III. Income-linked bonds

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Introduction

Traditional sovereign debt has been used for a long time. The benefit of accessing to these international markets is that the country can smooth national consumption over time. The main disadvantage is that repayment is a rigid commitment; hence countries face difficulties to honor the debt service when an adverse event occurs. That is, countries, especially developing ones, can hardly avoid the pain of pro-cyclical adjustment.

Curiously, on a modern scale King Philip II, who ruled Spain between 1556 and 1598, was the first monarch to borrow from international markets, and many of these "loans were explicitly contingent on observable events; others featured options allowing either the king or the bankers to reschedule disbursements and repayments at will, hence allowing the parties to modify cash flows in response to unforeseen circumstances" (Drelichman and Voth, 2013). Philip II of Spain and his Genoese bankers developed a system that dealt with adverse shocks much more effectively than modern-day debt markets, according to these authors.

However, Drelichman and Voth (2013) recognize that Philip II's system cannot simply be copied. And yet, it seems odd that so little experimentation has gone into better risk-sharing arrangements: oil importers could issue debt with coupons varying inversely with oil prices (this came sometime in the mid-1980s); or alternatively, automatic maturity extensions could be written into sovereign bond covenants in case risk premia hit a certain pre-defined level, reducing the risk of roll-over crises. Drelichman and Voth do not propose any particular solution or financial instrument; they are simply pointing out that it seems odd that, for all of the financial sophistication of today's markets, sixteenth-century financiers came up with more creative ways to make borrowing safe and effective than today's market players.

Another old example is the issuance of the first ever inflation-linked bond in 1780 by the State of Massachusetts, then called a 'Depreciation Note', indexing the return to a basket of goods including corn, beef, wool and leather (Benford et al 2016). Brazil, Chile and Mexico designed and introduced

inflation-linked bonds during the second half of the XX Century. Even the US took these as examples to issue again an inflation-linked instrument, the Treasury Inflation-Protected Securities, or TIPS. The principal of a TIPS increases with inflation and decreases with deflation, as measured by the Consumer Price Index. When TIPS matures, bondholders are paid the adjusted principal or original principal, whichever is greater.

Nevertheless, since the external debt crisis of the 1980s and more recently, the great financial crisis of 2008-09, there has been some attempts to link the obligation to pay to an indicator of the ability to pay. The handful of cases that exist are mostly part of restructuring packages negotiated in the aftermath of defaults, such as the prominent GDP-indexed bonds of Argentina and Greece. It is argued that these instruments substantially reduce the risk of defaults (Kletzer, Newbery and Wright 1992; Borensztein and Mauro 2002; Borensztein et al. 2004).

This section describes these instruments to understand how they work, what is needed for their success and what are their advantages and disadvantages.

A. Rationale for state-contingent bonds

Countries face economic adverse events periodically (that is, they are subject to business cycles) which in turn pose problems on the country's fiscal stances; hence different instruments that seek buffering these negative effects have been designed over time. One of the most common and effective tools that was introduced recently was a set of fiscal rules, in particular, a salient one is the so-called *structural budget balance rule*.

The structural budget balance is the government's actual fiscal position purged of the estimated budgetary consequences of the business cycle and is designed in part to provide an indication of the medium-term orientation of fiscal policy (this definition is adopted by different organizations, including ECLAC, IMF, OECD). The implementation of such a rule is complex and varies from country to country. However, as it is a stabilization tool, this implies saving resources during boom times to finance the fiscal deficit present in a counter-cyclical strategy either with debt or funds coming from stabilization funds, designed explicitly for this purpose.

Nevertheless, when the debt ratio is high, the debt service may also soar, independent to the existence of the structural budget balance clause. This is normally the case for developing countries. In particular, this is true for Latin America and the Caribbean (LAC) ones, the most indebted region in the developing world (79% of GDP); this region actually pays the highest external debt service (59% of exports of goods and services). In addition, some economies in the region (at some point, Argentina in the early 2000s, Brazil in the late 1990s and México during the tequila crisis of 1995, among others) have made extensive use of the international capital market with long-maturity periods but with interest rate costs that are above their historical trend growth which could not only harden their liquidity constraints but could also set the stage for future situations of insolvency.

For this reason, a complementary policy is the introduction of alternative financial instruments, which may help to lower the effects of the adverse economic shocks, namely, the contingent sovereign debt. This type of debt is basically a loan which service is linked to an observable indicator, such as GDP, national income, exports, among many others. The concept is analogous for most of those variables, though the prospects for success may vary for different reasons.

It is important to pinpoint that emerging markets and developing economies, have less flexibility to utilize other traditional macroeconomic tools to implement as countercyclical policies, as they do not necessarily have automatic stabilizers nor access to international credit markets at times of economic distress, nor a well-financed stabilization Fund.

In sum, the LAC countries could benefit from the introduction of contingent sovereign debt so that they can face economic downturns more effectively and less painful. To facilitate the analysis, we temporarily use the GDP as the underlying variable, as the concept is analogous to most economic performance indicators. In addition, GDP-linked security is, by now, the most widely used. Later we introduce the idea of GNI-linked bonds (ILB, henceforth). We will show that these may be better suited for some countries in Latin America and the Caribe.

1. Definition

The GDP-linked bond is a financial instrument that links either principal or interest payments (or both) to GDP growth. Hence when the economy is in ascending phase the interest payments rise, and conversely, when the economy slows down or it is in a crisis, the service of the debt is reduced or even suspended (depending upon its design). These are especially useful for emerging countries which frequently write off foreign currency denominated debt.

On the other hand, these bonds provide the investors with a better way of taking the risk on a country's growth prospects. Because there is a modest correlation between GDP growth and the returns of equity, stock markets do not provide the possibility of taking such a risk, while these linked bonds allow for that risk-taking position.

As known, a *plain vanilla* bond contains mainly two elements, namely, the face value (principal) and the coupon (which implicitly yields the coupon rate). In a contingent bond, either or both, the principal and the coupon may be indexed to a variable, such as the GDP or GNI.

Shiller (1993)'s original proposal on contingent debt suggests that both the principal and coupon payments should be indexed to the level of nominal GDP. In turn, Borensztein and Mauro (2004) propose indexing only the coupon to the real GDP growth and fix the principal to par value.

2. Advantages

In principle, linking the debt service to an economic performance indicator, GDP or GNI, brings a stabilization of the debt ratio (debt over GDP or GNI) over time. This is so because the need to refinance or rollover existing debt diminishes. At the same time, with indexed debt, its service is reduced during the economic distress, a fact that facilitates using the resources to finance pro-growth activities. This inherent feature provides many benefits to both the issuing country and the investors.

The first benefit is for both counterparts. Given that the ratio of debt to GDP (or GNI) stabilizes, the probability of default goes down, and hence the likelihood of a debt crisis. When a debt crisis occur countries lose access to future credits, and may even receive trade sanctions, which send the economy to a vicious circle (such as the 1980s external debt type) causing unemployment and at the end an increase in poverty level.

Paradoxically, when a debt crisis occurs, this is the time when countries need to contract fresh debt to face the economic downturn. Thus, the linked security provides a better environment to launch an appropriate counter-cyclical program. The financing, we reiterate, may come from the debt service holdings, which in turn lower the necessity of contracting additional debt. This is in sharp contrast to the historical experience of emerging markets, which are often forced to follow pro-cyclical fiscal policies during periods of slow growth to maintain access to external credit markets. GDP-indexed bonds reduce the need for procyclical policies, by acting as an 'automatic-stabilizer' type mechanism (Blanchard et al. 2016, Benford et al. 2016).

Therefore, the need for an immediate fiscal reform may be delayed or even avoided, depending upon several events. Social expenditures and infrastructure programs may be kept on. This implies in developing countries containing the increase in poverty levels, and social disruptions.

Finally, in principle and especially for developing countries, they could help establish consistent legal standards to facilitate bond pricing, develop options to improve the reliability of growth statistics, and coordinate issuance by several countries in order to create a liquid market more quickly.

From the investors side, the linked bond provides an additional instrument to invest in, so they may diversify risk. Citizens from different countries may take advantage from the fact that economic performance in the world is not perfectly correlated, hence the instrument may help diversification.

In addition, stock indices and economic performance are not perfectly correlated, so a position on the growth of the country is possible. Besides, developing countries, especially the small ones, do not necessarily have a developed and strong stock market. The instrument provides the possibility for investors to take a position on future growth of a small-developing country.

Moreover, as the probability of default is lower, the investors invest in a lower-risk instrument (Borensztein and Mauro, 2004).

3. Problems and challenges

As described, in principle GDP-linked bonds may present a good number of benefits. If so, why the market for growth-indexed bonds has not developed if it could have such substantial benefits?

This is because there are still some challenges that need to be addressed. Most of these come from deficient securities design or because they do not work when there are weak institutions in the issuing countries. For this reason, here we briefly list some of the main challenges and disadvantages. Most of these come from the experiences that different countries have had when implementing them. This list will be better understood in the next section when we present an exam of the main experiences.

First, there are concerns about data reliability, as many developing and emerging economies have weak institutions, which include deficiently designed institutes of statistics (in charge of estimation of economic variables). Sometimes these institutes are not independent from the executive branch; this fact may tempt the executive leader to influence the estimation of the variables, so they obtain certain results. Some other cases, the institutes simply suffer from lack of funding. Finally, in a few cases even low level of human capital has also been a problem (Griffith-Jones and Sharma, 2011).

A second obstacle, related to the previous one, is a typical moral hazard problem, as countries may have the incentive to misreport figures on economic performance or inflation rate. Depending upon the situation, the benefit of doing so is paying a lower amount of debt service; or, even sending the signal that the country is doing well, at the cost of paying higher debt service, as we will see it happened in one of the experiences below. This will depend on the politicians' political objectives. One may prefer to pay higher interest payments because it pays more politically. Others (or the same politician in other political context) may prefer to economize resources. In other words, the possibility of one-sided manipulation deters investors and makes it difficult to sustain a well-functioning market (Benford et al, 2016).

An additional data related challenge is related to the revisions of national account methodologies and changes of base year. The practical issues associated with GDP or GNI data revision remain a formidable obstacle to the broad issuance and acceptance of these instruments (Cecchetti and Schoenholtz, 2017). One of the experiences below showed some skepticism about the methodology change that took place during the life of the warrant.[1]

The other crucial challenge is about the financial security's design. This is relevant because the investors' interest highly depends on a sound design that takes care of the main concerns.

[1] Warrants are a derivative that give the right, but not the obligation, to buy or sell a security —most commonly an equity— at a certain price before expiration. The price at which the underlying security can be bought or sold is referred to as the exercise price or strike price. The instrument is not standardized as a typical option (see Hull 2011).

We have just mention one important investors' concern, namely, the data problem. Nevertheless, other concerns include pricing, liquidity, appropriate legal framework. For example, the difficulty in successfully introducing new financial instruments, in addition to the examples of inflation-indexed bonds and credit-default swaps, is the use of collective action clauses (CACs) in U.S.-law bond contracts.

CACs are present in the US law. The definition of a collective action clause (CAC) is the one that allows bondholders to agree on debt restructuring even when some bondholders are against restructuring as long as majority agrees. This means that even if issuing country does not want to restructure the contingent debt, if majority of bondholders obtain the legal authorization, they may do so. This has been considered a potential obstacle for contingent debt.

Investors also expressed concern and claimed that they would only purchase bonds with these clauses if they received a premium (Griffith-Jones and Sharma, 2011). This one depends highly on good pricing. Investors' appetite is almost always there. They will be attracted should a security is well-designed so that it acts as an equity-like exposure to a country's economic performance.

If valuing this type of security works properly then hedging risks should be easier. Therefore, by designing a simple, clear, and appropriate linked security, the pricing should be much easier.

From these elements it is possible to summarize the challenges as in Council of Economic Advisers (2004):[2]

- Draft a sample bond contract to clarify exactly how certain potential concerns could be addressed.
- Provide concrete alternatives to ensure reliable and accurate GDP statistics.
- Explore options to help jump-start a liquid market for growth-indexed bonds.
- Encourage involvement by the Multilateral Organizations. These may serve as advisers on designing autonomous National Institutes of Statistics; or alternatively, as monitors to check them.
- The most important consideration for governments is to adopt sound macro- and microeconomic policies. Financial innovation cannot compensate for inconsistent and unsustainable economic policies.

In addition, Schröder et al (2014) provide guides for introduction based on surveys. These are consistent with that of the Council (2004). These authors carried out a survey to determine features and conditions for a successful introduction of indexed bonds. These bonds should have a simple structure (easy to understand and to price) if they are to be accepted by the capital market.

Moreover, they argue that high total volume of issues to guarantee a liquid secondary market (at least 500 million euros or US dollars).

However, Roch and Roldan (2021), based on a Eaton and Gersovitz (1981) sovereign model, argue that lenders distort probabilities by assigning higher likelihood to those states where the bond promises lower repayments. This washes out the advantage of lower default risk. This explains the modest use of contingent debt, despite the benefits it brings about. Cohen et. al (2020) argue that investors have typically steeply discounted these "equity-like" instruments given their nonstandard designs, illiquidity, and idiosyncratic risk profiles; hence they have often provided poor value for their cost to borrowers.

However, Cohen et. al (2020) reckon that designing better SCDI contracts will also raise their appeal; future SCDIs should increase the use of standardized terms to promote liquidity and avoid historical shortcomings such as measurement issues, lagging indicators, and uncapped payouts.

[2] See also Hatchondo and Martínez (2012).

The conjuncture also provides an opportunity to consider the issuance of exchange bonds with payouts that vary with both good and bad times. The post-COVID outlook is one that leaves sovereign debtors exposed to heightened uncertainty on both the upside and downside, and even seemingly conservative baselines may prove to have been optimistic.

Accordingly, "symmetric" instruments —with coupons linked to a variable (for example, commodity prices) that is outside the control of the issuing sovereign (hence avoiding measurement and manipulation risks)— should be explored. In this study we explore this element by indexing the bond to GNI, which, we argue, is subject to outside verification in their main variables, for some countries, such as the Central American and Caribbean ones.

4. Related bonds

As previously mentioned, linked instruments have existed for a long time. In the modern era we do have three prime examples. The first is the inflation-indexed bonds which are the most closely related example and show the difficulty in introducing new financial instruments. However, they have been functioning well in LAC, such as Brazil, Chile and México, among others. There is a liquid market and investors' appetite have been quite extensive. Undoubtedly, the data on inflation needed to be reliable. These countries have done a good job in strengthening the institutes in charge of estimating statistics.

Two other existing instruments sharing certain characteristics of growth-indexed bonds are commodity-linked bonds and catastrophe-insurance contracts. These instruments can also play an important role in reducing country vulnerabilities and stabilizing budgets. One potential benefit of these two instruments over growth-indexed bonds is that the sovereign has less ability to affect the information about the relevant variable determining the bond payments (such as a commodity price).

Commodity-linked bonds are less promising than growth-indexed bonds for emerging markets, however, since most emerging markets have fairly diversified production and exports, so there is often no natural commodity price to link to bond payments, except for some small countries.[3] Furthermore, indexing to exports is a way to include the commodities as less developed countries that rely on a single commodity often sell this commodity abroad. So exports may be a better candidate.

5. An example: Mexican debt service during the pandemics

This section sketches the importance of including in the country debt portfolio an economic —performance— linked bond. The purpose of the example is to emphasize the value of issuing such a security.

