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Exchange rate and balance of payment crisis risks in the global development finance architecture[☆]

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ABSTRACT

We analyze exchange rate and balance of payment crisis constraints when multilateral development banks (MDBs) lend, in hard currency, to national development banks (NDBs), for NDBs to onlend to investment projects. Investment projects may be "export-enhancing" (EXIPs), which generate hard currency, or "domestic-oriented" (DOIPs), which do not generate hard currency. To increase the proportion of onlending to DOIPs, MDBs should increase their refinancing to NDBs. Furthermore, MDBs have to reduce the interest rate charged on NDBs. In addition, high return EXIPs need to be financed, and more locally-produced supplies, in contrast with imported supplies, should be fostered.

1. Introduction

In the past six decade, the collaboration between multilateral development banks (MDBs) and national development banks (NDBs) has experienced the rise, decline and renaissance (Ocampo and Ortega, 2022). 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 (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 with the past. On the one hand, collaboration between MDBs and NDBs, through

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on-lending arrangements, can help enhance the complementarity of international resources and local market knowledge. On the other hand, there are 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. MDBs are usually reluctant to lend in local currency to NDBs because they, in turn, finances themselves in the international bond market that is USD dominated and they are unwilling to risk downgrades due to currency mismatches in their balance sheets by credit rating agencies.[1] According to the Committee on the Global Financial System (2020) at the Bank for International Settlements, about 50% of all outstanding international debt securities and cross-border loans are denominated in USD. Moreover, according to Bertaut et al. (2021), around 60% of foreign currency debt issued by firms is USD denominated and 23% is Euro denominated.

The objective of this research paper is to analyze the exchange rate and balance of payment crisis risks that arise when an MDB finances itself in the international bond market to lend USD to an NDB for it to do on-lending to investment projects (IPs) in the NDB's country (host country).[2] Investment projects maybe "export-enhancing" (EXIPs), which generate hard currency (for example, building a port or developing export agriculture), or "domestic-oriented" (DOIPs), which do not 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 in line with the comparative advantage of the host country, 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. By contrast, 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.[3] 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 an MDB funds itself in the international bond market in order to lend USD funds to an NDB, which onlends, in turn, in local currency to investment projects in the host country. Then 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-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) and 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: the first case with abundant USD liquidity, the second case with normal USD liquidity, and the 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 affects the foreign exchange market. In the scenario with normal USD liquidity, the NDB needs to consider how its decision affects the foreign exchange market, but does not need to 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. 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) and 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. Although the so-called Lawson Doctrine states that only those current-account deficits that arise because of excessive government deficits should be of concern, Diaz-Alejandro (1985) and Velasco (1987) discussed that the balance of payment crisis of the 1980s 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.

[1] Although MDBs have explicitly aimed to promote local currency financing via means such as issuing local currency bonds in local capital markets, local currency financing only accounts for a small share in their total loan portfolios.

[2] In this paper, when we refer to hard currency, we mainly make reference to USD, but other hard currency may also be EUR or RMB. Thus, the conclusions from our paper hold even if the trade and capital flows are mostly in EUR or RMB.

[3] DOIPs 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.

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 from 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) and 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 (Ali and Iness, 2020; Chang and Velasco, 1998; Chui et al., 2018; Jeanne, 2000; Krugman, 1999; Levy-Yeyati, 2006). Other theoretical studies analyzing foreign indebtedness include, among others, Acharya et al. (2020), Aghion et al. (2004), Giavazzi and Spaventa (2011), Jeanne and Zettelmeyer (2002) and Korinek (2011).

To the best of our knowledge, our paper is the first to formally analyze the cooperation between MDBs and NDBs and the impact of this cooperation upon the exchange rate and balance of payments crisis risks. Development banks are a relatively understudied field. The existing literature has primarily explored the following aspects: 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 (2022), Shelepov (2017), and Wang (2017) discuss the cooperation between MDBs, NDBs and local governments; Griffith-Jones et al. (2018), Griffith-Jones et al. (2022), and Gottschalk et al. (2022) provide an introduction to the role, characteristics, funding sources, financing instruments, and banking regulations of NDBs; Brei and Schclarek (2018), Brei and Schclarek (2013), Galindo and Panizza (2018), Meriläinen (2016) and Perry (2009) analyze the countercyclical lending behavior of MDBs, NDBs and state-owned commercial banks.

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 constraints. We analyze how the optimal lending policy is affected by the interest rate that MDBs charge NDBs, the refinancing of MDBs to NDBs, and the country of origin of the supplies that are needed to develop the real investment projects. Finally, in Section 4, we conclude with key findings.

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 Section 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, which does on-lending to a real IP. Second, in Section 2.2, we analyze the process of on-lending whereby the NDB provides a local currency Loc$ denominated loan to the IP. Finally, in Sections 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) and Schclarek et al. (2019). Every entry to an account has a subscript, which refers to the agent for which that entry represents an asset, and a superscript, which refers to the agent for which that entry represents a liability. Furthermore, 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 International Commercial Bank (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. Fig. 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 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 ($USD\ Bond_{ICB}^{MDB}$). 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.

2.2. The NDB provides 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. Fig. 2 depicts this process, where the starting point is final line (F) of Fig. 1.[4]

[4] 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.

T	ICB		MDB		NDB	
	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
0						
1	$+USD\ Bond^{MDB}_{ICB}$	$+USD\ Dep^{ICB}_{MDB}$	$+USD\ Dep^{ICB}_{MDB}$	$+USD\ Bond^{MDB}_{ICB}$		
2		$-USD\ Dep^{ICB}_{MDB}$ $+USD\ Dep^{ICB}_{NDB}$	$+USD\ Loan^{NDB}_{MDB}$ $-USD\ Dep^{ICB}_{MDB}$		$+USD\ Dep^{ICB}_{NDB}$	$+USD\ Loan^{NDB}_{MDB}$
F	$USD\ Bond^{MDB}_{ICB}$	$USD\ Dep^{ICB}_{NDB}$	$USD\ Loan^{NDB}_{MDB}$	$USD\ Bond^{MDB}_{ICB}$	$USD\ Dep^{ICB}_{NDB}$	$USD\ Loan^{NDB}_{MDB}$

Fig. 1. The MDB funds the NDB by issuing bonds in the international bond market.

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

Fig. 2. The NDB finances the IP in local currency Loc$.

