

Exchange rate and balance of payment crisis risks in the global development finance architecture*

Alfredo Schclarek[†]

Jiajun Xu[‡]

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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. In addition, high return EXIPs need to be financed to increase the supply of hard currency.

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[†]National Scientific and Technical Research Council (CONICET), and Department of Economics, Universidad Nacional de Córdoba, Argentina; e-mail: alfredo@eco.unc.edu.ar; www.cbaeconomia.com.

[‡]Institute of New Structural Economics, Peking University, China; e-mail: jiajunxu@nsd.pku.edu.cn.

1 Introduction

In the past six decades, 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 (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. Certainly, 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. Still, there are also risks that may jeopardize that collaboration. Among the main risks, 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.

The objective of this research paper is to analyse the exchange rate and balance of payment crisis risks that arise when a MDB finances itself in the international bond market to lend USD to a NDB for it to do on-lending to investment projects (IPs) in its own 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 investment projects, which improve the future current account balance, the exchange rate and balance of payment crisis 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, the exchange rate and balance of payment crisis risks increase because DOIPs generate local currency proceeds and do not help increasing the supply of foreign exchange in the host country.¹ As will become clear below, the exchange rate and balance of payment crisis risks arise both when the loans from the NDB to the IPs are USD denominated as well as when they are local currency denominated.

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 bond market in order to lend USD funds to a NDB, which onlends, in turn, in local currency to investment projects in its own country (host country). Further, we model the monetary transactions involved when the investment projects produce their monetary proceeds and all the loans, both in USD and in local currency, have to be paid back, distinguishing two special cases. The first case is when the investment project is export-

¹DOIPs may generate positive externalities and development impact, such as the fostering of small and medium-sized enterprises and green finance. However, in this paper we are not analyzing these positive aspects of domestic-oriented projects, but focusing on the exchange rate and balance of payment crisis risks associated with its funding in USD.

enhancing and increases the supply of foreign exchange in the host country's banking system. Here the monetary transactions involved in the repayment of the loans are executed without significantly affecting the exchange rate or straining the foreign exchange market. In the second case, we analyze the consequences when the investment project is domestically-oriented and is not helping to increase the supply of foreign exchange. In this case, in order to avoid a big depreciation or a balance of payment crisis, the NDB needs to get USD funds generated by other export-oriented investment projects or by having access to the foreign exchange reserves of the central bank. Alternatively, the MDB may refinance the NDB (capital and interests) in order to reduce the demand for USD funds in the domestic foreign exchange market. Note that in this case, the MDB also has to refinance its own liabilities (bond issuance) in the international bond market.

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.

Regarding the related literature, there is quite a consensus that current account deficits are a problematic macroeconomic and financial issue (see, for example, Edwards (2002); Obstfeld (2012); Ocampo (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 the 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; Levy-Yeyati, 2006). Other theoretical studies analyzing foreign indebtedness, include among other, Acharya et al. (2020); Aghion et al. (2004); Giavazzi and Spaventa (2011); Jeanne and Zettelmeyer (2002); Korinek (2011).

Regarding the cooperation of MDBs and NDBs, and the exchange rate and balance of payments crisis risks that results from this cooperation, to the best of our knowledge our paper is the first to formally analyze these issues. However, Bechelaine and Bresser-Pereira (2019), and Hoschka (2005) analyze the exchange rate risks that arise when MDBs lend in USD and the prospects of lending in local currency; Humphrey (2016) discusses the funding of MDBs in the international bond market; Ocampo and Ortega (2020), Shelepov (2017), and Wang (2017) discuss the cooperation between MDBs, NDBs and local governments; and Brei and Schclarek (2018), Galindo and Panizza (2018) and Perry (2009) analyze the countercyclical lending behavior of MDBs and NDBs.

The rest of the paper is organized as follows. In section 2, 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 3. Specifically, in section 3, 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 section 4, we present our conclusions.

2 Balance-Sheet Presentation

In this section, we graphically analyze the different payments and settlements, in particular interbank payments, that arise when the involved agents interact financially. First, in subsection 2.1, we analyze the process in which the MDB obtains financing by issuing bonds in the international bond market and uses those USD funds to finance the NDB, who do on-lending to a real investment project (IP). Second, in subsection 2.2, we analyze the process of on-lending whereby the NDB provides a local currency Loc\$ denominated loan to the IP. Finally, in subsections 2.3 and 2.4, we analyze the repayment process of the IP, the NDB and the MDB, distinguishing between export-enhancing and domestic-oriented IPs.

We explicitly model these financial transactions by analyzing, at each point in time, the balance sheets of the involved agents using T-accounts: that is, assets on the left-hand side and liabilities on the right-hand side, following the “money view” monetary theory, presented in Mehrling (2011, 2012); Mehrling et al. (2015); Schclarek et al. (2019). Every entry to an account has a subscript, which refers to the agent for which that entry represent an asset, and a superscript, which refers to the agent for which that entry represents a liability. Further, the currency denomination of each entry is explicitly indicated. For example, $USD Bond_{ICB}^{MDB}$ is a USD denominated bond that is an asset for the ICB and a liability for the MDB.

2.1 The MDB obtains financing to finance the NDB

In this subsection, we analyze the financial and monetary mechanism by which the MDB obtains financing by issuing bonds in the international bond market and uses those USD funds to provide a USD denominated loan to the NDB. Figure 1 depicts this process.

In the initial period ($T=0$), agents have neither assets nor liabilities. In the first period ($T=1$), the MDB issues a bond in the international bond market ($+USD Bond_{ICB}^{MDB}$), which is acquired by an International Commercial Bank (ICB). The ICB debits the corresponding amount into the MDB's bank account at the ICB ($+USD Dep_{MDB}^{ICB}$). In the second period ($T=2$), the MDB uses these USD funds to grant a USD denominated loan to the NDB ($+USD Loan_{MDB}^{NDB}$) and, thus, transfers its deposits in the ICB ($-USD Dep_{MDB}^{ICB}$) to the NDB ($+USD Dep_{NDB}^{ICB}$).