The year 2020 was one of the hardest for most countries, as the pandemics hit the economy. For that year México's debt service reached 3% of GDP. Many experts and national and international organizations recommended to launch a recovery plan that involved aid (workers included) to micro and small firms, among other measures.[4] The costs associated to most economic recovery proposals reached figures around 3 to 4% GDP. México is one of the very few countries that did not launch such an anti-cyclical program.

Had México issued (say three years before) GDP/GNI linked bonds, part of the debt service could have been used in financing the recovery package that could have helped buffer the increase in the unemployment rate. This was not the case, and Mexico could not implement any recovery package. The result was an abrupt reduction in the rate of growth (around 8%) of GDP, one of the largest negative figures in the region. Still, the country honored the debt service for this year (see figure III.1), which reached 3% of GDP.

[3] Still, some countries' public finances largely rely on the revenues coming from these commodities. For example, Mexico on oil revenues and Chile on Copper revenues.

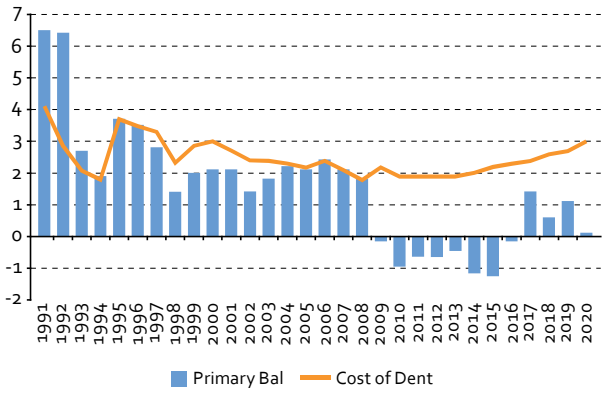
[4] Notably, the proposals were made by Levy (2020) and CEEY (2020), among many others. These suggested a relief package which consisted among other elements, in extending credits to micro and small firms, release temporarily the social security contributions, and the payment of salaries of the micro and small firms for up to six months.

Hence, the importance of having had a contingent sovereign debt is highlighted.[5] Should one third[6] of total indebtedness would have been indexed to GDP, more than one third[7] of the 3% of GDP spent on servicing the debt would have been put on hold. These resources could have been used to finance in part the suggested anti-cyclical program.

This example is only provided to illustrate the usefulness of the instrument. We do not mean that this example is a formal one. The basic idea is for their coupons payments to be indexed to nominal GDP, and in so doing allow both the burden of servicing interest payments and repayments of principal to adjust with the sovereign's ability to pay.

No sovereign in the world has yet issued a GDP-linked bond with full risk-sharing between sovereigns and their creditors, with returns that vary symmetrically, falling with lower GDP and rising with higher GDP.

Figure III.1
Mexico's financial primary balance vs Debt Service, 1991-2020
(Percentage of GDP)



Source: SHCP.

Next, we proceed to briefly present the available empirical evidence and source-cases (countries that have issued GDP-linked bonds) that exemplify the applicability of GDP-linked bonds and the lessons learned. This section would then use the empirical analysis to evaluate the case for income-linked bonds.

B. Selected source-cases

The history of contingent sovereign debt is old. Still, there are only a few known cases such as those part of the Brady Plan (Bosnia Herzegovina, Bulgaria and Costa Rica) and the recent examples of Argentina, Greece and Portugal. However, Pina (2020) argues that there are many more cases apart from these well-known ones.

Table III.1 presents a complete list of such instruments developed by Pina (2020). As it may be seen, there are at least 30 countries which have issued a type of contingent-sovereign security (34 issues). These financial instruments are issued on different variables; some of them contingent on exports, others are indexed to commodities, whereas others are contingent on the occurrence of natural disasters. Finally, about 30% of all issues are indexed to GDP.

[5] This is not judging or analyzing whether the Mexican response was adequate or not. We only illustrate the importance of the contingent sovereign debt.

[6] This percentage is arbitrary, and more rigorous analysis is needed to determine, if any, the optimal total debt proportion to be indexed to an economic performance variable.

[7] This is more than one third due to the fact that indexed-bonds pay a higher premium. Thus, they may account for more than one third of the debt service.

Table III.1
Selected examples of contingent-sovereign securities

Sovereign	Debt instrument and linkage	Type
Algeria	Oil-linked loan	Loan
Argentina	Real GDP growth linked warrants	Warrants
Bolivia (Plurinational State of)	Bond linked to the price of tin	Bond
Bosnia and Herzegovina	GDP Performance Bonds	Warrants
Bulgaria	Additional Interest Paid linked to GDP	Warrants
Burkina Faso, Mali, Mozambique, Senegal & Tanzania	AFD countercyclical loans linked to Exports	Loan
Confederate States of America	Cotton Bonds	Bond
Costa Rica	Value Recovery Rights linked to GDP	Warrants
France	Pinay Bond linked to gold	Bond
France	Pinay Bond linked to industrial production	Bond
France	Rente Giscard linked to Gold	Bond
Greece	GDP-Warrant linked to Real GDP	Warrants
Grenada	Bond Hurricaine Clause	Bond
Grenada	Citizenship by Investment revenues linked bond	Bond
Various Countries	Petrocaribe Bonds linked to oil	Loan
Honduras	GDP-Linked Bonds	Warrants
India	Oil-linked bonds	Bond
India	Gold Bonds	Bond
Ivory Coast	GDP-Linked Bonds	Warrants
Malaysia	Citibank Loan	Loan
Mexico	Petrobonos linked to oil	Bond
Mexico	Value Recovery Rights linked to oil	Warrants
Mexico	CatMex linked to earthquackes	Bond
Mexico	Multicat linked to earthquakes and Hurricanes	Bond
Nigeria	Payment Adjustment Warrant linked to oil	Warrants
Papua New Guinea	Metallgesellschaft loan linked to copper	Loan
Peru, Colombia, Chile, Mexico	IBRD Cat Bonds CAR 116-120 linked to earthquakes	Bond
Portugal	Treasury Certificates linked to real GDP growth	Bond
Singapore	New Singapore shares, Economic Restructuring Shares linked to GDP growth	Share
Turkey	Revenue Indexed Bond	Bond
Ukraine	Warrants linked to real GDP	Warrants
Uruguay	Value Recovery Rights linked to terms of trade	Warrants
Uruguay	Nominal wage linked bond	Bond
Venezuela (Bolivarian Replubic of)	Oil-indexed payment obligation	Warrants

Source: Pina 2020.

In terms of type of instrument, Pina (2020) found bonds, warrants, and loans. Bonds and warrants are traditionally issued to the public, while loans are issued to official or private lenders, usually banks. Warrants have been usually linked to a traditional "plain vanilla bond" but, in some cases, they have been detachable.[8]

[8] This instrument Works in a similar way a convertible bond. In a contingent liability like the one we are studying, the plain vanilla bond, after six months of issuing date, a "coupon" may be detachable and be sold as an independent instrument. The value of this is the one contingent on economic performance.

The main difference between a bond and a warrant is that warrants are designed in a way that may lead to an increase in payments to investors, but never a decrease. In other words, the contingency is only on the upside. Unsurprisingly, warrants are traditionally issued as a type of reward in debt restructuring deals.

Some other features highlighted by Pina (2020) database is that most of them are issued in foreign currency, whereas only 20% in local currency; the unweighted average maturity tends to be long run, mostly with a maturity between 10 and 20 years. Seventy percent of the whole sample has been activated, that is, the payment has been made. This is an important feature because it suggests that probability of not getting paid because of the contingency, is less than 30%.

In sum, only 34 indexed-securities have been issued in contemporary history of sovereign credit markets. Out of these only 12 have been written in the form of warrants. Next, we review the main and most representative of these derivative instruments.

1. Country case experiences with contingent sovereign securities

This section briefly examines the features of the main cases listed above.

a) Bulgaria

Miyajima (2006) uses the 2004 Bear Stearns Sovereign Eastern Europe Report to briefly describe the cases of Bulgaria and Bosnia-Herzegovina. The Bulgarian GDP-linked bond is a warrant which payment is triggered if both of the following conditions are met:

(i) Its GDP reaches 125% of its 1993 level, and

(ii) the rate of yearly growth is positive.

According to those reports (Bear Sterns) when both conditions are met, 50% of the GDP rates of growth are paid on underlying plain vanilla bonds, in addition to the plain vanilla coupons.

The determination for the bond ending up "in-the- money" need an important input, namely, the GDP rate of growth estimation. The bond prospectus is ambiguous on the source of data to obtain the GDP level, referring only to World Tables published by World Bank. As known, this international organization publishes several yearly reports; the Bulgarian prospectus is not clear about which one to use. Miyajima (2006) finds that around this date the World Bank Tables included four different estimations of GDP, and the document did not specify which one to take as a reference for calculation.

Moreover, World Tables were replaced by World Development Indicators which collected data at constant and current prices and in USD and Bulgarian Leva. With four different indicators, the Bulgarian government had the incentive to choose the one that better accommodated its budget. And this is what happened. The Bulgarian authorities used constant-value local currency units to avoid triggering the service of contingent debt payment. Had they utilized current-value, payments would have been triggered.

Finally, the other questionable element that has been identified is that the bond was callable. This means that the issuer may call the bond whenever it desires. Normally a government calls a bond when the conditions of the market (mainly interest rates) suggest that the issuing country may save debt service resources through an exchange of bonds.[9]

Miyajima argues that this feature was inconsistent with the *raison d'être* of the bond -reduce the proportion of the contingent debt, hence reducing the insurance against growth slowdowns, and the benefit for investors to enjoy higher returns in the good times.

[9] Suppose a bond is now paying a 10% of coupon rate. Suddenly the market drives down the interest rate on similar bonds, say at 8%. The country calls the 10% coupon rate and issues a 8% coupon rate bond.

Two main lessons arise from the Bulgarian case. First, the source of data should be precise (apart of the accuracy problem) in terms of currency (local or foreign), value (nominal or constant prices), time horizon, among others. Second, the callable clause should be studied further. A call premium could resolve this obstacle.

b) Bosnia-Herzegovina (BH)

The BH GDP-linked bond matured in 2017 and was issued in 1993. This was a warrant, which payment was triggered if both of the following conditions were met:

(i) Its GDP level reaching a predetermined target and, more importantly, remaining at such level for two consecutive years: 125% of its 1993 level, and

(ii) GDP per capita surpassing the USD$2,800 in 1997 prices, adjusted using German CPI.

As it may be appreciated from reading the conditions above, it seems a poor security design. Moreover, as in many developing economies, the informal sector was large and, at issuance, was not considered in official data statistics. Therefore, the GDP misrepresented its true level. The GDP figures were estimated by the central bank, in a possible conflict of interest.

On the other hand, as the second condition was in per capita terms, and the population statistics were obtained by a third institution, which by that time was questioned about their capabilities to provide reliable numbers. This was and additional source of data problem.

Finally, the price of the warrants was rarely published; thus trading activity was scarce.

The lesson from the BH case is that the source of data should clear and precise, and obtained by an independent body. This could be solved in different ways, which will be discussed in section 3.

c) Singapore

This country issued an equity[10], as opposed to most contingent sovereign debt issued in the past. That is, this security was not issued as a result of a debt restructuring. In this sense this was by that time an innovative instrument. The share had the purpose to benefit low-income population in case the economy was in a healthy path of growth.

The Singaporean government issued this share in 2001, which dividends were linked to GDP growth. This posed a negligible conflict of interest between the issuer and the holder. Shares were not tradable nor transferable and were supposed to be exchanged only for cash with the government.

The government issued two series of shares, the New Singapore Shares, and the Economic Restructuring Shares. The first one was issued during the economic slowdown and earned annual dividends (as in a *preferred stock*) which were estimated at 3% plus the real GDP growth rate of the preceding calendar year. The second, was introduced to subsidize the low-income population after the increase of the rate of Value Added Tax. Both were a 5-year preferred stock. Unlike a regular equity, which does not expire, these shares were limited with an expiration date after 5 years of the IPO.

The flaw of the security is that the solution was highly pro-cyclical. In general, this could be solved by government credit to the recipients right at the GDP slowdown.

d) Argentina

The Argentinian case has become the "textbook" illustration of a GDP-linked bond. It has been extensively studied (Borensztein and Mauro, 2002; 2004; Miyajima, 2006; Costa et al, 2008; Cao, 2012; among others). This is so because it is one that has been traded regularly over time, and partly corrected the problems of the previous "Brady" cases. Many lessons have been learned from its design and implementation. For this reason, we spend some more space in examining this case. To better understand this bond, we begin by providing some background on the Argentinian crisis of 2001.

[10] As opposed to a bond, an equity has no face value per se.

At the end of 2001 Argentina announced a moratorium on its outstanding debt and a few months later, in 2002, it abandoned the currency board regime which maintained the peso pegged to the dollar, making that economy virtually a dollarized one. The economic turmoil ended in a bank-run crisis that forced the Argentinian government to freeze bank deposits. Inflation rate soared and the peso depreciated abruptly.

As a result, the debt to GDP ratio went from 48% in 2001 to 147.2% in 2002, a fact that led to a debt rescheduling (table III.2). The debt renegotiation started in 2003, which lasted over 2 years as nearly 50% of the outstanding total public debt was in default (81.8 billion USD) (see Costa et al, 2008).

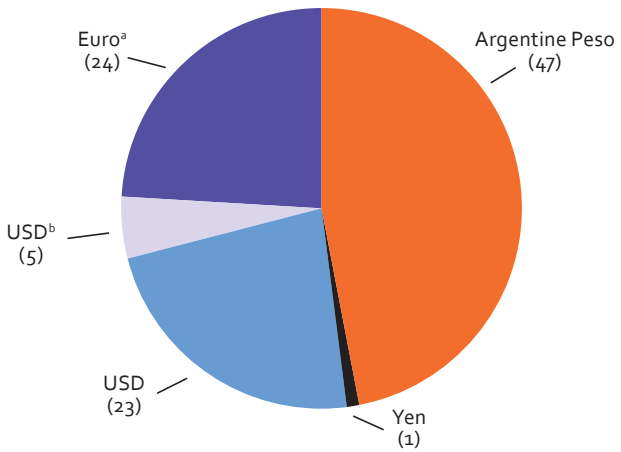
Table III.2
Argentina: selected macroeconomic indicators, 1998-2008

	Argentina										
	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
GDP *(billions of pesos, constant)*	500.7	483.7	479.9	458.7	408.8	445.4	485.1	528.0	570.5	621.9	647.1
GDP growth	3.9	-3.4	-0.8	-4.4	-10.9	9.0	8.9	8.8	8.0	9.0	4.1
Primary fiscal balance *(percentage of GDP)*	0.5	-0.7	0.2	-1.5	0.2	3.2	5.2	5.1	3.3	2.6	1.9
Public debt *(percentage of GDP)*	34.1	38.9	40.8	48.0	147.2	125.1	117.8	80.2	70.8	62.1	53.8

Source: World Bank Database.

The exchange finalized in the mid-2005 with the participation of 76% of the bondholders. According to Costa et al (2008) the participating creditors swapped their claims with a 43% cut, that is, they accepted a 57% of original face value. The newly developed bonds included three varieties, namely, a par, a discount, and a quasi-par one. All of these had a pre-determined interest rate, varying over time, and issued in four different currencies: Argentinian peso, US dollar, Euro and Yen (see figure III.3).

Figure III.2
Argentina: GDP bonds currency distribution
(Percentages)



Source: Prepared by author.
[a] Under British Law.
[b] Under Argentinean Law.

As it may be observed from figure III.2, 47% of the GDP bonds were denominated in Argentinian pesos; 23% in USD dollars; 24% in Euros (British law was chosen to regulate these); 5% in USD but under the Argentinian law; and only 1% was denominated in yens.