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 local commercial bank (LCB). Thus, the NDB uses its USD deposits at the ICB ($-USD\ Dep^{ICB}_{NDB}$) 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 ($+\$Loc\ Dep^{LCB}_{NDB}$). Note that this deposit transfer and foreign exchange operation imply a balance sheet expansion for the LCB that witnesses an increase in both its assets ($+USD\ Dep^{ICB}_{LCB}$) and its liabilities ($+\$Loc\ Dep^{LCB}_{NDB}$). In the second period ($T = 2$), the NDB can now grant a loan to the IP ($+\$Loc\ Loan^{IP}_{NDB}$) by transferring its local currency Loc$ deposits ($-\$Loc\ Dep^{LCB}_{NDB}$) to the bank account of the IP at the LCB ($+\$Loc\ Dep^{LCB}_{IP}$).

The final situation is depicted in line $T = F$. The balance sheet of the ICB does not have a major modification: the asset-side remains unchanged, while its liabilities are now in possession of the LCB ($USD\ Dep^{ICB}_{LCB}$). The balance sheet of the LCB has been increased on both sides: on the asset-side by $USD\ Dep^{ICB}_{LCB}$, and on the liability-side by $\$Loc\ Dep^{LCB}_{IP}$, 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 $USD\ Loan^{NDB}_{MDB}$ from Fig. 1), its assets are now denominated in local currency Loc$ ($\$Loc\ Loan^{LCB}_{NDB}$). 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

T	ICB		MDB		NDB		LCB		Investment Project	
	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities	Assets	Liabilities
0	$USD\ Bond^{MDB}_{ICB}$	$USD\ Dep^{ICB}_{firm}$	$USD\ Loan^{NDB}_{MDB}$	$USD\ Bond^{MDB}_{ICB}$	$USD\ Loan^{IP}_{NDB}$	$USD\ Loan^{NDB}_{MDB}$			$TradGood$	$USD\ Loan^{IP}_{NDB}$
1		$-USD\ Dep^{ICB}_{firm}$							$-TradGood$	
		$+USD\ Dep^{ICB}_{IP}$							$+USD\ Dep^{ICB}_{IP}$	
2		$-USD\ Dep^{ICB}_{IP}$							$-USD\ Dep^{ICB}_{IP}$	
		$+USD\ Dep^{ICB}_{LCB}$					$+USD\ Dep^{ICB}_{LCB}$	$+\$Loc\ Dep^{LCB}_{IP}$	$+\$Loc\ Dep^{LCB}_{IP}$	
					$-\$Loc\ Loan^{IP}_{NDB}$			$-\$Loc\ Dep^{LCB}_{IP}$	$-\$Loc\ Dep^{LCB}_{IP}$	$-\$Loc\ Loan^{IP}_{NDB}$
					$+\$Loc\ Dep^{LCB}_{NDB}$			$+\$Loc\ Dep^{LCB}_{NDB}$		
3		$-USD\ Dep^{ICB}_{LCB}$			$-\$Loc\ Dep^{LCB}_{NDB}$		$-USD\ Dep^{ICB}_{LCB}$	$-\$Loc\ Dep^{LCB}_{NDB}$		
		$+USD\ Dep^{ICB}_{NDB}$			$+USD\ Dep^{ICB}_{NDB}$					
		$-USD\ Dep^{ICB}_{NDB}$	$-USD\ Loan^{NDB}_{MDB}$		$-USD\ Dep^{ICB}_{NDB}$	$-USD\ Loan^{NDB}_{MDB}$				
		$+USD\ Dep^{ICB}_{MDB}$	$+USD\ Dep^{ICB}_{MDB}$							
4		$-USD\ Dep^{ICB}_{MDB}$	$-USD\ Dep^{ICB}_{MDB}$							
	$-USD\ Bond^{MDB}_{ICB}$			$-USD\ Bond^{MDB}_{ICB}$						
F										

Fig. 3. Repayment of loans and bonds when the IP is export-enhancing.

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 ($\$Loc\ Dep^{LCB}_{IP}$) and maintains a liability denominated in local currency Loc$ ($\$Loc\ Loan^{LCB}_{NDB}$).

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.

Fig. 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 Figs. 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 ($USD\ Dep^{ICB}_{firm}$).[5] 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 ($-USD\ Dep^{ICB}_{firm}$) to the IP's bank account in the ICB ($+USD\ Dep^{ICB}_{IP}$).

The second period of Fig. 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 $T = 1$ ($-USD\ Dep^{ICB}_{IP}$) to its local currency Loc$ account in the LCB ($+\$Loc\ Dep^{LCB}_{IP}$). 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 ($+USD\ Dep^{ICB}_{LCB}$) by creating local currency Loc$ deposits ($+\$Loc\ Dep^{LCB}_{IP}$), which is a liability for the LCB. Secondly, with these local currency Loc$ deposits ($-\$Loc\ Dep^{LCB}_{IP}$), the IP cancels its loan with the NDB ($-\$Loc\ Loan^{IP}_{NDB}$) and the NDB receives local currency Loc$ deposits at the LCB ($+\$Loc\ Dep^{LCB}_{NDB}$).

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

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

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

Fig. 4. Repayment of loans and bonds when the IP is domestically-oriented — first operations.

In conclusion, at the end of the process described in this subsection, all liabilities have been canceled without suffering from any problems with lack of USD, i.e. there are 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 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.

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 canceled, considering the scenario where the IP is domestic-oriented and produce only local currency Loc$ proceeds. First, in Fig. 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 Fig. 5, we analyze the difficulties that arise at the time of canceling 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 Fig. 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, the NDB can use the local currency Loc$ received from the IP to buy USD from the LCB to pay back the MDB.[6] 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 Fig. 4 in detail, the initial period ($T = 0$) corresponds to the situation prevalent in the final lines (F) of Figs. 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 ($NTrad\,Good$) that it can sell to a local firm, which have local currency Loc$ deposits at the LCB ($\$Loc\,Dep^{LCB}_{firm}$). In the first period ($T = 1$), the IP sells these goods to a local firm ($-NTrad\,Good$). The latter pays for those goods by transferring its local currency Loc$ deposits at the LCB ($-\$Loc\,Dep^{LCB}_{firm}$) to the IPs bank account in the LCB ($+\$Loc\,Dep^{LCB}_{IP}$).

The second period of Fig. 4 ($T = 2$) shows the financial operation by which the IP cancels its local currency Loc$ denominated liability with the NDB ($-\$Loc\,Loan^{IP}_{NDB}$) by transferring its local currency Loc$ deposits at the LCB ($-\$Loc\,Dep^{LCB}_{IP}$) to the NDB ($+\$Loc\,Dep^{LCB}_{NDB}$). Note that in this case, neither the LCB nor the NDB have obtained USD from the IP, as was the case in the last Section 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

[6] Note that there are other possible solutions not analyzed in this subsection.

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

Fig. 5. Repayment of loans and bonds when the IP is domestically-oriented — second operations.

exchange (this could even be the Central Bank by using its foreign reserves). Alternatively, another solution, discussed in Fig. 5, is that the NDB obtains a refinancing of the loan by the MDB.

