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CHILE

SELECTED ISSUES PAPER

November 2018

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CHILE

SELECTED ISSUES

October 24, 2018

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CONTENTS

PRIVATE SECTOR INDEBTEDNESS IN CHILE: HIGH BUT WITH LIMITED RISKS[1]

Private sector debt in Chile has been increasing at a faster pace and has remained higher than regional and emerging market peers since 2010. However, a closer look at the underlying dynamics and drivers offers a number of mitigating factors. While corporate debt increased largely through higher external borrowing, the rise in household debt was mainly domestic through mortgages. Non-bank financing has also been increasing, pointing at the importance of closer supervision. The analysis in this paper suggests that neither of these developments presents any imminent risks to the Chilean economy, because debt is either FDI-related, long-term with fixed rates, hedged, covered by corresponding private sector assets, or associated with firms with large foreign operations. Nonetheless, there are still macro-financial linkages which should be managed closely through better data collection and supervisory practices and, if necessary, macroprudential policies.

A. Introduction

1. In the aftermath of the Global Financial Crisis, corporate debt across emerging market economies surged in light of ample liquidity, search for yield, and large international capital flows. There has also been heterogeneity across emerging markets (EM) in terms of financial vulnerabilities imposed by the increase in debt. Recent studies focusing on non-financial corporate debt have identified a number of factors that determine these vulnerabilities: borrower characteristics, debt maturity, currency denomination, and risk mitigation practices (see BIS, 2015; Tarashev et al, 2016, Advjiev et al, 2017). FDI-related (direct investment debt) corporate debt has also picked up in several EMs and became comparable in size to other types of capital inflows. This trend highlighted new potential vulnerabilities especially in EMs where lending translated into increase in overall leverage (Advjiev et al, 2017). This paper will describe and assess the surge in Chile's corporate debt and discuss the limited risks in light of these afore-mentioned factors and other debt dynamics and characteristics.

2. With Chile's high level of financial development, total private sector debt exceeds those of regional peers and several other emerging markets, faring closer to advanced economies; however, underlying dynamics and debt composition have been different. Chile's total private sector debt (about 190 percent of GDP in 2017) consists of domestic household debt (about 44 percent of GDP), domestic non-financial corporate debt (about 94 percent of GDP) and external non-financial corporate debt (about 45 percent of

[1] Prepared by Burcu Hacibedel.

GDP). In comparison to peer emerging markets (with the exception of China), Chile's private sector debt stands higher and has increased at a faster pace. However, total private debt has traditionally been above these countries. The main subcomponents are: higher external debt of non-financial corporates (NFCs) and higher domestic debt of households. These subcomponents are leading to an increase in both external and domestic debt.

Figure 1. Selected Countries: Financial Development Index 2016

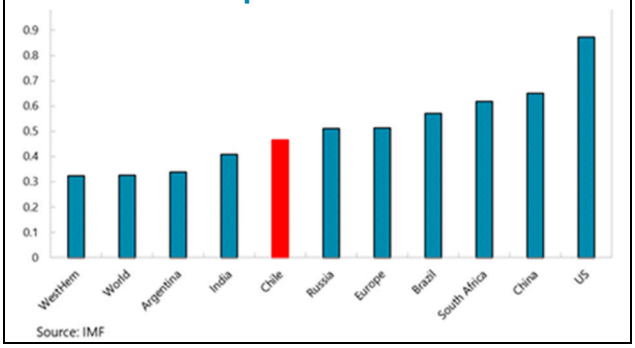


Figure 2. Selected EM: Total Private Sector Debt (In percent of GDP)

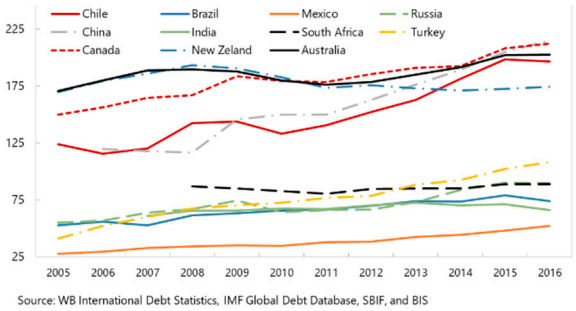
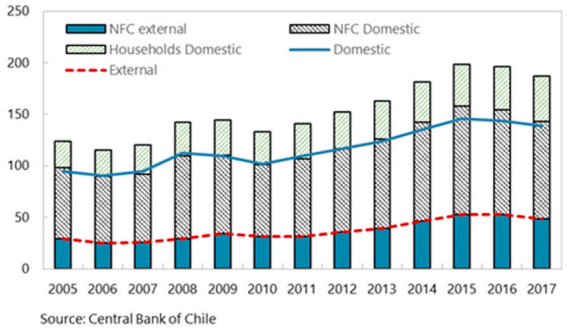


Figure 3. Chile: Private Sector Debt
(In percent of GDP)

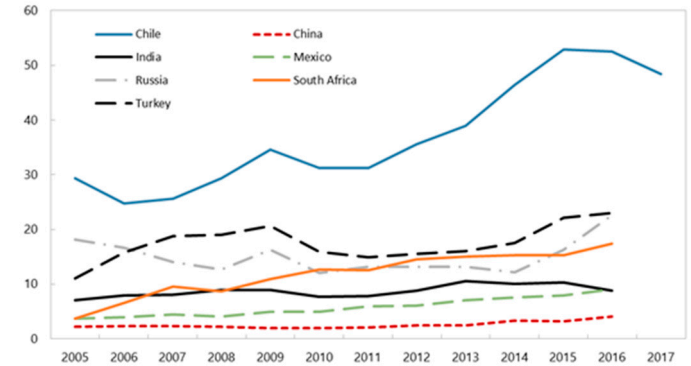


B. External Debt

3. External private sector debt reached 48 percent of GDP in 2017, due to high levels of borrowing by non-financial corporates. It rose consistently from almost 30 percent of GDP in 2010. Notably, both the level and growth rate of external private debt have been higher than in other EMs. While it has come down from its peak in 2015, it still fares significantly above EM average of 17 percent of GDP and closer to advanced economies' average of 46 percent, in line with Chile's high financial development and market access.

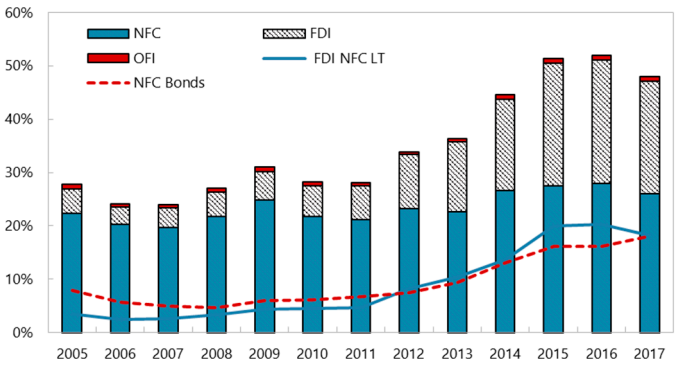
4. About half of external non-financial corporate debt was FDI-related, which is generally associated with lower risks. External corporate debt had two main components: FDI-related debt and international corporate bonds.[2] In 2017, each were around 20 percent of GDP. The surge in FDI-related debt is in part explained by loan transfers from foreign-based parent companies of Chilean corporates. This is in part due to a tax advantage of foreign investment in Chile, via debt rather than equity, so that non-financial corporates have increasingly utilized this type of loans from parent companies to finance investments.[3] This implies that part of external corporate debt in Chile is close in nature to equity, and hence it is not necessarily associated with typical risks from indebtedness, such as those due to investor sentiment and counterparty risk.

Figure 4. Selected EM: External Private Sector Debt
(In percent of GDP)



Source: WB International Debt Statistics and SBIF

Figure 5. Chile: Private Sector Total External Debt
(In percent of GDP)



Soure: Central Bank of Chile

5. The other half of foreign non-financial corporate debt is of long maturity or hedged, and often backed by other assets. External non-financial corporate debt also rose through corporates' increasing international bond issuances in recent years reaching over 20 percent of GDP in 2017 (BIS and Central Bank of Chile/Monetary Policy Report 20181H) The outstanding corporate bonds are mostly of long-term maturity, with fixed rates and denominated in U.S. dollars (BIS). The average maturity is 5 years and only around 10 percent of this debt is short-term (BIS). A substantial portion of this debt has been issued by large

[2] In comparison, financial companies, including private and public banks and other financial institutions, issued much smaller amounts of external debt securities, with private banks' amount outstanding equivalent to 4 percent of GDP and other financial corporations and public banks at 1 percent of GDP each.

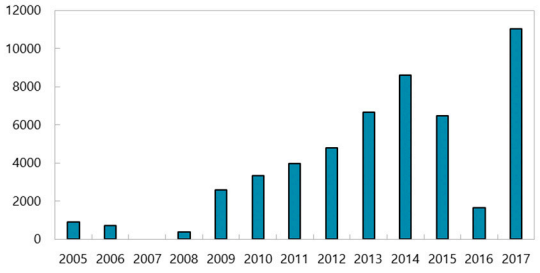
[3] A foreign-based parent company pays a 4 percent withholding tax on interest income derived from lending to a Chilean company whereas t tax rate goes up to 35 percent if the parent company invests as equity. However, the decision on how to finance Chilean branch may involve several accounting aspects, rather than tax-exemption only, such repatriation of retained earnings.

Chilean corporates with substantial earnings in U.S. dollars such as mining companies and other exporters (Central Bank of Chile Statistics). As such, it does not necessarily present significant or imminent maturity or currency mismatch risks. Fig. 7 shows that the mining sector has been the largest private borrower with 25 percent of total external debt. Only a small portion of this debt (corresponding to 4 percent of GDP) has been issued by corporates with peso-denominated accounting (Central Bank, Monetary Policy Report, 2018. However, most of these companies have implemented FX risk mitigation policies resulting in hedged FX debt exposures. The practice of hedging has been widely adopted by corporates, limiting the impact of exchange rate fluctuations on revenues.[4] The international investment position of NFCs also demonstrates that around 50 percent of their foreign liabilities are backed up by foreign assets, lowering the risk of their debt obligations (Fig. 8) (Central Bank of Chile Statistics). Additionally, when scaled by GDP, corporate debt might overestimate the relevance of indebtedness, given the importance of revenues and value added obtained abroad.[5]

6. Global market conditions appear to have had limited impact on Chilean corporates access to international markets (see also Box 1 in Staff Report). Gross NFC debt issues have been increasing since 2009 with a decrease only in 2015–16 due to the economic downturn (Fig. 6, 9, 10), without a visible effect on the cost of borrowing. This also illustrates how international investors perceive Chilean corporates' risk differently from other EMs due to their structure. CDS spreads and bond yields have been below regional peers. Overall, these factors mitigate corporates' external debt risk as indicated by markets.

Figure 6. Chile: Gross NFC International Bond Issuance

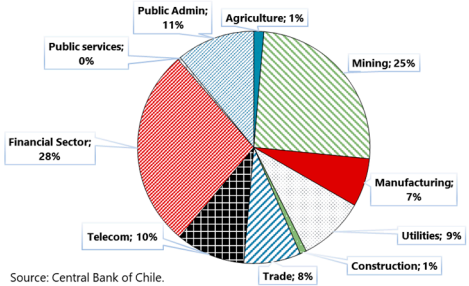
(In U.S. dollars)



Source: BIS

Figure 7. Chile: External Debt by Sector [1/]

(2017 total; US$181 billion)

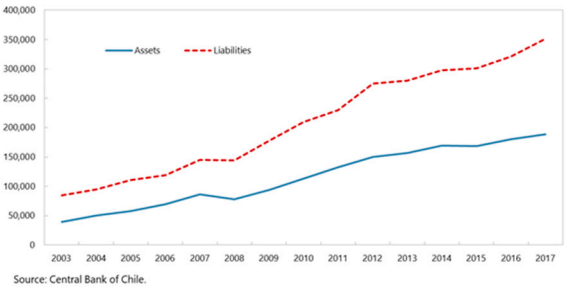


Source: Central Bank of Chile.
1/ Excludes external sovereign debt.

[4] The external debt of companies with a mismatch of more than 10 percent of their assets amounts to barely 0.3 percent of GDP (Central Bank of Chile, Monetary Policy Report September 2018). Corporates for which hedging data is not available have external debt equivalent to 3 percent of GDP.

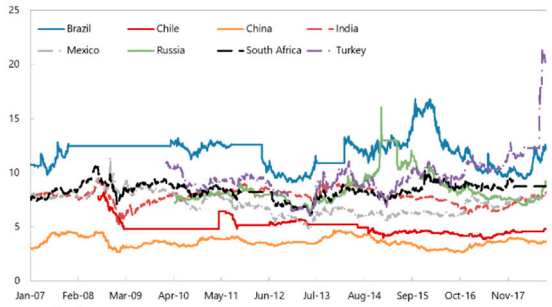
[5] In their Financial Stability Report 2017H1, the Central Bank of Chile suggests a number of alternative measures, such as debt-to-assets, to better gauge the NFC debt.

Figure 8. Chile: Non-financial Corporate Sector Assets and Liabilities
(In millions of U.S. Dollars, end of each period)



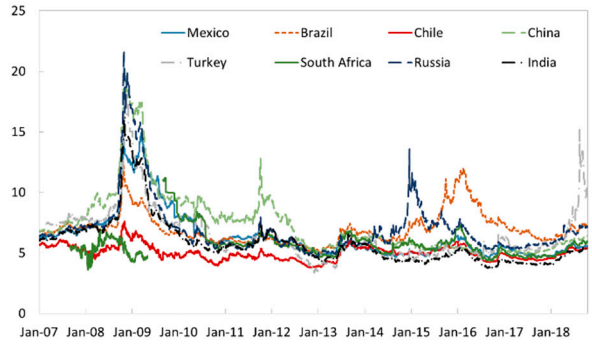
Source: Central Bank of Chile.

Figure 9. Selected EM: 10-Year Government Bond Yields
(In percent)



Source: Bloomberg

Figure 10. Corporate EM Bond Index Yield 1/
(In percent)

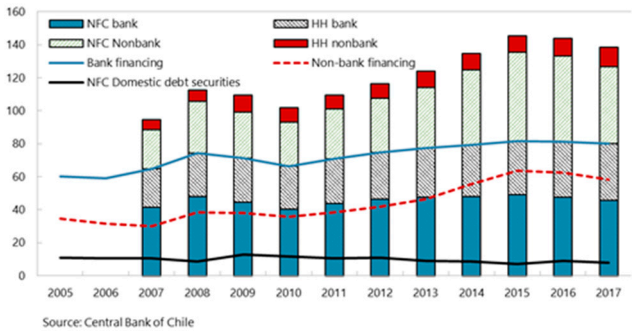


Source: Bloomberg and JP Morgan CEMBI.
1/ Index only takes into account USD denominated bonds.

C. Domestic Debt

7. Domestic debt levels and trends have been comparable to other EMs, although non-bank financing started to play a relatively more prominent role. In 2017, domestic debt constituted the largest portion of private sector debt and increased substantially from 101 percent in 2010 to 140 percent of GDP in 2017. The increase has been partly fueled by higher household debt, which rose by 12 percent of GDP since 2010, while domestic corporate debt increased by 25 percent of GDP. Such trends have been associated with increasing financing from non-bank financial intermediaries including pension funds, insurance companies, and mutual funds. While non-bank financing has been increasing across all EMs

Figure 11. Chile: Total Domestic Credit to Private Sector



Source: Central Bank of Chile

over the past decade, the ratio of non-bank to bank financing in EMs is lower at 1:3 compared to 2:3 in Chile. This phenomenon was in part driven by the increasing volatility in global markets over the past decade, which gave an incentive to large Chilean institutional investors such as pension funds to redirect their investments to the domestic market, leading to higher liquidity and lower borrowing costs, and explaining the increase in non-bank financing.

Figure 12. Chile: Private Sector Debt
(In percent of GDP)

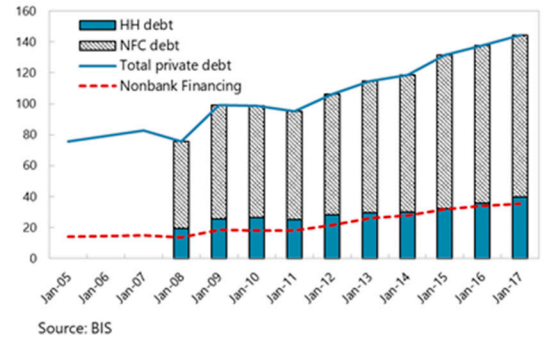
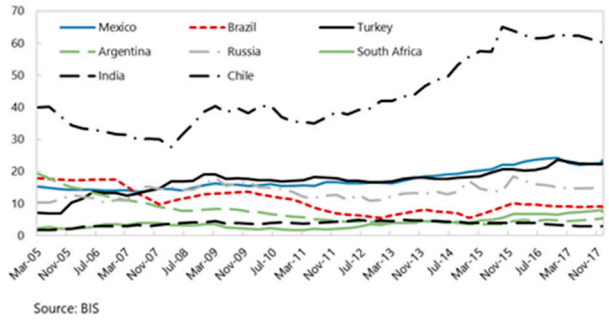
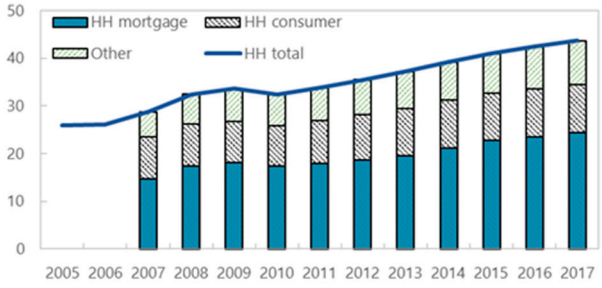


Figure 13. Selected EM: Non-Bank Private Sector Debt
(In percent of market value GDP)



8. Besides non-financial corporates, households have been the largest contributors to private sector debt in Chile. There have been two major trends in household debt concerning systemic risk: an increase in mortgage loans and the role of non-bank financing. Household debt constitutes about one-quarter of total private sector debt in Chile, at around 44 percent of GDP in 2017. Its exposure is limited to domestic borrowing only, and increased by about 12 percent of GDP since 2010. Compared to other large EMs, household debt in Chile is at the top of the distribution. A large part of household debt is bank-financed, composed of mortgage loans (24 percent of GDP in 2017), and consumer loans (10 percent of GDP in 2017). The remaining (other) household debt is from non-bank financial intermediaries and includes shadow banking (credit cards by large retail stores), educational loans (backed by the State) and mortgage loans provided by non-traditional lenders, such as insurance companies. Most of the increase is associated with bank-financed mortgages.