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 ($USD Dep_{NDB}^{ICB}$) and possesses a USD liability with the MDB ($USD Loan_{MDB}^{NDB}$). The MDB, in turn, possesses in the asset-side a USD loan granted to the NDB ($USD Loan_{MDB}^{NDB}$), and in the liability-side the issued USD denominated bonds ($USD Bond_{ICB}^{MDB}$). Clearly, for the MDB to be able to pay back the issued bonds to the ICB, the MDB is dependent on the NDB paying back its loan to the MDB. Thus, it is in the interest of both the MDB and ICB that the onlending of the NDB to the IP is profitable.

T	Int Com Bank		Mult Dev Bank		Nat Dev Bank	
	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
0						
1	$+USD Bond_{ICB}^{MDB}$			$+USD Bond_{ICB}^{MDB}$		
		$+USD Dep_{MDB}^{ICB}$	$+USD Dep_{MDB}^{ICB}$			
			$+USD Loan_{MDB}^{NDB}$			$+USD Loan_{MDB}^{NDB}$
2		$-USD Dep_{MDB}^{ICB}$	$-USD Dep_{MDB}^{ICB}$			
		$+USD Dep_{NDB}^{ICB}$			$+USD Dep_{NDB}^{ICB}$	
F	$USD Bond_{ICB}^{MDB}$	$USD Dep_{NDB}^{ICB}$	$USD Loan_{MDB}^{NDB}$	$USD Bond_{ICB}^{MDB}$	$USD Dep_{NDB}^{ICB}$	$USD Loan_{MDB}^{NDB}$

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

2.2 The NDB provide lending to the IP

In this subsection, we analyze the financial and monetary mechanism by which the NDB finances the IP through a local currency Loc\$ denominated loan. Figure 2 depicts this process, where the starting point is final line (F) of figure 1.²

In the first period ($T=1$), since the NDB is lending to the IP in local currency Loc\$ and it maintains USD deposits at the ICB, it needs to transfer these USD deposits to its local currency Loc\$ bank account in the LCB. Thus, the NDB uses its USD deposits at the ICB ($-USD Dep_{NDB}^{ICB}$) to exchange them for local currency Loc\$ from the LCB at a given exchange rate S and receives local currency Loc\$ deposits at the LCB ($+\$Loc Dep_{NDB}^{LCB}$). Note that this deposit transfer and foreign exchange operation implies a balance sheet expansion for the LCB that sees both its assets increase ($+USD Dep_{LCB}^{ICB}$) and its liabilities increase ($+\$Loc Dep_{NDB}^{LCB}$). In the second period ($T=2$), the NDB can now grant a loan to the IP ($+\$Loc Loan_{NDB}^{IP}$) by transferring its local currency Loc\$ deposits ($-\$Loc Dep_{NDB}^{LCB}$) to the bank account of the IP at the LCB ($+\$Loc Dep_{IP}^{LCB}$).

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 unchanged, while its liabilities are now in possession of the LCB ($USD Dep_{LCB}^{ICB}$). The balance sheet of the LCB has been increased on both sides: on the asset-side by $USD Dep_{LCB}^{ICB}$, and on the liability-side by $\$Loc Dep_{IP}^{LCB}$, which implies that there is a currency mismatch between its assets and liabilities. The NDB, in turn, also faces a currency mismatch between its assets and liabilities: while its liabilities are denominated in USD (recall $USD Loan_{MDB}^{NDB}$ from figure 1), its assets are now denominated in local currency Loc\$ ($\$Loc Loan_{NDB}^{LCB}$). Note, however, that the currency mismatch of the NDB is worse than the currency mismatch of the LCB because it is worse, in terms of exchange rate risks, to have assets in local currency Loc\$ and liabilities in USD. This is clear if one considers that in the case of a strong depreciation, the local currency Loc\$ value of the USD denominated liabilities increases substantially while the USD value of the local currency Loc\$ denominated assets diminish substantially. Finally, the IP has acquired the necessary funds to finance and develop its real investment project ($\$Loc Dep_{IP}^{LCB}$) and maintains a liability denominated in local currency Loc\$ ($\$Loc Loan_{NDB}^{LCB}$).

²The 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.

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

Figure 2: The NDB finances the IP in local currency Loc\$

2.3 Repayment when the IP is export-enhancing

In this subsection we analyze the financial and monetary mechanism by which all the different liabilities of the IP, the NDB and the MDB are canceled, considering the scenario where the IP is export-enhancing and produce USD proceeds. First, the IP obtains USD deposits as a result of the monetary proceeds of the export-enhancing project developed, and uses them in the financial operation to cancel its liability with the NDB. Second, the NDB uses these financial proceeds to meet its commitment with the MDB, which in turn pays back its issued bonds in the possession of the ICB.

Figure 3 depicts this process. The initial period ($T=0$) corresponds to the situation, with respect to the liabilities and assets of the different agents, prevalent in the final lines (F) of figures 1 and 2. In addition, in the initial period ($T=0$), the IP, as a result of the use of the local currency Loc\$ funds obtained from the loan granted by the NDB and the development of the export-enhancing investment project, has tradable goods ($TradGood$) that it can sell to a foreign firm, which has USD deposits at the ICB ($USD Dep_{firm}^{ICB}$).³ In period 1 ($T=1$), the IP sells these tradable goods to the foreign firm ($-TradGood$). The latter pays those goods by transferring its USD deposits at the ICB ($-USD Dep_{firm}^{ICB}$) to the IP's bank account in the ICB ($+USD Dep_{IP}^{ICB}$).

The second period of figure 3 ($T=2$) shows the financial operations by which the IP cancels its local currency Loc\$ denominated liability with the NDB. Firstly, the IP transfers the USD deposits at the ICB obtained in $T=1$ ($-USD Dep_{IP}^{ICB}$) to its local currency Loc\$ account in the LCB ($+\$Loc Dep_{IP}^{LCB}$). Note that this deposit transfer implies a foreign exchange operation at a given exchange rate S and a balance sheet expansion for the LCB that is buying those USD ($+USD Dep_{LCB}^{ICB}$) by creating local currency Loc\$ deposits ($+\$Loc Dep_{IP}^{LCB}$), which is a liability for the LCB. Secondly, with these local currency Loc\$ deposits ($-\$Loc Dep_{IP}^{LCB}$), the IP cancels its loan with the NDB ($-\$Loc Loan_{NDB}^{IP}$) and the NDB receives local currency Loc\$ deposits at the LCB ($+\$Loc Dep_{NDB}^{LCB}$).