Fig. 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 Fig. 4. In the first period ($T = 1$), the ICB buys new bonds issued by the MDB ($+USD\,Bond2^{MDB}_{ICB}$) and pays by crediting USD funds in the bank account of the MDB at the ICB ($+USD\,Dep^{MDB}_{ICB}$). This transaction is the refinancing of the MDB by the ICB. In the second period ($T = 2$), the MDB uses those USD deposits ($-USD\,Dep^{MDB}_{ICB}$) to make a new USD denominated loan to the NDB ($+USD\,Loan2^{NDB}_{MDB}$) and the NDB receives those USD deposits at the ICB ($+USD\,Dep^{NDB}_{ICB}$). This transaction is the refinancing of NDB by the MDB.

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

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 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.

In conclusion, at the end of the process described in this subsection, all the initial USD liabilities have been canceled, but new USD denominated liabilities were used to avoid suffering from 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 from 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 would also have faced balance of payment crisis risks.

With respect to the exchange rate risks, in the process described above, the NDB suffers from 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 from 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 would have faced exchange rate risks too.

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 IPs. The NDB needs to optimally choose which proportions of its onlending goes to EXIPs and 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 its choice affects the foreign exchange market, but need not worry about balance of payment problems, i.e. lack of USD liquidity in the domestic foreign exchange market. In the third case with scarce USD liquidity, the NDB is bound by balance of payment problems, i.e. lack of USD liquidity in the domestic foreign exchange market.

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.

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 a foreign exchange dealer in the domestic foreign exchange market, that could be the central bank, that is willing to exchange the USD for local currency Loc$ at an exchange rate of S_0 in the initial period 0.[7][8] Below we discuss more about this foreign exchange dealer 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 $I_{Loc\$} = I_{USD} \cdot S_0$ 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 this subsection, we assume that these supplies are locally produced, which imply that they do not require using USD funds to procure them. In Section 3.3, we analyze the case when there are both locally produced supplies and imported supplies that requires using USD funds to pay for them.

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$. 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$, at an exchange rate of S_1, obtaining local currency Loc$ funds equivalent to $(1 + r_{EXIP}) \cdot \alpha \cdot S_1 \cdot I_{USD}$. 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 $(1 + E_0(r_{DOIP})) \geq (1 + i_{NDB})$.

[7] We use the convention that the exchange rate represents the price in local currency Loc$ of a unit of USD.

[8] For a discussion on the dealer function, please see Mehrling (2011, 2012, 2013) and Treynor (1987).

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 honor 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. $D_{Loc\$} = (1+i_{NDB}) \cdot I_{Loc\$}$. Then 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 in the final period 1, we analyze three extreme cases. In the first case, with abundant USD liquidity, in the final period 1, the foreign exchange 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 in the final period 1 ($(1+i_{MDB}) \cdot I_{USD}$), and the supply of USD by the EXIPs in the final period 1 ($(1+r_{EXIP}) \cdot \alpha \cdot I_{USD}$). This means that in the initial period 0, the expected exchange rate of the final period 1 is $E_0(S_1) = S_0$. This case represents a situation where the foreign exchange dealer has abundant access to USD liquidity in the final period 1 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 foreign exchange dealer is willing to exchange any amount of local currency Loc$ for USD but at a variable exchange rate. Specifically, we assume that $S_1 = S_0 + \gamma \cdot ND_{USD}$, where γ is a fixed positive coefficient and ND_{USD} is the net demand for USD in the final period 1. The net demand for USD in the final period 1 is $ND_{USD} = (1+i_{MDB}) \cdot I_{USD} - (1+r_{EXIP}) \cdot \alpha \cdot I_{USD}$, which means that the exchange rate S_1 is positively related to the demand for USD by the NDB in the final period 1 ($(1+i_{MDB}) \cdot I_{USD}$), and negatively related to the supply of USD by the EXIPs in the final period 1 ($(1+r_{EXIP}) \cdot \alpha \cdot I_{USD}$).[9] Therefore, in the initial period 0, the expected exchange rate of the final period 1 is $E_0(S_1) = S_0 + \gamma \cdot ((1+i_{MDB}) \cdot I_{USD} - (1+E_0(r_{EXIP})) \cdot \alpha \cdot I_{USD}$. This case represents a situation where the dealer has normal access to USD liquidity in the final period 1 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 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 is greater than zero, i.e. $ND_{USD} > 0$, the market exchange rate tends to infinity ($S_1 \to \infty$). This extreme case represents a situation where the dealer has hit position limits in the final period 1, 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.

Regarding the availability of USD liquidity, which determines the behavior of the foreign exchange dealer, it is dependent on both domestic monetary and financial conditions and global factors, such as the Global Financial Cycle and the Global Trade and Commodity Cycle (Aldasoro et al., 2020; Arregui et al., 2018; Miranda-Agrippino and Rey, 2021). According to Miranda-Agrippino and Rey (2021), the Global Financial Cycle and the Global Trade and Commodity Cycle are mostly explained by the monetary policy of the US Federal Reserve, and, to a less extent, by the monetary policy of the European Central Bank. Although the People's Bank of China (PBOC) still has an insignificant role in the Global Financial Cycle, it already has an important role in determining the Global Trade and Commodity Cycle. Furthermore, there is evidence that the Renminbi already influences exchange rate and monetary policy strongly in Asia (Fratzscher and Mehl, 2014; McCauley and Shu, 2019). In the coming years, and through the internationalization of the Renminbi and the setup of bilateral currency swap lines by the PBOC, it is probable that the influence of the PBOC will increase in the Global Financial Cycle (Ito, 2017; Liao and McDowell, 2015). A natural question that arises is whether such an enhanced influence of China will be a factor that reduces the variance of the Global Financial Cycle, and thus helps to increase the stability of the cycle. It is reasonable to expect that a more stable Global Financial Cycle implies that the foreign exchange dealer has a higher availability of USD liquidity, and has less risk of suffering from a contraction in the USD liquidity, saddling himself or herself with a shift from a situation with abundant or normal USD liquidity to a situation with scarce USD liquidity. In addition, to foster the increase in the use of RMB-denominated loans, if the foreign exchange dealer is a local branch of a Chinese state-owned bank, it might be more willing to exchange local currency for RMB, especially when the industrial structure of host countries is complementary to that of China so that China can use local currency to purchase local intermediate goods.

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.[10] This condition implies that for the MDB to lend to the NDB the following must hold:

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

[9] Note that in terms of the balance of payment components, the supply of USD by the EXIPs is equivalent to a surplus in the current account and the demand of USD by the NDB is equivalent to a capital account deficit.

[10] Although, 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 reasons, we prefer assuming that banks are risk neutral instead of being risk averse in terms of their profits.