Figure 14. Chile: Household Debt
(In percent)



9. In Chile, the increase in mortgage loans was also accompanied by an increase in real house prices. Two sets of house prices indicators are currently being used to track these price developments by supervisory authorities. Both indices report a similar upward trend. On the one hand, the OECD real house price index based on Central Bank of Chile data shows a 15 percent increase in real prices since 2010, which is modest by international standards (text chart, left panel).[6]

Figure 15. Selected EM: Household Debt, Loans, and Debt Securities
(In percent of GDP)

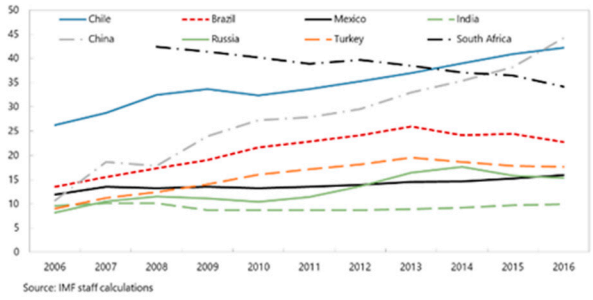


Figure 16. Selected EM: Real House Prices
(2010=100)

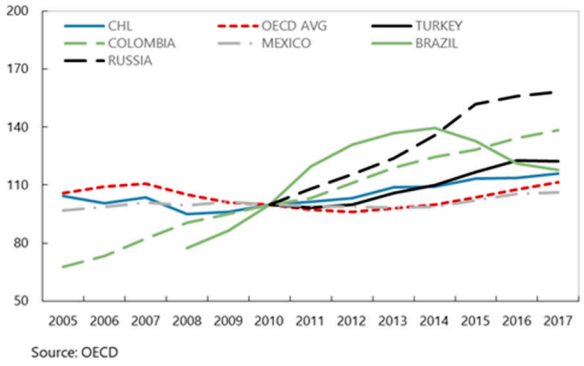
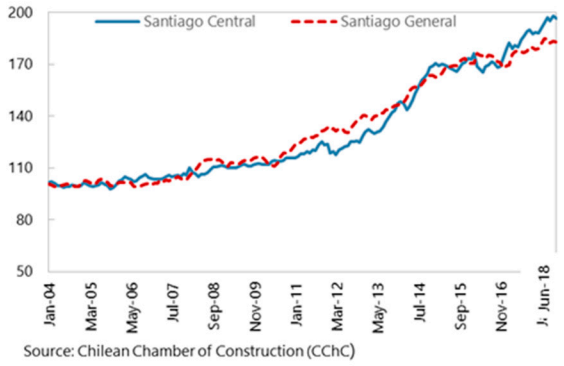


Figure 17. Chile: Real House Price Index
(2004=100)



The correlation coefficient between house prices and mortgage loans over this time period is positive and significant: 0.85. On the other hand, the real house price index of the Chilean Chamber of Commerce, illustrates a much larger increase in prices. However, this index is based on new construction prices (including properties in development) in Santiago.

10. While not constituting any immediate risks, recent developments in household debt highlight the importance of broadening financial sector surveillance and systemic risk. Increasing household borrowing from non-bank financial intermediaries imply that financial surveillance should be deepened also beyond banks, to monitor and contain any risks from this expanding source of finance. Secondly, these trends indicate a need to improve data quality and comparability, as well as to closely monitor housing market and mortgage loans in order to assess any build-up of systemic risk over time. For example, data on asset (house) prices should be systematically collected and assessed, so as to be able to contain possible

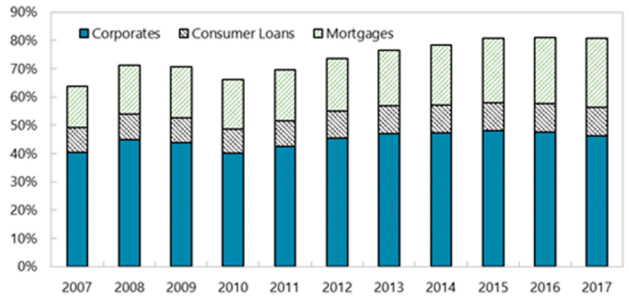
[6] The real house price is given by the ratio of nominal price to the consumers' expenditure deflator in each country, both seasonally adjusted, from the OECD national accounts database.

housing market vulnerabilities—which would have implications for the rest of the economy via macroprudential policies. Chile's plans to centralize financial sector supervision and efforts to contain shadow banking are expected to mitigate these risks. Since bank-financed mortgage loans are mostly long-term with fixed/inflation indexed interest rates, any negative developments in house prices are not expected to pose an immediate risk to the banking sector. However, the emergence of macro-financial linkages would imply that any macroeconomic shocks affecting borrowers' income and ability to service debt could lead to distress in banks' balance sheets. This could be addressed with additional macroprudential policies. For the time being, banks voluntarily utilize a number of prudential measures, such as loan-to-value (80 percent for standard customers and 90 percent for prime ones) and debt-service-to-income ratios (25 percent). With the implementation of the new banking law, these could be better monitored under a unified macroprudential framework and authority, which could also address related issues for broader financial sector.

D. Concluding Remarks

11. Since 2010, private sector debt increased through external corporate and domestic household debt placing Chile above EM average; however, risks appear limited and possible macro-financial linkages call for stronger monitoring. While debt is above regional and EM peers, Chile's high level of financial development partially explains this trend. Moreover, unlike most EMs, transmission of exchange rate volatility to the financial sector is contained in Chile through strong monetary policy credibility and effectiveness as well as covered foreign exchange positions. The increase in debt does not present imminent risks to the Chilean economy, because debt is either FDI-related, long-term with fixed rates, hedged, covered by corresponding private sector assets, or associated with firms with large foreign operations. Nonetheless, macro-financial linkages are significant, deeming broader financial sector and systemic risk surveillance necessary. Risks to the outlook concerning corporate borrowing include shocks to copper prices and to export demand from trade disputes or partners' growth slowdown (see Staff Report). Moreover, stronger surveillance of conglomerates would minimize large-exposure and related-party lending risks and limit any spillovers to, or spillbacks from, the financial sector. Concerning household debt, economic distress affecting borrowers' capacity to repay their debt would be a potential channel of transmission from the real economy to the financial sector. On the upside, the availability of long-term funding for the banking sector (such as from the pension funds) is a source of stability and shock absorber for the banks, which are already well capitalized. Approval of the

Figure 18. Chile: Bank Loans to Private Sector
(In percent of GDP)



Source: SBIF

pension reform might also slowly increase funding for banks over time, since pension funds are a significant source of stable financing for banks (see Staff Report for more details on preliminary plans for the pension reform). This would highlight the importance of continued management of credit risk to avoid any deterioration in banks' asset quality. The upward trend in real house prices would benefit from closer surveillance and data collection to avoid any build-up of asset price vulnerabilities. An additional issue to be closely surveilled is the growing non-bank financing, which differs from traditional sources and point to the need of further strengthening the regulatory and surveillance environment.

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IMPACT OF DEBT ON SOVEREIGN CREDIT RATINGS AND SPREADS[1]

The study investigates the relationship between public debt and sovereign credit ratings and spreads, with a particular emphasis on Chile's position. Drawing on several alternative analytical tools, it finds that higher debt is likely to result in weaker sovereign credit ratings, higher probability of downgrade, and wider sovereign spreads. Thereby, the findings in the paper underscore the potential for fiscal consolidation in helping to regain a better credit rating and move to a higher investment grade category.

A. Introduction

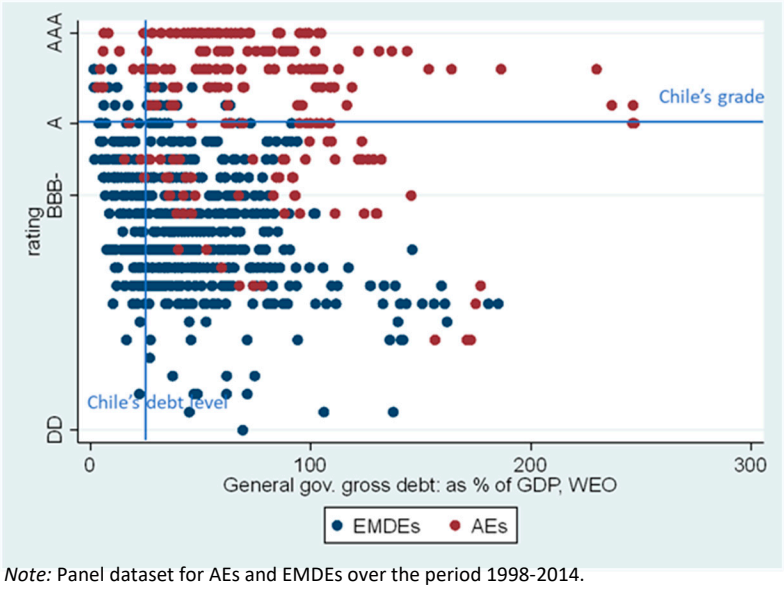
1. There is a negative relationship between debt levels and sovereign credit ratings. In general, higher levels of public debt increase fiscal vulnerabilities and raise concerns about the capacity to service obligations. Therefore, higher debt levels are expected to be associated with perceptions of lower creditworthiness and weaker sovereign credit ratings. This relationship is illustrated in Figure 1 using credit rating data from Fitch Ratings and government gross debt. As expected, countries with higher levels of debt have lower credit ratings. Nonetheless, there are clear differences between Emerging Markets and Developing Economies (EMDEs) and Advanced Economies (AEs)—for the same level of debt AEs typically have higher credit ratings than EMDEs—as well as within each country grouping.

2. Deeper insights into the impact of debt on credit ratings is particularly relevant for Chile in light of the recent credit downgrades. In particular, the continued increase in public debt over the past decade has been emphasized as one of the key reasons for the negative credit actions undertaken by several major credit rating agencies since mid-2017.

3. Chile has a relatively low debt level and strong credit ratings compared to the group of EMDEs. Notwithstanding the recent downgrade, the sovereign rating remains among the highest across EMDEs, and higher than some AEs. At the same time, despite the significant increase of almost 20 percentage points of GDP between 2007 and 2017, government gross debt at about 24 percent of GDP in 2017 remains moderate compared to other emerging markets.

[1] Prepared by Metodij Hadzi-Vaskov.

Figure 1. Gross Debt and Credit Ratings

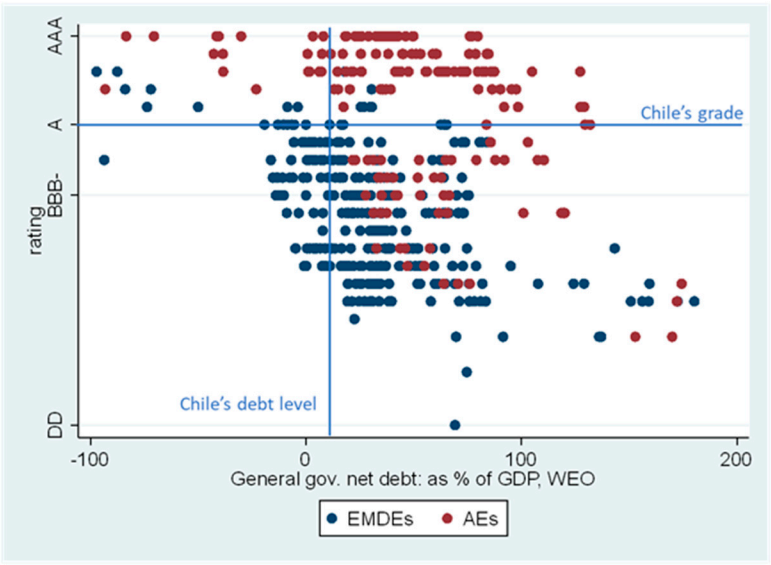


Note: Panel dataset for AEs and EMDEs over the period 1998-2014.

Source: IMF WEO database and Fitch Ratings data.

4. Net debt displays a stronger negative relationship with credit ratings compared to gross debt. Figure 2 highlights the role of financial assets by showing that countries with lower net debt generally receive better credit ratings, and the relation appears stronger than for gross debt. Most of the countries with assets above gross debt have high investment-grade ratings. While Chile's net debt increased considerably over the last decade, it amounts to about 5 percent of GDP in 2017, remaining below many countries with similar credit ratings.

Figure 2. Net Debt and Credit Ratings



Note: Panel dataset for AEs and EMDEs over the period 1998-2014.

Source: IMF WEO database and Fitch Ratings data.

5. The rest of the paper formally investigates the relationship between public debt and sovereign credit ratings, with a particular emphasis on Chile's position. Having shown some indicative evidence about the relationship between public debt and credit ratings in this section, the analysis turns to a more formal approach, employing various empirical procedures and techniques (based on Hadzi-Vaskov and Ricci, forthcoming). Section B briefly describes the dataset. Section C presents results from ordered probit regressions. Section D draws on findings from standard panel regressions. Section E calculates transition probabilities of sovereign downgrade/upgrade. Section F complements the analysis of credit ratings by providing a glimpse on debt's impact on Chile's sovereign spreads. Finally, Section G offers some concluding remarks.

B. Dataset and Empirical Strategy

6. The analysis is based on widely available data sources. Data on general government gross and net debt (as percent of GDP) comes from the IMF's World Economic Outlook (WEO) database. Data on sovereign credit ratings comes from Fitch Ratings. As an alternative measure we also use the Institutional Investor Index, obtained from Institutional Investor, Inc; this indicator is based on information on likelihood of default provided by senior economists and sovereign-risk analysts at leading global banks and money management as well as securities firms. Among the control variables used in the analysis, GDP and inflation come from WEO database, while 10-year U.S. interest rates and the implied volatility index VIX are retrieved from Bloomberg. Series on sovereign bond spreads come from JP Morgan's Emerging Market Bond Index Global (EMBIG). The indicator for quality of institutions comes from the World Economic Forum's database. The analysis covers annual data over the period 1998–2014, unless stated otherwise. Both advanced economies and emerging and developing economies are included in the analysis of ratings (while the work on spreads further below is based only on emerging markets).

C. Ordered Probit Regressions

7. The ordered probit regressions are based on the following specification:

$$y_{it}^{*} = \beta D_{it} + \gamma X_{it} + u_i + \epsilon_{it}$$

Where the dependent variable y_{it}^{*} is the country i's credit rating category that takes three values:

$$y_i^{*} = \begin{cases} 1 \; if \; y_i \in NIG \\ 2 \; if \; y_i \in LIG \\ 3 \; if \; y_i \in HIG \end{cases}$$

where *NIG* stands for non-investment grade credit rating, *LIG* for low investment grade, and *HIG* for high investment grade, based on sovereign credit ratings by Fitch. The overview and definition of these three categories across credit ratings are provided in Annex Table 1. D_{it} stands for (gross or net) debt to GDP ratio of country *i* in year *t*, and *X* stands for the set of control variables for country *i* in year *t*. The regression encompasses fixed effects (u_i).

8. The results presented in Table 1 indicate that both higher gross and net debt lower the probability of being in a better rating category and this effect is statistically significant at conventional levels. In addition, net debt seems to have a somewhat larger effect than gross debt, most likely reflecting the credit agencies' attention to governments' financial assets, besides gross debt figures, in their rating decisions. As expected, higher inflation and tighter global market conditions (captured by U.S. interest rates) lower the probability of being in a better rating category, while stronger GDP growth raises this probability (in the specification with gross debt).

Table 1. Ordered Probit Results 1/

	Rating category	Rating category
Gross debt	-0.0779***	
	(0)	
Net debt		-0.120***
		(0)
GDP growth	0.0627***	0.0425
	(0.00773)	(0.193)
Inflation	-0.0594**	-0.118***
	(0.0287)	(0.00571)
VIX	0.0158	0.0204
	(0.279)	(0.344)
US interest rates	-0.323***	0.0101
	(3.41e-06)	(0.915)
Observations	730	438
R-squared		
Countries		

p-val in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: NIG stands for non-investment grade, LIG for low investment grade, and HIG for high investment grade cases.
1/ Regression results remain qualitatively unchanged when a diversification index and GDP per capita (PPP-adjusted) are included as additional control variables in the specifications.

9. The empirical results suggest that an increase in debt lowers the probability of being classified in the higher rating category. On the basis of the ordered probit regressions, Tables 2a and 2b present calculations (using results based on gross debt and net debt, respectively) for average/marginal probabilities of being placed in each of the three credit rating categories. Calculations evaluated at Chile's current values suggest that an increase in Chile's debt by 10 percent of GDP will result in 6 percent lower probability of being placed in the high investment grade category. The same result holds for both gross and net debt calculations.

Table 2a. Probabilities Implied by Ordered Probit Results
(Gross debt)

Ratings		Evaluated at Average Values		Evaluated at Chile's Values	
		Average probability	Marginal probability	Average probability	Marginal probability
NIG	1	0.460	0.006	0.353	0.005
LIG	2	0.325	-0.002	0.302	0.000
HIG	3	0.215	-0.005	0.345	-0.006

Note: NIG stands for non-investment grade, LIG for low investment grade, and HIG for high investment grade cases.

Table 2b. Probabilities Implied by Ordered Probit Results
(Net debt)

Ratings		Evaluated at Average Values		Evaluated at Chile's Values	
		Average probability	Marginal probability	Average probability	Marginal probability
NIG	1	0.414	0.008	0.269	0.006
LIG	2	0.325	-0.003	0.318	0.000
HIG	3	0.261	-0.005	0.413	-0.006

Note: NIG stands for non-investment grade, LIG for low investment grade, and HIG for high investment grade cases.

D. Panel Regressions

10. This section complements the results from the ordered probit regressions with standard panel estimations allowing for country-specific fixed effects. For this purpose, the categorical dependent variable is converted into integers from 1 to 23, each of them corresponding to a different credit rating (see Annex Table 1), with the highest (23) indicating the best rating (AAA). The empirical specification is similar to the one used in the ordered probit, with the key difference being the transformation of the dependent variable y:

$$y = \beta D_{it} + \gamma X_{it} + u_i + \epsilon_{it}$$

The results from the full sample, and separate subgroups (corresponding to the rating categories NIG, LIG, and HIG) are presented in Table 3.

Table 3. Panel Regression Results for Credit Ratings
(Fixed effects)

	All ratings	NIG ratings	LIG ratings	HIG ratings	All ratings	NIG ratings	LIG ratings	HIG ratings
Gross debt	-0.0525***	-0.0297***	-0.0404***	-0.0345***				
	(0)	(3.60e-08)	(1.58e-08)	(1.82e-06)				
Net debt					-0.0416***	-0.0222***	-0.0507***	-0.0447***
					(0)	(0.000404)	(1.04e-06)	(4.68e-05)
GDP growth	0.0640***	0.0175	0.0363*	0.0105	0.0504**	0.00871	0.00950	-0.00309
	(0.000459)	(0.451)	(0.0561)	(0.540)	(0.0241)	(0.783)	(0.629)	(0.868)
Inflation	-0.0417***	-0.0270**	0.00118	0.00120	-0.0120	-0.00741	-0.00345	-0.00821
	(0.000671)	(0.0216)	(0.955)	(0.948)	(0.325)	(0.521)	(0.885)	(0.712)
VIX	0.00172	-0.00158	-0.0369***	-0.0385***	-0.00209	0.00294	-0.0577***	-0.0543***
	(0.872)	(0.910)	(0.000489)	(0.000153)	(0.862)	(0.855)	(4.41e-06)	(1.33e-05)
US interest rates	-0.0783	0.0991	-0.327***	-0.273***	0.0451	0.0303	-0.259***	-0.257***
	(0.138)	(0.274)	(2.92e-07)	(8.84e-06)	(0.470)	(0.799)	(0.000328)	(0.000560)
Observations	730	334	239	209	438	181	142	128
R-squared	0.301	0.153	0.289	0.243	0.248	0.126	0.397	0.351
Countries	108	72	45	42	65	38	27	25

p-val in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: NIG stands for non-investment grade, LIG for low investment grade, and HIG for high investment grade cases.