In the third period ($T=3$), the NDB uses its local currency Loc\$ deposits at the LCB ($-\$Loc Dep_{NDB}^{LCB}$) to exchange them for USD from the LCB at a given exchange rate S and receives USD deposits at the ICB ($+USD Dep_{NDB}^{ICB}$). Note that this foreign exchange operation implies a balance sheet contraction for the LCB that sees both its assets diminish ($-USD Dep_{LCB}^{ICB}$) and its liabilities diminish ($-\$Loc Dep_{NDB}^{LCB}$). With the USD deposits, the NDB can now cancel its debt with the MDB ($-USD Loan_{MDB}^{NDB}$) by transferring its USD deposits ($-USD Dep_{NDB}^{ICB}$) to the MDB ($+USD Dep_{MDB}^{ICB}$). Finally, when ($T=4$), the MDB cancels its liabilities with the ICB ($-USD Bond_{ICB}^{MDB}$) by transferring its USD deposits at the ICB ($-USD Dep_{MDB}^{ICB}$).

Concluding, at the end of the process described in this subsection, all liabilities have been cancelled without suffering any problems with lack of USD, i.e. there were no balance of payment crisis risks. This is a direct consequence of the IP being export-enhancing, and producing USD proceeds. With respect to the exchange rate risks, in the process described above, there were two foreign exchange operations. Moreover, the local currency Loc\$ value of the IP's USD proceeds, with which to cancel its local currency Loc\$ denominated liability, and the USD value of the NDB's local currency Loc\$ proceeds, with which to cancel its USD denominated liability, depend on the prevalent foreign exchange rate S . Thus, it is evident that the IP, the

³For simplicity reasons we do not explicitly model the balance sheet of the foreign firm, besides showing that it has USD deposits at the ICB.

NDB, the MDB and the ICB face exchange rate risks. However, the exchange rate risks are limited by the fact that the IP is export-enhancing and produce a certain USD supply in the domestic foreign exchange market. In addition, the USD proceeds of the IP benefit, in terms of eliminating balance of payment crisis risks and limiting the exchange rate risks, not only the IP, but also the NDB, the MDB and the ICB.

T	Int Com Bank		Mult Dev Bank		Nat Dev Bank		Loc Com Bank		Investment Project	
	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
0	$USD\ Bond_{ICB}^{MDB}$	$USD\ Dep_{Irrm}^{ICB}$	$USD\ Loan_{MDB}^{NDB}$	$USD\ Bond_{ICB}^{MDB}$	$USD\ Loan_{NDB}^{IP}$	$USD\ Loan_{MDB}^{NDB}$		$TradGood$	$USD\ Loan_{NDB}^{IP}$	
1		$-USD\ Dep_{Irrm}^{ICB}$						$-TradGood$		
		$+USD\ Dep_{IP}^{ICB}$						$+USD\ Dep_{IP}^{ICB}$		
		$-USD\ Dep_{IP}^{ICB}$						$-USD\ Dep_{IP}^{ICB}$		
2		$+USD\ Dep_{LCB}^{ICB}$					$+USD\ Dep_{LCB}^{ICB}$	$+Loc\ Dep_{IP}^{ICB}$		
					$-\$Loc\ Loan_{NDB}^{IP}$			$-\$Loc\ Dep_{IP}^{ICB}$		$-\$Loc\ Loan_{NDB}^{IP}$
					$+\$Loc\ Dep_{NDB}^{ICB}$			$+\$Loc\ Dep_{NDB}^{ICB}$		
		$-USD\ Dep_{LCB}^{ICB}$			$-\$Loc\ Dep_{NDB}^{ICB}$			$-\$Loc\ Dep_{NDB}^{ICB}$		
		$+USD\ Dep_{NDB}^{ICB}$			$+USD\ Dep_{NDB}^{ICB}$					
		$-USD\ Dep_{NDB}^{ICB}$			$-USD\ Dep_{NDB}^{ICB}$					
		$+USD\ Dep_{MDB}^{ICB}$								
		$-USD\ Dep_{MDB}^{ICB}$								
4										
	$-USD\ Bond_{ICB}^{MDB}$			$-USD\ Bond_{ICB}^{MDB}$						
F										

Figure 3: Repayment of loans and bonds when the IP is export-enhancing

2.4 Repayment when IP is domestically-oriented

In this subsection we analyze the financial and monetary mechanism by which the liabilities of the IP, the NDB and the MDB are cancelled, considering the scenario where the IP is domestic-oriented and produce only local currency Loc\$ proceeds. First, in figure 4, we show the process by which an IP produces goods that are sold within the domestic market, obtains local currency Loc\$ proceeds, and uses those funds to pay back its local currency Loc\$ denominated liability with the NDB. Second, in figure 5, we analyse the difficulties that arise at the time of cancelling the liabilities of the NDB with the MDB and the liabilities of the MDB with the ICB, when the NDB has financed itself in USD and has financed a domestic-oriented investment project that is not generating USD proceeds. Concretely, we analyze the case when the MDB refinances the NDB by granting it a new loan for it to pay back the old loan and the ICB refinances the MDB by buying new bonds issued by the MDB for it to repay the old matured bonds.

Note that the case analyzed in figure 5 is only one of the possible solutions to the problem caused by the currency mismatch between the assets and liabilities of the NDB. Alternatively, and emphasising that there are other possible solutions not analyzed in this subsection, the NDB can use the local currency Loc\$ received from the IP to buy USD from the LCB to pay back the MDB. In this case, the LCB would have to give its own USD in exchange for the local currency Loc\$, or find another agent that is willing to exchange its USD for local currency Loc\$, at an exchange rate S . In this alternative, the LCB would be acting as a dealer in the foreign exchange market.

Analyzing figure 4 in detail, the initial period ($T=0$) corresponds to the situation prevalent in the final lines (F) of figures 1 and 2, with respect to the liabilities and assets of the different agents. In addition, in the initial period ($T=0$), the IP, as a result of the use of the local currency Loc\$ funds obtained from the loan granted by the NDB and the development of the domestic-oriented investment project, has non-tradable goods ($N\text{Trad Good}$) that it can sell to a local firm, which have local currency Loc\$ deposits at the LCB ($\$Loc Dep_{firm}^{LCB}$). In the first period ($T=1$), the IP sells these goods to a local firm ($-N\text{Trad Good}$). The latter pays for those goods by transferring its local currency Loc\$ deposits at the LCB ($-\$Loc Dep_{firm}^{LCB}$) to the IP's bank account in the LCB ($+\$Loc Dep_{IP}^{LCB}$).