In the case of the maximization problem of the NDB, we assume that the NDB maximizes the proportion $(1-\alpha)$ of onlending that goes to the DOIPs, and minimizes the proportion α of onlending that goes to the EXIPs. Thus, the utility function of the NDB to maximize is

$$\max_{\alpha} \quad 1-\alpha. \tag{2}$$

This special preference for the DOIPs, and dislike for 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, however, that we would reach the same main conclusions of this paper 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. Thus, we assume maximization problem (2) for simplicity reasons. Note also 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 addition, when the NDB optimally chooses the proportions α and $(1-\alpha)$, condition (1) must hold. Furthermore, it will only lend to the IPs if it is not making expected losses, which implies that the following conditions must hold:

$$(1+E_0(r_{EXIP}))\cdot E_0(S_1)/S_0 \geq (1+i_{NDB}) \tag{3}$$

$$(1+E_0(r_{DOIP})) \geq (1+i_{NDB}). \tag{4}$$

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, in the initial period 0 the NDB may freely choose 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. Moreover, if we assume that $i_{NDB} \geq i_{MDB}$, condition (1) is met because $E_0(S_1) = S_0$. Thus, if conditions (3) and (4) hold, from the maximization problem (2) it is clear that 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 in period 1 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.[11]

From the discussion above, we have the following proposition:

Proposition 1. *When there is abundant USD liquidity,* $\alpha^* = 0$ *and* $(1-\alpha^*) = 1$.

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 its decision affects the foreign exchange market, but does not need to worry about balance of payment problems, i.e. lack of USD liquidity in the local foreign exchange market. 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 $S_1 = S_0 + \gamma\cdot ND_{USD}$, which is increasing in the net demand of USD. This means that when the NDB solves maximization problem (2), it has to consider how its decision about 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 has to consider how choosing α^* and $(1-\alpha^*)$ affects the exchange rate S_1 and the USD value of its proceeds in local currency Loc$. The NDB has to choose α^* and $(1-\alpha^*)$ so that the following condition holds

$$\alpha \geq \frac{\gamma\cdot(1+i_{MDB})^2\cdot I_{USD} - S_0\cdot(i_{NDB}-i_{MDB})}{I_{USD}\cdot\gamma\cdot(1+i_{MDB})\cdot(1+E_0(r_{EXIP}))}. \tag{5}$$

Clearly, from condition (5) and the maximization problem (2), the optimal behavior of the NDB is to choose the following proportions

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

[11] Note 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.

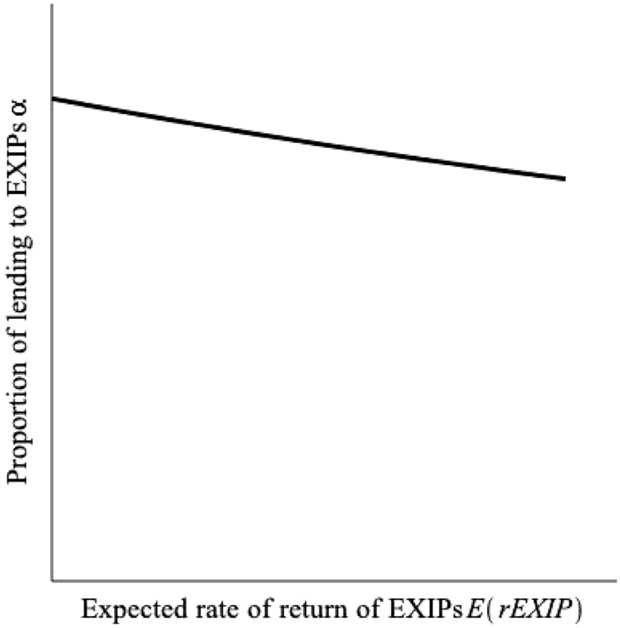

Fig. 6. Proportion of lending to EXIPs in relation to the expected rate of return of EXIPs.

$$(1-\alpha^*) = 1 - \frac{\gamma \cdot (1+i_{MDB})^2 \cdot I_{USD} - S_0 \cdot (i_{NDB} - i_{MDB})}{I_{USD} \cdot \gamma \cdot (1+i_{MDB}) \cdot (1+E_0(r_{EXIP}))}. \tag{7}$$

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$ ($E_0(S_1)$). In addition, the case with normal USD liquidity implies that the proportion of lending to DOIPs ($1-\alpha^*$) is lower in comparison with the case with abundant USD liquidity. Moreover, as is clear from Fig. 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 ($1-\alpha^*$) and a lower proportion of lending to EXIPs (α^*). Furthermore, as Fig. 7 shows, the lower the interest rate that the MDB charges the NDB (i_{MDB}), the higher the proportion of lending to DOIPs and the lower proportion of lending to EXIPs. The reason is that a lower interest rate i_{MDB} implies a lower demand for USD in the final period 1. In addition, as Fig. 8 shows, a higher interest rate charged by the NDB (i_{NDB}) implies a higher proportion of lending to DOIPs and lower proportion of lending to EXIPs, because it can support a higher depreciation (S_1) as the NDB has more local currency Loc$ funds. Finally, note that the larger the interest rate differential $i_{NDB} - i_{MDB}$, the higher the proportion of lending to DOIPs and the lower proportion of lending to EXIPs.

From the discussion above, we have the following proposition:

Proposition 2. *When there is normal USD liquidity,* $(1-\alpha^*)$ *is: (a) increasing in* $E_0(r_{EXIP})$*; (b) decreasing in* i_{MDB}*; and (c) increasing in* i_{NDB}*. The converse relationships for* α^* *holds.*

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 (maximization problem (2)), the NDB is constrained by the effect of its behavior on the local foreign exchange market and faces balance of payment problems, i.e. lack of USD liquidity in the local foreign exchange market. Accordingly, 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 ($S_1 \to \infty$). This means that the USD value of the local currency Loc$ funds held by the NDB tends to zero ($(1+i_{NDB}) \cdot I_{Loc\$}/S_1 \to 0$), and condition (1) is not met. Only when the net demand of USD is zero or negative, meaning that the supply of USD by the EXIPs ($(1+E_0(r_{EXIP})) \cdot \alpha \cdot I_{USD}$) is larger than the demand of USD by the NDB ($(1+i_{MDB}) \cdot I_{USD}$), will the exchange rate be constant ($S_1 = S_0$). In this case, condition (1) is met. Thus, in the initial period 0, when the NDB maximizes problem (2), it has to choose the largest possible α, and smallest $(1-\alpha)$, but avoid a large expected depreciation of the local currency Loc$ (So that $E_0(S_1) = S_0$). For this to be the case, the following condition has to be met

$$(1+E_0(r_{EXIP})) \cdot \alpha \cdot I_{USD} \geq (1+i_{MDB}) \cdot I_{USD}. \tag{8}$$