In sum, the inclusion of a GDP warrant in the Argentinian debt restructuring package came after a five-year de facto default (2001-2005). The main features of the warrant are the following (See Borensztein and Mauro, 2004 and Prospectus Supplement, 2004).

- The warrant provides the holder with a payment if the following three conditions are met in a given year:
  - (i) Actual real GDP exceeds base case GDP,
  - (ii) real annual growth results greater than the growth implied by the base case GDP, and
  - (iii) the cumulative amount of past payments made on GDP warrant do not exceed the payment cap -0.48 per unit of security (in the issuing currency).
- Payments are calculated as a 5% of the difference between the actual growth and the base case growth of GDP, multiplied by unit of currency coefficient.
- Trading of the GDP warrant is denominated in pesos, but interest payments were paid in currencies of corresponding underlying bonds.
- Payments are made one year after the reference year and cannot be negative.
- Each new bond issued under the restructuring had a GDP-linked warrant detachable after November 29, 2005, which could be traded independently.

It is important to pinpoint that in the case of the conditions in (i) were all met, the total payment on all warrants is a fraction of the excess GDP in the reference year (the difference between actual GDP and baseline GDP). Payments were made on December 15 of the year following the reference year (first one took place in 2006).

Now, with respect to the performance of the bond, after 2003 Argentina experienced an impressive economic recovery thanks to a surge in agricultural and natural resource commodity prices, as this nation is top in producing soybeans, maize and wheat (see table above). This rate of growth facilitated the debt rescheduling based on economic performance.

However, inflation was still a problem. As known Argentina has had a long history of inflationary pressures over time. For this reason, this indicator is closely monitored by international markets. And by this time these were skeptical about the performance of the Argentine bureau Instituto Nacional de Estadísticas y Censos (INDEC) which inflation estimates were somehow questionable to save costs on inflation-linked domestic government bonds, as these represented 47% of total contingent debt (see Cao, 2012).

Paradoxically, artificially lowering inflation increased real GDP, a fact that favored foreign denominated contingent debt, as warrants premium increased. Hence the payout increased as seen in table III.3 below, from 0.62 in 2005 to 4.38% in 2010.

Ubide and Levy (2015) have argued that Argentina's inflation and national accounts statistics have been dubious by that time. Inflation has been significantly understated for political reasons (low inflation is "good"), but real GDP growth has been overstated (slow growth is "bad"). Thus, short-term political incentives to exaggerate growth have led Argentina to overpay on its debt. It paid the 2008 coupon, although later revisions to national accounts data showed that its trigger, the real growth rate in 2007, had not exceeded the threshold.

Still, the cap on Argentine warrants, however, may be reached much earlier than at maturity because each year's payment is not individually capped and is proportional to the cumulative discrepancy between the actual Argentine GDP and a specified base-case path. Real Argentine GDP has been growing much faster than anyone expected at the time of the debt exchange, and the payout on the warrants has, as a result, been very high during that period.

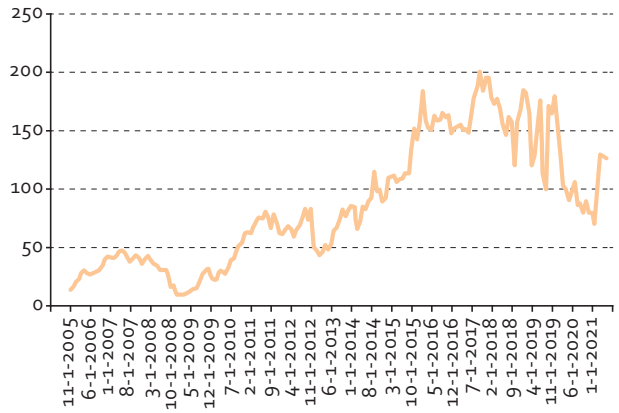
Table III.3
Argentina's GDP warrant payout

Accrual start date	Rate *(Percentage)*[a]
Nov 1, 2005	0.62
Dec 15, 2006	1.32
Dec 15, 2007	2.28
Dec 15, 2008	3.17
Dec 15, 2009	0.00
Dec 15, 2010	4.38

Source: Prepared by author.
[a] Rounded to two decimals.

However, lags in payments meant that some payments were due while Argentina was experiencing a recession, which created public pressure not to pay. An important issue was that the base year to compute GDP was changed in March 2014, from 1993 to 2004, which reduced the estimated growth in 2013 to 3 percent, almost half of what was initially forecasted, and just below the trigger for warrant payment. Aurelius, a hedge fund, filed a suit in January 2019, New York, for missed payments in 2013, arguing that there had been a statistical manipulation in the change of the base year. Although the case is still in court (as of December 2020), this litigation risk appears to have shunned interest in the Argentine GDPwarrants and poses an important challenge for these assets elsewhere. Still, figure III.3 presents the trading history of this warrant. As it can be seen, it still trades and has been trading with cuts as a result of the pandemic. The main problem investors faced was related to data accuracy, which was manipulated as part of a political strategic behavior.

Figure III.3
Trading history of Argentina's GDP-linked bond, January 2005- January 2021
(Adjusted closing price in US$)



Source: Bloomberg.

e) Greece

Once more, the Greek warrant was part of a debt rescheduling as many other indexed securities.

As a result of the great financial crisis, this country experienced deep difficulties in honoring its debt service. By 2009 the level of indebtedness surpassed their level of annual GDP and the budget deficit reached 13% of GDP, more than four times the EU's 3% limit. In addition, Greek pension system was expensive, as pension payments had absorbed 17.5% of GDP, higher than in any other EU country. Public pensions were 9% underfunded, compared to 3% for other nations. (Zettelmeyer, Trebesch, Gulati ,2013).

Because of this situation, Greece entered a long and difficult process of renegotiation with creditors, mostly German and French banks. This process involved a partial bailout and heavy and painful austerity measures (that caused political problems in that country). The stabilization program included a debt renegotiation program which in turn involved the issuing of GDP-linked warrants.

The exchange offer to holders of Greek government debt was a package of several securities (Cao, 2012):

- 31.5% in a basket of new Greek external debt with a step-up coupon and 11- to 30-year maturity,
- a GDP-linked warrant,
- 15% of the face value of old bonds in short-dated European Financial Stabilization Facility (EFSF) bonds of up to two-year maturity (the "sweetener"), and
- short-dated EFSF bills that pay in full the accrued interest.

Regarding the 31.5% GDP-linked securities, it is important to note that these securities were issued for the official creditors (i.e., European Countries) to hold, and were not market traded instruments. Calculated as a percentage of the same notional as the New Bonds (31.5%), these securities pay interest provided both nominal GDP is greater than a reference level and real GDP growth is greater than a reference level. They have a final maturity of 2042, with the principal reducing by about 5% per year starting in 2024. The interest rate is capped at 1% and calculated as follows:

- Payment is made equal to
  - GDP index percentage * notional if nominal GDP >= reference nominal GDP rate
  - Zero if nominal GDP < reference nominal GDP rate

where GDP index percentage = max {0, min{1, 1.5*(real GDP rate – reference real GDP rate)}}.

Reference levels for nominal GDP and real GDP growth are in table III.4 below. The bonds are callable at the option of Greece after 1 January 2020 at market levels, they contain standard collective class actions clauses (CACs) and are issued under English law. The threshold GDP growth rate is set between 2.25% and 2.90% for the reference years 2014-2020 and is equal to 2% in 2021-2041.

According to Credit Suisse "the experience with Argentine GDP warrants suggests that the Greek GDP warrants are unlikely to trade anywhere near the value that reflects the consensus view on Greek real GDP growth, at least in the beginning".

While the total payment on Greek warrants is capped at 18.6% of notional value, the cumulative payments on Argentine warrants are capped at 48% of their nominal amount. The high returns achieved by holders of Argentine warrants (see above) were supposed to translate into investor interest in the Greek GDP warrants. The Greek warrant structure is less complicated than that of the Argentine warrants and they are easier to model. Therefore, over time, these instruments may trade closer to their 'fair value' than the Argentine securities.

Table III.4
Greece: GDP levels and growth thresholds for the warrants

Reference year	Minimal nominal GDP level	Nominal annual growth needed to reach this level[a]	Real GDP growth threshold
2014	210.1014	-1.20%	2.35%
2015	217.9036	0.00%	2.90%
2016	226.3532	0.80%	2.85%
2017	235.7155	1.30%	2.80%
2018	245.4696	1.70%	2.60%
2019	255.8822	2.00%	2.50%
2020	266.4703	2.30%	2.25%
2020-2041	266.4703	2.00%	2.00%

Source: Credit Suisse, Invitation Memorandum 2011.
[a] Annual growth between 2012 and the Reference Year to achieve the Minimal Nominal GDP level. For the 2011 base year we use the Eurostat estimate for Greece's GDP of 217,828bn Warrants are paying excess real GDP growth over the base-case (Real GDP Growth Threshold in the table), provided that nominal GDP is higher than a specified level (Minimal Nominal GDP level in EUR bn).

Nevertheless, the value of the Argentinian and Greek growth-linked warrants (GLWs) experienced an opposite fate, determined in the first place by the change in GDP that happened in the first years following the default and restructuring of debt: while Argentinian economy quickly recovered, triggering initially a high payment almost every year (see previous section), the Greek one did not, making its GLW akin to a far out-of-the-money call option on its GDP.

Ubide and Levy (2015) argue that even though the Greek bond was not issued as a market-traded bond but as a GDP-indexed loan to an official creditor, valuation was still a relevant matter. And add: "That risk aversion may well be lower for an official creditor, but valuation should still be the relevant concern and could become an obstacle if the idea turns into a real exchange proposal. The loans to Greece are large and have fiscal implications for the creditor countries. In the Argentine case the warrant was detached so that it could trade independently and the bond could be easier to price separately. How would GDP-indexed bonds be valued and booked by a European government, or the ESM?".

Credit Suisse argues that given the significantly bleaker economic backdrop in Greece in 2012 compared to Argentina in 2005, investors assigned very little value to these warrants.

Major improvements include an independent audit of GDP numbers and the choice of overseas monitoring. Unfortunately, in the Greek case, it was a poor economic performance what made the warrants trade poorly.

f) Ukraine

Ukraine has also issued GDPwarrants as part of debt restructurings recently. In the Ukrainian case, payouts are capped between 2021 and 2025 at 1 percent of the overall nominal GDP, but not afterward, until 2040. Recent economic performance suggests that the cap will be reached, raising the question of whether these bonds represent a looming fiscal risk once the cap is withdrawn.

g) Portugal[11]

As many European nations, Portugal's strategy to deal with the international economic crisis that began in 2008 affected the country's economy and social situation. Between 2008 and 2013 Portugal adopted three different approaches to the crisis, each of which was implemented by a different government. The first approach focused on the sustainability of the financial sector. The second shifted the focus to

[11] See Pina (2020).

mitigating the adverse economic and social impact of the crisis. And the third approach concentrated on fiscal adjustment. Since 2008 Portugal has had two center-left governments, formed by the Socialist Party, and one center-right coalition government. These governments implemented policies agreed with the EU and later with the troika of the European Commission (EC), the European Central Bank (ECB) and the International Monetary Fund (IMF). Meanwhile public debt skyrocketed those years, despite of signs of economic recovery and some success in reducing the public deficit. The debt relief strategy was somehow different in Portugal (Pedroso, 2014). Nevertheless, it involved some GDP-linked securities, though these *were not issued as part of a debt restructuring*. Furthermore, these certificates target domestic savers.

Portugal wrote off two GDPlinked treasury certificates. Initially, in 2013, with a maturity of 5 years then, in 2017, with a maturity of 7 years, both certificates being redeemable after one year. The instrument is nontradeable and can be subscribed continuously. They include a fixed base interest rate, which raises over time, and additional payments linked to real GDP growth. Payments are not updated due to revisions of GDP statistics.

These certificates were innovative and did not experience major issues. They represented 6.7% of total government debt in May 2019, about €17 billion. The indexation was always activated, and additional payments linked to GDP have been sizable as real GDP growth has exceeded expectations since 2014 (up to 2019).

Pina (2020) documents that in the 2013 edition, the coupon in the final two years was linked to 80% of the average real GDP growth in the last four quarters known in the month before the date of interest payment. The government announced a reduction in base interest rates in midJanuary 2015, taking effect at the end of that month, without specifying the details on the new rates. This prospective decrease in interest rates led to a surge in subscriptions in January 2015.

The 2017 edition further decreased base rates and, starting in year two, included variable payments indexed to 40% of the average real GDP growth in the last four quarters known in the month before the date of interest payment. Both instruments include a coupon floor equal to zero. The 2017 edition also includes a cap of 1.2 percentage points on additional interest payments related to real GDP growth. Payments are not corrected due to statistical revisions.

The recent experience in Portugal with debt linked to real GDP growth shows that it is possible to implement statecontingent government debt in an advanced economy. These certificates saw substantial demand, and there have not been any issues regarding their payment. Expost, they may have been more expensive for the Portuguese government compared to alternative financing options, but they insured the government against shocks to real GDP growth and increased the domestic market for public debt.

From the buyers' point of view, the relatively generous base interest rates and the substantial GDP growth numbers have contributed to the popularity and substantial demand for these debt instruments.

Table III.5
Summary of the selected source cases

Country	Duration	Reason to issue	Type	Instrument	Payment triggered if	Pitfalls	Lesson learnt
Argentina	2005-current	Debt restructuring	Warrant	Real GDP growth linked warrants	(i) Actual real GDP exceeds base case GDP; (ii) Real annual growth results greater than the growth implied by the base case GDP; (iii) The cumulative number of past payments made on GDP warrant do not exceed the payment cap per unit of security (in the issuing currency)	• Inflation has been significantly understated for political reasons (low inflation is "good"), but real GDP growth has been overstated (slow growth is "bad") • Incentives to exaggerate growth have led Argentina to overpay on its debt	• Absence of independent statistical agency is inefficient • Change in the base year for GDP calculation to avoid payments might be seen as suspicious and led to legal controversy with private investors
Bulgaria	2004	Debt restructuring	Warrant	Additional Interest Payment (AID) linked to GDP	(i) Its GDP reaches 125% of its 1993 level, and ii) The rate of yearly growth is positive	• The prospectus was ambiguous on the source of data to obtain the GDP level • The bond was callable and limited the possibility for investors to enjoy higher returns during expansionary phases	Callable options are not fully compatible with the nature of GDP-linked securities and might undermine investors' appetite for the security
Bosnia-Herzegovina (BH)	1993-2017	Debt restructuring	Warrant	GDP Performance Bond	(i) GDP level reaching 125% of its 1993 level and, remaining at such level for two consecutive years; (ii) GDP per capita surpassing the USD$2,800 in 1997 prices, adjusted using German CPI	• GDP figures were estimated by the central bank, in a possible conflict of interest • Data reliability on the population statistics • The price of the warrants was rarely published; thus, trading activity was scarce	Data should be clear and precise, and obtained by an independent body
Singapore	2001-2006	Help the low-income population and subsidize it after the increase of VAT	Share	2 Preferred stocks: the New Singapore Shares (NSS) and the Economic Restructuring Shares (ERS) linked to GDP	Annual dividends (as in a preferred stock) were estimated at 3% plus the real GDP growth rate of the preceding calendar year	The security is that the solution was highly pro-cyclical	Alternative financing is effective if work in a countercyclical manner

Country	Duration	Reason to issue	Type	Instrument	Payment triggered if	Pitfalls	Lesson learnt
Greece	2012-2042	Debt Restructuring	Warrant	GDP-warrant linked to real GDP	Payment equal to: (a) GDP index percentage * notional if nominal GDP >= reference nominal GDP rate, where GDP index percentage = max {0, min{1, 1.5*(real GDP rate – reference real GDP rate)}} (b) 0, if nominal GDP < reference nominal GDP rate NOTA	The Greek GDP did not recover, making its GLW akin to a far out-of-the-money call option on its GDP	Warrants traded poorly due to weak economic recovery after the crisis
Portugal	2013-2018/ 2017-2024	Deal with 2008 economic crisis	Bond	Treasury Certificates linked to real GDP growth	(i) 2014 certificate: the coupon in the final two years was linked to 80% of the average real GDP growth in the last four quarters known in the month before the date of interest payment; (ii) 2017 certificate payments: indexed to 40% of the average real GDP growth and also included a cap of 1.2% on additional interest payments related to real GDP growth	These certificates saw substantial demand, and there have not been any issues regarding their payment	
Ukraine		Debt restructuring	Warrant	Warrant linked to GDP	Payouts are capped between 2021 and 2025 at 1 percent of the overall nominal GDP, but not afterward, until 2040	Recent economic performance suggests that the cap will be hit, raising the question of whether these bonds represent a looming fiscal risk once the cap is withdrawn	

Source: Pina (2020).