The second period of figure 4 ($T=2$) shows the financial operation by which the IP cancels its local currency Loc\$ denominated liability with the NDB ($-\$Loc Loan_{NDB}^{IP}$) by transferring its local currency Loc\$ deposits at the LCB ($-\$Loc Dep_{IP}^{LCB}$) to the NDB ($+\$Loc Dep_{NDB}^{LCB}$). Note that in this case, neither the LCB nor the NDB have obtained USD from the IP, as was the case in the last subsection 2.3. As discussed above, for the NDB to pay back its USD denominated loan with the MDB, it will have to buy USD at the exchange rate S from another agent, different from the USD produced by the IP, that is willing to accept local currency Loc\$ in exchange (this could even be the Central Bank by using its foreign reserves). Alternatively, another solution, discussed in figure 5, is that the NDB obtains a refinancing of the loan by the MDB.

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

Figure 4: Repayment of loans and bonds when the IP is domestically-oriented - first operations

Figure 5 depicts in detail the financial and monetary mechanisms when the MDB refinances the NDB by granting it a new loan for it to pay back the old loan and the ICB refinances the MDB by buying new bonds issued by the MDB for it to repay the old matured bonds. The initial period ($T=0$) corresponds to the situation prevalent in the final line (F) of figure 4. In the first period ($T=1$), the ICB buys new bonds issued by the MDB ($+USD\ Bond_{ICB}^{MDB}$) and pays by crediting USD funds in the bank account of the MDB at the ICB ($+USD\ Dep_{ICB}^{MDB}$). This transaction is the refinancing of the MDB by the ICB. In the second period ($T=2$), the MDB uses those USD deposits ($-USD\ Dep_{ICB}^{MDB}$) to make a new USD denominated loan to the NDB ($+USD\ Loan_{MDB}^{NDB}$) and the NDB receives those USD deposits at the ICB ($+USD\ Dep_{ICB}^{NDB}$). This transaction is the refinancing of NDB by the MDB.

In the third period ($T=3$), the NDB uses the received USD deposits ($-USD\ Dep_{ICB}^{NDB}$) to cancel the initial loan granted by the MDB ($-USD\ Loan_{MDB}^{NDB}$) and the MDB receives those USD deposits at the ICB ($+USD\ Dep_{ICB}^{MDB}$). In the fourth period ($T=4$), the MDB uses the USD deposits at the ICB ($-USD\ Dep_{ICB}^{MDB}$) to cancel the initially issued bonds in possession of the ICB ($-USD\ Bond_{ICB}^{MDB}$).

In the final period ($T=F$), both the NDB and the MDB have refinanced their USD denominated liabilities, despite the investment project being domestically oriented. However, both the NDB and the MDB still have USD denominated liabilities that mature further in the future with the MDB and the ICB, respectively. Moreover, although the MDB may be willing to refinance the liabilities of the NDB, this possibility will also require that the MDB, in turn, obtains itself a refinancing of its liabilities with the ICB.

Concluding, at the end of the process described in this subsection, all the initial USD liabilities have been cancelled, but new USD denominated liabilities were used to avoid suffering problems with lack of USD, i.e. the balance of payment crisis risks were avoided thanks to the refinancing willingness of both the MDB and the ICB. Note, however, that both the NDB and the MDB still have USD denominated liabilities, implying that the balance of payment crisis risks have not been avoided but the final outcome has been postponed into the future due to the willingness and financial capacity of the creditors to refinance the USD denominated liabilities. Moreover, as briefly discussed above, if the refinancing of the USD denominated liabilities is not an option, the avoidance of the materialization of the balance of payment crisis risks is dependent on the willingness of another agent to provide the needed USD in exchange for local currency Loc\$ at the exchange rate S . Thus, when the IP is domestic oriented there are substantial balance of payment crisis risks, not only for the NDB, but also for the MDB and the ICB. Note that the IP is not suffering these risks because it had a local currency Loc\$ denominated liability with the NDB, which it can pay with its local currency Loc\$ proceeds. If the loan from the NDB had been USD denominated, the IP too would have faced balance of payment crisis risks.

With respect to the exchange rate risks, in the process described above, the NDB suffers currency mismatch between its assets and liabilities, even when postponing the final settlement of its USD liabilities with the MDB. Evidently, the cancellation of the NDB's USD denominated liabilities will depend on the USD value of its local currency Loc\$ denominated assets, which is a function of the prevalent exchange rate S . Moreover, balance of payment crises are closely linked with substantial exchange rate depreciations. In addition, if the NDB cannot pay back its liabilities to the MDB, the MDB will also have problems in paying back its liabilities with the ICB. Thus, the NDB, the MDB and the ICB face substantial exchange rate risks when the IP is domestically-oriented. Note, however, that the IP is not suffering exchange rate risks

because both its assets and liabilities are denominated in local currency Loc\$. If the loan from the NDB had been USD denominated, the IP too would have faced exchange rate risks.

T	Int Com Bank		Mult Dev Bank		Nat Dev Bank	
	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
0	$USD\ Bond_{ICB}^{MDB}$		$USD\ Loan_{MDB}^{NDB}$	$USD\ Bond_{ICB}^{MDB}$	$\$Loc\ Dep_{NDB}^{LCB}$	$USD\ Loan_{MDB}^{NDB}$
1	$+USD\ Bond_{ICB}^{MDB}$	$+USD\ Dep_{MDB}^{ICB}$	$+USD\ Dep_{MDB}^{ICB}$	$+USD\ Bond_{ICB}^{MDB}$		
2		$-USD\ Dep_{MDB}^{ICB}$	$+USD\ Loan_{MDB}^{NDB}$		$+USD\ Dep_{NDB}^{ICB}$	$+USD\ Loan_{MDB}^{NDB}$
3		$+USD\ Dep_{NDB}^{ICB}$	$-USD\ Dep_{MDB}^{ICB}$		$-USD\ Dep_{NDB}^{ICB}$	
4	$-USD\ Bond_{ICB}^{MDB}$	$-USD\ Dep_{MDB}^{ICB}$	$+USD\ Dep_{MDB}^{ICB}$	$-USD\ Bond_{ICB}^{MDB}$		$-USD\ Loan_{MDB}^{NDB}$
F	$USD\ Bond_{ICB}^{MDB}$		$USD\ Loan_{MDB}^{NDB}$	$USD\ Bond_{ICB}^{MDB}$	$\$Loc\ Dep_{NDB}^{LCB}$	$USD\ Loan_{MDB}^{NDB}$

Figure 5: Repayment of loans and bonds when the IP is domestically-oriented - second operations

3 Mathematical model of the optimal behavior of the NDB

3.1 Basic model

In this section we present a mathematical model to analyze the MDB lending to the NDB for it to do onlending to real investment projects (IPs). 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 USD amount I_{USD} to the NDB at a fixed and given interest rate of 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 the USD amount $I_{USD} \cdot (1 + i_{MDB})$ to the MDB. Below we analyze the conditions that have to be met for the MDB to lend to the NDB.