Thus, when there is scarce USD liquidity, from condition (8) and maximization problem (2), the optimal proportion of lending to EXIPs (α^*) and the optimal proportion of lending to DOIPs ($1-\alpha^*$) are

$$\alpha^* = \frac{1+i_{MDB}}{1+E_0(r_{EXIP})}; \tag{9}$$

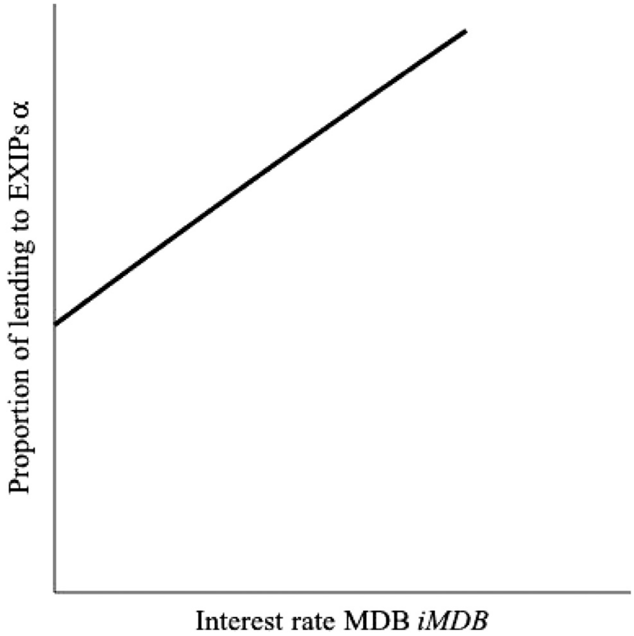

Fig. 7. Proportion of lending to EXIPs in relation to the interest rate charged by the MDB.

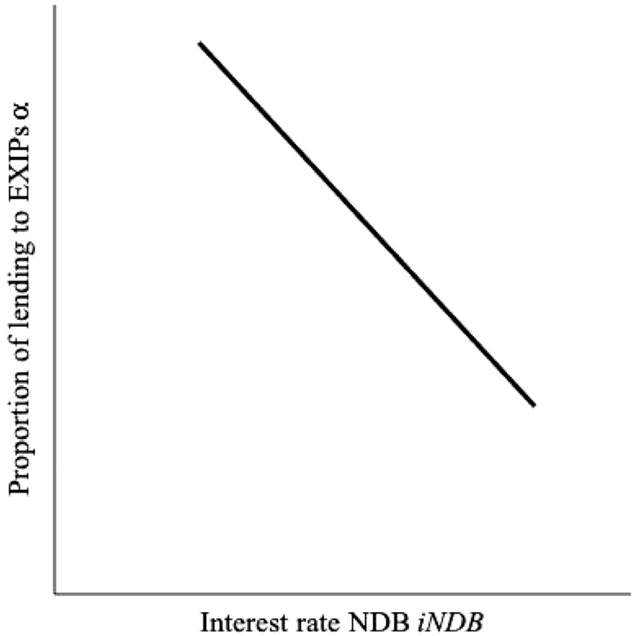

Fig. 8. Proportion of lending to EXIPs in relation to the interest rate charged by the NDB.

$$(1-\alpha^*) = 1 - \frac{1+i_{MDB}}{1+E_0(r_{EXIP})}. \tag{10}$$

Clearly, 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 with the cases with normal and abundant USD liquidity. Furthermore, a higher expected rate of return of EXIPs $(E_0(r_{EXIP}))$, means higher expected supply of USD by EXIPs in the final period 1, and allows a higher proportion of lending to DOIPs $(1-\alpha^*)$ and a lower proportion of lending to EXIPs (α^*). Further, a lower interest rate charged by the MDB (i_{MDB}), implies a higher proportion of lending to DOIPs and a lower proportion of lending to EXIPs. The reason is that a lower interest rate i_{MDB} implies a lower demand for USD by the NDB in the final period 1. 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 and given by the supply of USD by EXIPs in the final period 1).

From the discussion above, we have the following proposition:

Proposition 3. *When there is scarce USD liquidity,* $(1-\alpha^*)$ *is: (a) increasing in* $E_0(r_{EXIP})$*; and (b) decreasing in* i_{MDB}*. The converse relationships for* α^* *holds.*

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 and gives the NDB more time to make the final payment of the MDB loan. The model setup follows the basic model from Section 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 Section 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. Moreover, 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.

The amount that the MDB is willing to refinance the NDB in the intermediate period 1 is given by $\delta \cdot I_{USD}$, where $\delta \leq 1$. We assume that the interest rate charged by the refinancing is the same interest rate i_{MDB} prevalent in the initial period 0. This USD denominated refinancing allows the NDB to partially postpone the final payment 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 are received from the repayment of the loans by the EXIPS and the DOIPs, but are not exchanged into USD due to the refinancing by the MDB. The spare local currency Loc$ funds in the intermediate period 1 are $L_{Loc\$} = (1+i_{NDB}) \cdot I_{Loc\$} - (1+i_{MDB}) \cdot I_{USD} \cdot S_1 + \delta \cdot I_{USD} \cdot S_1$. 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 rates of return $E_1(r_{EXIP})$ 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 $(1+i_{MDB}) \cdot \delta \cdot I_{USD}$ 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, the following condition must hold in the intermediate period 1:

$$(1+i_{MDB}) \cdot \delta \cdot I_{USD} \leq (1+i_{NDB}) \cdot L_{Loc\$}/E_1(S_2). \tag{11}$$

Furthermore, as in Section 3.1, in the initial period 0, the MDB lends 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:

$$(1+i_{MDB}-\delta) \leq (1+i_{NDB}) \cdot S_0/E_0(S_1). \tag{12}$$

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. Thus, we have the following maximization problems in the initial period 0 and in the intermediate period 1