C. The benefits of linking bonds to real national dispobale income

The benefits of linked bonds (LB) are vast, at least theoretically. Yet there are a number of challenges that have to be addressed to introduce this class of securities successfully. As argued earlier most flaws do not come from the nature of LBs. They come either from inadequate bond design or from weak institutional settings in the issuing countries, which allows strategic political behavior.

One of the main concerns was related to data accuracy. As reviewed, this may be caused by different reasons. First, in developing countries the institutions in charge of generating and estimating statistics are not always autonomous, and sometimes there are more than one institution generating relevant data such as estimation of GDP or GNI, on the one hand, or inflation, on the other. In some developing nations these two sets of information are dissociated. Typically, in LAC the central bank estimates national accounts and a different organization (which may include the National Institutes of Statistics or even the Finance Ministry) calculates the inflation; this varies from country to country, however. An obvious solution to this problem is to better design an autonomous institution that formally obtains the responsibility of producing and estimating relevant economic information. This would increase the probability of success of introducing contingent debt.

Second, in some less developed countries the statistics are seen as an accessory, thus the institutions are not well funded. Because of this, it is said that institutions cannot hire capable human capital. The cacophonous solution is to increase the funding of the institutions. Moreover, multilateral organizations may help to train the public officials and to advise in improving the methodologies of estimation.

In short, should a government want to issue a LB, the market would need a binding commitment to comply with these two conditions.

Finally, the problem of political strategic behavior was mainly found in the Argentinian case. As pointed out earlier, Ubide and Levy (2015) argue that Argentina's inflation and national accounts statistics have been dubious especially during the first years after having issued the warrant. In particular, these authors reckon that inflation has been significantly understated for political reasons (low inflation is "good"), but real GDP growth has been overstated (slow growth is "bad"). Thus, short-term political incentives to exaggerate growth have led Argentina to overpay on its debt. It paid the 2008 coupon, although later revisions to national accounts data showed that its trigger, the real growth rate in 2007, had not exceeded the threshold.

Undoubtedly that this is an implementation problem (i.e. it does not come from the nature of linked bonds). It is true that developing countries present weak democracies and institutions, and the solution of these obstacles are beyond a commitment with the multilateral organizations or the international credit markets. However, as we just underlined a well-funded autonomous statistics institute, which in addition may receive the advice from multilateral organizations, may help.

Yet there is no way to guarantee that the strategic behavior will not take place. Ubide and Levy-Yeyati (2015) are very skeptical about these type of bonds because of this reason. However, one needs to remind that that is the very nature of all types of sovereign debt, as Eaton and Gersovitz (1981) seminal paper show.

In effect, economists acknowledged the presence of default risk arising from the absence of legal enforcement long ago (Eaton and Gersovitz,1981; Sachs and Cohen, 1982; Sachs, 1989; Kletzer, 1984). For these authors a country would default if the costs associated to default are lower than the benefit of doing so in a dynamic setting.

Nevertheless, it is not clear what the cost is for defaulting countries. Eaton and Gersovitz (1981) argued that the main cost is the loss of future access to international credit markets. However, history has shown that most defaulting countries have regained that access relatively quick (Eichengreen and Portes, 1986; and Lindert and Morton, 1989).

What is more, African countries transferred in 2018 2% of their GNI to creditors, whereas Latin American and the Caribbean transferred on average 3% of their GNI in 2018 to creditors, according to data drawn from world bank data base. This fact raises the paradox in sovereign loan markets that even though a creditor usually lacks the ability to seize much of debtor's assets if it defaults, creditors do make loans and debtors often repay them.[12]

Thus, Ubide and Levy-Yeyati (2015) skepticism applies for all type of sovereign debt. In this sense well-designed linked bonds may well be attractive to investors who try to take a risk on countries economic performance. Hedging this risk could be a challenge but is quite possible if we can get the right design.

Here we argue that some elements of national accounts are harder to be manipulated by a government as they may be verifiable through other sources. This is the case of the Gross National Income (GNI) or at least some of its components.

It is true that GNI and GDP are highly correlated. As an illustration see figure III.4A, B, C, D and E. However, the components may be subject to different verifications. Even as obvious as it may seem, it is useful to look at chart 1 below which provides a visual of what is and is not included in GDP and GNI. As it may be seen there are two elements that can be calculated through sources different from the official statistics. These two sources are net exports (NX) and Remittances and may be estimated through foreign statistics.

NX are defined as exports minus imports; the first represent the buyer country's imports, whereas the latter represent the seller country's exports. Hence, NX may be double checked to verify that these have not been manipulated by the host country. For example, the top five U.S. export markets to the Western Hemisphere for 2019 were: Canada ($292.6 billion), Mexico ($256.6 billion), Brazil ($42.9 billion), Chile ($15.7 billion), and Colombia ($14.7 billion). These figures should be the imports from the US for these countries. And, the top five import suppliers from Western Hemisphere for 2019 were: Mexico ($357.8 billion), Canada ($319.4 billion), Brazil (30.8 billion), Colombia ($14.2 billion), and Chile ($10.4 billion). Again, these represent exports to the US from these countries. In short, trade can be estimated from statistics coming from trade partners.[13]

Remittances is the other element that may be subject to external verification. The foreign financial system does report all this information by country. Thus, it can be estimated from outside sources. For example, as a result of the fiscal stimulus approved by the US Congress, remittances peaked aided by stimulus checks from the administration of U.S. President Joe Biden.

Table III.6
Components of GDP, GNI and GNP

Income earned by	GDP	GNI	GNP
Residents in country	C+I+G+X	C+I+G+X	C+I+G+X
Foreigners in country	Includes	Includes if spent in country	Excludes all
Residents out of country	Excludes	Includes if remitted back	Includes all
Foreigners out of country	Excludes	Excludes	Excludes

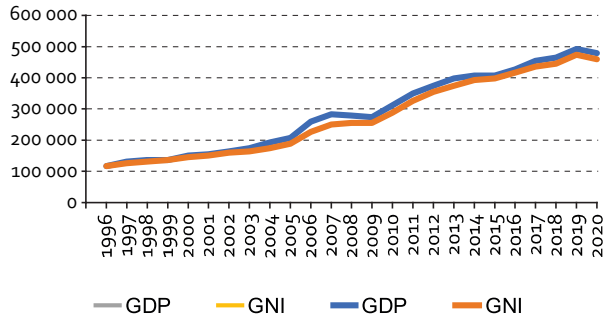
Source: Prepared by the author.

[12] This raises the question as to what incentive a sovereign borrower has to repay the debt. Bulow and Roggoff (1989) and Krugman (1985) argue that the main reason to repay debt is the loss of access to trade. Hernández-Trillo (1995) provides empirical evidence that this is the most likely explanation.

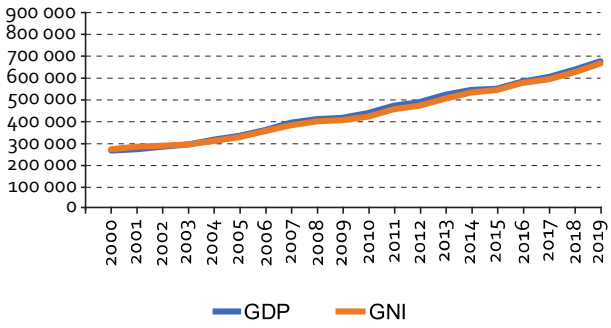
[13] USTR (2022).

Figure III.4
Evolution of GDP and GNI for selected economies

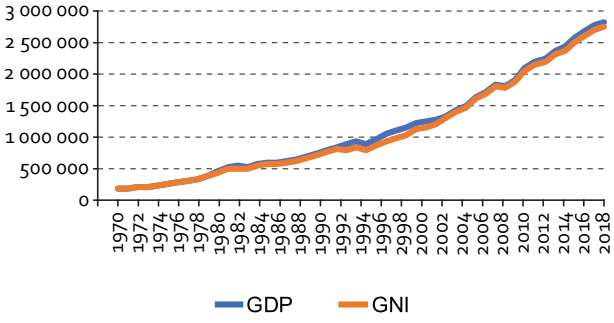
A. Chile GDP & GNI (1966-2020)
(*Millions of dollars*)



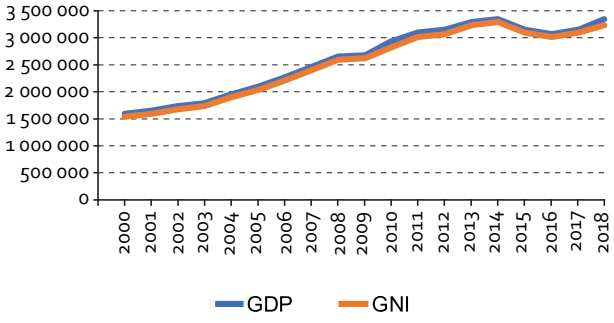
B. Colombia GDP & GNI (2000-2019)
(Millions of dollars)



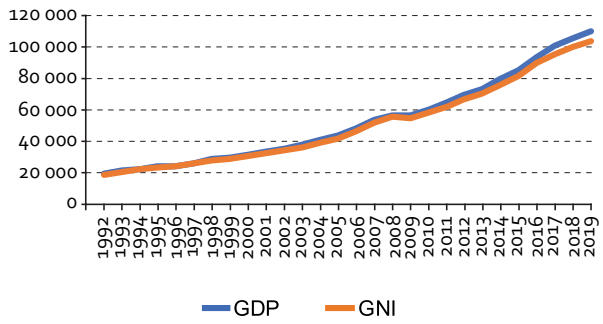
C. Mexico GDP & GNI (1970-2018)
(*Millions of dollars)*



D. Brazil GDP & GNI (2000-2018)
(*Millions of dollars)*



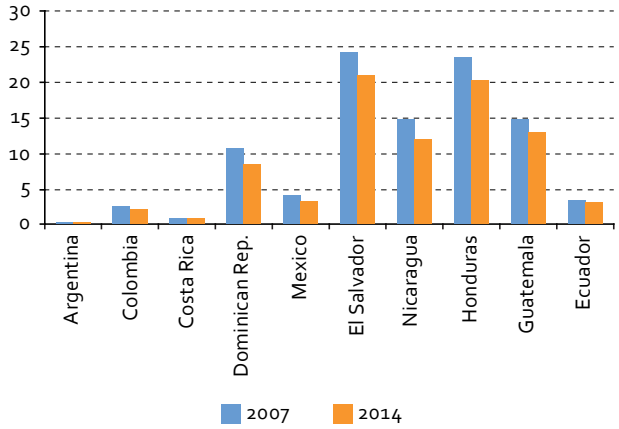
E. Costa Rica GDP & GNI (1992-2019)
(Millions of dollars)



Source: World Bank Database.

When a given country is open, NX may be more associated to the trade partners cycle, and because of this reason, in some countries these variables account for a relatively high proportion of the GNI. Let us begin with remittances. Figure III.5 presents the Remittances as a proportion of GNI for some LAC selected countries. We placed especial interest in nations which traditionally are net recipients. As it may be observed El Salvador, Guatemala, Honduras, and Nicaragua are highlighted. These Central American countries' GNI/GDP is highly dependent on remittances reaching between 15 and 25% of the national income. The Dominican Republic's proportion is around 10%. México, Colombia and Ecuador is about 3%, 2.2% and 2.9% of their GNI, respectively (figure III.5).

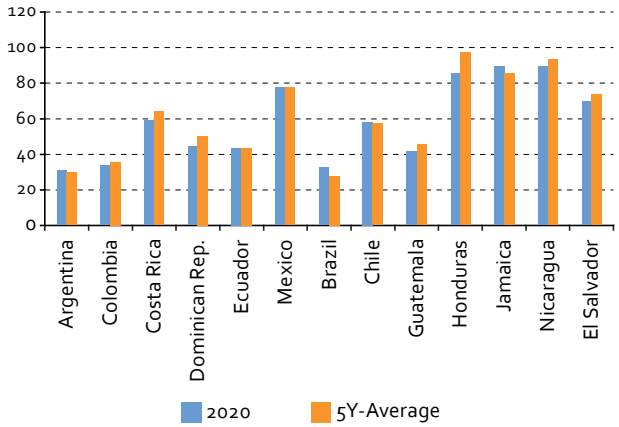
Figure III.5
Remittances as percentage of GNI for selected Latin American countries, 5-year average and 2020



Source: World Bank Database.

Let us now look at the exports as a proportion of GNI. Figure III.6 presents this indicator for selected LAC countries. In general, one could say that LAC region is open to trade. Argentina, Colombia, and Brazil are the least open to trade countries. In the opposite extreme Mexico, Costa Rica, Chile, Honduras, Jamaica, and Nicaragua present high proportions of (X/GNI) ratio. The figure is beyond the 30% and in the case of México and Nicaragua reaches 40%.

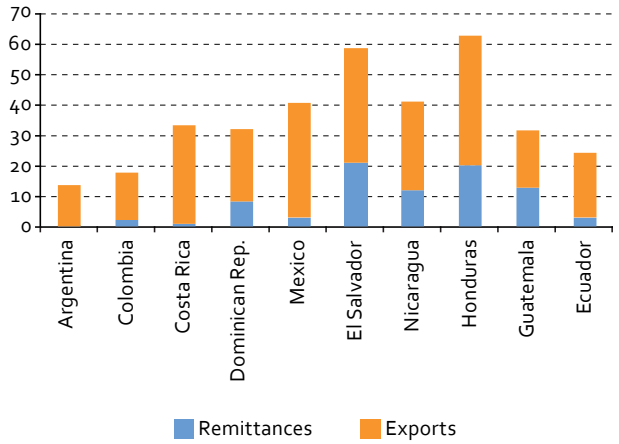
Figure III.6
Exports of goods and services as percentage of GNI for selected Latin American countries, 5-year average and 2020



Source: World Bank Database.

When remittances and exports are added up, we can see that for El Salvador and Honduras these two variables represent 60% of their GNI. For México and Nicaragua, the same indicators jointly reach more than 40%. A third group of countries present a 30% proportion, namely, Costa Rica, Dominican Republic, and Guatemala. Finally, Argentina (and Brazil, not included in the figure) and Colombia exhibit a number around the 10% of GDP. We recognize that imports should be considered in the picture (see figure III.7).

Figure III.7
Exports of goods and services and remittances as percentage of GNI for selected Latin American countries, 5-year average and 2020



Source: World Bank Database.