Also, in the initial period 0, the NDB invest the proceeds I_{USD} , from the loan by the MDB, into onlending to IPs that maybe EXIPs or DOIPs. However, we assume that the NDB grants all its loans to IPs in local currency Loc\$. Therefore, the NDB needs to exchange the USD that it received from the MDB to get local currency Loc\$ to lend to the IPs. 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 0.⁴ 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 both EXIPs and DOIPs, charging a fixed and given interest rate of i_{NDB} , and loans maturing in the final period 1. The NDB needs to optimally choose the proportion of lending α that goes to the EXIPs and the proportion of lending $(1 - \alpha)$ that goes to the DOIPs, so that the EXIPs and DOIPs may receive lending equivalent to $\alpha \cdot I_{Loc\$}$ and $(1 - \alpha) \cdot I_{Loc\$}$, respectively. Note that by lending in local currency Loc\$ while having USD liabilities, the NDB has a currency mismatch on its balance sheet and it incurs into exchange rate risks. Below we analyze further the optimal decision of the NDB. With the obtained funds from the NDB, the IPs 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, IPs produce stochastic proceeds, given by the stochastic rate of return r , which is different for EXIPs and DOIPs. The expected rate of return in the initial period 0 of the EXIPs is $E_0(r_{EXIP})$ and for the DOIPs it is $E_0(r_{DOIP})$. Furthermore, the EXIPs obtain these proceeds in USD and the DOIPs obtain the proceeds in the local currency Loc\$.

⁴We use the convention that the exchange rate represents the price in local currency Loc\$ of a unit of USD.

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 pay back 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 pay back 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, in the initial period 0, for the NDB to have incentives to lend to IPs without making expected losses, it is necessary that the expected exchange rate of the final period 1 $E_0(S_1)$, the expected rate of returns $E_0(r_{EXIP})$ and $E_0(r_{DOIP})$, and the interest rate i_{NDB} 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 pay back the principal and interests of the USD denominated loan granted by the MDB. Therefore, the NDB needs to exchange into USD, all or part, of the funds received in local currency Loc\$ from its local currency Loc\$ denominated loans to the IPs. Then, to pay back 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 with the MDB. Accordingly, in the initial period 0, for the MDB to have incentives to lend to the NDB without making expected losses, the following must hold: $(1 + i_{MDB}) \cdot I_{USD} \leq (1 + i_{NDB}) \cdot I_{Loc\$}/E_0(S_1)$. Note that this last condition implies that the NDB exchanges into USD all the local currency Loc\$ funds received from the NDB loans to the IPs, 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 domestic foreign exchange market, that could be the central bank, who buy and sell USD and local currency Loc\$.⁵ 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, independently of the demand for USD by the NDB $((1 + i_{MDB}) \cdot I_{USD})$ and the supply of USD by the EXIPs $((1 + r_{EXIP}) \cdot \alpha \cdot I_{USD})$ 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 $ND_{USD} = (1 + i_{MDB}) \cdot I_{USD} - (1 + r_{EXIP}) \cdot \alpha \cdot I_{USD}$. Thus,

⁵For a discussion on the dealer function, please see Mehrling (2011, 2012, 2013); Treynor (1987).

we assume that $S_1 = S_0 + b \cdot ND_{USD}$, where b is a fixed positive coefficient. This means that $E_0(S_1) = S_0 + b \cdot ((1 + i_{MDB}) \cdot I_{USD} - (1 + E_0(r_{EXIP})) \cdot \alpha \cdot I_{USD})$. 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 market exchange rate tends to infinity ($S_1 \rightarrow \infty$). This extreme case represent a situation where the dealer has hit position limits, beyond which it is not prepared, or able, to expand further its exposure to the local currency Loc\$. If $ND_{USD} > 0$, then the dealer stops making markets, the foreign exchange market starts breaking down, and a balance of payment crisis ensues.

Having studied the exchange rate determination in the final period 1 for the three USD liquidity cases, we now turn to analyzing the optimal behavior of the MDB and the NDB in the initial period 0. Regarding the MDB, the conditions that have to be met for the MDB to lend USD funds equivalent to I_{USD} to the NDB in the initial period 0, we assume that the MDB requires not making expected losses.⁶ This condition implies that for the MDB to lend to the NDB the following must hold:

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

In the case of the NDB, for simplicity reasons, we assume that the maximization problem for the NDB is to maximize the proportion $(1 - \alpha)$ of onlending that goes to the DOIPs, and minimize the proportion α of onlending that goes to the EXIPs. This special preference for the DOIPs, and dislike of the EXIPs, may be justified if the DOIPs provide higher social welfare than the EXIPs. This assumption may also have a political economy justification if the DOIPs provide higher electoral gains for politicians than the EXIPs (Castro and Martins, 2018; Drazen and Eslava, 2010). Note that we have assumed that the NDB charges the same interest rate to the EXIPs and the DOIPs, so the profit maximization condition cannot tell us much about the optimal proportions of lending to the EXIPs and the DOIPs. In any case, this highly simplified utility function is used for simplicity reasons without affecting the main conclusions of this paper. We would reach the same main conclusions had we assumed a utility function for the NDB that implies preferring certain positive, non-zero, proportions α of onlending that goes to the EXIPs and $(1 - \alpha)$ of onlending that goes to the DOIPs.

In addition, when the NDB optimally chooses the proportions α and $(1 - \alpha)$, condition 1 must hold. Further, it will only lend to the IPs if it is not making expected losses, which implies that the following conditions hold:

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

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

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

⁶Although, in reality, banks not only consider the mean but also the variance of their profits, adding the variance of the profits would not change our main results and conclusions. Thus, for simplicity reason, we prefer assuming that banks are risk neutral instead of risk averse in terms of their profits.