$$t=0: \quad \max_{\alpha_0} \quad 1-\alpha_0, \tag{13}$$

$$t=1: \quad \max_{\alpha_1} \quad 1-\alpha_1. \tag{14}$$

Again, as in Section 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 in each period. Accordingly, we assume that, in the intermediate period 1, the exchange rate is $S_1 = S_0 + \gamma \cdot ND_{USD}^1$ and that, in the final period 2, $S_2 = S_1 + \gamma \cdot ND_{USD}^2$. The net demand for USD in the intermediate period 1 is $ND_{USD}^1 = (1+i_{MDB}-\delta) \cdot I_{USD} - (1+r_{EXIP}) \cdot \alpha_0 \cdot I_{USD}$, which means that the exchange rate S_1 is positively related to the demand for USD by the NDB in the intermediate period 1 to pay the interest and capital of the MDB loan, net of the refinancing by the MDB ($(1+i_{MDB}-\delta) \cdot I_{USD}$); and negatively related to the supply of USD by the EXIPs in the intermediate period 1 ($(1 + r_{EXIP}) \cdot \alpha_0 \cdot I_{USD}$). Furthermore, the net demand for USD in the final period 2 is $ND^2_{USD} = (1 + i_{MDB}) \cdot \delta \cdot I_{USD} - (1 + r_{EXIP}) \cdot \alpha_1 \cdot L_{Loc\$}/S_1$, which means that the exchange rate S_2 is positively related to the demand for USD by the NDB in the final period 2 to pay the interest and capital of the refinanced MDB loan from the intermediate period 1 ($(1 + i_{MDB}) \cdot \delta \cdot I_{USD}$), and negatively related to the supply of USD by the EXIPs in the final period 2 ($(1 + r_{EXIP}) \cdot \alpha_1 \cdot L_{Loc\$}/S_1$). This means that $E_0(S_1) = S_0 + \gamma \cdot ((1 + i_{MDB} - \delta) \cdot I_{USD} - (1 + r_{EXIP}) \cdot \alpha_0 \cdot I_{USD})$ and that $E_0(S_2) = E_0(S_1) + \gamma \cdot ((1 + i_{MDB}) \cdot \delta \cdot I_{USD} - (1 + E_0(r_{EXIP})) \cdot \alpha_1 \cdot L_{Loc\$}/E_0(S_1))$. 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 that the following condition holds in the intermediate period 1

$$(1 + i_{MDB} - \delta) \leq (1 + r_{EXIP}) \cdot \alpha_1, \tag{15}$$

and that the following condition holds in the final period 2

$$(1 + i_{MDB}) \cdot \delta \leq (1 + r_{EXIP}) \cdot \alpha_2 \cdot (1 + i_{NDB}) - (1 + i_{MDB} - \delta). \tag{16}$$

Again, if the net demand for USD by the NDB and the EXIPs is greater than zero in any period, the effective exchange rate tends to infinity ($S_1 \to \infty$ or $S_2 \to \infty$).

Regarding the optimal behavior of the NDB, 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, from the maximization problems (13) and (14), 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 $\alpha_1^* = 0$).

From the discussion above, we have the following proposition:

Proposition 4. *When there is abundant USD liquidity,* $(1 - \alpha^*)$ *and* α^* *are independent of* δ*.*

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 (11) holds. This means that the chosen α_1 and $(1 - \alpha_1)$ need to respect the following condition:

$$\alpha_1 \geq \frac{S_1 \cdot (I^2_{USD} \cdot \gamma \cdot \delta^2 \cdot (1 + i_{MDB})^2 + I_{USD} \cdot S_1 \cdot \delta \cdot (1 + i_{MDB}) - L_{Loc\$} \cdot (1 + i_{NDB}))}{L_{Loc\$} \cdot I_{USD} \cdot \gamma \cdot \delta \cdot (1 + E_1(r_{EXIP})) \cdot (1 + i_{MDB})}. \tag{17}$$

Clearly, from condition (17) and the maximization problem (14), the optimal behavior of the NDB in the intermediate period 1 is to choose the following proportions

$$\alpha_1^* = \frac{S_1 \cdot (I^2_{USD} \cdot \gamma \cdot \delta^2 \cdot (1 + i_{MDB})^2 + I_{USD} \cdot S_1 \cdot \delta \cdot (1 + i_{MDB}) - L_{Loc\$} \cdot (1 + i_{NDB}))}{L_{Loc\$} \cdot I_{USD} \cdot \gamma \cdot \delta \cdot (1 + E_1(r_{EXIP})) \cdot (1 + i_{MDB})}; \tag{18}$$

$$1 - \alpha_1^* = 1 - \frac{S_1 \cdot (I^2_{USD} \cdot \gamma \cdot \delta^2 \cdot (1 + i_{MDB})^2 + I_{USD} \cdot S_1 \cdot \delta \cdot (1 + i_{MDB}) - L_{Loc\$} \cdot (1 + i_{NDB}))}{L_{Loc\$} \cdot I_{USD} \cdot \gamma \cdot \delta \cdot (1 + E_1(r_{EXIP})) \cdot (1 + i_{MDB})}. \tag{19}$$

In the initial period 0, the NDB needs to choose the maximum $(1 - \alpha_0^*)$, given that the condition (12) holds. This means that the chosen α_0 and $(1 - \alpha_0)$ need to respect the following condition:

$$\alpha_0 \geq \frac{\gamma \cdot (1 + i_{MDB} - \delta)^2 \cdot I_{USD} - S_0 \cdot (i_{NDB} + \delta - i_{MDB})}{I_{USD} \cdot \gamma \cdot (1 + i_{MDB} - \delta) \cdot (1 + E_0(r_{EXIP}))} \tag{20}$$

Thus, the optimal behavior of the NDB in the initial period 0, following the maximization problem (13), is to choose the following proportions

$$\alpha_0^* = \frac{\gamma \cdot (1 + i_{MDB} - \delta)^2 \cdot I_{USD} - S_0 \cdot (i_{NDB} + \delta - i_{MDB})}{I_{USD} \cdot \gamma \cdot (1 + i_{MDB} - \delta) \cdot (1 + E_0(r_{EXIP}))}; \tag{21}$$

$$1 - \alpha_0^* = 1 - \frac{\gamma \cdot (1 + i_{MDB} - \delta)^2 \cdot I_{USD} - S_0 \cdot (i_{NDB} + \delta - i_{MDB})}{I_{USD} \cdot \gamma \cdot (1 + i_{MDB} - \delta) \cdot (1 + E_0(r_{EXIP}))}. \tag{22}$$

From Eqs. (21) and (22), it is clear that there is a positive relationship between δ, the proportion of refinancing by the MDB, and the proportion $(1-\alpha_0^*)$ of onlending to the DOIPs. Inversely, as Fig. 9 shows, there is a negative relationship between δ 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 (Eq. (22)) with the normal USD liquidity case without refinancing (Eq. (7)), analyzed in Section 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 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.