11. The results suggest that an increase of gross debt by 10 percent of GDP is associated with half a notch lower credit rating in the full sample. Similarly, an increase of net debt by 10 percent of GDP is associated with close to half a notch lower rating. The effect corresponds to about 10–15 percent of one standard deviation of the categorical rating variable. In both cases, the middle category LIG seems to be the most sensitive to changes in debt.[2]

12. An alternative way of capturing investors perception about countries' sovereign risk is through the Institutional Investors Index, which has been compiled since the 1970s. Hence, Table 4 contains results from regressions that employ this index as the dependent variable, which ranges from 0 (worst) to 100 (best). The results suggest that a debt increase of 10 percent of GDP is associated with a decline in the index by close to 3 units, or about 15–20 percent of one standard deviation. Such results are similar to the results that use credit ratings as dependent variable.

[2] The estimated relation is valid on average across the whole sample and not always observed in specific cases (such as in Chile in 2011 when the rating improved while debt was rising).

Table 4. Panel Regression Results
(Fixed effects)

	Ins Inv Index	Ins Inv Index
Gross debt	-0.292***	
	(0)	
Net debt		-0.244***
		(0)
GDP growth	0.166**	0.234**
	(0.0403)	(0.0334)
Inflation	-0.178***	0.00404
	(0.00125)	(0.947)
VIX	0.0756	0.0671
	(0.108)	(0.255)
US interest rates	-2.427***	-1.608***
	(0)	(2.59e-07)
Observations	721	434
R-squared	0.390	0.288
Countries	108	65

p-val in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: Dependent variable is the Institutional Investor Index of country sovereign risk.

E. Transition Probabilities

13. This section aims to shed light on the impact of debt changes on the probability of moving from one credit rating category to another one. This analysis complements the one in the previous sections, which demonstrated the negative effects of higher debt levels on credit ratings, and on the probabilities to be placed in a certain rating category.[3]

14. An increase in debt raises the probability of moving to a worse credit rating category. Table 5 contains four matrices with transition probabilities calculated on the basis of the same dataset used in the previous sections. The top matrices show the general transition probabilities of moving from one category to another calculated on the basis of the entire dataset—when debt goes up, there is some probability of moving into lower credit rating bracket (between 3 and 14 percent), and much lower probability of moving to a better bracket (most probabilities equal 0, though some go to 3–7 percent). In addition, the lower panel shows the results for a 10 percent of GDP increase in debt, instead of the general (unspecified) increase in the debt level considered above. In that case, there is 17–50 percent probability of moving into a lower rating category, and zero probability of moving into a better category. Particularly sensitive to a deterioration in debt appears to be the best

[3] The probabilities refer to transitions between rating categories and not to changes in the outlook (negative, stable, positive), which generally anticipate the movement between rating categories.

HIG category, with 33–50 percent probability of moving to LIG, and 33 percent probability of moving into NIG with a 10 percent of GDP increase in debt.

Table 5. Transition Probability Matrices

Increase in gross debt

	NIG	LIG	HIG
NIG	0.93	0.07	0.00
LIG	0.14	0.86	0.00
HIG	0.03	0.13	0.84

Increase in net debt

	NIG	LIG	HIG
NIG	0.97	0.03	0.00
LIG	0.06	0.91	0.03
HIG	0.03	0.14	0.83

Increase in gross debt by 10% of GDP

	NIG	LIG	HIG
NIG	1.00	0.00	0.00
LIG	0.17	0.83	0.00
HIG	0.33	0.33	0.33

Increase in net debt by 10% of GDP

	NIG	LIG	HIG
NIG	1.00	0.00	0.00
LIG	0.00	1.00	0.00
HIG	0.00	0.50	0.50

Source: IMF staff calculations based on Fitch Ratings data.
Note: Matrices contain transition probabilities of moving from credit rating category marked by row to category marked by column. NIG stands for non-investment grade, LIG for low investment grade, and HIG for high investment grade. Green areas indicate probabilities of improving credit rating, red areas indicate probabilities of worsening credit rating, and the diagonal contains probabilities of remaining in the same category.

F. Debt and Sovereign Spreads

15. There are several arguments why higher debt is associated with higher sovereign spreads and borrowing costs. For instance, an increase in public debt raises the default risk for the sovereign, thereby leading to higher spreads in order to compensate investors for the higher risk of the securities they are holding. In addition, rapid expansion of debt creates an excess supply of certain securities relative to the portfolio benchmarks followed by investors, thereby necessitating a higher return to make the investors willing to deviate from the original (preferred) portfolio. Among others, Gruber and Kamin (2012) provide various theoretical arguments underpinning the positive debt-spreads relationship.

16. Debt increase of 10 percent of GDP is associated, on average, with 110–120 basis points higher sovereign spreads in emerging markets. Based on the empirical analysis provided in Hadzi-Vaskov and Ricci (2016), Table 6 illustrates that the effects of gross and net debt are similar in magnitude, while the standard control variables have the expected signs (higher growth lowers spreads, while higher inflation and market uncertainty raise them). More generally, the findings in Table 6 are consistent with the regression results for credit ratings in the previous sections.

Table 6. Panel Regression Results for Spreads

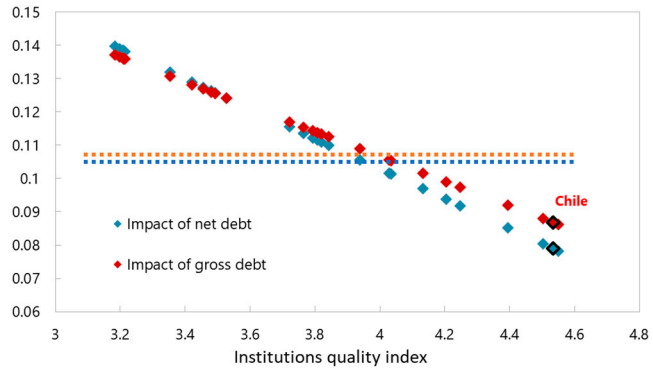
Panel regression results		
Gross debt	0.113***	
	(0)	
Net debt		0.121***
		(0)
VIX	0.125***	0.127***
	(0)	(0)
US interest rate	0.152	0.0607
	(0.130)	(0.538)
GDP growth	-0.141***	-0.111***
	(5.35e-05)	-0.00124
Inflation	0.112***	0.111***
	(3.64e-05)	-0.00283
Constant	-5.423***	-4.289***
	(0)	(0)
Observations	336	336
R-squares	0.521	0.546
Countries	30	30

p-val in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Hadzi-Vaskov and Ricci (2016).
Note: Dependent variable is EMBI spread.

17. The adverse effect of debt on sovereign spreads is lower in countries with stronger institutions, such as Chile. Figure 3 shows the impact of debt as a function of the institutional quality, measured by WEF's index. It indicates that the effect for Chile drops to 80–90 basis points, down from 110–120 basis points found for the typical emerging economy included in the sample. Table 7 summarizes the effect of debt on spreads for countries with different institutional quality, which range from 80 basis points for the strongest institutions to 140 basis points for countries with the weakest institutions.

Figure 3. Impact of Debt on Spreads Conditional on Institutional Quality



Source: Bloomberg, WEF, and Fund staff calculations.

Table 7. Impact of Debt on Spreads Conditional on Institutions

Gross debt effect on spreads for:	
Country with weakest institutions	0.137
Country with average quality of institutions	0.115
Chile	0.087
Country with strongest institutions	0.086

Note: Effect of 1 percentage point higher debt-to-GDP ratio on EMBI spread (in percent).

Net debt effect on spreads for:	
Country with weakest institutions	0.140
Country with average quality of institutions	0.113
Chile	0.079
Country with strongest institutions	0.078

Note: Effect of 1 percentage point higher debt-to-GDP ratio on EMBI spread (in percent).

G. Concluding Remarks

18. Higher debt is likely to result in weaker sovereign credit ratings, higher probability of downgrade, and wider sovereign spreads. Drawing on several alternative analytical tools, this paper presents consistent results about the adverse impact of increase in public debt for sovereign credit position and financing costs. This suggests that, going forward, the announced fiscal consolidation—by eventually contributing to a decline in the debt-to-GDP ratio over the medium term (see the Debt Sustainability Analysis accompanying the 2018 Article IV Staff Report)—has the potential to allow Chile to regain a better credit rating and move to the high investment grade category (of course, other factors may contribute to such outcome). Such a strategy is likely to result in lower sovereign spreads as well, providing an opportunity for Chile to move to a virtuous cycle of lower debt and lower financing costs.

Annex I. Credit Rating Categories

Annex Table 1. Credit Rating Categories

Credit rating (Fitch)	Category
AAA	
AA+	
AA	High Investment Grade (HIG)
AA-	
A+	
A	
A-	
BBB+	Low Investment Grade (LIG)
BBB	
BBB-	
BB+	
BB	
BB-	
B+	
B	
B-	
CCC+	Non-Investment Grade (NIG)
CCC	
CCC-	
CC	
RD	
DDD	
DD	

Note: Chile's current credit rating marked in red.

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Gruber, J. W. and S.B. Kamin, 2012, "Fiscal Positions and Government Bond Yields in OECD Countries", Journal of Money, Credit, and Banking, Vol. 44 (8).

Hadzi-Vaskov, M. and L. A. Ricci, 2016, "Does Gross or Net Debt Matter More for Emerging Market Spreads?", IMF Working Paper No. 16/246 (Washington: International Monetary Fund).

Hadzi-Vaskov, M. and L. A. Ricci (forthcoming), "Public Debt and Sovereign Credit Ratings", IMF Working Paper (Washington: International Monetary Fund).

WEF, 2017, The Global Competitiveness Report 2017–18.

ANCHORING CHILE'S FISCAL FRAMEWORK[1]

The rise of debt in the past ten years and the recent downgrades call for a strengthening of the fiscal anchor over the medium-to-long term. In many countries with a fiscal rule, an anchor expressed in terms of a stock variable (debt, net debt, or assets) guides fiscal policy over the medium-to-long run, while targets on budget aggregates, like the structural balance or expenditures, guide fiscal policy in the short term. This paper discusses the conceptual framework and international experience with anchoring fiscal policy (particularly via debt ceilings) and describe a way to anchor Chile's fiscal framework and maintain buffers.

A. Introduction

1. Since 2001 Chile's fiscal framework has been guided by the structural balance rule, but over time the function of the rule as a fiscal anchor has weakened. Chile's fiscal rule establishes a target for the structural balance of the central government. The target is set within the first 90 days of each new presidential mandate but can be changed with the budget law.[2] The parametrization and the calculation of the structural balance is especially complex so that it is difficult to replicate the calculation and assess ex-post whether the target has been met.

2. Chile's gross public debt to GDP ratio rose 20 percentage points over the past ten years. Undoubtedly, Chile suffered a 3 percent of GDP loss in copper revenues since 2011, amidst declining copper prices. However, the structural balance target under Chile's fiscal rule was lowered from a balance in 2010 to a 1.8 percent of GDP deficit in the 2011 budget and the target has remained in negative territory since then. At the same time, the overall balance worsened from a surplus in 2011 to a deficit. In addition, the ongoing payout of pension benefits under the discontinued state pension system (in the form of repayment to "the recognition bond") and the accumulation of government assets contributed substantially to the increase in gross debt over the last ten years. As a result, the debt-to-GDP ratio reached 23.6 percent of GDP in 2017 and is expected to reach about 27 percent in the medium term—under staff's baseline projections—before it starts to decline.

3. Currently, Chile's fiscal framework lacks a clear and well-specified medium-term anchor on debt or on the government balance sheet. It is certainly appropriate that a fiscal rule allows fiscal policy to act as a shock absorber in the face of a significant commodity revenue decline, as the one experience by Chile in recent years. However, the current rule does not offer guidance as to the direction of gross and net debt, i.e. whether and how fast debt will return to previous levels to rebuild buffers, whether it should remain constant, or whether it may be allowed to increase in the

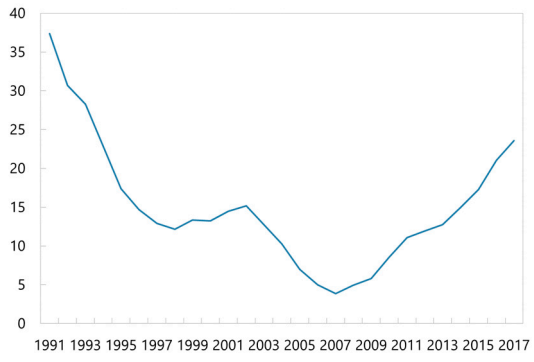
[1] Prepared by Paolo Dudine.

[2] The Decree establishing the target may also just set the target for the end of the presidential mandate, leaving space for each budget to define the annual targets. A new Decree may also be issued with new annual or end-of-mandate targets.

face of additional shocks. When the Corbo Commission examined Chile's fiscal rule in 2011 (Corbo et al., 2011) gross debt was only about 12 percent of GDP and introducing a debt anchor was not an urgent improvement to the rule. More recently, discussions of Chile's debt dynamics have become more frequent, both within the country and outside, and ponderings about instituting a debt limit have emerged (Larraín and Valente, 2017).

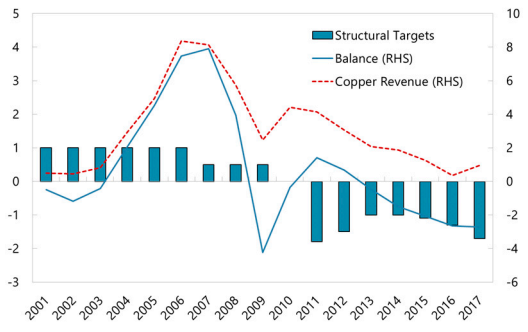
4. The sustained deterioration in the sovereign balance sheet was one of the motivations for the downgrade of Chile's credit rating. Fitch indicated that "The downgrade of Chile's IDRs reflects the prolonged period of economic weakness and lower copper prices, which are contributing to a sustained deterioration in the sovereign balance sheet." Moody's indicated that "the strength of the government's balance sheet is no longer sufficiently robust," while S&P indicated that "The government's debt burden, although still low compared with most sovereigns, has consistently increased in recent years".

Figure 1. Central Government Gross Debt
(In percent of GDP)



Source: IMF WEO 2017.

Figure 2. General Government Balance, Structural Targets, and Copper Revenue
(In percent of GDP)



Source: IMF WEO 2017.

5. In this paper we discuss the conceptual framework and international experience with anchoring fiscal policy, review how to design a fiscal anchor, describe the concepts of debt ceilings, debt anchor, and buffers, and, finally, we offer tools to assess debt buffers. In particular, we use the IMF fiscal rule database to illustrate the international experience with fiscal rules in general, and debt rules in particular, and we use IMF 2018c to guide our conceptual framework. Finally, we illustrate how to use the framework described in IMF 2017 and in IMF 2018a to define a debt ceiling, a debt anchor, and a cash buffer for Chile.

B. Conceptual Framework and International Experience with Fiscal Rules and Anchors

6. A key objective of fiscal rules is to ensure the sustainability of fiscal policy. By putting a cap on deficits, expenditure, or debt, fiscal rules help building buffers to cope with shocks and preventing excessive deficits (and the consequent debt buildup), which could otherwise be observed under unconstrained policy discretion. Hence, well-designed fiscal rules limit the risk that restoring

fiscal sustainability would eventually require measures that threaten macroeconomic stability, such as abrupt and large fiscal adjustments, debt default, or inflation. Fiscal sustainability is indeed an implicit objective in Chile's fiscal framework and that of other countries.[3]

7. Fiscal rules can also have complementary objectives. Fiscal rules should support (or at least not impede) the capacity of fiscal policy to foster macro-economic stability and long-term growth. For this reason, and in support of their main objectives, fiscal rules may be designed to facilitate economic stabilization, contain the size of the government, support investment (and other specific type of spending), and—for commodity exporters—improve intergenerational equity.

8. To preserve fiscal sustainability, well-functioning fiscal rules and frameworks should specify an explicit anchor in terms of the stock of either government assets or liabilities (or both, i.e. on net debt). For most countries, the natural choice is an anchor expressed in terms of debt. This is because the level and trajectory of debt are used to assess solvency, which is a necessary (but not sufficient) condition for fiscal sustainability. For commodity exporters, where the objective of fiscal frameworks and rules may also include coping with large revenue (and macroeconomic) volatility and with ensuring intergenerational equity, targets in terms of assets or in terms of net wealth are also important.

9. Anchors should guide fiscal policy over the medium term. Because the dynamics of assets and liabilities depend on factors outside of the direct control of the fiscal authority (GDP growth, interest rates, exchange rate, and valuation changes), anchors should mainly guide fiscal policy over the medium term and not necessarily on a high-frequency basis. Complementary dynamic adjustment rules can help guide fiscal policy over the short term, in order to ensure convergence to the anchor over the medium term. This will help avoid placing unnecessary constraints on fiscal policy, especially during downturns, limiting the output stabilization objective of fiscal policy.

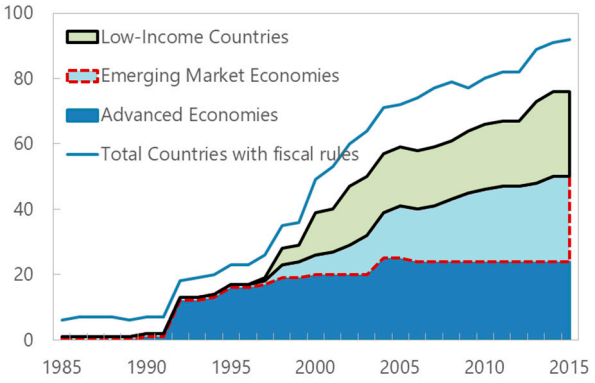
10. Operational rules expressed in terms of limits on budget aggregates should instead provide short-term guidance for the formulation and execution of the budget. These operational rule(s) should set limit(s) on budget aggregates that are under the direct control of policymakers, and that have a close and predictable link to the anchor. These limits should not be considered targets; rather, they should only mark a perimeter within which fiscal aggregates can be set on the basis of policy discretion. These limits should be calibrated to ensure compliance with the anchors over the medium term.

11. In practice, debt-based rules have been amongst the most common types of fiscal rules since the early 90s'. As of 2015, 76 out of 92 countries with a fiscal rule had adopted an

[3] In Chile, Mensaje Nº 259-353/2005 mentions fiscal sustainability as one of the goals of the fiscal rule. In the European Union, the set of rules that constitute the Stability and Growth Pact aim at inducing member countries to pursue "sound fiscal policies", prevent fiscal policies from heading in "potentially problematic directions", and correct excessive budget deficits or debt. Similarly, the objective of New Zealand's Fiscal Responsibility Act is to reduce total debt to "prudent levels", and the U.K.'s Code for Fiscal Stability indicates that fiscal policy should be conducted to ensure that "the fiscal position is sustainable over the long term".

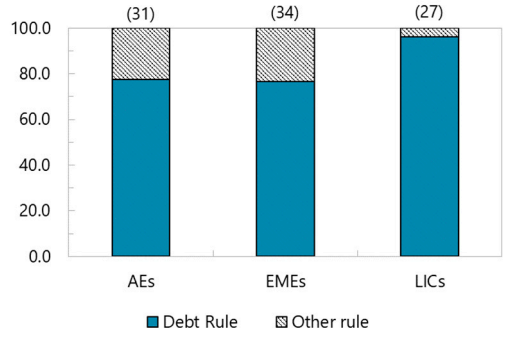
explicit cap on debt or a debt target to guide their fiscal framework. Ceilings on public debt or debt targets are present in about 80 percent of rules in Advanced and Emerging Market Economies, and in over 96 percent of rules in Low-Income Countries. Although less frequent, they are also present among the few commodity exporters that have a fiscal rule (IMF 2017 and Lledo and others 2017.) In most countries (including Emerging Market economies) debt rules have always been complemented by other rules defining operational targets for either spending or the budget balance (see next section).