In summary, the GNI may be verifiable relatively well for some countries open to trade-cum-net receivers of remittances. Because of this GNI-linked bonds may be introduced in these group of countries, especially Central American countries. México is clearly in this group. An additional advantage of the latter is that its National Statistics Institute (INEGI) and its central bank (in charge of reporting remittances) are independent from the executive branch.

Yet, an institutional feature that would increase the probability of success of GNI linked bonds is the independence from the executive branch of the institutes or central banks in charge of generating national accounts estimates and the rate of inflation. This varies from country to country (see table III.7). This is

not a necessary condition, but facilitates the introduction, as markets would perceive lower possibility of manipulating the statistics. The only four countries that comply with both autonomous institutions, are Chile, Costa Rica, México and Paraguay (we exclude Venezuela from the analysis). Thus, multilateral organization may encourage countries to reform their bodies in charge of generating information.

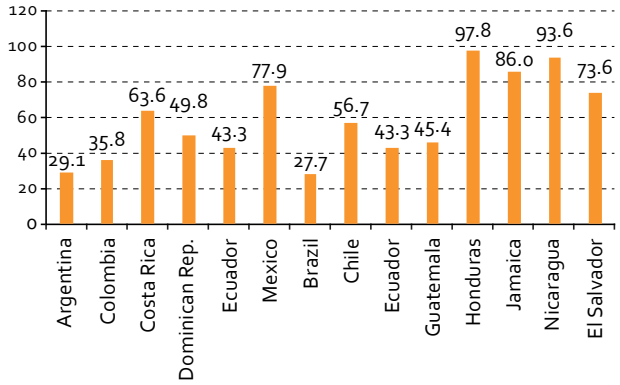
Table III.7
Independence in the generation of national statistics for Latin American and Caribbean economies

Country	Central Bank	Statistic Institute
Argentine	Independent	Dependent
Aruba	Dependent	Dependent
Bahamas	Dependent	Dependent
Barbados	Dependent	Dependent
Belice	Dependent	Dependent
Bolivia (Plurinational State of)	Dependent	Dependent
Brazil	Independent	Dependent
Cayman Islands	Independent	Dependent
Chile	Independent	Independent
Colombia	Independent	Dependent
Costa Rica	Independent	Independent
Cuba	Independent	Dependent
Curaçao and St Maarten	Independent	Independent
Dominic Republic	Independent	Dependent
Ecuador	Independent	Dependent
El Salvador	Independent	Dependent
Guatemala	Independent	Dependent
Guyana	Independent	Dependent
Haiti	Dependent	Independent
Honduras	Dependent	Independent
Jamaica	Independent	Dependent
Mexico	Independent	Independent
Nicaragua	Dependent	Independent
Paraguay	Independent	Independent
Peru	Independent	Dependent
Surinam	Independent	Dependent
Trinidad y Tobago	Dependent	Dependent
Uruguay	Independent	Dependent
Venezuela (Bolivarian Republic of)	Independent	Independent

Source: Prepared by author.

It is true that for some countries such as Argentina and Brazil, the proportion of GNI to be verifiable, is relatively small. The degree of openness, defined as (X+M)/GNI, is also a way to capture how important trade is to the country. As discussed earlier, those opened countries tend to default less, because the cost of doing so is the loss of access to international trade. Hence, those with a degree of openness higher than 50% may be candidates for issuing GNI-linked bonds. Among these, we can find Costa Rica, Dominican Republic, México, Chile, Honduras, Jamaica, Nicaragua and El Salvador (see figure III. 8).

Figure III.8
Trade openness for selected Latin American economies
(Percentage of GNI)



Source: World Bank Database.

In contrast, there are countries that in relative terms are not that opened to trade. The two prime examples are Argentina and Brazil, whose degree of openness to trade is less than 30 percent, the lowest in the region. This does not necessarily mean that these relatively closed countries may not be able to issue GNI-linked bonds. What this mean is that verification of national account figures must be done through other ways.

In particular, the existence of independent autonomous institutions in charge of generating the main national account indicators might be a condition to be able to issue such a bond. Yet, there is always a possibility that such institutions may be endangered when democracy is weak. Nevertheless, this pre-condition diminishes the probability of misreporting the actual GNI or GDP.

One way to determine whether a country is a better candidate for issuing GNI bonds, given that they are open to trade and are net receivers of remittances, is verifying that GNI is cointegrated to X and Remittances. This would imply a long-term relation between the two sets of variables. If so, one can say that GNI is highly verifiable through X and R. Thus, good candidates to issue GNI linked bonds. To illustrate we ran cointegration tests for the following selected countries Argentina, Brazil, Colombia, Costa Rica, Dominican Republic, Guatemala, El Salvador, Honduras and Mexico.

Results of cointegration are presented in appendix. Based on the Phillips-Ouliaris test, it is concluded that for all selected countries there exists a long run cointegration relationship between exports and GNI. However, for the cointegration between remittances and GNI, Argentina and Brazil do not present statistical evidence of a long run relationship as we cannot find evidence of cointegration between those two variables. For the remaining countries, Colombia, Costa Rica, Dominican Republic, Guatemala, El Salvador, Honduras and Mexico the Engle-Granger and Phillips-Ouliaris tests support evidence of cointegration.

With respect to the terms of trade, TOT, defined as the price of one country's exports in terms of the other (say the price of wine in terms of cheese)[14] we found that six out of eight countries (Argentina and Brazil, the exceptions) report the presence of a long run cointegration relationship between terms of trade and exports. The estimated sign is positive: long term improvement in the terms of trade is associated with higher exports, reflecting the highly probability of the region to experience similar co-movements in both variables.

[14] Terms of Trade (TOT) = (Index of Export Prices / Index of Import Prices)* 100.

Estimates also suggest there exists cointegration between remittances and terms of trade in all countries but Argentina and Dominican Republic. In this case the relationship appears to be positive as higher terms of trade might be associated with higher remittances.

In summary, for countries where the trade is important and remittances represent some proportion of GNI, a GNI linked bond may in principle be attractive to investors, as they can easily verify the accuracy of the data. Next we outline the features of such bonds.

D. GNI-linked bond

As we have argued, GNI-linked bonds (ILB) are like GDP-linked bonds and their design may take a myriad of forms. The contingent bonds may link the interest rate only, or alternatively both principal and interest rates as in Shiller (1993). We consider here a bond which only links the interest rate to GNI performance, because its valuation is simpler, a feature that may facilitate its introduction.

As said most contingent debt has been introduced as part of a debt-restructuring process. This fact has *facilitated* the acceptance of some of the existing issues (recall Portugal and Singapore are an exception to this). Nevertheless, under "normal" economic conditions the bonds should be better designed, and an attempt should be made to have a liquid market. In other words, the linked bonds should not only be "sweeteners" of a debt-restructuring process; if properly designed, they should be liquid bonds that provide the investors additional instruments to invest in, so they may diversify risk. In turn, countries may use them as an additional instrument to stabilize the economy when needed (during economic downturns).

As an illustration we use some features of the Argentine warrant to portray the GNI-linked bond, even though they were designed under pressure coming from harsh economic conditions. In this sense, the bond includes a free, detachable warrant which can be traded in the market independently and only has positive payments. That is, the linked-bond provides the holder with a payment if the three following conditions are met: (i) actual real GNI exceeds baseline real GNI in the reference year (see below for definition); (ii) rate of growth in actual real GNI exceeds rate of growth in baseline real GNI in reference year; and, (iii) the cumulative amount of past payments do not exceed, if defined, a payment cap (in the Argentinian case this was a set at 0.48 per unit of security). Hence, if payment cap is not set, then only two preconditions should be met to have a positive payment amount.

We must stress that the total payment is a fraction of the excess GNI in the reference year (actual GNI minus baseline GNI). In the Argentinian case this fraction was set at 5%; clearly this amount may be set differently. We stick to this percentage in our example. We next outline the components of the GNI-linked bond.

1. Features and components of the GNI-linked bond

As known a plain vanilla bond pays off a par (or face) value at expiration and a series of coupons commonly paid twice a year during the life of the instrument. The final payment at maturity includes the coupon and face value amounts. It is important to point out that the coupons are normally detachable and in fact they may be sold independently. In our case the par (face) value of the GNI-linked bond remains constant[15]; the coupons are detachable, and their returns are contingent on GNI performance. So, the bond's valuation is just the sum of present value of contingent coupons plus the present value of par value. The key element for pricing the bond is then the estimation of the value of the -detachable- contingent coupon value.

To determine the amount coupon pays, several features must be stipulated. First, the currency must be specified in the prospectus. This may be set in national currency or any other major currency such as Euro or USD, among others. Second, the reference year should be the previous year in which payments occur (i.e. the year on the basis of which payments are calculated); this feature implies that coupon payments would be made once a year.[16]

[15] In Shiller's proposal, this portion is also contingent on economic performance.
[16] In contrast to a traditional, plain vanilla, bond, which makes payments twice a year.

Third, a baseline real GNI ought to be defined. There are different approaches to do it; for simplicity we propose here that the baseline should be the potential rate of GNI, which is an estimate of the value of the output that the economy *would have* produced if labor and capital had been employed at their maximum sustainable rates —that is, rates that are consistent with steady growth and stable inflation. This estimate is not trivial. However, it could be based on the estimation of the potential made under the structural fiscal rules in the region.

Fourth, it must be clear that a unit of debt represents the proportion that one [GNI]-linked security with a notional amount of one unit of currency bears to the aggregate eligible amount of all eligible securities outstanding (Costa et al 2008, from Argentinian Debt Prospectus). In other words, this may be interpreted as the share of the excess GNI that the holder one unit of each security of currency is entitled to.

Finally, the payment amount must be specified. In the Argentinian and Greek cases, a percentage of the difference between the actual growth and the baseline growth of GNI, was set at 0.05, or 5%. We propose this percentage, as we considered that markets have already accepted it in those cases.

Given these features, the GNI-linked coupon would be the following in case the three (or two if no payment cap) conditions are met:

C_{gni}= 0.05(real GNI growth rate – baseline GNI growth rate) x (1/size of debt).

For valuation purposes the Coupon would look like:

$$C_t = \begin{cases} \left(\frac{0.05(Y_t - y_t^b \pi_t^d)}{e_t} \right) \times \frac{1}{D_t} \text{ for any } g_t > \overline{g}, \\ 0 \text{ for any } g_t < \overline{g} \end{cases}$$

where

C_{t+1}: Coupon payment at time t+1

Y_t: Nominal GNI in period t

y_t^b: Real GNI in baseline case for t

π_t^d: GDP deflator in period t

e_t: Exchange rate (Local$/ Foreign $)

D_t: size of debt

g_t: rate of growth of GNI

$\overline{g}$: Baseline rate of growth of GNI

Then, the value of the bond, B, would be defined as follows:

$$B_{t-1}^{GNI} = \sum_{t=1}^{T} \frac{C_t}{(1+i)^t} + \frac{FV_T}{(1+i)^T},$$

where i is the discount rate, FV the face value of the bond, C is the coupon. The valuation is out of the scope of this document. However, this has been widely estimated: Costa et al (2008) and Miyajima (2006) have developed solid pricing methodologies, which can easily be extended to our case.

Then, the payment structure of the ILB would be:

$$\text{Payment amount on GNI linked Bond} = \begin{cases} >0 \ldots\ldots\ldots\ldots \text{iff} \left(g_t - \bar{g} \right) \leq 0 \\ = 0 \ldots\ldots\ldots\ldots \text{iff} \left(g_t - \bar{g} \right) \leq 0 \end{cases}$$

However, a piece is missing for the success of ILB. This is the indexation premium, which is estimated next.

2. Indexation premium

ILB are expected to be one instrument in a multi-security portfolio. Thus, for holding ILB in their portfolios, investors require a premium over the risk-free rate. This as opposed to as a stand-alone product (Miyajima, 2006; Borenzstein and Mauro, 2004). Then an estimate must be obtained.

Should this premium be high relative to the value of the bond, then this would not be attractive.[17] To appreciate the financial viability of the ILB it is important to calculate it In addition, we assume a low correlation between the return of the ILB and the return of the other instruments of the investors' portfolio. The *ex-post* return on the instrument is determined by the difference between g_t and $\overline{g}$ (coupon) plus an indexation premium.

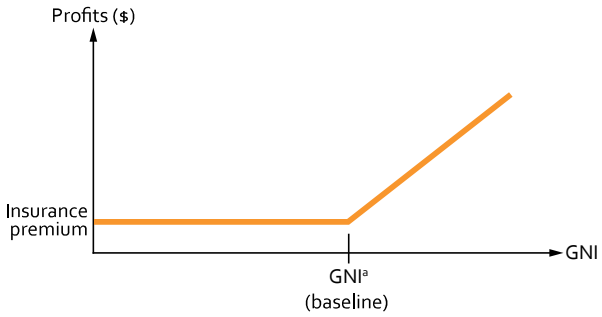
$$i_t = \rho + \phi\,(g_t - \overline{g}\,)$$

where ρ the indexation premium, ϕ is the extent to which total debt is indexed to GNI; $\overline{g}$ is the potential GNI rate of growth, and g_t the actual GNI rate of growth.

Note that the nature of each coupon may be seen as an *option* that gives the right to exercise it if the coupon if $GNI_t > \overline{GNI}$. Hence, the option looks as a caplet[18] as the forward price is already known (the baseline rate of growth). Graph 9 draws the horizontal axis the GNI level and the possible profits coming from the level of GNI. The baseline is drawn arbitrarily for illustration purposes.

As it may be appreciated, if GNI_t is greater than $\overline{GNI}$ then there is a profit (the difference, adjusted by the percentage set in the prospect). On the contrary, if $\overline{GNI} > GNI_t$ return on ILB is only the indexation premium. We presented here the case where indexed premium is present. There are other contingent bonds, which do not contain this premium explicitly.

Figure III.9
Insurance premium below and above the baseline GNI



Source: Prepared by author.
[a] Baseline real GNI.

To value this caplet or indexation premium, an extension of the Black and Scholes option pricing model is frequently used. This is the Black futures option model use for European derivative instruments. Assumptions behind the model are standard. Forwards follow a lognormal distribution with a constant volatility. The model is defined as follows, where f_o is the forward price and X, the strike price.[19]

[17] Miyajima (2006) argues that the premium is expected to be low if the return to ILB is not highly correlated with the return to the investors' existing portfolio, because by its very nature ILB would reduce the volatility of the portfolio. This would allow pricing the ILB as a stand-alone product.

[18] Caplets are interest rate options designed to "cap" the risk of rising rates. The typical use of a caplet is to limit the costs of rising interest rates for those corporations or governments that must pay a floating rate of interest on bonds they have issued. However, as with all derivatives, commercial speculators may trade caplets for short-term gains.