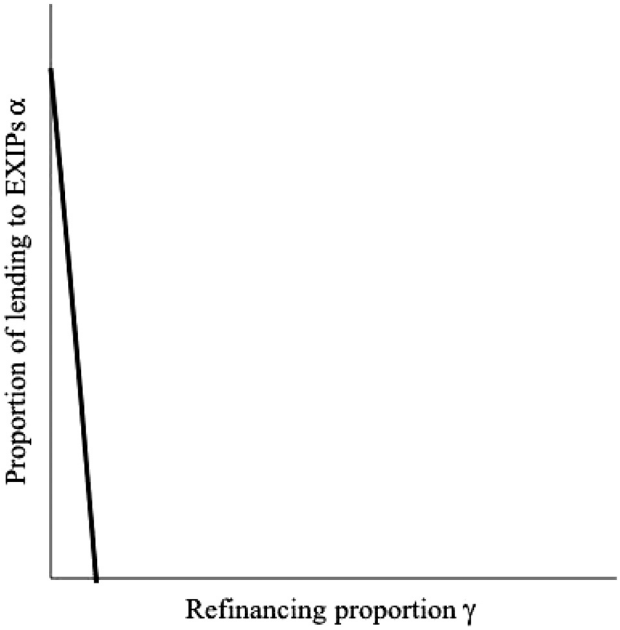

Fig. 9. Proportion of lending to EXIPs in relation to the proportion of refinancing by the MDB.

In the third case with scarce USD liquidity, when the NDB chooses the optimal proportions $(1-\alpha_0^*)$ and $(1-\alpha_1^*)$ 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 in both the intermediate period 1 and the final period 2. Accordingly, taking into account condition (16) and the maximization problem (14), in the intermediate period 1, the NDB chooses the optimal proportions

$$\alpha_1^* = \frac{1 + i_{MDB} + \delta \cdot i_{MDB}}{(1 + E_1(r_{EXIP})) \cdot (1 + i_{NDB})}; \tag{23}$$

$$(1-\alpha_1^*) = 1 - \frac{1 + i_{MDB} + \delta \cdot i_{MDB}}{(1 + E_1(r_{EXIP})) \cdot (1 + i_{NDB})}. \tag{24}$$

Furthermore, when taking into account condition (15) and the maximization problem (13), in the initial period 0, the NDB chooses the optimal proportions

$$\alpha_0^* = \frac{(1 + i_{MDB} - \delta)}{(1 + E_0(r_{EXIP}))}; \tag{25}$$

$$(1-\alpha_0^*) = 1 - \frac{(1 + i_{MDB} - \delta)}{(1 + E_0(r_{EXIP}))}. \tag{26}$$

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

From Eqs. (22), (21), (25), and (26), we have the following proposition:

Proposition 5. *When there is normal or scarce USD liquidity, $(1-\alpha_0^*)$ is increasing in δ, and α_0^* is decreasing in δ.*

3.3. Imported supplies for the real investment projects

In this subsection, we study how the model is affected by the country of origin of the supplies that are needed to develop the real investment projects, such as materials, machinery, and workforce. Specifically, we focus on the fact that locally-produced supplies can be paid in local currency Loc$, but imported supplies have to be paid in USD. Thus, there is a link between the country of origin of the supplies, and the currency of payment that has to be used, with the optimal proportion of onlending to EXIPs and DOIP by the NDB.

The model setup follows the basic model with 2 periods from Section 3.1. However, now we assume that the proportion of locally produced supplies is β and the proportion of imported supplies is $1-\beta$. This implies that in the initial period 0 the IPs need to exchange from the foreign exchange dealer local currency Loc$ into USD to procure the imported supplies that costs $(1-\beta) \cdot I_{USD}$.

This assumption implies that the foreign exchange dealer will end up holding USD funds equivalent to $\beta \cdot I_{USD}$ in the initial period 0 after buying I_{USD} from the NDB and selling $(1-\beta) \cdot I_{USD}$ to the IPs. Note that the higher the proportion of locally produced supplies demanded by IPs, the higher the USD funds holdings by the foreign exchange dealer in the initial period 0. These USD funds holdings by the foreign exchange dealer will affect the exchange rate determination in the final period 1, as is analyzed below.

For the exchange rate determination in the final period 1, we analyze again three extreme cases. In the first case, with abundant USD liquidity, in the final period 1, the foreign exchange dealer is willing to exchange an infinite amount of local currency Loc$ for USD at a fixed exchange rate, given by $S_1 = S_0$. This means that in the initial period 0, the expected exchange rate of the final period 1 is $E_0(S_1) = S_0$. This case represents a situation where the foreign exchange dealer has abundant access to USD liquidity in the final period 1 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 foreign exchange dealer is willing to exchange any amount of local currency Loc$ for USD but at a variable exchange rate. Specifically, we assume that $S_1 = S_0 + \gamma \cdot (ND_{USD} - \beta \cdot I_{USD})$, where $\beta \cdot I_{USD}$ are the USD funds holdings of the foreign exchange dealer obtained in the initial period 0, ND_{USD} is the net demand for USD in the final period 1, and γ is a fixed positive coefficient. Thus, in the initial period 0, the expected exchange rate of the final period 1 is $E_0(S_1) = S_0 + \gamma \cdot ((1 + i_{MDB}) \cdot I_{USD} - (1 + E_0(r_{EXIP})) \cdot \alpha \cdot I_{USD} - \beta \cdot I_{USD})$. Clearly, the expected exchange rate of the final period 1 ($E_0(S_1)$) is negatively related to the USD funds holdings obtained by the foreign exchange dealer in the initial period 0 ($\beta \cdot I_{USD}$) and the supply of USD by the EXIPs in the final period 1 ($(1 + r_{EXIP}) \cdot \alpha \cdot I_{USD}$), and positively related to the demand for USD by the NDB in the final period 1 ($(1 + i_{MDB}) \cdot I_{USD}$). Recall that in this paper we are assuming that a higher (or lower) exchange rate means a more depreciated (or appreciated) local currency Loc$.

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 in the final period 1 minus the USD funds holdings obtained by the foreign exchange dealer in the initial period 0 is negative or zero, i.e. $ND_{USD} - \beta \cdot I_{USD} \leq 0$. However, if the net demand for USD in the final period 1 minus the USD funds holdings obtained by the foreign exchange dealer in the initial period 0 is positive, i.e. $ND_{USD} - \beta \cdot I_{USD} > 0$, the market exchange rate tends to infinity ($S_1 \rightarrow \infty$).

Regarding the optimal behavior of the NDB in the initial period 0, again as in Section 3.1, it 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 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 affects the foreign exchange market, or being conditioned by exchange rate or balance of payment problems. Thus, taking into account the maximization problem (2), the NDB will choose the optimal proportions $\alpha^* = 0$ and $(1-\alpha^*) = 1$ of the lending to EXIPs and DOIPs, respectively.

From the discussion above, we have the following proposition:

Proposition 6. *When there is abundant USD liquidity,* $(1-\alpha^*)$ *and* α^* *are independent of* β.