Number of Countries with Debt Rule



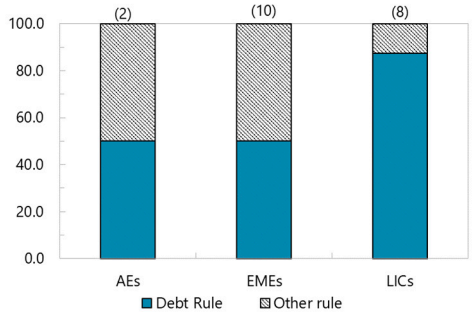
Source: IMF, Fiscal Rules Database.

Rules in 2015, All Countries
(In percent of countries with a rule)



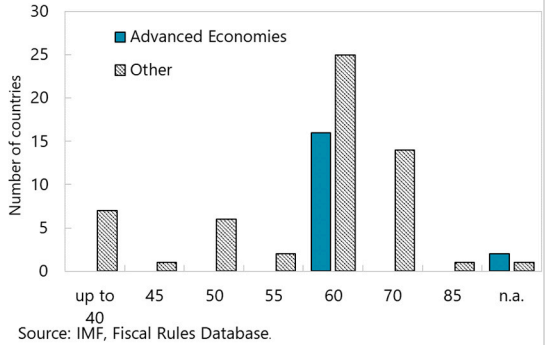
Source: IMF, Fiscal Rules Database.
Note: Number of countries with a rule within parenthesis.

Rules in 2015, Commodity Exporters
(In percent of countries with a rule)

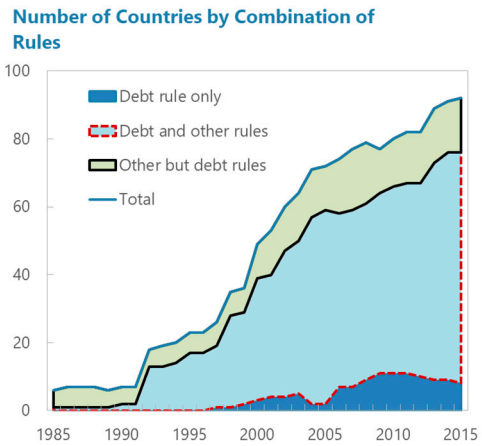


Source: IMF, Fiscal Rules Database
Note: Within parenthesis, number of commodity exporters with a rule.

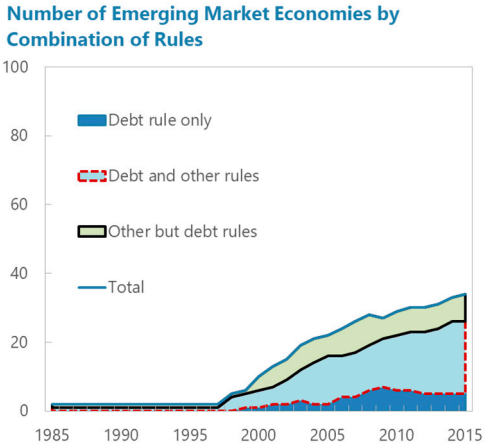
Distribution of Public Debt Ceilings
(In percent of GDP)



Source: IMF, Fiscal Rules Database.



Source: IMF, Fiscal Rules Database.

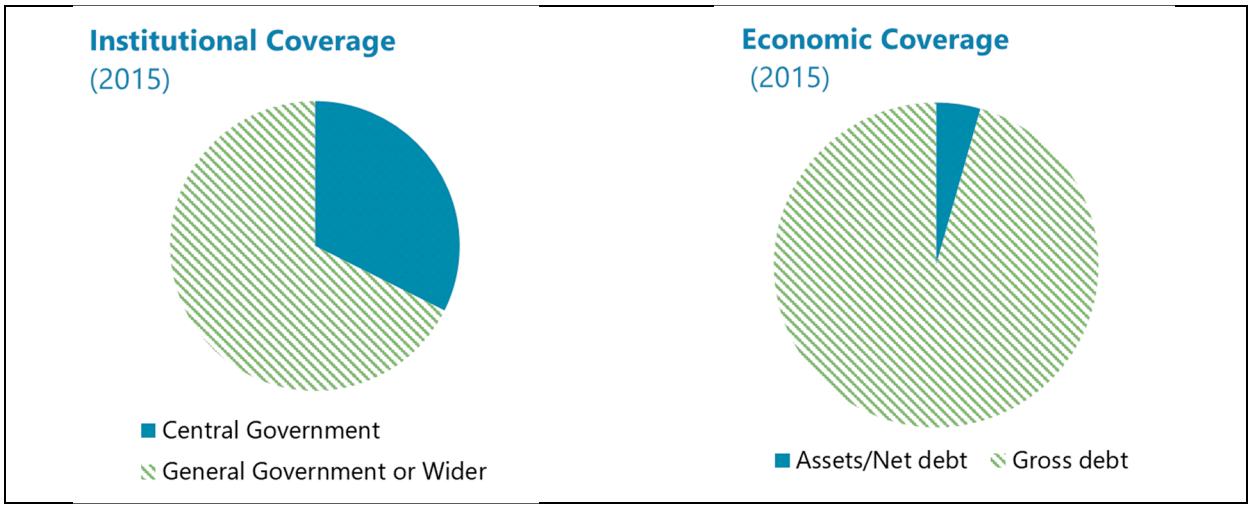


Source: IMF, Fiscal Rules Database.

12. In 72 out of 76 countries with a debt rule, the debt anchor is specified in terms of an explicit numerical cap or target. Caps and targets are predominantly concentrated between 60 and 70 percent of GDP (these levels are the common targets among supranational rules). Only four countries do not have an explicit numerical target: in Australia, the rule aims at improving net financial worth; in New Zealand, at keeping debt at prudent level; in Luxemburg, at keeping debt substantially below the limits foreseen in the Stability and Growth Pact; and in the United Kingdom, at putting the debt-to-GDP ratio on a downward trend. Only in Namibia the target is set in terms of an interval (between 25 and 30 percent of GDP).

13. To address intergenerational equity concerns and/or have additional cash buffers, some commodity exporters implicitly use financial wealth to anchor fiscal policy. When debt is not used as an explicit anchor, the fiscal framework and the operational rule is generally designed with the objective of building or preserving a certain amount of financial wealth. For example, East Timor's fiscal rule is implicitly anchored on the concept of net wealth, as it provisions that transfers from the national wealth fund (the Petroleum Fund) to the budget cannot exceed what is needed to maintain the expected value of the nation's net wealth, which includes both net financial wealth and the expected value of mineral wealth in the ground. Norway's fiscal rule is not explicitly anchored on debt, assets, or net financial wealth; however, by design, it guarantees that all resource revenues be saved for future generations as only the financial return on assets (up to a cap) can be transferred to the budget.

14. Virtually everywhere, the debt rule constrains gross debt and covers at least the general government sector. Out of 76 countries with a debt rule, assets are only considered in the rules of Australia (which targets net worth), New Zealand (via an additional target of maintaining a total net worth buffer), the United Kingdom, and Uruguay. Until 2006, Canada used to have a balanced budget rule explicitly aimed at eliminating net debt by 2021. Also, in only 1/3 of countries with a debt rule, such rule covers the central government. In the remainder of countries, it covers the general government or the public sector.



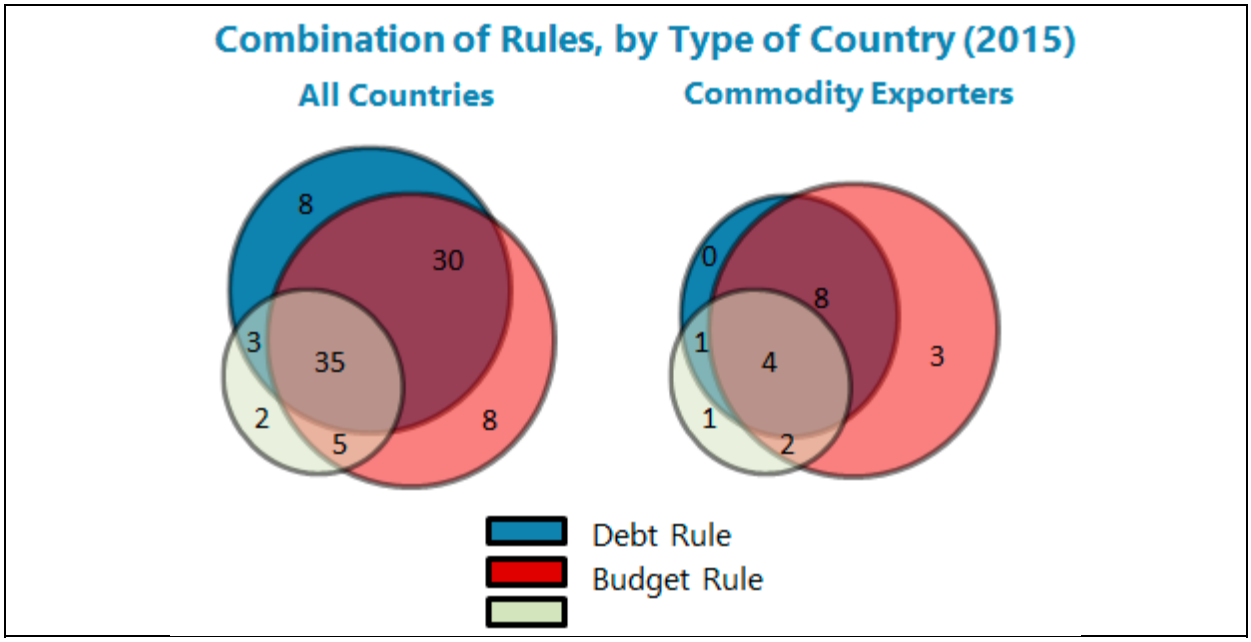
C. Debt Anchor Design

15. Incorporating a debt (or net wealth) anchor into a fiscal rule requires decisions about the appropriate operational target, the economic and institutional coverage of the anchor, and provisions that offer further short-term guidance. The choice of the appropriate operational limit is complex and involves considerations about the economic stabilization function, simplicity, and flexibility of the entire set of rules. Because this is by itself a vast topic, we only summarize here some main lessons (see IMF 2018b and 2018c for a full discussion). In terms of coverage, successful fiscal rules generally would have a broad institutional and economic coverage as limitations in coverage can open loopholes that encourage circumventing the rule (with the consequence of undermining its credibility, see IMF 2009). However, practical considerations about designing, monitoring, and enforcing the same rule at different institutional levels may warrant limiting the coverage of the rule to the central or the general government only. Finally, because deviations to the medium-term anchor may occur even if the operational target is met (for example, if exchange rate depreciation increases the debt-to-GDP ratio), additional provisions can be designed to provide further short-term guidance as debt (or net wealth) become un-anchored.

Operational Targets

16. Budget rule, often combined with expenditure rules, are the most common operational complement to debt rules. Out of 76 countries with a debt rule in 2015, 30 countries complement such a rule with a budget rule, 3 with an expenditure rule, and 35 with both a budget and expenditure rule. Nominal budget balance rules can be very effective in preserving debt sustainability, by constraining a fiscal aggregate that primarily influences debt dynamics (IMF 2018b). To prevent that a budget balance rule limits the ability of fiscal policy to foster macroeconomic stabilization, the rule corrects the balance for the cycle in 54 out of all the 78 countries with a budget rule (and in 15 and 34 countries, respectively, out of 30 and 35 countries mentioned above). Expenditure rules set limits on total, primary, or current spending, and the limits apply to nominal or real expenditure. They are typically set in absolute terms (levels) or growth rates and occasionally in percent of GDP, with a time horizon that typically ranges from three to five years

(Lledó and others 2017). Expenditure rules can support macroeconomic stabilization, provided that the limits are defined in percent of potential output or growth rates. This is because, spending growth is constrained during economic booms (when revenues are high and limits to the deficit are easier to comply with) but it is preserved when output contracts (when otherwise sluggish revenue would force spending cuts to meet the deficit target).



Economic Coverage

17. In principle, fiscal anchors should encompass both government's liabilities and assets, and, in theory, for commodity exporters, resource wealth. Because assets can be sold, if necessary, to enable the government to meet financing needs, a *net* debt ceiling offers a more comprehensive coverage of balance sheet items directly connected to solvency and liquidity concerns. For commodity exporters, because resource wealth—that is, the present value of future resource revenues—can be used as a collateral (for borrowing or for financing investment to raise potential GDP), net wealth offers an even more appropriate measure of solvency. Also, it allows addressing concerns about intergenerational fairness.

18. However, for practical purposes, net debt and wealth do not often constitute an appropriate fiscal anchor. Because it is difficult to define which government assets are truly liquid, especially under stress (IMF 2016), net debt can be complicated to define and communicate, may be less transparent, and would be harder to compare across countries. Similarly, evaluating the value of resource wealth is difficult and highly uncertain, because long-term commodity prices (which are necessary to project future resource revenue) are difficult to estimate and it is hard to separate temporary from permanent price changes. Also, it is difficult to assess the actual amount of exploitable reserves and of production, as the latter can depend on conjunctural factors (including the price of the commodity).

19. In any case, not all assets should be included in the measures of "net debt" or "net wealth". Assets should only be included if:

- they are under the government's direct control (assets of sub-national governments and public corporations may be beyond central government control);
- they are liquid (for example, accounts receivable should not be included since they may not be easily sold);
- it is possible to value them accurately and fairly, to ensure that the measure of net debt accurately reflects fiscal sustainability risks;
- it is possible to evaluate them timely, since measures of net debt will be used in debt rules that are monitored on an annual basis.

By these principles, the fiscal anchor should hardly include resource wealth, nor certain types of financial assets. Also, only countries with comprehensive and precise public finance statistics should consider moving their fiscal anchor from a gross to a net debt rule. Lacking the conditions described above, "net debt" should be used as a complementary fiscal indicator (to assess fiscal sustainability), rather than a substitute for the gross debt rule.

20. In the case of Chile, not all official central government assets should be accounted towards a possible net debt anchor. For example, assets of the Stabilization Fund should be included, as they meet all the criteria above. On the contrary, assets of the Pension Reservation Fund are legally earmarked to cover the solidarity pillar of the pension system, and can be transferred to the budget only up to a limit;[4] that is, these assets are not freely and fully disposable. A similar exclusion applies to the assets of other specific purpose funds (such as the Education Fund, the Regional Support Fund, and the High Cost Treatment and Diagnosis Fund).

Institutional Coverage

21. Fiscal rule should cover all entities that carry significant risks to the budget. A broad coverage is important to correctly assess exposure to vulnerabilities that arise beyond the central government and could have a significant impact on public finances. Specifically:

- Non-financial public enterprises that play key fiscal policy functions (or that, from an economic point of view, are part of the general government) should be covered by the rule.
- Where subnational governments do or can account for a large share of spending, and are not subjected to a balanced budget rule, establishing adequate coverage of fiscal aggregates in the national rules can help bring general government finances under control. This is because three factors make fiscal discipline challenging for subnational governments: (i) limited revenue

[4] The use of resources of the Pension Reservation Fund cannot exceed one third of the increase, relative to 2008, in the spending on the solidarity pillar of the pension system.

authority and dependence on central government transfers create moral hazard and accentuate common pool problems; (ii) differences in the timing and size of economic cycles across subnational governments may spur procyclical fiscal behaviors at the subnational level; and (iii) higher-spending jurisdictions (the central government) can spill spending over to lower-spending jurisdiction (for example, the municipalities) (IMF 2009).

22. In practice, broadening the institutional coverage of rules may be difficult and require establishing complementary sets of rules with the risk of complicating the rule framework. Specifically:

- Rule for public companies should not infringe on their financial autonomy and operations, which may greatly complicate the rule design. Also, obtaining timely data may be problematic for rule monitoring and compliance.

- In federal states or where subnational governments enjoy a high level of independence, establishing fiscal rules at the subnational levels requires a broad political agreement across all levels of government. In centralized states, where establishing broad rule may be legally easier, designing enforcement mechanism can be challenging. For example, the case of Italy demonstrated that financial sanctions of noncompliant subnational governments could exacerbate their financial difficulties and be politically difficult or even unconstitutional. In addition, administrative sanctions may also be difficult to design, due to information asymmetries. Differences in local government sizes and historical and cultural aspects also complicate the design of sanctions that may fit all subnational governments (Joumard and Kongsrud, 2003).

23. For Chile, the central government is probably the appropriate level of coverage. Chile can be classified as a unitary country (OECD/KIPF 2016). Although municipalities share responsibilities with the central government on public health, and primary and secondary education, municipalities cannot borrow, hence they do not pose risks to central government debt. Similarly, all of Chile's 26 public non-financial corporations are commercial in nature. Although their consolidated deficit amounted to 0.7 percent of GDP in 2017, all of them have a net asset position, and are not expected to pose risk to the government balance sheet.

Intermediate Arrangement and Triggers

24. Operational rules on budget aggregates can be complemented with provisions linked to the deviation of debt (or net wealth) from the anchor, to provide further short-term guidance to fiscal policy. In a few countries (such as Armenia, the Slovak Republic, Poland) the debt rule specifies actions that are triggered when debt gets closer to the limit imposed by the rule. Specifically:

- In Armenia, where public debt may not exceed 60 percent of GDP in any given year, if the ratio of public debt over the previous year's GDP exceeds 50 percent, the deficit in the following year

should be lower than 3 percent of GDP (where GDP is calculated as the average of the previous three years).

- In the Slovak Republic, where the debt rule establishes a 60 percent of GDP cap on debt, when debt exceeds 50 percent of GDP the Minister of Finance is obliged to report to parliament and suggest measures to reverse the debt growth. At 53 percent of GDP, the cabinet has to pass a package of measures to trim the debt. At 55 percent, expenditures are cut automatically by 3 percent and next year's budgetary expenditures (with few exceptions) are frozen. At 57 percent of GDP, the cabinet has to submit a balanced budget, and, at 60 percent of GDP, the cabinet faces a confidence vote in parliament. The law also includes numerically defined escape clauses for a major recession, banking system bailout, natural disaster, and international guarantee schemes.

- In Poland, the Constitution establishes a debt limit of 60 percent of GDP. In addition, the Public Finance Act establishes triggers and corrective actions if public debt crosses certain thresholds. If public debt is between 43 and 48 percent of GDP, the draft budget cannot propose a higher deficit-to-revenue ratio than in the current year. If the debt is between 48 and 53 percent of GDP, the draft central budget must not increase the ratio of central government debt to GDP in the following year. If debt exceeds 53 percent of GDP, the fiscal balance should be in balance or surplus.

25. In addition, an adjustment path can be specified in case debt exceeds the rule-based cap. For example, the Stability and Growth Pact establishes Medium-Term Budgetary Objectives (MTOs) for those countries where debt exceeds the 60 percent of GDP limit. The MTOs are set to allow debt to converge to the limit in 20 years, and annual budgets are expected to be formulated to make the overall deficit converge to the MTO within three years. In 2016, Pakistan adopted a Fiscal Responsibility Law that specified a 15-year debt reduction path to 50 percent of GDP.