[19] For details see R. Stafford Johnson (2010). Bond Evaluation, Selection, and Management, Second Edition by Copyright © Johnson.

$$c_0 = [f_0 N(d_1) - XN(d_2)]e^{-R_f T}$$

$$p_0 = [X(1 - N(d_2)) - f_0(1 - N(d_1))]e^{-R_f T}$$

$$d_1 = \frac{ln ln\left(\frac{f_0}{X}\right) + \left(\frac{\sigma_f^2}{2}\right)T}{\sigma_f \sqrt{T}}$$

$$d_2 = d_1 - \sigma_f \sqrt{T}$$

where,

c_o: price of a call option

p_0: price of a put option

σ_f^2 = variance of the logarithmic return of future prices = $V(\ln(f_n/f_0))$

T = time to expiration expressed as a proportion of a year

R_f = continuously compounded annual risk-free rate [if simple annual rate is R, the continuously compounded rate is $\ln(1+R)$]

N(d) = cumulative normal probability; this probability can be looked up in a standard normal probability table or by using the following formula:

$$N(d) = 1 - n(d), for\ d < 0$$

$$N(d) = n(d), for\ d > 0$$

To illustrate this, we next provide an example for selected countries, according to their actual rates of growth. Assumptions are as follow:

- The baseline real GNI rate of growth for each country is presented in table III.7, which is the 30-Y potential rate of growth of each economy. In our example, and for illustration purposes only, we set that rate of growth as the last 30-year average.
- Volatility of the rate of growth of GNI for the last 30 years.
- The risk-free rate is the sovereign yield of the highest maturity, preferable 30Y. However, many countries have not issued such a 30Y bond yet. We use the highest possible maturity span.[20]
- The forward price for the reference real GNI is set at 100. Then the strike price is the annual real GNI rate of growth, for each country according to table III.7. Then strike is 100 + (the latter in table III.7 is labeled as GNI trend).
- Notional Value (non-indexed) is assumed at 100 USD, the par value of a plain vanilla bond. Maturity is 30Y.

Table III.8
Selected financial indicators for selected Latin American economies used in the valuation exercise

	El Salvador	Guatemala	Honduras	Argentina	Brazil	Mexico
GNI trend	0.021	0.035	0.032	0.025	0.022	0.021
GNI volatility	0.028	0.015	0.035	0.068	0.030	0.037
Coefficient of variation of GNI	1.347	0.419	1.102	2.741	1.334	1.762
GDP trend	0.022	0.035	0.033	0.022	0.024	0.021
GDP volatility	0.023	0.016	0.031	0.065	0.029	0.032
Coefficient of variation of GDP	1.076	0.458	0.951	2.945	1.190	1.522
Interest rates	0.0575	0.0487	0.0625	0.46	0.1064	0.0798
Maturity of T bond	4Y	15Y	5Y	7Y	10Y	30Y

Source: PREDik Data-Driven (2022).

[20] World Government Bonds. (2022) Country Comparisons.

For the valuation we use a popular online software[21], and set all the information as follows for all the countries. Results for all countries are in shown in table III.8.

Observe in table III.8 that price of caplet (option) for Mexico is $5.795 and the present value of a 30Y Warrant is $65.36 (considering $5.795 for 30Y), which suggests that GNI option is valued at 3.27% of notional value and is calculated as the product of the PV ($65.36) times the payment proportion set by the prospectus we proposed (0.05). Each caplet is worth 0.29% (which according to our assumptions, the payment amount is 0.05 times the caplet, $5.795) of the underlying notional amount. This caplet may be interpreted as the yearly indexation premium on the interest rate. The results for all selected countries are presented in table III.9 below.

Table III.9
Indexation premium results for selected Latin American countries

	Mexico	Brazil	Argentina	Honduras	Guatemala	El Salvador
Caplet price	5.795	8.091	35.65	3.393	1.544	3.713
Discount factor	0.926097	0.926097	0.926097	0.926097	0.926097	0.926097
Discounted caplet	5.366735	7.493054	33.01537	3.142249	1.429894	3.4386
VP	65.36215	91.25887	402.0985	8.010743	17.41487	41.87915
Delta	0.9485	0.998	0.998	0.816	0.833	0.907
VP*0.05	3.268108	4.562944	20.10492	0.400537	0.870743	2.093957
Cap price*0.05						

Source: PREDik Data-Driven (2022).

Observe that for the Mexican case the indexation premium is about 0.29% of notional value and for Brazil this figure reaches 0.40%. For the three Central American Countries the indexation premium is rather small. 0.17%, 0.08% and 0.18% for Honduras, Guatemala and El Salvador. Argentina is the only country where the premium is high as it is 1.79%.

Using the CAPM, Borenzstein and Mauro (2002) and Miyajima (2006) have estimated that the indexation premium. The first authors obtained a figure about 0.4%. Both estimates (the latter and ours) are reasonable low and attractive for investors, except for Argentina, perhaps.

One further aspect to highlight in the methodology employed here, as opposed to CAPM one, is that the delta of the option is normally interpreted as the probability of exercising the option[22]. The delta is presented in table III.8. Note that for México and Brazil that probability is quite high (95% and 99%). For the Central American countries, the delta is 81%, 83% and 90% (Honduras, Guatemala and El Salvador, respectively). This means that probability that investors will receive yearly interest payments is high. Naturally, it is in economic downturns that they have the risk of not collecting the coupon.

Finally, it is worth carrying out the estimation of the indexation premium using the same methodology for GDP-linked bonds, as opposed to ILB. The data used is also presented in table III.7. Results are in table III.9. Note that growth rates and volatilities are statistically not different for both variables GNI and GDP (Table III.10). For this reason, indexed-premiums for a GDP-linked bond are also statistically the same as that for the ILB.

[21] This may be obtained manually, or using any financial software, including EXCEL Risk Calculator. There are also different online calculators. An example is https://www.optionseducation.org/toolsoptionquotes/optionscalculator or this other https://www.hkex.com.hk/eng/sorc/tools/calculator_stock_warrants.aspx.

[22] It is the derivative of the Option with respect to the underlying asset.

Table III.10
Insurance premium results for GDP for selected countries of Latin America

	Mexico	Brazil	Argentina	Honduras	Guatemala	El Salvador
Caplet price	5.771	7.937	35.293	3.283	1.581	3.658
Discount factor	0.92609743	0.90383225	0.68493151	0.94117647	0.95356155	0.94562648
Discounted caplet	5.34450824	7.17371656	24.1732877	3.08988235	1.50758081	3.45910165
VP	65.0914549	71.0037537	76.7230128	44.0063694	24.6681907	3.45910165
Delta	0.969	0.998	0.999	0.853	0.816	0.946
VP*0.05	3.25457275	3.55018769	3.83615064	2.20031847	1.23340953	0.17295508
Cap price*0.05	0.28855	0.39685	1.76465	0.16415	0.07905	0.1829

Source: PREDik Data-Driven (2022).

Therefore, the national debt service rate, R_t, for a representative country that have issue plain vanilla bonds and GNI linked bonds, may be written as:

$$R_t = \alpha r + (1 - \alpha)[\rho + \phi(g_t - \overline{g})].$$

Where r is the plain vanilla bond issue by the government with no indexation; ρ the indexation premium, ϕ is the extent to which total debt is indexed to GNI.; $\overline{g}$ is the potential GNI rate of growth, and g the actual GNI rate of growth; α is the proportion on plain vanilla bonds.

However, it must be noted that this implies discontinuities as pointed out by Costa et al (2008). Since payments occur only if growth is above the baseline (in our example, 2%), an achievement of a slightly lower rate, say 1.99% implies no payments, whereas a rate of GNI growth of 2.1% would imply a relatively important amount of payment. And this discontinuity may be the source of moral hazard with respect to data accuracy. This is a challenge to be solved.

3. A heuristic simulation for the Mexican case

One important question that arises from the discussion is what would be, the advantage of issuing linked-bonds, in terms of lowering the burden of debt service during economic recessions. We use the Mexican case to illustrate the benefits of issuing some proportion of the federal government total debt.[23] Unfortunately, at this stage one can only estimate an approximate amount as the precise data to calculate an exact one is not available (including all details of every debt issue, both, internal and external). Still, this is not the purpose of the document. The general amount gives an idea of the benefits of linked bonds in terms of relief of debt service payments.

Hence, we only provide an idea of the amount it would represent in case of the occurrence of and adverse shock, such as that of the 2020 pandemics. As known, this year was the worst for the world economy in nearly 100 years. The Mexican economic growth plummeted 8.5% in 2020 (table III.11).

Still, Mexico honored the debt service, which reached nearly 3 percent of GDP, as it may be observed in table III.10. Note that in the Mexican case the service increased precisely during the harsh economic year, even though as a percentage of GDP total debt did not increase. With international rates constant, this means that risk premium soared.

[23] We exclude public enterprises from the analysis. In the Mexican case, these issue debt on international markets.

Table III.11
Mexico: debt service indicators as percentage of GDP

	2015	2016	2017	2018	2019	2020
Total	2.2	2.3	2.4	2.6	2.7	2.9
Internal	1.6	1.6	1.7	1.8	1.9	2.0
External	0.6	0.7	0.7	0.8	0.8	0.9
Federal Government	1.7	1.8	1.9	2.0	2.1	2.4
Internal	1.4	1.5	1.6	1.7	1.8	2.1
External	0.3	0.4	0.3	0.3	0.3	0.4
State Enterprises	0.5	0.5	0.6	0.6	0.6	0.5
Internal	0.2	0.1	0.1	0.2	0.1	0.0
External	0.3	0.4	0.4	0.5	0.5	0.6

Source: SHCP.

Note that most interest payments are concentrated internally. For the federal government case 87.5% of interest payments were applied on internal debt. In turn, state enterprises (CFE and Pemex) relied completely in foreign debt.

We concentrate in federal government as the state enterprises can issue linked bonds on, say, oil prices. In fact, this has been done from time to time since the late 1980s, as we review in this document.

Having said this, and as we pointed out earlier, Mexico was one the very few countries that extended a relief plan without recurring to net indebtedness; hence, the relief was short of the resources needed to provide an appropriate counter-cyclical policy to impede the loss of formal and informal jobs.

Had the Mexican treasury issued income-linked bonds as part of debt policy, the service of debt would have been lower. Thus, these resources could have been used to fund the relief plan.

To obtain that amount some assumptions need to be made. In addition, these need to be made because of the lack of detailed information. First, the implicit rate of interest is obtained from interest payments and the federal government total debt stock. This may be a strong assumption as the Mexican government regularly issues zero-coupon bonds, and the issues are made through time, with different maturities and coupon rates. Second, issues are made in different currencies; and finally, we assume, ad-hoc, 30 and 50% of linked debt.

Results are presented in table III.12 and III.13. Table III.12 presents the results for 30% indexation of total debt, whereas table III.13 is for 50% of indexation of total debt. Note that we present the observed interest payments made by the federal government, then in the following row we include these plus the option value. The third row includes the real value; from this information we obtain the total present value for the 2011-2019, when the option is not exercised as there has not been any adverse shock; The number in red for 2020 is the amount that is saved by exercising the option. The final figure comes from the comparison of the amount saved by exercising the option to the PV of option value (2011-2019), that is, we obtain the net benefit in MX pesos. This is 0.66% of GDP and 1.10% of GDP for the 30 and 50% indexation alternatives. Observe that should the indexation be 50% of total federal government debt, the net amount available for an anti-cyclical program would have been 1.1% of GDP. This is an important amount in times of turmoil and crisis.

Table III.12
Mexico: valuation exercise with an indexation rate of 30% of total federal government debt

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Interest payments	225 091.50	243 613.98	256 593.47	280 116.99	311 281.26	349 557.07	373 936.87	428 929.74	474 283.06	522 262.78
Interest payments + option price	225 744.27	244 320.46	257 337.59	280 929.33	312 183.98	350 570.79	375 021.29	430 173.63	475 658.48	365 583.95
Option value	652.77	706.48	744.12	812.34	902.72	1 013.72	1 084.42	1 243.90	1 375.42	-156 678.83
PV option value	652.77	682.59	694.64	732.68	786.66	853.52	882.17	977.69	1 044.51	-114 960.11
Total PV option value	7 307.25									
Net benefit	-107 652.87									

Source: SHCP.

Table III.13
Mexico: valuation exercise with an indexation rate of 50% of total federal government debt

	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Interest payments	225 091.5	243 613.9	256 593.4	280 116.9	311 281.2	349 557.0	373 936.9	428 929.9	474 283.1	522 262.8
Interest payments plus option price	225 744.2	244 320.5	257 337.6	280 929.3	312 184.0	350 570.8	375 021.3	430 173.6	475 658.5	261 131.39
Option value	652.77	706.48	744.12	812.34	902.72	1 013.72	1 084.42	1 243.90	1 375.42	-261 131.39
PV option value	652.77	682.59	694.64	732.68	786.66	853.52	882.17	977.69	1 044.51	-191 600.19
Total PV option value	7 307.25									
Net benefit	198 907.4									

Source: SHCP.

E. Final remarks

In summary, this document argues that linked bonds may work well if well-designed. In addition, the success of the introduction of these instruments may increase if institutions in the issuing countries are strong. Those in charge of estimating inflation and national account figures.

The study also argues that even with some shortcomings in the institutional settings, those countries in which trade and remittances are important, ILB may work well as the statistics can be verified through third parties, particularly trade partners. Data accuracy should be of less concern.

In addition, to increase the interest of investors this contingent bonds may include in the return an indexation premium, which can be calculated as a caplet (price of a call option). Moreover, this methodology also estimates the probability of exercising such an option. This is call in the option literature is named the Delta, which measures the sensitivity of the call option with respect to the underlying asset. It is commonly interpreted as the probability of exercising the call. In our case, this is the probability that the payment amount will be positive.

1. Role of multilateral organizations

The design of this GNI-linked bond can be made with the participation of multilateral organizations, such as the International Monetary Fund, the reginal Development Banks (IADB) and technically supported by organizations such as ECLAC and UNCTAD.

Furthermore, as an initial step, one or more of these organizations (namely, those who may extend loans) may be the holders of the GNI-linked bond and in this way they may prove the feasibility of the instrument. Eventually a market may develop.

Cohen et al (2020) assert that official sector, or Multilateral institutions, promotion of SCDIs —including endorsement of standardized term sheets, enhanced data provisioning, and recognition of their benefits in debt sustainability— could also be catalytic.

2. Caveats

It is also evident that ILB are not necessarily suitable for all countries. As seen earlier, relatively closed to trade countries and very small receivers of family remittances, may face more difficulties in introducing GNI-linked bonds. This is so because the verification of data accuracy may be more difficult.

Still, establishing investor confidence in these instruments will require a better approach to the obstacles posed by data revisions and changes in methodology. This seems an excellent challenge for economists and finance practitioners alike (Cecchetti and Schoenholtz 2017).

3. Alternatives

There are some other alternatives to be subject to study. During the 1980s external debt crisis there was evidence that it is in the best interest of creditors that debtor country does not default and the way to avoid this was not necessarily forcing the payment immediately. Instead, the debt contract may include clauses that suspend temporarily the payments. Alternatively, the contract may include some principal reductions in the principal, in an attempt to have a more equal sharing of the losses associated with an economy collapse. Mian and Sufi (2012) support this idea for the private housing market.

This last alternative may make more sense for the developing world and may be activated when the recession comes from international markets. This was the moral hazard implicit in these contracts and it may be avoided. Those authors argue that the excessive lending was not only the result of irresponsible behavior by the countries and in their case the homeowners.

The temporary suspension of debt service in case an international markets crisis would come at a cost. There may well be an indexation premium. This can easily be accounted for in the debt prospectus of the countries- (Bolton et al. 2020).

Linked bonds on other verifiable variables are also an alternative. These variables may include commodities, exports, or even remittances only. The argument is similar to that made here in previous sections.

4. Considerations for a successful introduction

A carefully prepared pioneer ILB issue should be launched. If successful, this prototype would facilitate subsequent issue by other countries (Schröderet al, 2014).[24] Most studies point out that a favorable macroeconomic situation of the issuer country and the world economy is a pre-condition.

A stable track record of the issuer country in political and economic terms (could be partially substituted by a public guarantee) may help a lot. This combined with the existence of a rating on the instrument.