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 freely choose in the initial period 0 the optimal proportion of lending α^* that goes to the EXIPs and the optimal proportion of lending $(1 - \alpha^*)$ that goes to the DOIPs, without having to consider how its decision affect the foreign exchange market, or being conditioned by 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, if we assume that $i_{NDB} \geq i_{MDB}$, condition 1 is met because $E_0(S_1) = S_0$. 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.⁷

In the second case with normal USD liquidity, in the initial period 0, when the NDB chooses the optimal proportion of lending α^* that goes to the EXIPs and the optimal proportion of lending $(1 - \alpha^*)$ that goes to the 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 α^* 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 α^* 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 α^* and $(1 - \alpha^*)$ so that the following condition holds

$$\alpha \geq \frac{b \cdot (1 + i_{MDB})^2 \cdot I_{USD} - S_0 \cdot (i_{NDB} - i_{MDB})}{I_{USD} \cdot b \cdot (1 + i_{MDB}) \cdot (1 + E_0(r_{EXIP}))}. \quad (4)$$

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

$$\alpha^* = \frac{b \cdot (1 + i_{MDB})^2 \cdot I_{USD} - S_0 \cdot (i_{NDB} - i_{MDB})}{I_{USD} \cdot b \cdot (1 + i_{MDB}) \cdot (1 + E_0(r_{EXIP}))}, \quad (5)$$

⁷Note that the reason for the NDB to only finance DOIP and no EXIPs is that we assumed that the NDB valued more DOIPs than EXIPs. If the NDB preferred, for whatever reason, certain proportions of EXIPs and DOIPs, it would be able to freely choose those proportions without having to consider how its lending decision affected the exchange rate and the availability of USD liquidity, which is the main conclusion we want to emphasize. Note also that the NDB may prefer a certain proportion of EXIPs in order to increase the supply of USD liquidity so that the Central Bank can accumulate foreign reserves or to appreciate the exchange rate. These motivations are not analyzed in this paper.

$$(1 - \alpha^*) = 1 - \frac{b \cdot (1 + i_{MDB})^2 \cdot I_{USD} - S_0 \cdot (i_{NDB} - i_{MDB})}{I_{USD} \cdot b \cdot (1 + i_{MDB}) \cdot (1 + E_0(r_{EXIP}))}. \quad (6)$$

Thus, when there is normal USD liquidity, the NDB has to lend a certain positive proportion to EXIPs (α^*), so as to increase the expected supply of USD ($(1 + E_0(r_{EXIP})) \cdot \alpha^* \cdot I_{USD}$) and avoid a large expected depreciation of the local currency Loc\$ ($E_0(S_1)$). 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, the higher the expected rate of return of EXIPs ($E_0(r_{EXIP})$), meaning a higher expected supply of USD, allows a higher proportion of lending to DOIPs ($1 - \alpha^*$). 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.

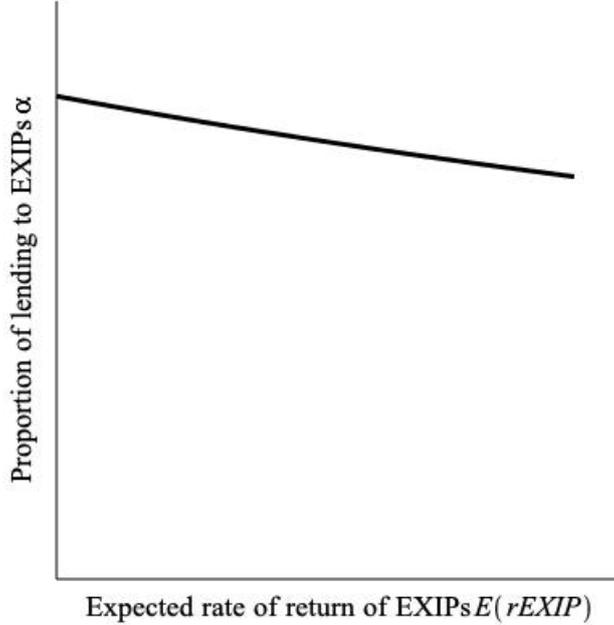


Figure 6: Proportion of lending to EXIPs in relation to the expected rate of return of EXIPs

In the third case with scarce USD liquidity, in the initial period 0, when the NDB chooses the optimal proportion of lending α^* that goes to the EXIPs and the optimal proportion of lending ($1 - \alpha^*$) that goes to the DOIPs, the NDB is constrained by its behavior's consequence in the foreign exchange market and faces 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 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 ($(1 + i_{NDB}) \cdot I_{Loc\$}/S_1$) tends to zero, 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 $S_1 = S_0$.

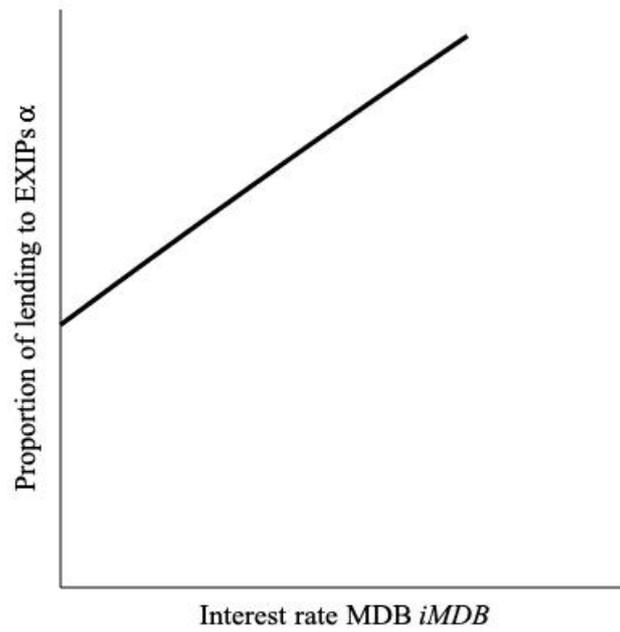


Figure 7: Proportion of lending to EXIPs in relation to the interest rate charged by the MDB