D. How to Calibrate the Numerical Anchor(s)

26. For a resource rich country such as Chile the fiscal anchor could combine a debt anchor and a floor on liquid financial assets. Copper prices (and, consequently, copper revenue) are intrinsically unpredictable, not just over the short term but mostly over the long run. Differently from a country where the major uncertainty is about the state of the economic cycle, in Chile the fiscal anchor(s) should be set taking into account that the structural (or long-run) copper prices could change. A debt anchor would allow Chile to keep debt safe when assets and resource revenues are low. At the same time, a floor on assets would allow Chile to maintain a safety buffers to smooth the budgetary impact of large declines in copper prices over time, which tend to coincide with periods when the cost of financing increases. These anchors could be complemented with a dynamic rule on the structural balance, to help rebuild buffers when assets are used or return debt below the anchor after adverse economic conditions justified running large overall deficits.

Framework for Setting the Debt Anchor

27. A debt anchor should be set below a debt limit, so as to leave a sufficient and prudent "safety buffer" that ensures that debt remains sustainable even if bad shocks occur (IMF 2018a). The principle idea is that fiscal sustainability is ensured if debt remains below a certain limit even under adverse shocks. The limit can be the level of debt above which the drag on growth rises, or the risk of debt distress increases substantially, or the risk premium escalates. Targeting a level of debt close to the limit would not be prudent. First, there would be little space to respond to shocks with expansionary fiscal policy. Second, the intrinsic randomness of the debt dynamic would risk pushing debt above the limit. The fiscal anchor should be set sufficiently below the limit so that, for a given fiscal response to shocks and given the intrinsic randomness of the debt dynamic, debt remains below the limit with a high probability.

28. Past cases of large increases in public debt provide a justification for a prudent approach to setting a fiscal anchor. Since 1980, there have been many cases of countries where debt increased from below 25 percent of GDP to over 50 percent of GDP within five years (Table 1). In about half of the cases, the increase was associated with a large depreciation of the currency. In other cases, it was mostly associated to the un-expected realization of contingent liabilities (for example, in Iceland and Ireland), and a combination of support to the financial sector and deficits (Slovenia).

List of countries where, since 1980, debt-to-GDP increased from below 25 to over 50 percent of GDP, and the cumulative deficit was above 15 percent of GDP, over a 5-year period.

Country	Episode	Starting level of debt	Increase in Debt	Change due to Nominal GPD Change	Sum deficits (not discounted by GDP growth)	Exchange rate Change (+ is depreciation)
Argentina	1980-1985	12.6	47.9	-12.5	33.3	327,339.2
Bhutan	1986-1991	15.2	43.5	-8.7	23.4	80.3
Burundi	1981-1986	22.7	32.0	-8.3	45.0	26.9
Ecuador	1980-1985	24.0	29.8	-2.5	15.6	0.0
Gabon	1983-1988	23.9	53.0	3.8	31.8	-21.8
Gabon	2011-2016	17.3	46.9	-0.5	-9.7	25.3
Iran, I.R. of	1984-1989	9.2	47.1	-4.2	31.4	-21.9
Ireland	2006-2011	24.8	79.3	1.9	49.8	-9.8
Lesotho	1980-1985	24.8	47.5	-11.5	16.6	181.6
Qatar	1991-1996	17.9	32.7	-4.3	26.5	0.0
Slovenia	2007-2012	23.1	29.8	-0.6	16.2	6.6
Thailand	1996-2001	10.7	46.4	-1.4	16.0	75.3
Trinidad & Tobago	1983-1988	11.0	39.0	0.9	38.2	60.2
Ukraine	1994-1999	24.9	36.1	-22.6	24.6	1161.1
Zimbabwe	2002-2007	20.1	45.0	7.6	17.4	0.0

Source: IMF, 2012, Historical Public Debt Database

Setting the Debt Limit

29. The level of the debt limit should be chosen on the basis of a range of considerations, related to the risks that debt brings to the economy. Specifically, the limit could be related to the risk of debt distress, the risk of solvency, the negative impact that debt could have on growth, or the influence of debt on cost of financing and sovereign credit ratings.

30. A strand of the empirical literature on debt uses the signal approach to derive "benchmarks" for debt distress indicators. For example, the IMF MAC DSA framework (IMF 2013) utilized the signal approach developed by Kaminsky and others (1998) to find the level of general government debt-to-GDP ratio that best predicts the occurrence of a debt distress event.[5] In this approach, "best" is defined as the threshold that minimizes the sum of the missed crises and false alarms. A noise-to-signal ratio below 100 suggests that the indicator is an efficient predictor of debt distress. The approach finds an indicative benchmark of 60 percent of GDP for emerging market economies.

31. A large literature on debt limits is based instead on assessing solvency either via a partial equilibrium framework, or through model-based approaches of the way fiscal policy endogenously reacts to the debt dynamic. The September 2003 WEO used both approaches to compute a debt limit for emerging market economies. Using the first method, the WEO computed the level of debt that the average emerging market economy would be able to sustain, compatibly with the historical averages for primary balances, interest rates, and growth rates. It concluded that, based on past fiscal performance, the sustainable public debt level for a typical emerging market economy may only be about 25 percent of GDP (IMF 2003). Introducing estimates of a fiscal reaction function, they concluded that the sustainable debt for a typical emerging market economy is as high as 50 percent of GDP. Ostry and others (2010) proposed a unifying empirical framework for the partial equilibrium-based approach and the model-based approach and concluded that sustainable debt limits for advanced economies ranged between 50 and 63 percent of GDP.

32. There is evidence that debt exerts negative effect on growth when it surpasses certain thresholds. At low levels, debt does not negatively affect growth. However, using a sample of 40 advanced and emerging market economies, Chudik and others (2015) show that in an average country growth is lower when debt surpasses a threshold between 30 and 60 percent of GDP. Based on a study of 93 countries, Pattillo, Poirson, and Ricci (2011) find that this threshold is 35 percent of GDP for external debt. They also show that the marginal (as opposed to average) effect of external debt on growth turns negative when debt reaches 25 percent of GDP, a result confirmed also by Cordella, Ricci, and Ruiz-Arranz (2010) when looking at the net present value of public debt.

33. An increase in debt has also negative implications for sovereign credit ratings and spreads. This literature does not offer a nonlinear analysis necessary to identify limits or thresholds,

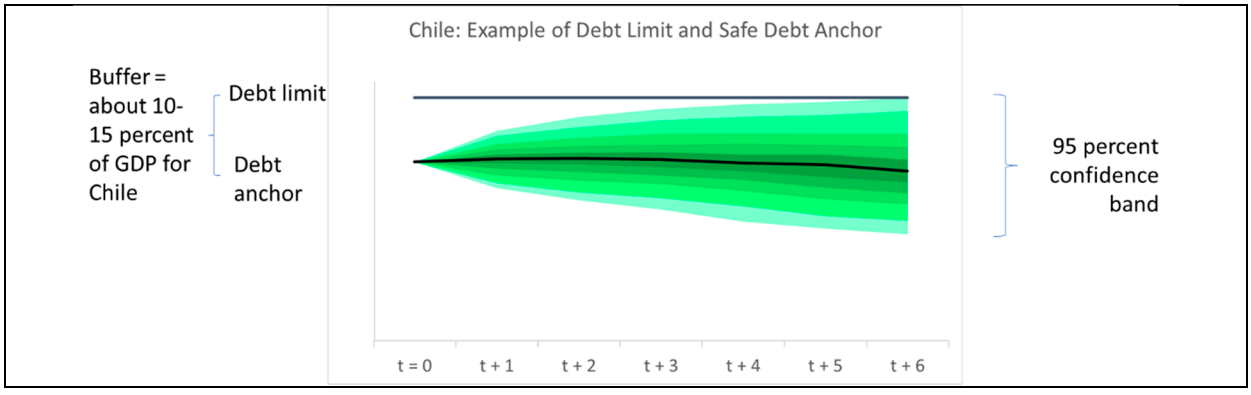
[5] For emerging market economies, episodes of debt distress are defined as period of default (including incurrence of arrears on principal or interest payments to commercial or official creditors), restructuring and rescheduling (that is any operation which alters the original terms of the debtor-creditor contract) or IMF financing.

but rather assesses the effect associated with a change in debt. Hadzi-Vaskov and Ricci (forthcoming) show that a debt increase of 10 percent of GDP would lower the probability that a country such as Chile enters into a high investment grade class by 6 percent (see also the other Selected Issues Paper). Such an increase in debt would also be associated with a decline by half a notch in the sovereign credit rating, while the impact on the Institutional Investor Index would be a decline of 3 units (equivalent to 15–20 percent of one standard deviation). Similarly, a debt increase of 10 percent of GDP is estimated to result in 100–120 basis points higher spreads (Hadzi-Vaskov and Ricci, 2016), an effect that may be somewhat mitigated (down to 80–90 basis points) for emerging markets with strong institutions, such as Chile (see other Selected Issues Paper).

Computing the Debt Buffer and Setting the Anchor

34. Once the debt limit is set, the debt anchor and buffer are estimated through stochastic simulations. A simple approach consists of estimating the distribution and covariance of fiscal and macroeconomic shocks using past data for Chile (IMF, 2018a). For the macroeconomic shocks we consider those to growth, the implicit interest rate on debt, the exchange rate, and the deviation of copper prices from their long-run average. For all, we use annual data going back to 1990. Using a Cholesky decomposition of the variance and covariance matrix of these shocks it is possible to construct Monte-Carlo simulations of the fundamental macroeconomic variables governing the debt dynamic around their long-run average (or baseline projections). A fiscal reaction function (that is, the way fiscal policy would react to the output gap and the level of debt) is estimated using a panel of Emerging Market Economies. Combining the Monte Carlo simulations of the shocks and the estimate of the fiscal reaction function it is possible to simulate future debt trajectories starting from different levels of debt.

35. We estimate that the appropriate debt buffer is between 10 and 15 percent of GDP, suggesting that the debt anchor should be 10–15 percent of GDP below the desirable debt limit. For each starting level of debt, we obtain the probability distribution of debt six years into the future. We calibrate the debt anchor as the initial level of debt so that public debt remains below the limit with a given probability (95 percent) over a six-year period. In most cases, the difference between the 95th percentile of the debt distribution and the median ranges between 10 and 15 percent of GDP.



Computing the Liquid Asset Buffer

36. To estimate a suitable floor on liquid financial assets, we adopt a risk-based approach, instead of a framework based on intergenerational equity. Copper production in Chile is at a mature stage, and proven reserves (U.S. Geological Survey, 2018) are estimated to allow current production levels for the next 90 years. Hence, consideration about intergenerational equity, which are traditionally used to determine a fiscal anchor in countries where production is at an early stage or where the production horizon is limited (see a review in IMF 2012), are less relevant for Chile. However, more important is the need to build a liquid buffer to protect fiscal policy from large shifts in long-term prices. Additional considerations would of course relate to the cost of holding assets, which are beyond the scope of this paper.

37. Under a risk-based approach, assets should allow to finance a gradual adjustment to a permanent loss in commodity revenues (see IMF 2012 and 2015). Specifically, the anchor on assets could be specified as a multiple of the copper revenues that fund the budget. The multiple should be set so that, with a high probability, financial assets are enough to absorb a permanent decline in copper revenue within a certain amount of years and with a cap on the implied adjustment to spending (say, spending should not decline by more than 0.25 percent of GDP per year in structural terms). During copper price booms, when the buffer needs to be replenished, only a fraction of headline (structural) copper revenues could be spent. During busts, the assets can be drawn down and spending can be gradually adjusted.

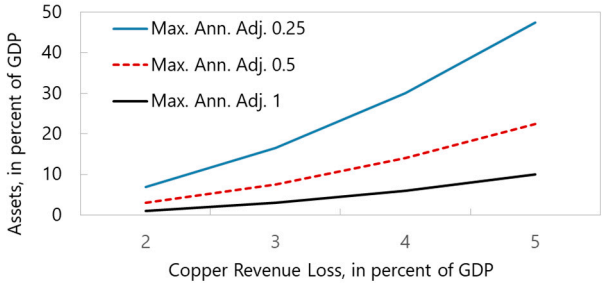
38. Hence, the desirable size of the buffer would increase with:

- Higher level of copper revenue in the budget: this is the maximum loss in case copper prices were to drop.
- Lower tolerance for the size or the duration of adjustment (that is, the smaller the maximum annual adjustment, or the number of years of painful adjustment the authorities are willing to tolerate): a permanent loss of revenues would eventually have to be absorbed by a contraction of spending.
- Higher volatility of structural prices: this determines the probability and extent of the possible copper revenues losses.
- Stronger risk aversion (i.e. lower risk tolerance).

Once again, the cost of holding assets should also be taken into account in the policy decision about the desirable level of assets.

39. As an example, assuming no tolerance for risk, a buffer of 7 percent of GDP as liquid financial assets would allow to smooth the adjustment of a 2 percent of GDP permanent loss of copper revenues in 8 years. A permanent loss of copper revenue is an extremely rare event. However, if there is no tolerance for risk, the government would seek protection against permanent revenue losses. In this case, the size of the buffers would depend on the tolerance for the size of the annual adjustment (or, the speed of the adjustment). If the government were willing to adjust immediately, there would be no need for assets. However, depending on the size of the adjustment, this could be highly costly in terms of the impact on activity. Hence, the government would likely prefer to smooth the adjustment over time, which requires some buffers.[6] The graph offers alternative calculations for the size of the necessary buffers assuming no tolerance for risk, as a function of the size of the revenue loss (in the horizontal axis) and the tolerance for the size of the annual adjustment (the colored lines). For example, with a tolerance for a maximum adjustment of 0.25 percent of GDP per year, it would take 8 years to absorb a sudden and permanent loss of 2 percent of GDP of copper revenues. During this period, the cash buffer would be used to cover the part of spending that remains to be adjusted: 1.75 percent of GDP in the first year, 1.5 percent of GDP in the second year, so on so forth. In this case, the cash buffers would have to be 7 percent of GDP.

Buffers Required to Smooth Adjustment to a Permanent Copper Revenue Losse
(No Risk Tolerance)



Sources: 2017 WEO and IMF Staff calculations.

[6] To the other extreme, if there is no tolerance for the adjustment, the government would need to have enough assets, such that the yields on the assets are as large as the revenue loss. This can be thought of a rationalization of the policy of saving all resource revenue and spend only the yields on the accumulated assets.

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TRENDS IN CHILE'S COMPOSITION OF EXPORTS[1]

This study takes stock of the evolution of Chile's export composition over the past half a century, focusing on key trends in export diversification, sophistication, economic complexity, and revealed comparative advantage. Overall, it finds that Chile's export basket remains around the median of Latin American peers for diversification and complexity, and below regional peers for export sophistication. Using the proximity of products in Chile's current export portfolio, the study also tries to provide insights on the possible changes in future export composition, underlining that Chile has a potential to gain comparative advantage in skill-intensive and technology-intensive exports, while lowering the relative importance of commodities.

A. Introduction

1. Countries' economic performance depends not only on how much they trade, but also on what kind of goods they actually trade.[2] Some export products contain high technological content and offer opportunities for faster productivity growth, while others require limited set of skills for their production and offer weaker productivity growth prospects. Similarly, some countries export a wide variety of products, while other countries have traditionally exhibited exports concentrated in a narrow group of limited products, either due to natural endowments, such as Chile, or due to policy decisions or historical context. In this context, analyzing the trends in the composition of exports is particularly relevant for countries that aim to diversify their export portfolios into products with potentially higher value added, and hence, better economic prospects in the future (Hausmann et al., 2014).

2. The paper takes stock of the trends in Chile's composition of exports over the past few decades and provides some considerations about the possible future trends. Section II presents four key dimensions of Chile's export composition: diversification/concentration, export sophistication, economic complexity, and revealed comparative advantage (RCA). Section III looks at product proximity of the Chilean current export basket and puts forward predictions about possible changes of the export basket in the future. Finally, Section IV provides some concluding remarks. The analysis presented here largely draws on the findings in Ding and Hadzi-Vaskov (2017).

B. Trends in Export Composition

3. The composition of a country's exports can be captured in different ways. For instance, one perspective will concentrate on the level of diversification across different product categories or the differences in the network of trading partners, while others will look at product characteristics such as quality, technological content, processing stage, or final use. On the basis of Ding and Hadzi-Vaskov (2017), this section provides a brief description of the four dimensions of export

[1] Prepared by Metodij Hadzi-Vaskov.

[2] For instance, see Hausmann, Hwang, and Rodrik (2007), Hausmann et al. (2014) and IMF (2017).

composition employed, and presents the evolution of Chile's composition of exports along these dimensions.

Diversification/Concentration

4. Diversification is a multifaceted concept that can be defined in different ways. In this analysis, product concentration (i.e. limited diversification) is measured by the Herfindahl concentration index given with the following formula:

$$HI_{jt} = \sum_{s} \left(\frac{x_{sjt}}{\sum_s x_{sjt}} \right)^2$$

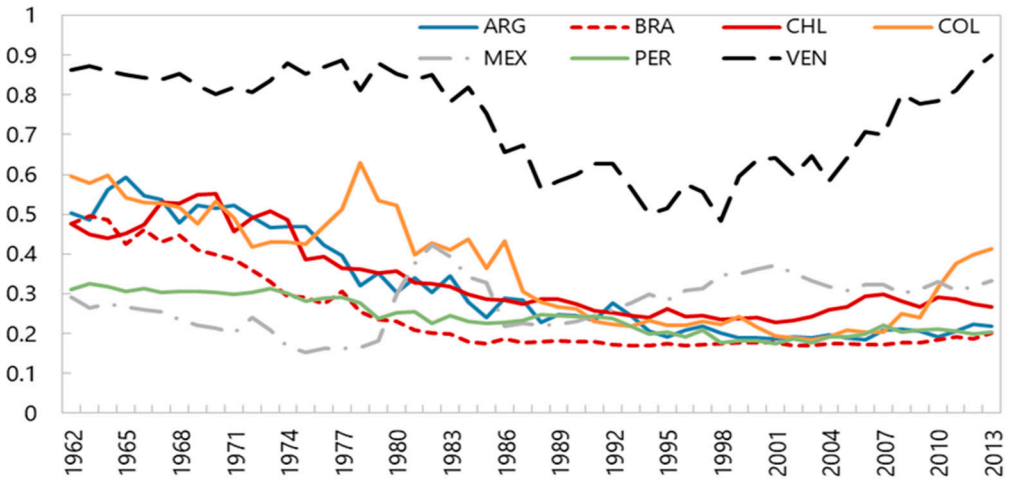
Where x_{sjt} represents exports (in nominal terms) of product category s for country j at time t. This concentration index is calculated across 10 product categories in accordance with the SITC classification for each country in the dataset (see the Annex for product classification). Higher HI_{jt} index values indicate less product diversification across groups of products, on the basis of the products' economic function.

5. Chile's improvement in goods export diversification was interrupted by the commodity boom. Figure 1 shows that Chile's export concentration has been gradually declining from the mid-1970s to the early 2000s. However, with the commodity boom of the 2000s, this trend started to revert, partly owing to a price effect. Despite a mild recovery of the trend decline in export concentration in the 2010s, Chile's export basket remains less diversified than in the 1990s.[3]

6. Overall, the diversification of Chile's goods export portfolio is in line with several Latin American peers. Figures from the 2010s suggest that Chile's export concentration in goods is lower than in large energy-commodity exporters such as Colombia, Mexico, and Venezuela, but higher than in Argentina, Brazil, and Peru.