In the second case with normal USD liquidity, in the initial period 0, when the NDB decides its optimal behavior, the NDB needs to consider how its decision affects the foreign exchange market, but does not need to worry about balance of payment problems, i.e. lack of USD liquidity in the local foreign exchange market. Thus, following the same logic as in Section 3.1 where the MDB will only lend to the NDB if it does not make expected losses, the NDB has to choose α^* and $(1-\alpha^*)$ in the initial period 0 so that the following condition holds

$$\alpha \geq \frac{\gamma \cdot (1 + i_{MDB}) \cdot (1 + i_{MDB} - \beta) \cdot I_{USD} - S_0 \cdot (i_{NDB} - i_{MDB})}{I_{USD} \cdot \gamma \cdot (1 + i_{MDB}) \cdot (1 + E_0(r_{EXIP}))}. \tag{27}$$

Clearly, from condition (27) and the maximization problem (2), the optimal behavior of the NDB is to choose the following proportions in the initial period 0

$$\alpha^* = \frac{\gamma \cdot (1 + i_{MDB}) \cdot (1 + i_{MDB} - \beta) \cdot I_{USD} - S_0 \cdot (i_{NDB} - i_{MDB})}{I_{USD} \cdot \gamma \cdot (1 + i_{MDB}) \cdot (1 + E_0(r_{EXIP}))}; \tag{28}$$

$$(1-\alpha^*) = 1 - \frac{\gamma \cdot (1 + i_{MDB}) \cdot (1 + i_{MDB} - \beta) \cdot I_{USD} - S_0 \cdot (i_{NDB} - i_{MDB})}{I_{USD} \cdot \gamma \cdot (1 + i_{MDB}) \cdot (1 + E_0(r_{EXIP}))}. \tag{29}$$

Thus, when there is normal USD liquidity, the higher the proportion of locally produced supplies β for the IPs in the initial period 0, or equivalently, the lower the proportion of imported supplies $1-\beta$, allows the NDB to choose a higher proportion of lending to DOIPs and a lower proportion of lending to EXIPs. The reason is that when the locally produced supplies are higher and the imported supplies are lower, the dealer can supply a higher amount of USD in the final period 1 given a certain level for the exchange rate S_1, which means that the NDB can choose a higher proportion of DOIPs in the initial period 0 without violating the condition that the MDB cannot make an expected loss when it lends to the NDB.

In the third case with scarce USD liquidity, in the initial period 0, the optimal behavior of the NDB is constrained by the balance of payment problems, i.e. lack of USD liquidity in the local foreign exchange market. Thus, in the initial period 0, the NDB needs to choose α^* and $(1-\alpha^*)$ so that the net demand of USD in the final period 1 minus the USD funds holdings of the foreign exchange dealer obtained in the initial period 0 is equal or lower to zero. Thus, taking into account this condition and the maximization problem (2), the optimal proportions of lending that goes to the EXIPs (α^*) and of lending that goes to the DOIPs $(1-\alpha^*)$ are

$$\alpha^* = \frac{1 + i_{MDB} - \beta}{1 + E_0(r_{EXIP})}; \tag{30}$$

$$(1-\alpha^*) = 1 - \frac{1 + i_{MDB} - \beta}{1 + E_0(r_{EXIP})}. \tag{31}$$

Thus, when there is scarce USD liquidity, the higher the proportion of locally produced supplies β for the IPs in the initial period 0, or equivalently, the lower the proportion of imported supplies $1-\beta$, allows a higher proportion of lending to DOIPs and a lower proportion of lending to EXIPs.

From Eqs. (28), (29), (30), and (31), we have the following proposition:

Proposition 7. *When there is normal or scarce USD liquidity,* $(1-\alpha^*)$ *is increasing in* β*, and* α^* *is decreasing in* β*.*

4. Conclusion

In this paper we theoretically analyze the exchange rate and balance of payments constraints prevalent when MDBs lend USD funds to NDBs for them to do onlending to real investment projects, which may be EXIPs and DOIPs. NDBs need to optimally choose the proportion of onlending that goes to EXIPs and DOIPs in order to assure that the MDBs are willing to lend to NDBs, which requires that MDBs not make expected losses for their lending to NDBs. We analyze three different scenarios depending on the availability of USD liquidity in the foreign exchange market of the host 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, NDBs may freely choose the proportion of lending between DOIPs and EXIPs without having to consider how these decisions affect the foreign exchange market, or being conditioned by exchange rate or balance of payment constraints. In the scenario with normal USD liquidity, NDBs have to consider how their decisions affect the foreign exchange market and the market exchange rate, but do not need to worry about balance of payment problems (i.e. lack of USD funds). In this case, NDBs can lend a certain proportion to DOIPs, but have to lend a certain proportion to EXIPs in order to increase the future supply of USD and avoid a large depreciation of the local currency that would reduce the USD value of the local currency proceeds of the investment projects. In the scenario with scarce USD liquidity, NDBs are bound by balance of payment constraints and they have to lend a sufficiently large proportion to EXIPs so that EXIPs produce enough USD funds to pay back the MDB loans. When there is scarce USD liquidity, NDBs have to lend a higher proportion to EXIPs, and a lower proportion to DOIPs, than the cases with abundant and normal USD liquidity.

If MDBs want to increase the proportion of onlending that goes to DOIPs, they need to reduce the interest rate that they charge NDBs. In addition, high return EXIPs need to be financed to increase the supply of hard currency. Moreover, they need to increase their refinancing to NDBs, and give NDBs more time to pay back their loans. In addition, the proportion of onlending that goes to DOIPs can also be increased, and the proportion to EXIPs be reduced, if the investment projects require a higher proportion of locally-produced supplies and a lower proportion of imported supplies.

The COVID-19 pandemic and the war in Ukraine correspond to situations where the USD liquidity scenario passes from an abundant or normal scenario to one of scarce USD liquidity. Thus, in order to minimize the adverse effects of the pandemic, it is necessary that MDBs reduce the interest rate that they charge NDBs. Further, it is necessary that MDBs refinances NDBs and give them more time to pay back loans.

As shown in our analysis, the situations with abundant and normal USD liquidity in the domestic foreign exchange market allow a more flexible strategy in terms of choosing the proportions of DOIPs and EXIPs. In order to increase the chances that the host economy would not suffer from the scarce USD liquidity, it is important that domestic policies are enacted so that the domestic monetary and financial conditions are more stable. From an international perspective, it is also important that the Global Financial Cycle and the Global Trade and Commodity Cycle are more stable. If the accelerating RMB internationalization fosters more stable cycles, this may be a positive feature for the host country in making a more flexible decision about the proportion of DOIPs and EXIPs when receiving on-lending from MDBs.

CRediT authorship contribution statement

Alfredo Schclarek: Conceptualization, Formal analysis, Visualization, Roles/Writing – original draft, Writing – review & editing. **Jiajun Xu:** Conceptualization, Data curation, Investigation, Methodology, Software, Validation, Roles/Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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