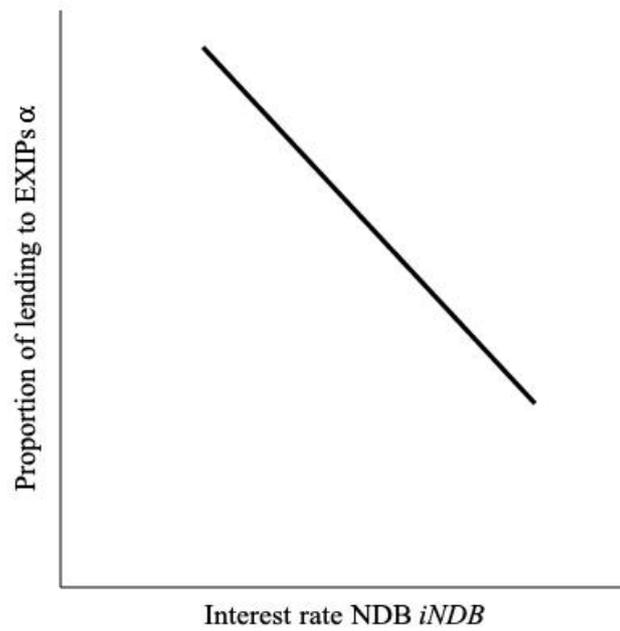


Figure 8: Proportion of lending to EXIPs in relation to the interest rate charged by the NDB

In this case, condition 1 is met. Thus, in the initial period 0, the NDB needs to choose α^* and $(1 - \alpha^*)$ so that the expected net demand of USD is equal or lower to zero, which implies that the optimal proportions are

$$\alpha^* = \frac{(1 + i_{MDB})}{(1 + E_0(r_{EXIP}))}; \quad (7)$$

$$(1 - \alpha^*) = 1 - \frac{(1 + i_{MDB})}{(1 + E_0(r_{EXIP}))}. \quad (8)$$

Thus, when there is scarce USD liquidity, the NDB needs to lend a sufficient proportion to EXIPs (α^*), so that the expected supply of USD $((1 + E_0(r_{EXIP})) \cdot \alpha^* \cdot I_{USD})$ is sufficient to meet the demand for USD $((1 + i_{MDB}) \cdot I_{USD})$, and avoid a large expected depreciation of the local currency Loc\$ ($E_0(S_1)$). Clearly, a higher expected rate of return of EXIPs ($E_0(r_{EXIP})$), means higher expected 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 with normal USD liquidity, because in this case with scarce USD liquidity having more local currency Loc\$ funds does not allow you to buy more USD (the supply of USD is fixed). Finally, note that the case with scarce USD liquidity implies that the proportion of lending to DOIPs $(1 - \alpha^*)$ is lower, and the proportion of lending to EXIPs (α^*) is higher, in comparison to the cases with normal and abundant USD liquidity.

3.2 MDB refinancing to the NDB

In this subsection, we deepen the analyzes by adding an intermediate period where the MDB refinances the NDB. The model setup follows the basic model from subsection 3.1. However, 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.

As in subsection 3.1, in period 0, the MDB lends a fixed amount I_{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 the EXIPs and the DOIPs, with the loans and real investment projects also maturing in the intermediate period 1.

Now, however, the MDB is willing to refinance $\gamma \cdot I_{USD}$, 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 the 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 $L_{Loc\$} = (1 + i_{NDB}) \cdot I_{Loc\$} - (1 + i_{MDB} - \gamma) \cdot I_{USD} \cdot S_1$. 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 $(1 + i_{MDB}) \cdot \gamma \cdot I_{USD}$ to the MDB, the NDB needs to exchange sufficient funds into USD at an exchange rate of S_2 . Thus, for the MDB to have incentives to refinance the NDB in the intermediate period 1 without making expected losses in the intermediate period 1, we assume that the following condition holds in the intermediate period 1:

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

Further, as in subsection 3.1, in the initial period 0, the MDB lend I_{USD} to the NDB with the condition of not making expected losses in the intermediate period 1. Thus, in the initial period 0, it is necessary that the following condition holds:

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

In this new model setup, the NDB needs to choose the optimal proportions of lending to the EXIPs and the DOIPs not only in the initial period 0 (α_0^* and $(1 - \alpha_0^*)$), but also the optimal proportions of new lending to the EXIPs and the DOIPs in the intermediate period 1 (α_1^* and $(1 - \alpha_1^*)$). For simplicity reason, we continue assuming that the maximization problem for the NDB is to maximize the proportions $(1 - \alpha_0)$ and $(1 - \alpha_1)$ of onlending that goes to the DOIPs in the initial period 0 and in the intermediate period 1, respectively, and to minimize the proportions α_0 and α_1 of onlending that goes to the EXIPs in the initial period 0 and in the intermediate period 1, respectively. Again, as in subsection 3.1, 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 domestic foreign exchange market.

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 $S_1 = S_0 + b \cdot ((1 + i_{MDB} - \gamma) \cdot I_{USD} - (1 + r_{EXIP}) \cdot \alpha_0 \cdot I_{USD})$, and that, in the final period 2, $S_2 = S_1 + b \cdot ((1 + i_{MDB}) \cdot \gamma \cdot I_{USD} - (1 + r_{EXIP}) \cdot \alpha_1 \cdot L_{Loc\$}/S_1)$. This means that $E_0(S_1) = S_0 + b \cdot ((1 + i_{MDB} - \gamma) \cdot I_{USD} - (1 + E_0(r_{EXIP})) \cdot \alpha_0 \cdot I_{USD})$ and that $E_0(S_2) = E_0(S_1) + b \cdot ((1 + i_{MDB}) \cdot \gamma \cdot I_{USD} - (1 + E_0(r_{EXIP})) \cdot \alpha_1 \cdot L_{Loc\$}/E_0(S_1))$.