[3] Due to data constraints, the analysis only considers goods and not services. Nonetheless, despite the substantial diversification of the Chilean economy into services in recent years, preliminary analysis suggests that services export diversification is not likely to lead to different conclusions as the share of services in total exports/GDP has been declining (see Annex II).

Figure 1. Export Concentration



Source: UN COMTRADE and Fund staff calculations.

Export Sophistication

7. Sophistication of a product aims to capture the potential income level a product may be associated with, based on the income levels of countries that export that product. For instance, if a country starts exporting (a relatively low-end version of) a new product that is exported by relatively rich countries, this may be an indication that over time this country can increase the prices charged as well as its income. In measuring product sophistication, the analysis follows Hausmann, Hwang, and Rodrik (2007) by computing the productivity level $PRODY_{it}$ associated with product i at time t as the weighted average of per capita GDP levels of countries exporting that product, with the weights corresponding to the revealed comparative advantage of each country in that product[4]:

$$PRODY_{it} = \sum_j \left[\frac{\left(\frac{x_{ijt}}{\sum_i x_{ijt}} \right)}{\sum_j \left(\frac{x_{ijt}}{\sum_i x_{ijt}} \right)} GDPpc_{jt} \right]$$

Similarly, the sophistication level that is associated with the export portfolio of country j at time t ($EXPY_{jt}$) is calculated as the weighted average of productivity levels ($PRODY_{it}$) for all products this

[4] Hausmann, Hwang, and Rodrik (2007) argue that the rationale for using revealed comparative advantage as a weight in the formula is to ensure that country size does not distort the ranking of products. The use of RCA allows higher weights for those countries that export more than their fair share in certain product.

country exports, with the weights corresponding to the shares of these products in total exports of country j:

$$EXPY_{jt} = \sum_i \left(\frac{x_{ijt}}{\sum_i x_{ijt}} \right) PRODY_{it}$$

While these measures of product and export portfolio sophistication have been widely used in the literature, they necessarily imply an increasing trend of sophistication over time given that GDP per capita for most countries persistently follows an upward trend. Therefore, to account for this time trend, the analysis here presents a "de-trended" product productivity $PRODY^S_{it}$ by replacing GDP per capita for country j in the original formula with GDP per capita for country j relative to the corresponding value for the world:

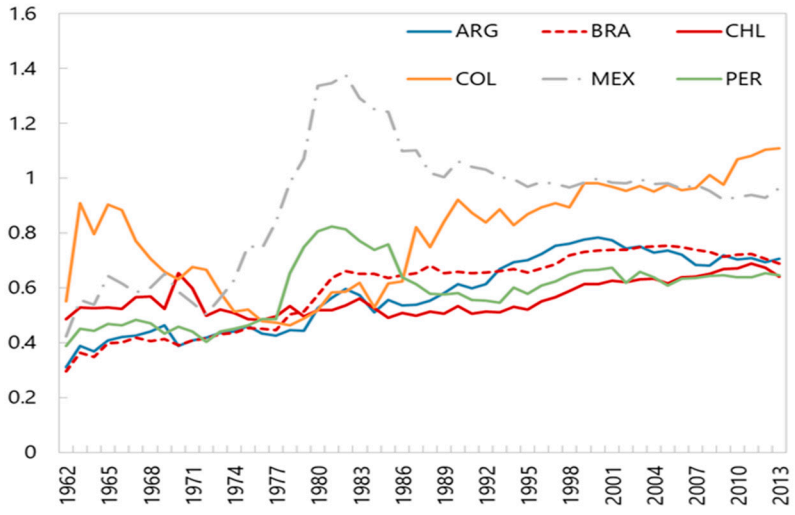
$$PRODY^S_{it} = \sum_j \left[\frac{\left(\frac{x_{ijt}}{\sum_i x_{ijt}} \right)}{\sum_j \left(\frac{x_{ijt}}{\sum_i x_{ijt}} \right)} \frac{GDPpc_{jt}}{GDPpc^{world}_{jt}} \right]$$

and recalculate a standardized measure for sophistication for country j's export basket accordingly:

$$EXPY^S_{jt} = \sum_i \left(\frac{x_{ijt}}{\sum_i x_{ijt}} \right) PRODY^S_{it}$$

8. As in many other commodity producers, export sophistication in Chile is low. Chile's export sophistication is among the lower half in regional peers, suggesting that its export basket may be associated with a relatively low potential income (on the basis of the income level of countries that export similar products). This is largely because its main products, such as copper, are exported by countries with relatively low-income levels. Nonetheless, the level of sophistication of Chilean exports has been on an upward trend over the past few decades, as in several other Latin American countries (Figure 2).

Figure 2. Export Sophistication



Source: UN COMTRADE and Fund staff calculations.

Economic Complexity

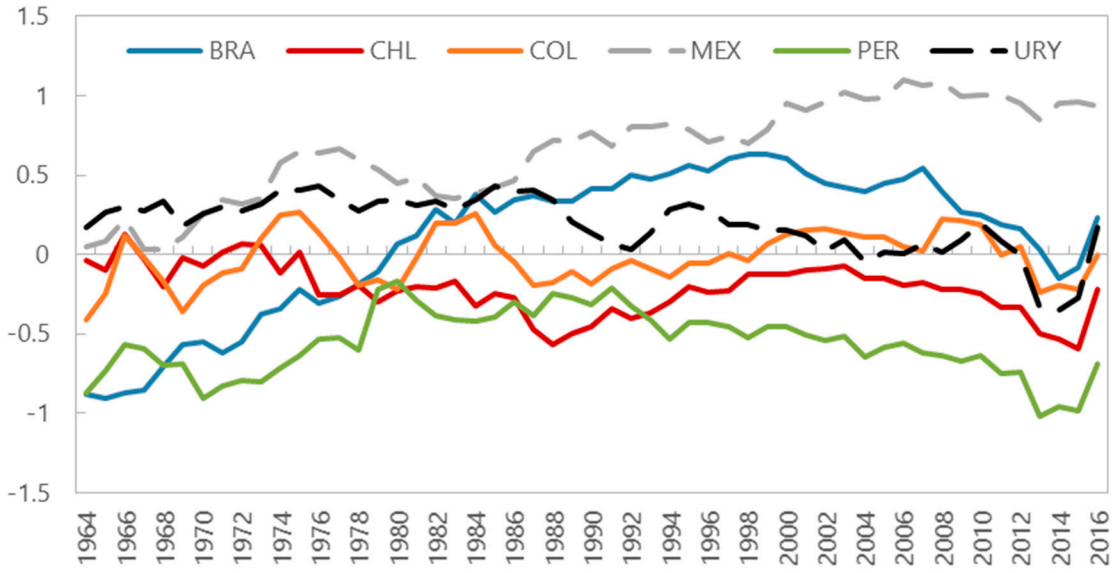
9. Economic complexity is conceptually related to the amount of productive knowledge that is embedded in a country's products (Hausmann et al., 2014). Some products require a lot of capabilities and knowledge and can be produced only by a limited group of countries. In this respect, countries that have more capabilities and knowledge are typically able to produce a more diversified set of goods. Moreover, these countries are also able to produce goods that only a selected group of a few other countries can produce as well. In turn, a country's ability to produce both many goods and a very distinguished set of goods suggests that the country is likely to possess complex knowledge and skills that only a few other countries, if any, enjoy.

10. Hence, higher complexity is linked to lower ubiquity (products that demand large volumes of knowledge that are feasible in a few locations only) and higher diversity (more knowledge can produce a more diverse set of products). A calculation of economic complexity, therefore, needs to correct the information that ubiquity and diversity convey by using each one to correct for the other (Hausmann et al. 2014). There are two measures of complexity used in this study. First, *product complexity* is calculated by the average diversity of countries that produce/export that product, corrected for the average ubiquity of the products in these countries' portfolio and so forth. Second, *economic complexity of a country* is measured by the average ubiquity of products that the country produces (exports), corrected for the average diversity of the products that make those products, etc. These recursive processes of average ubiquity and average

diversity provide measures for the Product Complexity Index (PCI) and countries' Economic Complexity Index (ECI).[5]

11. Economic complexity in Chile remains close to the average of Latin American peers. [6] Notwithstanding some movements over time, the complexity of Chile's exports remains close to Brazil's, Colombia's, and Uruguay's, higher than Peru's, and lower than Mexico's (the latter's score primarily reflecting its strong integration into global value chains with North American partners). The large share of products belonging to the quintile with the lowest level of complexity, such as copper, explains a large part of the relatively low overall level of complexity of Chile's export basket (Figure 4).

Figure 3. Economic Complexity

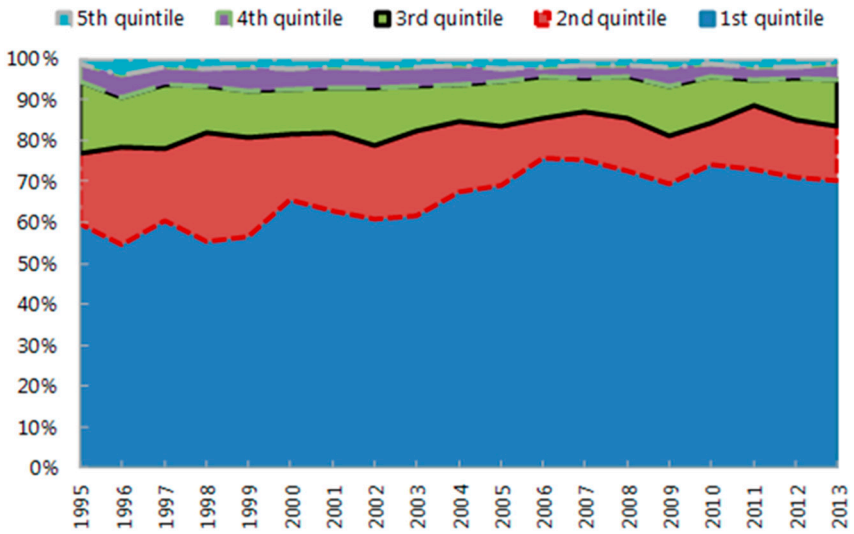


Source: Observatory of Economic Complexity.

[5] For a formal derivation of Product Complexity Index (PCI) and the Economic Complexity Index (ECI), see Hausmann et al. (2014) and the Observatory of Economic Complexity resources.

[6] See Hausmann et al. (2014) for detailed exposition of the concepts of economic complexity and product complexity.

Figure 4. Chile's Product Complexity
(Share of exports in each quintile of product complexity)



Note: 1st quintile contains least complex and 5th quintile most complex products.
Source: Observatory of Economic Complexity and IMF staff

Revealed Comparative Advantage

12. Revealed comparative advantage (RCA) shows the relative advantage or disadvantage that a country has in exporting a certain good or group of products. It is measured according to the RCA index introduced by Balassa (1965) that compares the share of a certain good in a country's total exports with the share of that product's world exports in total world exports of all goods. In this way, an RCA larger than one indicates that a country exports more than its "fair" share of a certain product, and therefore, enjoys revealed comparative advantage in that product. Similarly, an RCA below unity means that a country exports less than its "fair" share in world trade, and therefore, has a revealed comparative disadvantage for that certain product.

The RCA index for country j in good i is calculated with the following formula:

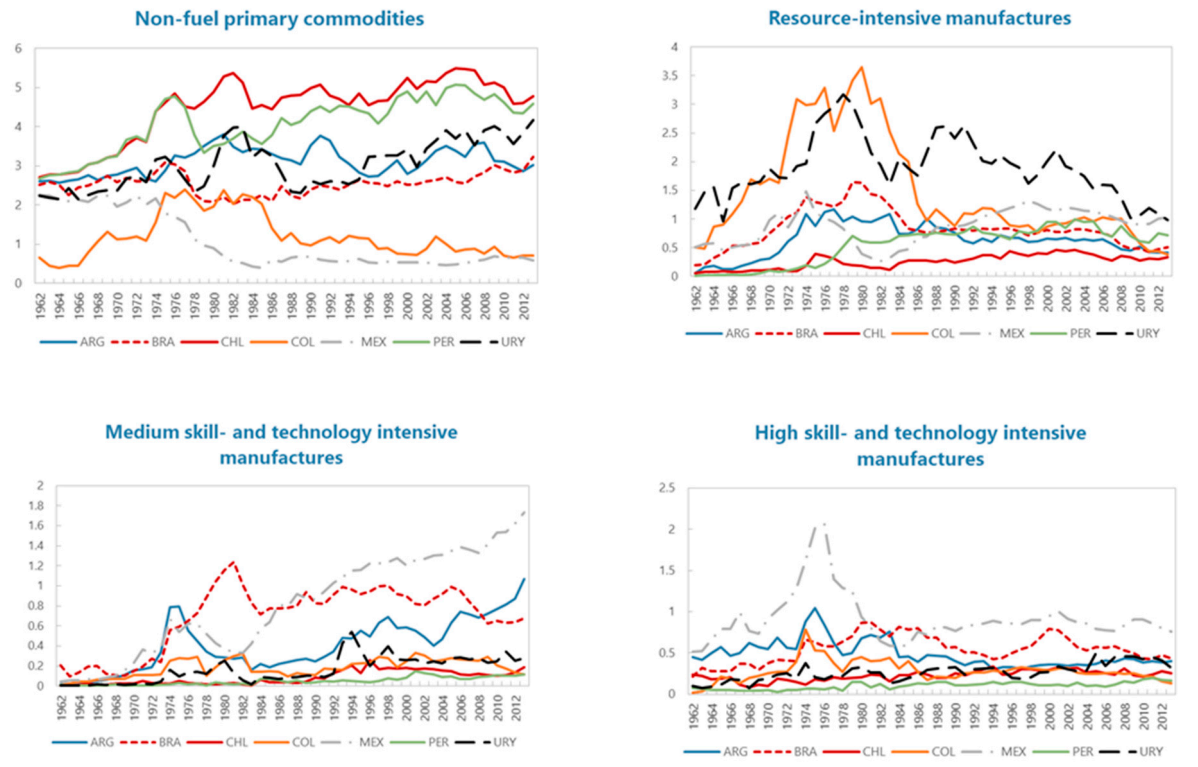
$$RCA_i^j = \frac{\frac{x_i^j}{\sum_i x_i^j}}{\frac{\sum_j x_i^j}{\sum_i \sum_j x_i^j}}$$

Where x_i^j stands for gross exports of product i for country j, so the numerator $x_i^j / \sum_i x_i^j$ refers to the share of product i in the overall exports of country j, and the denominator $\sum_j x_i^j / \sum_i \sum_j x_i^j$ captures the global share of product i exports in total world exports. Hence, if exports of product i for

country j represents 10 percent of its total exports, while global exports of product i represent only 5 percent of total world exports, then country j is said to enjoy RCA of 2 in product i.

13. Chile has a very strong revealed comparative advantage in non-fuel primary commodities, but not in other categories of goods exports. The share of metallic commodities in Chile's exports is about 5 times larger than the share of these commodities in the overall world exports of goods. However, Chile does not show comparative advantage in any other major category, such as fuels, resource-intensive manufactures or skill- and technology-intensive manufactures, despite some incipient signs of improvement in the last two categories in recent years.

Figure 5. Chile's Revealed Comparative Advantage



Source: UN COMTRADE and IMF staff calculations.

C. Product Proximity and Predicting Future Trends in Export Composition

14. Does Chile's current portfolio of export products reveal some information about the possible future changes in its patterns of trade? Product proximity as a concept aims to capture the intuition that it is easier for countries to move into industries/products that mostly reuse what countries already know, or into industries that require adding little new productive knowledge.[7]

[7] For a detailed discussion about product proximity and its measurement see Hausmann et al. (2014).

Hence, the capability of a country to produce a certain product is expected to depend on how similar or close that product is to the country's current production set, because similar products are expected to share more characteristics used in production. In turn, such products are more likely to be co-produced, and therefore co-exported, and can provide insights about the products that may be easier for a country to add to its export portfolio in the future.

Product Proximity

15. Product proximity between two products can be formally measured as the conditional probability of exporting one good given that the other good is also exported. Moreover, the literature typically refers to the co-exporting of goods with a revealed comparative advantage above one, given that this is a stronger concept that better captures the ability to export a certain product. Hence, the product proximity between two goods A and B can be defined as:

$$Proximity\ (A,B) = \min\{P(RCA_{At} \geq 1|RCA_{Bt} \geq 1)\,, P(RCA_{Bt} \geq 1|RCA_{At} \geq 1)\}$$

where, given that conditional probabilities are not symmetric, taking the minimum of the two probabilities reflects a more conservative stance to calculating proximity.[8]

16. The calculation of product proximity can be illustrated with a concrete example. The proximity between grapes and wine can be deduced on the basis of the set of countries that export them. For instance, if 16 countries export wine with $RCA \geq 1$, 24 countries export grapes with $RCA \geq 1$, and 8 countries export both with $RCA \geq 1$, then the proximity between wine and grapes will be calculated as:[9]

$$Proximity\ (wine, grapes) = \frac{P(wine \cap grapes)}{\max[P(wine), P(grapes)]} = \frac{8}{24} = 0.33$$

Hereby, using the classification of product groups according to the degree of skill- and technology-intensity (Box 1), product proximities are calculated for the period 1962–2013.

[8] Taking the minimum between the two probabilities in this asymmetric case is particularly relevant for minimizing the likelihood of a false relationship when one of the countries is the sole exporter of a certain good with RCA>1.

[9] Note that the proximity is calculated as 8/24=0.33, not as 8/16=0.5 in line with the conservative stance to minimize the chances of false relationship.

Predicting Composition of Trade

17. The current export portfolio and the proximity between its components can provide some guidance about the likely future changes in the composition of trade.[10] Following the methodology in Ding and Hadzi-Vaskov (2017), such predictions are formed on the basis of two elements that are known at present:[11] first, the distribution of RCAs for the different product groups; and second, all pairwise proximities between these product groups calculated from historical data.[12] Using these two pieces of information, the groups of products in which Chile is more likely to gain RCA as follows:

$$E\left(RCA_{it}^{g}\right) = \sum_{h=1}^{7} RCA_{it}^{h} \cdot Proximity\ (g,h)$$

where g and h are product groups, and $E\left(RCA_{it}^{g}\right)$ is the expected future RCA value for country i in product group g.

