIPs and DOIPs. We analyze three different scenarios depending on the availability of USD liquidity in the foreign exchange market of the developing country: a first case with abundant USD liquidity, a second case with normal USD liquidity, and a third case with scarce USD liquidity. Policy implications.

In the case with abundant USD liquidity, the NDB may freely choose the proportion of lending between the two types of investment projects, without any need to consider how this decision affect the foreign exchange market. In the scenario with normal USD liquidity, the NDB needs to consider how his decision affects the foreign exchange market, but needs not worry about balance of payment problems. The NDB can lend a certain proportion to DOIPs, but has to lend a certain proportion to EXIPs, so as to increase in the future the supply of USD in the local foreign exchange market and avoid a large depreciation of the local currency. In the scenario with scarce USD liquidity, the NDB is bound by the foreign exchange market and balance of payment constraints. Now, the NDB has to choose a higher proportion of EXIPs, and a lower proportion of DOIPs, than the cases with abundant and normal USD liquidity.

It is important that both NDBs and MDBs consider foreign exchange and balance of payment constraints when choosing what types of investment projects to finance. If MDBs want to increase the proportion of onlending that goes to DOIPs, they also need to increase their refinancing to NDBs, and give NDBs more time to pay back their loans. Further, it is important that MDBs reduce the interest rate that they charge NDBs.

In the current COVID pandemic, where the availability of USD liquidity has deteriorated for developing countries, it is key to increase the MDBs' refinancing to NDBs and lower the interest rate charged.

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