Finally, here we have argued that it should be encourage a subscription of the issuer country to the IMF's Special Data Dissemination Standard, or other multilateral organization, even if these do not extend loans. It is important to stress that countries which are not eligible for multilateral or regional banks credits are definitely not GNI-linked bond candidates.

F. Conclusions

- Should Latin American countries have had linked bonds, these would have been able for financing part of an anti-cyclical program. As known, countries face economic adverse events periodically (that is, they are subject to business cycles) which in turn pose problems on the country's fiscal stances; hence different instruments that seek buffering these negative effects have been designed over time. One of the most common and effective tools that was introduced recently was a set of fiscal rules, in particular, a salient one is the so-called *structural budget balance rule*.
- A *complementary policy* to that structural balance is the introduction of alternative financial instruments, which may help to lower the effects of the adverse economic shocks, namely, the contingent sovereign debt. This type of debt is basically a loan which service is linked to an observable indicator, such as GDP, national income, exports, among many others. The concept is analogous for most of those variables, though the prospects for success may vary for different reasons.
- The study argues that LAC countries could benefit from the introduction of contingent sovereign debt so that they can face economic downturns more effectively and less painfully.
- We review some cases that have attempted to introduce these types of bonds, namely Argentina and Greece. However, GDP linked bonds have not worked well because of difficulties of obtaining verifiable figures of GDP. There are concerns about data reliability, as many developing and emerging economies have weak institutions, which include deficiently designed institutes of statistics (in charge of estimation of economic variables). Sometimes these institutes are not independent from the executive branch; this fact may tempt the executive leader to influence the estimation of the variables, so they obtain certain results. Some other cases, the institutes simply suffer from lack of funding. Finally, in a few cases even low level of human capital has also been a problem.
- Here we argue that for some opened economies the issuance of GNI linked-bonds may be an appropriate alternative as those problems may be overcome.
- The GNI-linked bond is a financial instrument that links either principal or interest payments (or both) to GNI growth. Hence when the economy is in ascending phase the interest payments rise, and conversely, when the economy slows down or is in a crisis, the service of the debt is reduced or even suspended (depending upon its design). These are especially useful for emerging countries which frequently write off foreign currency denominated debt.

[24] See the score card, Campbell and Shiller (1996).

- In summary, the GNI may be verifiable relatively well for some countries open to trade-cum-net receivers of remittances. Because of this GNI-linked bonds may be introduced in these group of countries, especially Central American countries. México is clearly in this group. An additional advantage of the latter is that its National Statistics Institute (INEGI) and its central bank (in charge of reporting remittances) are independent from the executive branch.
- Yet, an institutional feature that would increase the probability of success of GNI linked bonds is the independence from the executive branch of the institutes or central banks in charge of generating national accounts estimates and the rate of inflation. This varies from country to country. This is not a necessary condition, but facilitates the introduction, as markets would perceive lower possibility of manipulating the statistics. The only four countries that comply with both autonomous institutions, are Chile, Costa Rica, México and Paraguay (we exclude Venezuela from the analysis).
- Thus, multilateral organization may encourage countries to reform their bodies in charge of generating information.
- From these elements it is possible to summarize the challenges as in Council of Economic Advisers (2004)[25]:
  - Draft a sample bond contract to clarify exactly how certain potential concerns could be addressed.
  - Provide concrete alternatives to ensure reliable and accurate GDP statistics.
  - Explore options to help jump-start a liquid market for growth-indexed bonds.
  - Encourage involvement by the Multilateral Organizations. These may serve as advisers on designing autonomous National Institutes of Statistics; or alternatively, as monitors to check them.
  - The most important consideration for governments is to adopt sound macro- and microeconomic policies. Financial innovation cannot compensate for inconsistent and unsustainable economic policies.
  - One of the main concerns was related to data accuracy. As reviewed, this may be caused by different reasons. First, in developing countries the institutions in charge of generating and estimating statistics are not always autonomous, and sometimes there are more than one institution generating relevant data such as estimation of GDP or GNI, on the one hand, or inflation, on the other. In some developing nations these two sets of information are dissociated. Typically, in LAC the central bank estimates national accounts and a different organization (which may include the National Institutes of Statistics or even the Finance Ministry) calculates the inflation; this varies from country to country, however. An obvious solution to this problem is to better design an autonomous institution that formally obtains the responsibility of producing and estimating relevant economic information. This would increase the probability of success of introducing contingent debt.
  - Second, in some less developed countries the statistics are seen as an accessory, thus the institutions are not well funded. Because of this, it is said that institutions cannot hire capable human capital. The cacophonous solution is to increase the funding of the institutions. Moreover, multilateral organizations may help to train the public officials and to advise in improving the methodologies of estimation.
  - In short, should a government want to issue a LB, the market would need a binding commitment to comply with these two conditions.

[25] See also Hatchondo and Martínez (2012).

Bibliography

Ali Abbas, Myrvin Anthony, Tom Best, Peter Breuer, Hui Miao, Alla Myrvoda, and Eriko Togo (2020), The Role of State-Contingent Debt Instruments in Sovereign Debt Restructurings Charles Cohen, S. I M F STAFF D I S C U S S I ON NOT E 06.

Benford, J. T Best and M Joy (2016), Sovereign GDP-linked bonds. Financial Stability Paper 39. Bank of England. September.

Benford, J., J. Ostry, and R. Shiller (2012), Sovereign GDP-Linked Bonds: Rationale and Design Edited by. CEPR Press.

Blanchard, O. P Mauro and J Acalin (2016), The case for Growth-Indexed Bonds in Advanced Economies Today. Peterson Institute for International Economics, Policy Brief 16-2.

Bloomberg L.P. (2022), GDP linked Notes for Argentina 11/01/05 to 3/01/2021.

Bolton P, L Buchheit, PO Gourinchas, M Gulati, CT Hsieh, U Panizza, B W di Mauro (2020), Born out of necessity: a debt standstill for Covid 19. CEPR Policy Insight No. 103. April.

Bonfim Diana and David Pereira (2018), GDP-linked bonds: design, effects, and way forward.

Borensztein E. and Mauro P. (2002), Reviving the case for GDP-Indexed Bonds. IMF Policy Discussion ¨Paper PDP/02/10 September.

Borensztein E. and Mauro P. (2004), The case for GDP-Indexed Bonds. Economic Policy. April 165-216.

Bulow J. y K. Rogoff (1989), LDC Debt: is to forgive to forget? American Economic Review. 79: 43-50.

Campbell J and R Shiller (1996), A score Card for Indexed Government Debt. NBER working Paper 5587. May.

Cao Ye (2012), GDP Warrant Design for Greek Debt Restructuring . Master Thesis. The Fletcher School, Tufts University. April.

Cecchetti, S., Schoenholtz, K. (2017), "GDP-linked bonds: A primer." http://voxeu.org/article/gdp-linked-bonds-primer.

CEEY (2020), Elementos de un plan integral para atender las consecuencias económicas de la pandemia de coronavirus en México. [PDF]. Disponible en: https://ceey.org.mx/wp-content/uploads/2020/04/ELEMENTOS-DE-UN-PLAN-INTEGRAL-PARA-ATENDER-LAS-CONSECUENCIAS-ECONOMICAS-DE-LA-PANDEMIA-DE-COVID_compressed.pdf.

Costa, Alejo, Marcos Chamon, and Luca Antonio Ricci (2008), "Is There a Novelty Premium on New Financial Instruments? The Argentine Experience with GDPIndexed Warrants." IMF Working Paper 08/109. International Monetary Fund.

Council of Economic Advisers (2004), Growth-Indexed Bonds: A Primer. November 22.

Credit Suisse (2011), Invitation Memorandum (dated 24 February 2012), Invitation by the Hellenic Republic to the holders of each series of securities listed in Annex I to this Invitation Memorandum, February 24, 2012.

Drelichman, Mauricio and Hans-Joachim Voth (2013), Contingent Sovereign Debt Contracts: The Historical Perspective CESifo DICE Report 11(3).

Eaton J. y M. Gersovitz (1981), "Debt with Potential Repudiation: Theoretical and Empirical Analysis". *Review of Economic Studies*.

Eichengreen B. y R. Portes (1986), Debt and Default in 1930s: Causes and Consequences. European Economic Review. 30: 599-640.

Griffith-Jones Stephany and Krishnan Sharma, "GDP Indexed Bonds: Making it Happen," DESA Working Paper No. 21, April 2006, available at http://www.un.org/esa/ffd/BackgroundPaper.doc, accessed October 28, 2011.

Hatchondo, Juan Carlos and Leonardo Martinez (2012), On the Benefits of GDP-Indexed Government Debt: Lessons from a Model of Sovereign Defaults. Federal Rerve Bank of Richmond. Economic Quarterly—Volume 98, Number 2—Second Quarter Pages 139–157.

Hernández Trillo, Fausto (1995), "A Model-Based Estimation of the Probability of Default in Sovereign Credit Markets". *Journal of Development Economics*.

Hull, J (2011), Options, Futures, and Other Derivatives. Pearson.

Kletzer, Keneth (1984), "Assymetries of Information and LDC Borrowing with Sovereign Risk". *The Economic Journal*.

Kletzer, Ken, D. M. Newbery and B. Wright Smoothing Primary Exporters' Price Risks: Bonds, Futures, Options and Insurance *Oxford Economic Papers*. New Series, Vol. 44, No. 4, Special Issue on Financial Markets, Institutions and Policy (Oct., 1992), pp. 641-671 (31 pages).

Krugman, P. (1988), Financing vs Forgiving a Debt Overhang. Journal of Development Economics, 29: 253-68.
Levy, S. (2020), Superemos la pandemia juntos. Nexos. Disponible en: https://www.nexos.com.mx/?p=47405 &fbclid=IwAR020QBeIOZtvtHuzy5skFEs2zWW-Gm-dwO9YXEKNkvlHTRhA_g3hqqqazo.
Lindert P. y P. Morton (1989), "How sovereign debt has worked" en J. Sachs (comp). *Third World Debt (NBER Project)*. University of Chicago Press.
Miyajima Ken (2006), How to evaluate GDP-linked Warrants: Price and Repayment Capacity. IMF Working Paper WP/06/85. March.
Office of the United States Trade Representative (USTR) (2022), Countries & Regions.
Pedroso, P (2014), Portugal and the Global Crisis The impact of austerity on the economy, the social model and the performance of the state Friedrich Ebert Stiftung Working Paper. April.
Pina, Gonçalo (2020), GDPlinked bonds in the Portuguese Economy Estudos da fundação Francisco Manuel dos Santos. Lisbon.
PREDik Data-Driven (2022), CentralAmericaData.
_____(2022), CentralAmericaData. Guatemala.
Prospectus Supplement (to Prospectus Dated December 27, 2004), The Republic of Argentina Offers to Owners of Each Series of Bonds Listed in Annex A to This Prospectus Supplement, January 10, 2005, available at 41 http://www.mecon.gov.ar/finanzas/download/us_prospectus_and_prospectus_supplement.pdf, accessed February 9, 2012.
R. Stafford Johnson (2010), Bond Evaluation, Selection, and Management, Second Edition by Copyright © Johnson.
Roch, Francisco y F. Roldán (2021), Uncertainty Premia, Sovereign Default Risk, and State-Contingent Debt. IMF working paper. WP/21/76.
Sachs, Jeffrey (1989), The Debt Overhang of Developing Countries. En Calvo, G.,R. Findlay, P. Kouri y J. Braga de Macedo ed. Debt Stabilization and Development: Essays in Honor of Carlos Diaz Alejandro. Oxford: Basil Blackwell.
Sachs J. and D Cohen (1982), Ldc Borrowing with Default Risk. NBER Working Paper No. w 0925.
Schröder, Michael, Friedrich Heinemann, Susanne Kruse, Matthias Meitner (2004), *GPD-linked Bonds as a Financing Tool for Developing Countries and Emerging Markets* Discussion Paper No. 04-64 Center for European Economic Research CEER.
Secretaría de Hacienda y Crédito Público (SHCP). Estadística Oportunas de Finanzas Públicas.
Shiller, Robert (1993), Macro Markets: Creating Institutions for Managing Society's Largest Economic Risks. Ney York: Oxford University Press.
The World Bank, World Bank Database (2022).
Ubide Ángel and Eduardo Levy Yeyati (2015), GDP-linked Bonds: Can Argentina's Failure Become Greece's Success? (Harvard Kennedy School of Government) February.
World Government Bonds. (2022), Country Comparisons.
Zettelmeyer, J., Trebesch, C., Gulati, M. (2013), "The Greek debt restructuring: an autopsy." Economic Policy, 28(75), 513–563.

Annex III.A1
Cointegration Tests: (Exports-GNI) and (Remittances-GNI), Argentina, Brasil, Colombia, Costa Rica, Dominican Republic, Guatemala, El Salvador, Honduras and Mexico

A. Procedure

- Cointegration test is performed following Engel and Granger and Phillips-Ouliaris methodology.
- We used the GNI, exports and remittances at constant price for 2010.
- Data frequency is annual, from 1960 to 2020. However, some countries data is available for shorter time.
- We first define the order of integration of remittances, exports, and GNI for all countries following the canonical Augmented Dickey-Fueller (ADF) methodology. Results are available in the Annex. A p value greater than 0.05 states that the series has a unit root.
- ADF test suggest that for all countries the three variables under scrutiny are I(1).
- We then estimate a model where GNI is regressed on remittances and a constant. For some cases, a trend may be also included to capture the upward trajectory in the variables. Estimations also include country-specific dummy to account for specific crisis / outliers in the series.
- We repeat the same exercise for the relation between GNI and exports. In this case, the regression for countries such as Mexico, Honduras, and Dominican Republic, also includes the GNI for the United States due to the close commercial relationship between the two countries.
- Notice that some T-statistics for coefficients in the Export-GNI regressions are high due to the high correlations between the two series. However, given the objective of our it not a source of concern. Indeed, we aim to test the long run correlation between series rather than calculate any forecast. This problem is avoided in the Remittances-GNI estimates.

Table III.A1
Estimates for Exports-GNI cointegration Test

	Argentina	Brazil	Colombia	Costa Rica	Dominican Republic	Guatemala	Honduras	Mexico
Log (X)	0.44	0.44	0.65	0.65	0.41	1.1	0.43	0.24
SD	(18.69)	(21.68)	(29.15)	(4.96)	(7.44)	(31.58)	(7.44)	(5.59)
C	15.66	16.72	10.48	-0.94	37.33	-0.91	1.73	8.14
SD	(27.67)	(32.41)	(19.92)	(-2.85)	(7.95)	(-1.16)	(0.37)	(3.76)
Dummy	0.32		0.15	0.17	0.1	0.26	0.1	0.18
SD	(4.07)		(2.51)	(4.03)	(3.74)	(4.58)	(3.77)	(3.51)
Trend					0.052			
SD					(11.01)			
Log (GNI U.S.)					-0.82		0.37	0.43
SD					(-5.29)		(2.78)	
Observations	59	51	52	60	48	59	48	49
Engle-Granger Test								**(4.00)**
tau-statistic	0.02	0.08	0.05	0.09	0.04	0.04	0.13	0.06
z-statistic	0.02	0.18	0.06	0.07	0.03	0.02	0.03	0.11
Phillips-Ouliaris Test								
tau-statistic	0.02	0.05	0.05	0.09	0.04	0.03	0.07	0.05
z-statistic	0.02	0.09	0.06	0.07	0.04	0.02	0.09	0.1

Source: Author's own estimates on the basis of official data.
Note: Engle-Granger and Phillips-Ouliaris Test Ho: unit root. A p-value >0.05 indicates stationarity in residual —thus cointegration— at 95% confidence. SD= standard deviation.