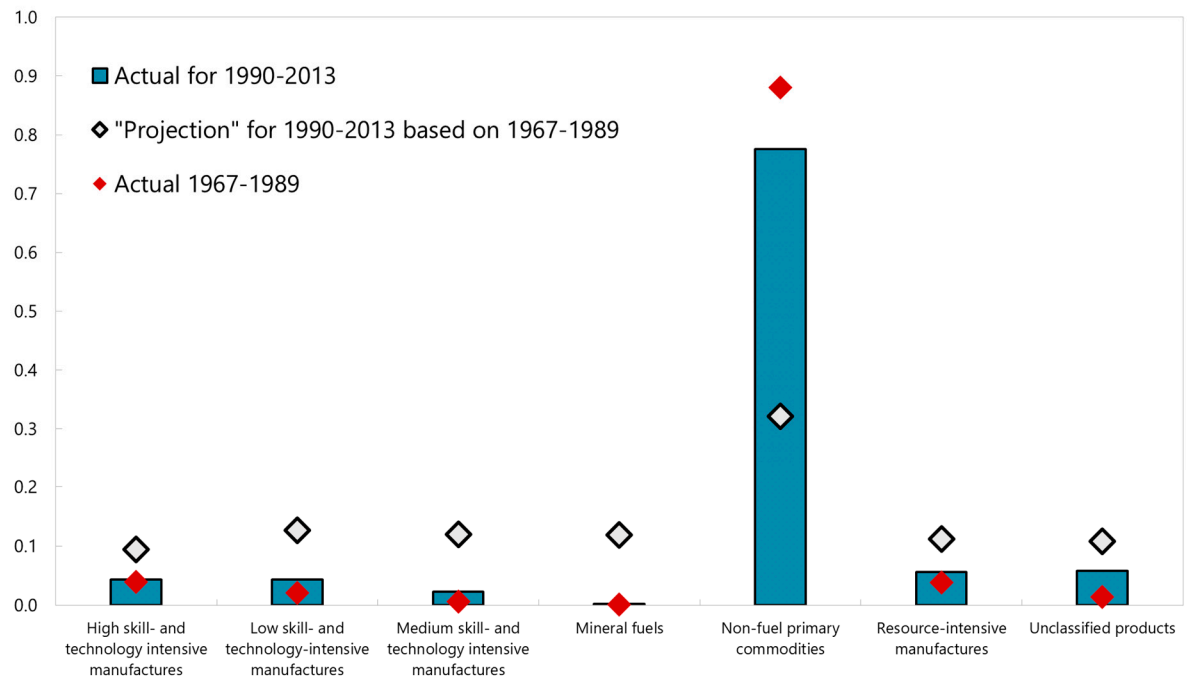
18. Product proximity correctly predicted the direction of change for most categories of Chilean goods exports over the last quarter century. Figure 6 shows that the product proximity among different export categories over the period 1962–89 correctly predicted the direction of the changes in the relative importance of these export categories (measured by the RCA) over the period 1990–2013. As predicted, Chile increased its RCA in most categories and lowered its RCA in non-fuel primary commodities (category that includes copper). Nevertheless, one category where these predictions underperformed somewhat is high skill-intensive and technology-intensive manufactures: Chile's RCA barely changed, while product proximity suggested an increase.

[10] See Ding and Hadzi-Vaskov (2017) for more details on the methodology for predicting future patterns of trade based on the product proximities in the current export portfolio.

[11] The present moment here refers to 2013, the latest year with historical data.

[12] Proximities between product groups are calculated from data series for the period 1962–2013. The results are quite robust to alternative sub-periods used in the calculation of product proximities.

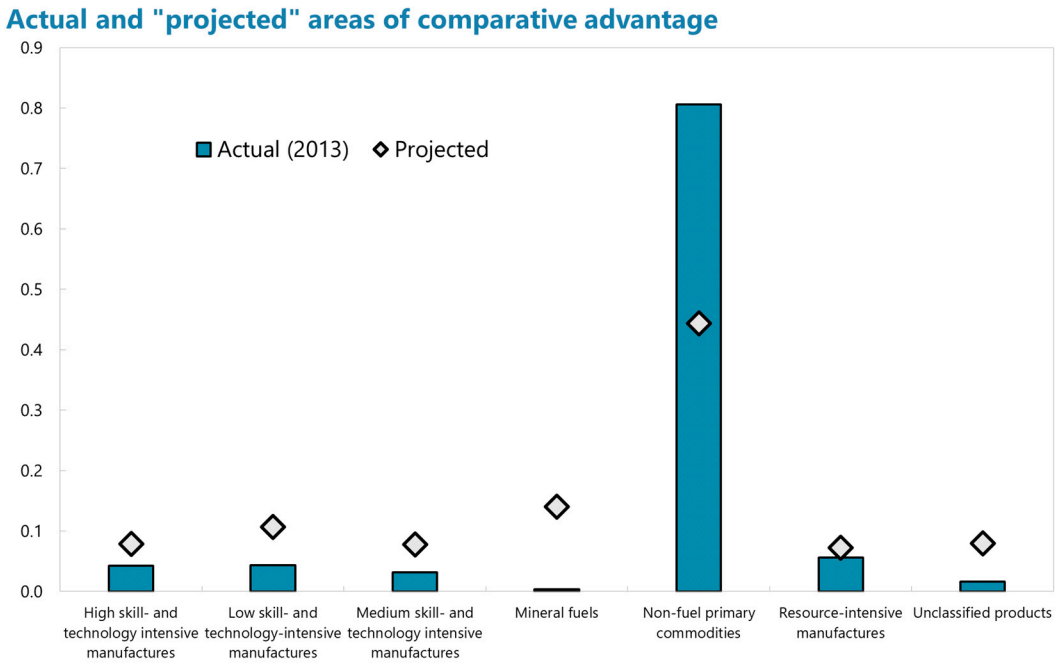
Figure 6. Prediction of Past Export Trends Based on Product Proximity



Source: UN COMTRADE and IMF staff caluclations.
Note: Units of measurement are "standardized" RCA that sum up to 1 across the seven product categories.

19. Going forward, proximity among product categories in Chile's current export basket suggests that the relative importance of skill-intensive products is likely to increase and the importance of commodities to decrease. The same setup that helped correctly predict the direction of change in RCA of different export groups over 1990–2013 now implies that Chile is likely to continue advancing its relative share in all product categories with the exception of non-fuel (metallic) commodities (Figure 7). While the approach presented here reveals a "potential" to move into new export groups, based solely on proximities of the current export portfolio, the future outcome is likely to reflect a complex set of factors that facilitate or inhibit the transition towards new exports. In this context, the Article IV Staff Report and Hadzi-Vaskov (2018) discuss growth-enhancing structural reforms that could also favor diversification into new products.

Figure 7. Prediction of Future Export Trends



Source: UN COMTRADE and IMF staff caluclations.
Note: Units of measurement are "standardized" RCA that sum up to 1 across the seven product categories.

D. Determinants of Export Composition

20. Policy decisions can help shape the prospects for diversification into new products and determine trends in export composition. Table 1 presents results about the role different factors play in shaping export composition. The results suggest that policies that facilitate investment in infrastructure and improve infrastructure quality are likely to result in more complex and sophisticated exports, and raise the relative importance of high-skill and technology-intensive manufactures in overall exports. Similarly, better education quality is likely to support diversification efforts into such high-skill and technology-intensive exports that are potentially associated with higher value added. On the other hand, more protective trade policies, measured by average trade tariffs, can negatively affect economic complexity, sophistication, and diversification.

Table 1. Factors that Affect Composition of Exports

	I	II	III	IV	V
	complexity	concentration	sophistication	RCA in high-skill products	share of high-skill products
Infrastructure	8.017***	0.113	0.401**	4.301***	1.127***
	(5.85e-07)	(0.559)	(0.0457)	(5.90e-08)	(1.90e-07)
Tariffs	-0.0622***	0.00549**	-0.00491***	-0.00153	-0.000592
	(1.33e-06)	(0.0152)	(0.000981)	(0.862)	(0.808)
Education	-0.00165	-0.000197	7.32e-05	0.0291***	0.00799***
	(0.581)	(0.565)	(0.844)	(3.34e-08)	(2.00e-08)
Gini Index	-0.0230***	-0.00137	-0.00263**	0.0161***	0.00446***
	(0.00239)	(0.160)	(0.0121)	(0.000967)	(0.000850)
Constant	1.576***	0.269***	0.953***	-0.590***	-0.169***
	(2.48e-06)	(0)	(0)	(0.00230)	(0.00144)
Observations	708	708	708	708	708
R-squared	0.457	0.083	0.249	0.258	0.271

pval in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source: Ding and Hadzi-Vaskov (2017).
Note: Estimation results from instrumental variables (IV) panel regressions that include time fixed effects. Infrastructure, tariffs, education, and Gini index are instrumented by their first two lags. Infrastructure is measured by the density of the railway network from the WDI, tariffs refer to average applied tariffs retrieved from the WITS database, education refers to secondary school enrollment rate and to share of population with tertiary education in regressions for RCA and share of high-skill products, and income inequality is measured by the net Gini index from the SWIID.

E. Concluding Remarks

21. Overall, the diversification, sophistication, and complexity of Chile's export basket have remained below or around the median of Latin American peers. Following some important improvements in the earlier period, Chile's trend of increasing export diversification was interrupted during the commodity boom in the 2000s (to the extent that such change is driven by a price effect, it would be less of a reflection of a structural change). Given the dominance of copper exports, Chile continues to enjoy a very strong revealed comparative advantage in non-fuel commodity exports. The composition of the current export portfolio suggests that Chile has the potential to gain comparative advantage in skill-intensive and technology-intensive exports, while lowering the relative importance of commodities. Nonetheless, the future outcome is likely to reflect a complex set of factors, including policy measures, that facilitate or inhibit the transition towards new exports. In particular, policies that support infrastructure investment, education quality, and trade integration are likely to support export diversification, and result in a higher share of skill and technology-intensive exports with potentially higher value-added. Growth-enhancing structural reforms, such as those discussed in the 2018 AIV Staff Report and Hadzi-Vaskov (2018), could also support changes in Chile's export composition.

Annex I. Dataset and Data Description

Data used in this analysis comes from several sources. The core part of the dataset employed in the calculation of dimensions of trade composition consists of series on gross exports of goods that come from the United Nations Commodity Trade Statistics (COMTRADE) database at annual frequency over the period 1962–2013. Data on economic complexity comes from the Observatory of Economic Complexity (atlas.media.mit.edu). The analysis makes use of two data series: the product complexity index (PCI) and the country-level economic complexity index (ECI).

The analysis of trade composition follows two product classifications. First, it uses the skill- and technology-intensity product classification from UNCTAD for most of our analysis (Box 1). Besides distinguishing between technology-intensive and other products, it also allows differentiation within technology-intensive products according to the level of technology required for their production. When looking at export product diversification (concentration), the analysis classifies products on the basis of their economic function and processing stage according to the main sections of the SITC classification (Box 2).

Box 1. Skill- and Technology-Intensity Product Classification from UNCTAD

This classification distinguished products according to their level of skill- and technology-intensity. It has been developed by Basu and Das (2011) and Basu (forthcoming) on the basis of UNCTAD (1996, 2002) and Lall (2000). According to this classification, the products are organized into the following seven categories:

- High skill- and technology-intensive manufactures
- Medium skill- and technology-intensive manufactures
- Low skill- and technology-intensive manufactures
- Resource-intensive manufactures
- Non-fuel primary commodities
- Mineral fuels
- Unclassified products

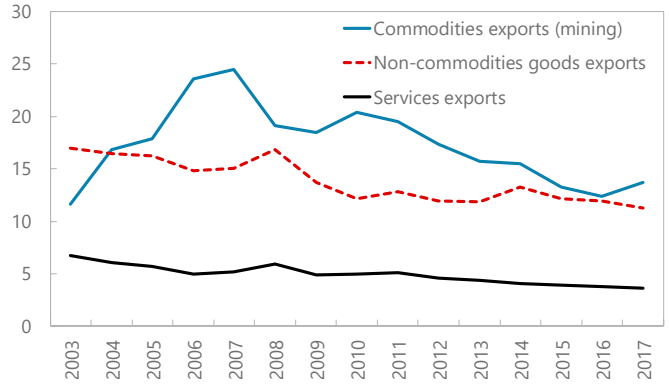
Box 2. Standard International Trade Classification (SITC)

Developed by the United Nations with the purpose to classify trade products not only on the basis of their material/physical properties, but also according to their economic function and the processing stage, the SITC into the following ten broad sections:

- Food and live animals
- Beverages and tobacco
- Crude materials, inedible, except fuels
- Mineral fuels, lubricants and related materials
- Animal and vegetable oils, fats, and waxes
- Chemicals and related products
- Manufactured goods (classified by material)
- Machinery and transport equipment
- Miscellaneous manufactured articles
- Commodities not classified elsewhere

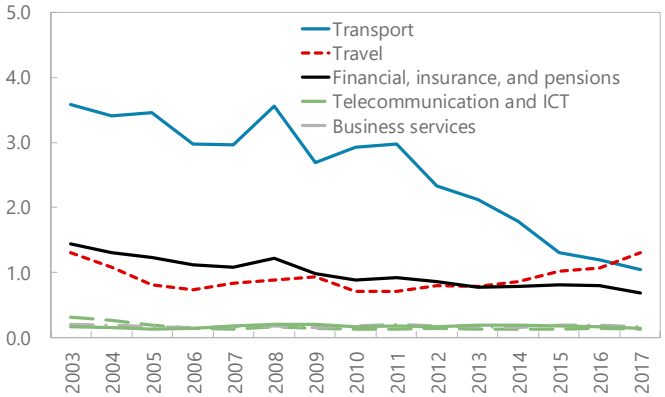
Annex II. Trends in Services Exports

Composition of exports
(In percent of GDP)



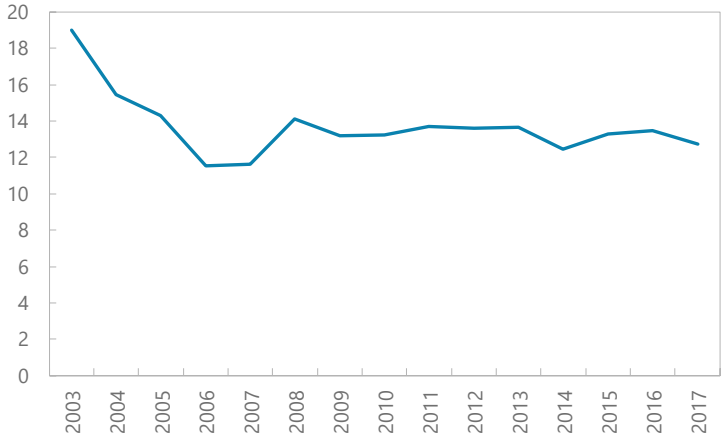
Source: Central Bank of Chile and IMF staff calculations.
Note: Non-commodities include agriculture, forestry, fishing, and all industry.

Composition of services exports
(In percent of GDP)



Source: Central Bank of Chile and IMF staff calculations.

Services exports
(Share of total exports)



Source: Central Bank of Chile and IMF staff calculations.

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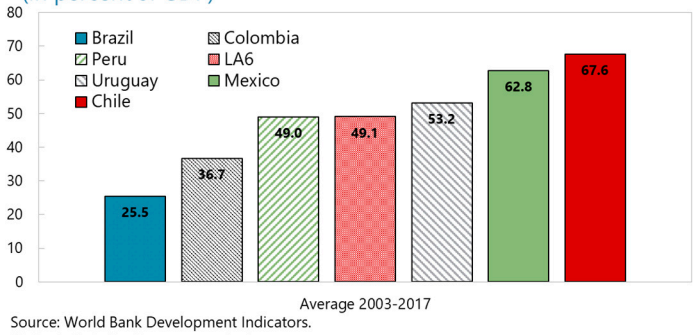
THE MACROECONOMIC EFFECTS OF EXTERNAL AND DOMESTIC SHOCKS IN CHILE[1]

This paper investigates the importance of external and domestic shocks in Chile's highly open economy. Using a Bayesian Vector Autoregression (BVAR) and a two-step multivariate regression, the analysis suggests that both external and domestic factors have been playing an important role, though the relative contribution varied across periods.

A. Introduction

1. For a small and very open economy such as Chile, external shocks tend to have a substantial impact. It is, thus, interesting to ask how much of the business cycle fluctuations in economic activity (e.g., as measured by GDP growth) can be attributed to factors external to the Chilean economy *vis-à-vis* domestic factors. While this distinction is not always econometrically straightforward, this paper attempts such a decomposition for GDP fluctuations observed over the last two decades.

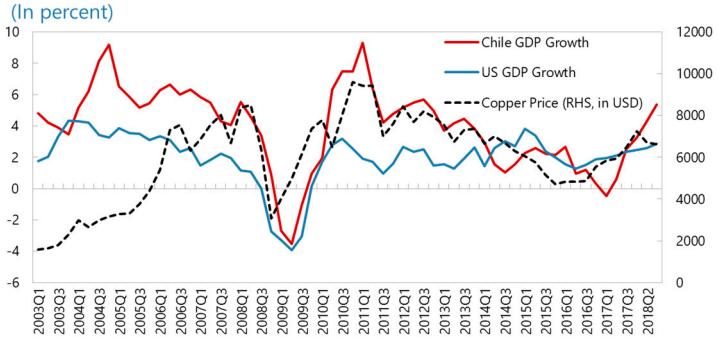
Trade Openness 1/
(In percent of GDP)



Source: World Bank Development Indicators.
1/: Trade is defined as exports plus imports.

2. Over the past decade, the Chilean economy experienced large swings in growth. After growing at a fast pace, Chile's GDP growth has averaged a mere 1.3 percent between 2014Q1 and 2017Q2. This is a very subdued rate—especially in the absence of any outright economic recession or a financial crisis—well below Chile's historical average growth of about 4½ percent since 1990 and below the growth of most of its main trading partners including the U.S. However, this period of low growth was associated with low copper prices and at the same time a spike in domestic policy

GDP Growth and Copper Price
(In percent)



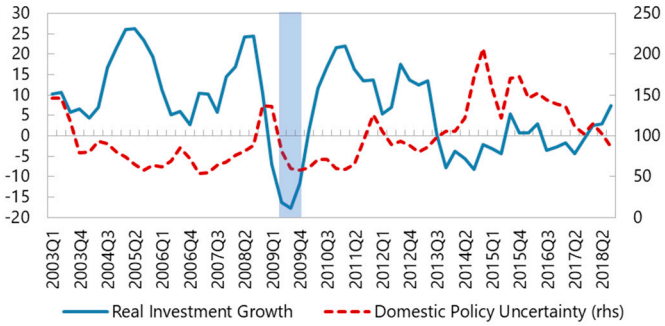
Sources: IMF 2018 WEO and Bloomberg.

[1] Prepared by Andrea Pescatori and Martin Sasson.

uncertainty (both of these factors are likely to have contributed to the fall in business confidence and investment). The subsequent analysis, will try to shed lights on these casual observations.

3. In light of the extensive openness of the Chilean economy, several external factors tend to play a significant role. The degree of Chile's economic openess (i.e., export plus imports as share of GDP) is about 68 percent on average over the 2003–17 period, which is among the highest in the region. Almost 55 percent of Chile's export value, however, comes from commodities and about 45 percent is related to copper.[2] Shocks to U.S. GDP and interest rates also have a prominent impact on Chile's economic activity, both via trade channels and financial channels. Indeed, the U.S. is Chile's second largest export market, while Chile's financial market and banking systems are well integrated in the global financial markets. At the same time, the exchange rate is free to float since the end of the 90s and thus responding to international factors (although with one of the lowest pass-through effects of the region (IMF, 2016)). The Chilean economy is, thus, substantially exposed to fluctuations in the global demand for commodities, especially copper. Since about 50 percent of metal demand (including copper) comes from China, the Chilean economy is, directly and indirectly, exposed to fluctuations in the Chinese economic activity (especially its utility and construction sectors which are the main consumers of copper).[3]

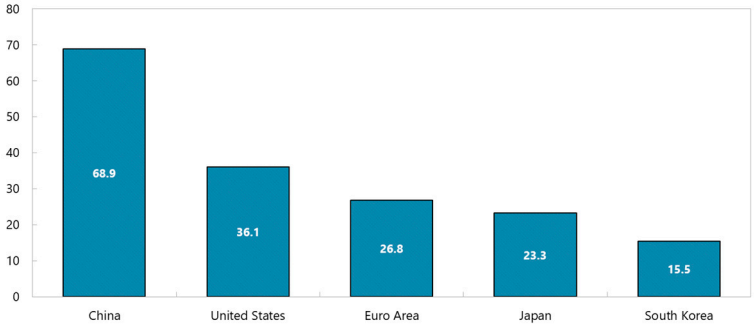
Investment and Policy Uncertainty



Source: Central Bank of Chile.