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. However, there will be enough supply of USD funds, so no balance of payment crisis will ensue. In the intermediate period 1, the NDB needs to choose the maximum $(1 - \alpha_1^*)$, given that the condition 9 holds. This means that the chosen α_1 and $(1 - \alpha_1)$ need to respect the following condition:

$$\alpha_1 \geq \frac{S_1 \cdot (I_{USD}^2 \cdot b \cdot \gamma^2 \cdot (1 + i_{MDB})^2 + I_{USD} \cdot S_1 \cdot \gamma \cdot (1 + i_{MDB}) - L_{Loc\$} \cdot (1 + i_{NDB}))}{L_{Loc\$} \cdot I_{USD} \cdot b \cdot \gamma \cdot (1 + E_1(r_{EXIP})) \cdot (1 + i_{MDB})}. \quad (11)$$

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

$$\alpha_1^* = \frac{S_1 \cdot (I_{USD}^2 \cdot b \cdot \gamma^2 \cdot (1 + i_{MDB})^2 + I_{USD} \cdot S_1 \cdot \gamma \cdot (1 + i_{MDB}) - L_{Loc\$} \cdot (1 + i_{NDB}))}{L_{Loc\$} \cdot I_{USD} \cdot b \cdot \gamma \cdot (1 + E_1(r_{EXIP})) \cdot (1 + i_{MDB})}. \quad (12)$$

$$1 - \alpha_1^* = 1 - \frac{S_1 \cdot (I_{USD}^2 \cdot b \cdot \gamma^2 \cdot (1 + i_{MDB})^2 + I_{USD} \cdot S_1 \cdot \gamma \cdot (1 + i_{MDB}) - L_{Loc\$} \cdot (1 + i_{NDB}))}{L_{Loc\$} \cdot I_{USD} \cdot b \cdot \gamma \cdot (1 + E_1(r_{EXIP})) \cdot (1 + i_{MDB})}. \quad (13)$$

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

$$\alpha_0 \geq \frac{b \cdot (1 + i_{MDB} - \gamma)^2 \cdot I_{USD} - S_0 \cdot (i_{NDB} + \gamma - i_{MDB})}{I_{USD} \cdot b \cdot (1 + i_{MDB} - \gamma) \cdot (1 + E_0(r_{EXIP}))} \quad (14)$$

Thus, the optimal behavior of the NDB in the initial period 0 is to choose the following proportions

$$\alpha_0^* = \frac{b \cdot (1 + i_{MDB} - \gamma)^2 \cdot I_{USD} - S_0 \cdot (i_{NDB} + \gamma - i_{MDB})}{I_{USD} \cdot b \cdot (1 + i_{MDB} - \gamma) \cdot (1 + E_0(r_{EXIP}))}. \quad (15)$$

$$1 - \alpha_0^* = 1 - \frac{b \cdot (1 + i_{MDB} - \gamma)^2 \cdot I_{USD} - S_0 \cdot (i_{NDB} + \gamma - i_{MDB})}{I_{USD} \cdot b \cdot (1 + i_{MDB} - \gamma) \cdot (1 + E_0(r_{EXIP}))}. \quad (16)$$

From equations 15 and 16, it is clear that there is a positive relationship between γ , the proportion of refinancing by the MDB, and the proportion $(1 - \alpha_0^*)$ of onlending to the DOIPs. Inversely, as figure 9 shows, there is a negative relationship between γ and the proportion α_0^* of onlending to the EXIPs. Moreover, when the proportion of refinancing is large enough, the NDB may lend all its funds in the initial period 0 to the DOIPs ($1 - \alpha_0^* = 1$). In addition, comparing this case with refinancing (equation 16) with the normal USD liquidity case without refinancing (equation 6), analyzed in subsection 3.1, we get that the proportion of lending to the DOIPs $(1 - \alpha_0^*)$ in the initial period 0 is higher for the case with refinancing than for the case without refinancing, i.e. $(1 - \alpha_0^*) > (1 - \alpha^*)$. Note that the refinancing of the NDB allows

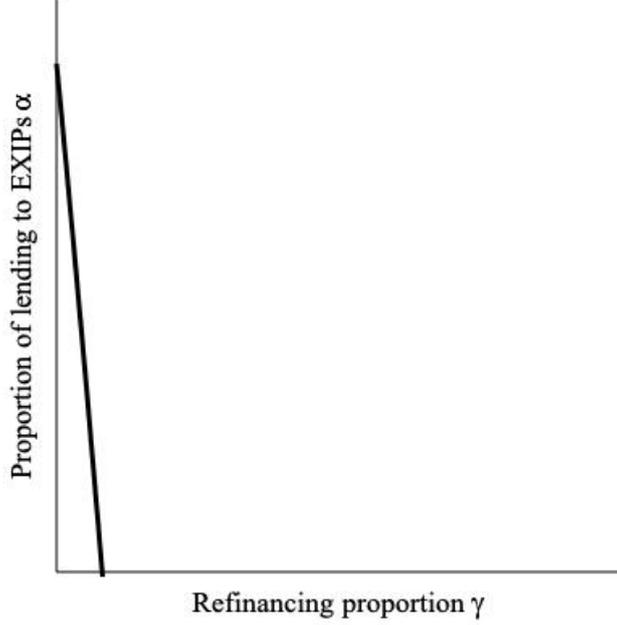


Figure 9: Proportion of lending to EXIPs in relation to the proportion of refinancing by the MDB

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 this sense, having more time to pay back a loan implies that the borrower has more flexibility on how to use those funds and obtain the necessary funds to pay back the loan.

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 expected net demand of USD is equal or lower to zero, which implies that the optimal proportions are

$$\alpha_0^* = \frac{(1 + i_{MDB} - \gamma)}{(1 + E_0(r_{EXIP}))}; \quad (17)$$

$$(1 - \alpha_0^*) = 1 - \frac{(1 + i_{MDB} - \gamma)}{(1 + E_0(r_{EXIP}))}. \quad (18)$$

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 α_0^* 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.

4 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.

In this paper we have analyzed the case with full information, and, thus, the optimal decisions by the MDB and the NDB incorporate all the information in their decisions. However, if there is not full information and both the MDB and the NDB decide the optimal proportion of EXIPS and DOIPs without properly considering the exchange rate and balance of payments constraints, the result of their decision may not completely internalize these risks. This case would mimic the results from the case with abundant USD liquidity. This case would be a situation where there is a coordination failure in the sense that the agents choose their optimal behavior without considering how their decisions affect the exchange rate and the balance of payment, expecting that an external agents, maybe the central bank, will be there to provide the necessary USD liquidity. In this case, when the NDB has to pay back the loan to the MDB, either the exchange rate will be such that the local currency \$Loc proceeds from the loans to the investment projects are not enough or that there is a balance of payment crisis. In this case, if the MDB wants to avoid that the NDB defaults on its loan, the MDB will have to refinance a larger proportion of the loan to the NDB than planned.

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