Table III.A2
Estimates for Remittances-GNI cointegration Test

	Argentina	Brazil	Colombia	Costa Rica	Dominican Republic	Guatemala	Honduras	Mexico
Log (Rem)	0.45	0.45	0.58		0.24	0.29	0.38	0.57
SD	(4.86)	(5.55)	(17.18)		(2.41)	(5.14)	(12.44)	(14.27)
C	17.74	18.02	13.21		16.86	15.84	15.92	13.99
SD	(10.28)	(10.64)	(18.98)		(10.34)	(16.77)	(-24.82)	(15.26)
Dummy	1.62	1.44	0.69		0.46	0.25	1.48	-0.56
SD	(2.94)	(2.46)	(3.69)		(2.95)	(4.14)	(5.66)	(-2.56)
Trend					0.05	0.02		
SD					(3.92)	(3.92)		
Observations	42	39	49		50	44	59	41
Engle-Granger Test								
tau-statistic	0.36	0.56	0.05		0.12	0.04	0.04	0.01
z-statistic	0.38	0.55	0.06		0.13	0.12	0.02	0.03
Phillips-Ouliaris Test								
tau-statistic	0.32	0.52	0.05		0.09	0.03	0.03	0.01
z-statistic	0.35	0.5	0.06		0.09	0.04	0.02	0.01

Source: Author's own estimates on the basis of official data.
Note: Engle-Granger and Phillips-Ouliaris Test Ho: ∃ unit root. A p-value >0.05 indicates stationarity in residual —thus cointegration— at 95% confidence. SD= standard deviation.

Table III.A3
Estimates for Exports-TOT cointegration Test

	Argentina	Brazil	Colombia	Costa Rica	Dominican Republic	El Salvador	Guatemala	Mexico
Log (TOT)	-1.109	-1.291	0.459	0.844	2.155	1.701	1.02	1.257
SD	(-4.23)	(-7.77)	(3.80)	(4.366)	(22.14)	(7.51)	(11.67)	(9.09)
C	26.983	27.31	17.675	14.33	14.196	10.92	16.62	18.25
SD	(25.69)	(38.46)	(20.82)	(16.29)	(45.58)	(9.39)	(41.39)	(32.02)
Dummy1	-0.256	0.118	0.066		0.098	0.104	0.102	0.12
SD	(-3.69)	(4.29)	(4.36)		(10.08)	(3.33)	(5.69)	(27.67)
Dummy2	0.221				0.072			
SD	-3.87				-6.39			
t	0.061	0.125	0.184	0.162	-0.078	0.068	0.036	0.049
	(15.99)	(17.06)	(9.19)	(14.18)	(-8.32)	(27.11)	(53.53)	(27.66)
t^2		-0.0006	-0.0017	-0.001	0.0001			
		(-6.97)	(-6.54)	(-8.29)	(11.59)			
Observations	36	34	33	32	32	31	35	31
Jarque-Bera (p-value)	0.43	0.37	0.73	0.67	0.69	0.47	0.45	0.65
Engle-Granger Test								
tau-statistic	0.06	0.51	0.05	0.5	0.62	0.68	0	0.41
z-statistic	0.05	0.57	0.06	0.6	0.61	0.72	0	0.42
Phillips-Ouliaris Test								

	Argentina	Brazil	Colombia	Costa Rica	Dominican Republic	El Salvador	Guatemala	Mexico
tau-statistic	0.06	0.45	0.03	0.46	0.52	0.58	0	0.31
z-statistic	0.06	0.5	0.06	0.56	0.48	0.61	0	0.28

Source: Author's own estimates on the basis of official data.

Table III.A4
Estimates for Remittances-TOT cointegration Test

	Argentina	Brazil	Colombia	Costa Rica	Dominican Republic	El Salvador	Honduras	Mexico
Log (TOT)	5.548	-0.271	0.451	-1.37	1.303	0.752	0.928	1.29
SD	(2.77)	(-0.53)	(1.83)	(-6.59)	(6.94)	(3.97)	(0.54)	(1.739)
C	-17.56	9.212	10.62	11.72	9.172	8.509	7.293	12.542
SD	(-1.56)	(4.47)	(7.14)	(12.56)	(14.82)	(9.74)	(0.89)	(5.69)
Dummy1	0.74	1.445	0.675	0.834		0.2	1.438	0.424
SD	(3.65)	(13.95)	(15.74)	(35.47)		(3.52)	(4.17)	(8.41)
Dummy2		0.893	0.409	0.377		0.269	0.969	0.373
SD		-9.826	-7.82	-15.02		-8.56	-3.99	-8.41
t	0.51	0.54	0.338	0.516	0.199	0.339	0.2	0.142
	(3.42)	(19.12)	(10.13)	(44.69)	(12.35)	(33.08)	(20.25)	(2.39)
t^2	-0.005	-0.005	-0.003	-0.004	-0.001	-0.002		-0.0007
	(-2.61)	(-15.31)	(-6.40)	(-31.27)	(-6.83)	(-20.09)		(-1.13)
Observations	32	39	35	34	36	38	33	33
Jarque-Bera (p-value)	0.06	0.49	0.31	0.56	0.53	0.42	0.32	0.9
Engle-Granger Test								
tau-statistic	0.9	0.01	0.07	0.03	0.51	0.28	0	0.07
z-statistic	0.95	0	0.05	0.07	0.58	0.02	0	0.07
Phillips-Ouliaris Test								
tau-statistic	0.84	0	0.05	0.03	0.46	0.05	0	0.07
z-statistic	0.89	0.01	0.02	0.07	0.54	0.05	0	0.08

Source: Author's own estimates on the basis of official data.

B. Results interpretation

- From table III.A1 we can conclude that for all countries there exists a long run cointegration relationship between exports and GNI.
- From table III.A2 we can infer that for Argentina and Brazil there is not statistical evidence of a long run cointegration relationship between GNI and Remittances. For the remaining countries, however, the evidence from Engle-Granger Test and Phillips-Ouliaris Test support finds evidence of cointegration.

Table III.A5
Unit Root Test Results for Log (Remittances).
All variables are stationary in first difference, while in level the ADF test shows they are integrated of first order, I(1), Null Hypothesis: the variable has a unit root

		Argentina	Brazil	Colombia	Honduras	Dominican Republic	Costa Rica	Guatemala	Mexico
At level									
With constant	t-Statistic	-0.6556	-1.2461	-1.1726	-1.0685	-1.2283	-1.5156	-1.0970	-3.4694
	Prob.	*0.8468*	*0.6459*	*0.6792*	*0.7203*	*0.6551*	*0.5163*	*0.7085*	*0.0140*
		no	no	no	no	no	no	no	**
With constant and trend	t-Statistic	-1.6936	-1.9628	-2.3128	-1.4152	-2.2092	-1.1593	-2.6357	-1.3188
	Prob.	*0.7365*	*0.6049*	*0.4195*	*0.8432*	*0.4742*	*0.9062*	*0.2674*	*0.8683*
		no	no	no	no	no	no	no	no
Without constant and trend	t-Statistic	1.6355	0.8876	2.3233	2.8260	3.2491	2.1996	0.8030	4.9764
	Prob.	*0.9733*	*0.8967*	*0.9945*	*0.9985*	*0.9996*	*0.9924*	*0.8823*	*1.0000*
		no	no	no	no	no	no	no	no
At First Difference									
With constant	t-Statistic	-5.8470	-4.9631	-6.9311	-6.7416	-8.7828	-7.5256	-7.1580	-17.4122
	Prob.	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		***	***	***	***	***	***	***	***
With constant and trend	t-Statistic	-5.7854	-2.5114	-6.9633	-6.7927	-9.1488	-7.6896	-14.9320	-16.6551
	Prob.	0.0001	0.3213	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		***	no	***	***	***	***	***	***
Without constant and trend	t-Statistic	-5.6647	-4.8617	-6.2132	-5.6542	-6.6714	-6.6813	-7.0826	-3.0145
	Prob.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0035
		***	***	***	***	***	***	***	***

Source: Author's own estimates on the basis of official data.
Note: a: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1% and (no) Not Significant. b: Lag Length based on SIC. c: Probability based on MacKinnon (1996) one-sided p-values.

Table III.A6
Unit Root Test Results for Log (GNI).
All variables are stationary in first difference, while in level the ADF test shows they are integrated of first order, I(1), Null Hypothesis: the variable has a unit root

		Argentina	Brazil	Colombia	Honduras	Dominican Republic	Costa Rica	Guatemala	Mexico
At level									
With constant	t-Statistic	-2.5986	-1.7599	-1.3076	-1.6283	-1.1437	-0.6800	-0.7430	-2.3707
	Prob.	0.1001	0.3940	0.6205	0.4620	0.6928	0.8436	0.8274	0.1545
		no	no	no	no	no	no	no	no
With constant and trend	t-Statistic	-3.2579	-1.2680	-1.5526	-1.6205	-2.2685	-3.0099	-3.8171	*0.7644*
	Prob.	*0.0855*	*0.8808*	*0.7996*	*0.7729*	*0.4440*	*0.1383*	*0.0228*	*0.9626*
		*	no	no	no	no	no	**	no
Without constant and trend	t-Statistic	1.6006	1.7717	2.4742	2.7582	3.8542	4.9144	6.7302	3.0860
	Prob.	0.9717	0.9797	0.9964	0.9983	0.9999	1.0000	1.0000	0.9993
		no	no	no	no	no	no	no	no
At first difference									
With constant	t-Statistic	-6.8922	-4.9654	-4.9335	-4.9446	-8.3929	-6.3544	-5.8213	-6.5184
	Prob.	0.0000	0.0002	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000
		***	***	***	***	***	***	***	***
With constant and trend	t-Statistic	-6.9826	-5.1106	-5.0378	-5.1036	-8.4512	-6.3331	-5.8066	-7.1212
	Prob.	0.0000	0.0010	0.0006	0.0005	0.0000	0.0000	0.0001	0.0000
		***	***	***	***	***	***	***	***
Without constant and trend	t-Statistic	-6.6922	-4.7421	-4.0290	-3.7789	-6.6336	-4.8353	-1.7607	-5.1203
	Prob.	0.0000	0.0000	0.0001	0.0003	0.0000	0.0000	0.0744	0.0000
		***	***	***	***	***	***	*	***

Source: Author's own estimates on the basis of official data.
Note: a: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1% and (no) Not Significant. b: Lag Length based on SIC. c: Probability based on MacKinnon (1996) one-sided p-values.

Table III.A7
Unit Root Test Results for Log (Exports of goods and services).
All variables are stationary in first difference, while in level the ADF test shows they are integrated of first order, I(1), Null Hypothesis: the variable has a unit root

		Argentina	Brazil	Colombia	Costa Rica	Dominican Republic	El Salvador	Guatemala	Honduras	Mexico
At level										
With constant	t-Statistic	-0.4282	1.6168	0.1369	1.9347	-0.7697	-0.3958	0.0685	-0.9219	2.0244
	Prob.	*0.8971*	*0.9994*	*0.9660*	*0.9998*	*0.8202*	*0.9023*	*0.9606*	*0.7747*	0.9999
		no	no	no	no	no	no	no	no	no
With constant and trend	t-Statistic	-1.7189	-1.8848	-1.9626	-1.4148	-2.6800	-1.7396	-1.4055	-2.4553	-1.4527
	Prob.	*0.7306*	*0.6500*	*0.6093*	*0.8467*	*0.2484*	*0.7200*	*0.8495*	*0.3485*	0.8347
		no	no	no	no	no	no	no	no	no
Without constant and trend	t-Statistic	1.4845	4.4338	-2.3655	4.5510	0.8482	1.2986	3.3445	1.3519	4.5825
	Prob.	*0.9647*	*1.0000*	*0.0188*	*1.0000*	*0.8911*	*0.9493*	*0.9997*	*0.9543*	1.0000
		no	no	no	no	no	no	no	no	no
At first difference										
With constant	t-Statistic	-6.1529	-6.1929	-3.6119	-3.9720	-4.1504	-6.1112	-6.1077	-6.1470	-5.4841
	Prob.	0.0000	0.0000	0.0083	0.0029	0.0017	0.0000	0.0000	0.0000	0.0000
		***	***	***	***	***	***	***	***	***
With constant and trend	t-Statistic	-6.0026	-6.5914	-3.2848	-4.0957	-3.8552	-5.9721	-6.0379	-5.9948	-5.9725
	Prob.	0.0000	0.0000	0.0083	0.0029	0.0017	0.0000	0.0000	0.0000	0.0000
		***	***	*	**	**	***	***	***	***
Without constant and trend	t-Statistic	-5.6795	-4.9152	-3.2642	-3.3135	-4.0316	-5.7130	-5.1743	-5.7115	-4.4689
	Prob.	0.0000	0.0000	0.0015	0.0013	0.0001	0.0000	0.0000	0.0000	0.0000
		***	***	***	***	***	***	***	***	***

Source: Author's own estimates on the basis of official data.
Note: a: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1% and (no) Not Significant. b: Lag Length based on SIC. c: Probability based on MacKinnon (1996) one-sided p-values.

Table III.A8
Unit Root Test Results for Log (Terms-of-trade).
All variables are stationary in first difference, while in level the ADF test shows they are integrated of first order, I(1),
Null Hypothesis: the variable has a unit root

		Argentina	Brazil	Colombia	Costa Rica	Dominican republic	EL Salvador	Guatemala	Honduras	Mexico
At level										
With constant	t-Statistic	-1.8789	-1.4349	-1.4354	-2.6281	-1.9338	-1.7224	-5.1989	-1.6931	-1.6102
	Prob.	*0.3384*	*0.5553*	*0.5548*	*0.0961*	*0.3140*	*0.4124*	*0.0002*	*0.4263*	0.4680
		no	no	no	*	no	no	***	no	no
With constant and trend	t-Statistic	-3.7301	-3.6507	-2.2521	-2.6775	-2.5364	-2.2223	-5.6065	-2.2432	-2.2922
	Prob.	*0.0319*	*0.0393*	*0.4486*	*0.2509*	*0.3100*	*0.4645*	*0.0004*	*0.4526*	0.4281
		**	**	no	no	no	no	***	no	no
Without constant and trend	t-Statistic	-0.6145	0.3125	0.0680	-0.3369	-0.0214	-1.1570	0.2299	-0.1394	0.0455
	Prob.	*0.4447*	*0.7710*	*0.6986*	*0.5573*	*0.6695*	*0.2212*	*0.7461*	*0.6289*	0.6914
		no	no	no	no	no	no	no	no	no
At first difference										
With constant	t-Statistic	-4.7937	-6.3706	-4.7988	-7.2217	-7.7016	-6.2166	-5.2157	-5.3042	-6.6902
	Prob.	0.0004	0.0000	0.0004	0.0000	0.0000	0.0000	0.0001	0.0..001	0.0000
		***	***	***	***	***	***	***	***	***
With constant and trend	t-Statistic	-5.0674	-6.2771	-4.7307	-7.1341	-7.6434	-6.1271	-5.5328	-5.3949	-6.6770
	Prob.	0.0011	0.0000	0.0027	0.0000	0.0000	0.0001	0.0003	0.0005	0.0000
		***	***	***	***	***	***	***	***	***
Without constant and trend	t-Statistic	-4.8584	-6.3728	-4.8366	-7.3278	-7.8079	-6.2009	-5.1417	-5.3856	-6.7869
	Prob.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
		***	***	***	***	***	***	***	***	***

Source: Author's own estimates on the basis of official data.
Note: a: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1% and (no) Not Significant. b: Lag Length based on SIC. c: Probability based on MacKinnon (1996) one-sided p-val