4. The most noticeable external development over the last 10 years is the behavior of the terms of trade—mostly driven by copper prices. The terms of trade, driven by copper prices, rebounded strongly after the 2008-2009 global financial crisis and peaked in 2011. The terms of trade declined rapidly

Top 5 Export Markets for Chile, 2017
(In percent of GDP)



Source: IMF Direction of Trade Database.

[2] Commodities are defined as the sum of mining, agriculture and silviculture, and fishing. Their 2017 shares of exports are 54.9 and 43.9, respectively, not dissimilar to their 2003-2017 average. The value of copper exports as share of GDP peaked at 25 percent in 2007.

[3] The domestic power sector is the largest copper consumer in China, due to investment in power network upgrades and rural power network renovation. The residential construction sector is also a key driver of copper demand. The relevance of China, however, has clearly increased over time. In the empirical analysis we, thus, weight China GDP growth by its share of world trade (see Figure 3).

afterwards, reflecting the fall in the price of copper that started in 2011 and reached a trough in 2016 (offset in part by the oil price collapse in 2014–16). Also, trading partner growth disappointed as the Euro crisis unfolded with GDP in the Euro Area (the third largest Chile's trading partner) declining each quarter between 2011Q4 and 2013Q1.

5. Domestic factors are usually related in these analyses to the behavior of fiscal and monetary policy but also, in the case of Chile, to domestic policy uncertainty. A proxy for domestic policy uncertainty is used to capture the role of uncertainty associated with the policy discussions and the political and electoral environment, among other things, which tend to affect consumer and business sentiment.

B. Methodology

6. We employ two techniques, a BVAR and a two-step multivariate regression, to disentangle the role of domestic and external factors. The economic literature has often relied on dynamic stochastic general equilibrium models (DSGE) to provide a shock decomposition of GDP or other observable variables (Smets and Wouters, 2007; and Adolfson and others 2007; among many). The use of a DSGE model, however, is more demanding since it introduces a substantial amount of cross-equation restrictions and, thus, requires to put considerable faith in the ability of the chosen economic model to replicate the actual data-generating process. Hence, in this case, a more flexible approach is preferred, and we employ a BVAR and a two-step multivariate regression approach. In both cases, we use a set of variables to proxy external forces and another set to control for domestic shocks.

7. Both approaches exploit the fact that Chile is a small economy that does not affect global variables. The BVAR exploits the presence of a block with external variables and of a tight prior which indicates that fluctuations in external variables are *a priori* expected to be only very modestly affected by developments of Chilean domestic variables. Similarly, shocks affecting the external block are allowed to affect Chile's set of domestic variables, but not vice versa. The BVAR, thus, exploits a partial identification strategy where the goal is simply to disentangle external and domestic shocks without being more specific on the contribution of each type of external or domestic shock.[4] Overall, the benefit of the BVAR approach is a reasonably good identification of the relative role of external versus domestic factors (it also better captures the dynamics imbedded in the data). The multivariate regression approach uses a two-step procedure where in the first step domestic variables are orthogonalized by regressing them on external variables. This method has the advantage of simplicity, and indeed it lends itself to a more refined assessment of the contribution of each variable. However, it is less effective at a clean identification of external versus domestic factors (especially the latter), and presents a residual which cannot be intepreted as external or domestic: notably it relies on the reasonable assumption that external shocks are not affected by domestic variables, while domestic variables will attempt to explain the remaining

[4] The BVAR, for example, does not attempt to distinguish between domestic supply and demand shocks. Partial identification strategies have a long-standing tradition in the VAR literature, one of the first examples is in Christiano and others (1999).

volatlity (i.e. after controlling for external shocks). Note also, that the contribution of each variable may mask correlation across variables, for example the role of copper may be in part captured by the China growth variable.

8. Both approaches are based on the same data sample. The analises are perfomed using quarterly data from 1999 to 2017. The external block includes global variables relevant for Chile as discussed above—i.e., U.S. and China real GDP (the latter interacted with its share of world trade to account for its growing role), real copper prices, the U.S. 10-year yield, we include also Chile's real mining output, which is considered mostly exogenous to domestic developments. A beta-convergence factor (i.e., the GDP per-capita difference between Chile and the U.S.) has been introduced in both exercises as a exogenous process as suggested by the growth literature (Sala-i-Martin, 1996). The block of domestic variables, instead, includes real GDP (the variable of interest), real investment, the 3-month interest rate on BoC's notes, the Peso-USD real exchange rate, and domestic policy uncertainty in Chile.[5,6] The fiscal balance to GDP is also introduced in the multivariate regression; to limit the number of parameters to estimate, it is not included in the BVAR, but a robustness exercise shows that results would be similar when including it. The choice of domestic variables strikes a balance between parsimony and the need to capture developments in the aggregate domestic demand including the ones induced by movements in the Peso and interest rates.

C. Findings

9. Both external and domestic factors have played an important role in the post crisis period and recent slowdown but with different timing. Figure 1 and the text chart show the results of the BVAR approach in terms of historical contributions of GDP growth into external and domestic factors, as well as the convergence factor (capturing the secular trend). The sum of all contributions, by construction, equals the observed GDP growth in the BVAR approach.[7] Results point to a strong negative contribution to GDP growth of external factors especially during the global crisis and since the end of 2015. In particular, they were a drag on growth from mid-2015 to mid-2017 owing to lower trading partner growth in 2015 and the decline in copper prices in 2016. The 2017Q1 is attributed to the sizeable drop in mining output (due to the mining strike) which is classified as exogenous in the analysis. Since mid-2017, external factors have been strongly

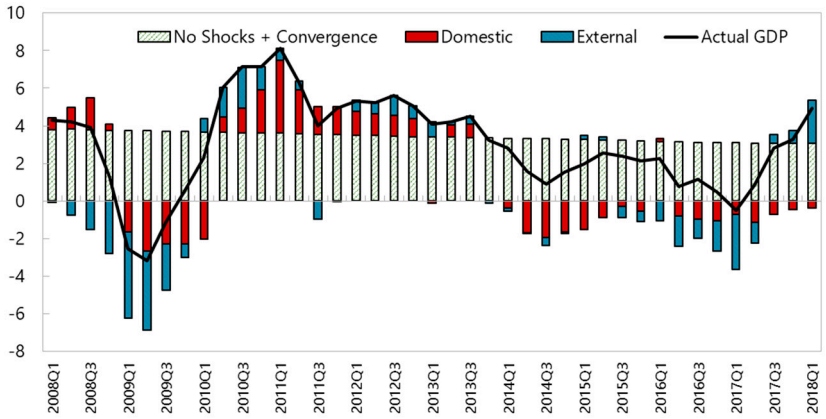
[5] All variables are in log-differences but for the 3-month interest rate, domestic policy uncertainty, the fiscal balance-to-GDP, and credit-to-GDP which are introduced untransformed in levels, while the real effective exchange rate is in logs. For robustness, in the BVAR, we have also introduced the fiscal balance over GDP (in levels), replaced domestic policy uncertainty with credit-to-GDP (in levels), replaced U.S. GDP with G7 GDP (in PPP US$), and the copper price with the World Bank's commodity price index. Results are qualitatively unchanged and quantitatively very similar.

[6] Chile's data are from Banco Central de Chile, copper price data are from Bloomberg and divided by U.S. CPI, China and U.S. data are from HAVER. The domestic policy uncertainty index comes from the Economic Policy Uncertainty website: http://www.policyuncertainty.com/chile_monthly.html.

[7] Given the large volatility of q/q growth rates, results are presented as a 4-quarter moving average of the q/q growth rates employed in the BVAR. This also eases the comparability with the other methodology that adopts y/y growth rates.

contributing to the growth recovery, owing also to a rebound in copper price. Domestic factors also contributed both to the contraction during the global crisis and the subsequent recovery. They negatively affected growth afterwards, particularly in 2014, and more mildly since 2016, partly reflecting policy uncertainty. Finally, the convergence factor and internal BVAR cyclical dynamics contribute by about half a percentage point to the reduction in potential growth from the pre-crisis period to 2018Q1 (the most recent data point in the sample).

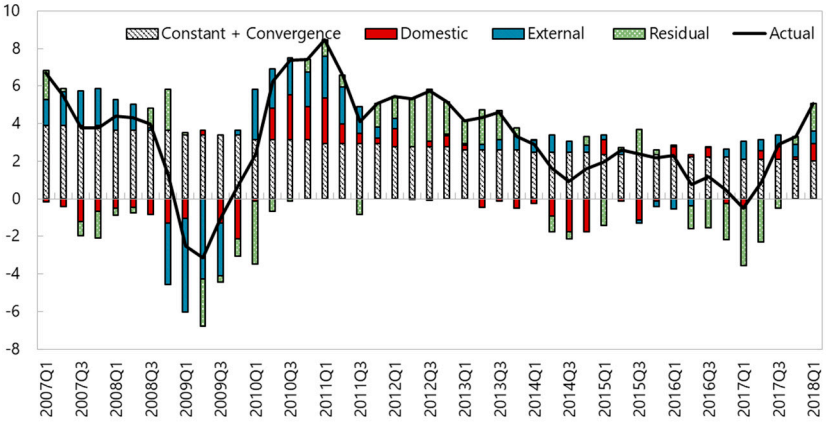
BVAR: Contributions to Growth
(In percent, four quarter moving average)



Source: National sources, 2018 IMF WEO, Bloomberg, and IMF staff calculations.

10. To some extent, the results from the multivariate approach are consistent with the BVAR findings. However, the presence of the residual makes them more difficult to interpret, as it cannot be easily ascribed to an external versus a domestic component (Figure 2 and text chart). The importance of both external and domestic shocks during the global crisis is confirmed. Also, domestic shocks were a drag on growth in 2014, while external shocks were a positive contributor since 2017. However, the model is unable to explain most of the 2016–17 growth decline, as visible from the important contribution of the residual (which captures unidentified factors).

Multivariate: Contributions to Growth
(In percent)



Source: National sources, 2018 IMF WEO, Bloomberg, and IMF staff calculations.

D. Concluding Remarks

11. Both external and domestic factors play an important role in driving business cycle fluctuations in Chile as well as low frequency trends. The two methodologies tend to offer a similar picture for some key patterns. Both external and domestic factors were strognly relevant in explaining growth during and after the global crisis. When looking at the more recent period, we see domestic factors as a drag on growth particularly in 2014, and external factor as helping the recent rebound since 2017. It is also worth noting that income convergence with advanced economies has been playing a persistent role in lowering growth towards advanced economy averages as Chile increases its physical and human capital and approaches to the technological frontier.

Appendix I. Technical Appendix

A. The Bayesian VAR

1. We assume the following specification for the Bayesian VAR model:

$$\Pi(L)y_t = \Phi d_t + e_t$$

Where y_t is a p-dimensional vector of time series at time t, d_t is a q-dimensional vector of deterministic trends or other exogenous variables. $\Pi(L) = I_p - \Pi_1 L^1 - \cdots - \Pi_k L^k$ is the matrix of coefficients to be estimated where L is the back-shift operator such that $L^k y_t = y_{t-k}$. We assume that y_t is a stationary process and $e_t \backsim N(0, \Sigma)$ with independence between time periods. Let's also assume that the vector y_t can be understood as combination of two vectors of size n_1 and n_2 such that $y_t = (y_{1t}; y_{2t})$.

2. Bayesian inference requires a prior distribution on $\Sigma, \Pi_1, \ldots, \Pi_k$ and Φ. The prior on Σ is

$$\mathrm{p}(\Sigma) \propto |\Sigma|^{-\frac{p+1}{2}}.$$

Let $\Pi = (\Pi_1, \ldots, \Pi_k)'$, the prior for $vec(\Pi)$ is

$$\mathrm{vec}(\Pi) \backsim N(\theta_\pi, \Omega_\pi)$$

similarly for Φ .

3. In the analysis we have defined y_{1t} as the external block which includes the following variables: the U.S. and China GDP (log-diff), copper prices (logs), the U.S. 10-year yield, and Chilean mining output (log-diff). The domestic block, instead, includes domestic Chilean variables such as investment (log-diff), the 3-month interest rate, the exchange rate (logs), and credit-to-GDP (logs). Defining $\Pi = [\Pi_{11}, \Pi_{12}; \Pi_{21}, \Pi_{22}]$ and, consistently, $\theta_\pi = [\theta_{\pi 11}, \theta_{\pi 12}; \theta_{\pi 21}, \theta_{\pi 22}]$, and similarly for Σ, we have assumed that $\theta_{\pi 12}$ and Σ_{12} have their elements equal to 0.001. This guarantees a high exogeneity tightness for the external block of variables. The rest of the parameters follow the Minnesota prior (Litterman 1986).

4. Finally, the BVAR matrix of structural shocks is computed assuming a Cholesky decomposition where the external block is ordered first. A historical decomposition is then performed. A historical decomposition answers the following question: what would the data have looked like if a subset of the shocks had been zero throughout the estimation period? We, thus, shut down all domestic (external) shocks (and remove the exogenous converge term), to compute the contributions of external (domestic) shocks. We start the decomposition in 2008 since the early part of the sample is usually affected by the choice of the initial conditions.[1]

[1] As standard in the literature (see Kilian 2007, for example), we assume the first point to be the VAR steady state.

B. The Two-Step Multivariate Approach

5. The methodology builds on Yeyati and Williams (2012) and its further improvements in de la Torre and others (2013) and subsequent editions of the Semiannual report of the World Bank's Office of the Chief Economist for Latin America and the Caribbean. The domestic variables are orthogonalized by regressing them on lagged external factors and taking the residual.

$$CHL_t = c + \beta * CHN\ INT_t + \gamma * G7_t + \gamma * US10yr_t + \lambda * TRCRB_t + \delta * MPR_{t-4} + \theta * FBAL_{t-4} + \kappa * DPU_t + \pi * CONV_t + \varepsilon_t \qquad (2)$$

where CHL_t is Chile's YoY real GDP growth rate, $CHN\ INT_t$ is China's YoY real GDP growth rate interacted with its share of world trade, $G7_t$ is the G7's YoY real GDP growth rate, $US10yr_t$ is the 10-year U.S. Treasury yield, $TRCRB_t$ is the YoY growth rate of the Thomson Reuters CRB commodity index, and ε_t is the error term. The orthogonalized variables are: the lagged residual from the monetary policy rate regression (MPR_{t-4}), the lagged residual from the central government's fiscal balance regression ($FBAL_{t-4}$), the residual from the domestic policy uncertainty index regression(DPU_t). Finally, $CONV_t$ is the convergence term. The text table shows the regression coefficients.

VARIABLES	(1)
G7	0.454**
	(0.202)
CHN INT	4.424***
	(1.300)
US10yr	-0.0484
	(0.431)
TRCRB	0.0296*
	(0.0157)
CONV	0.0558
	(0.0347)
L(4)FBAL	-0.206*
	(0.123)
L(4)MPR	-0.194
	(0.212)
DPU	-0.000187***
	(5.88e-05)
CHN	
Constant	-0.0852*
	(0.0490)
Observations	85
R-squared	0.516

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

C. Figures

Figure 1. Bayesian VAR. Chile's GDP Growth Decomposition

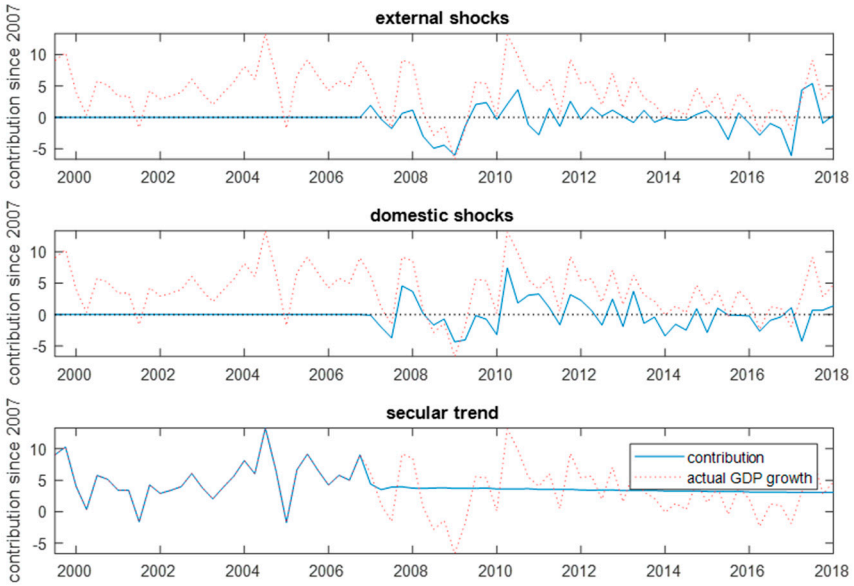
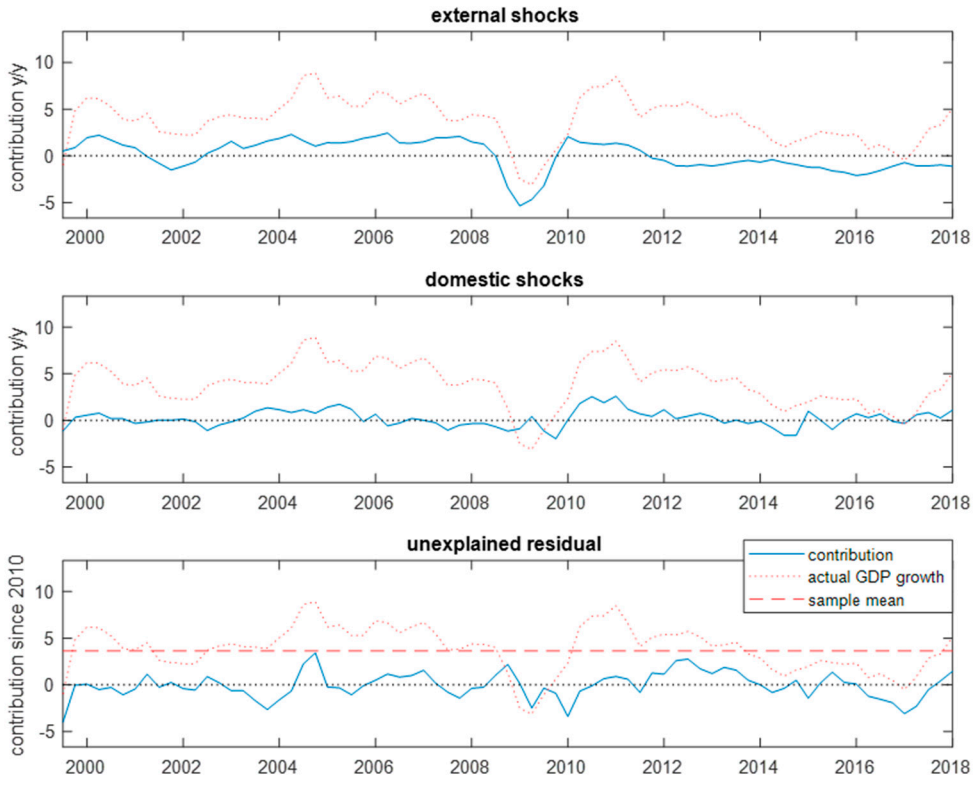
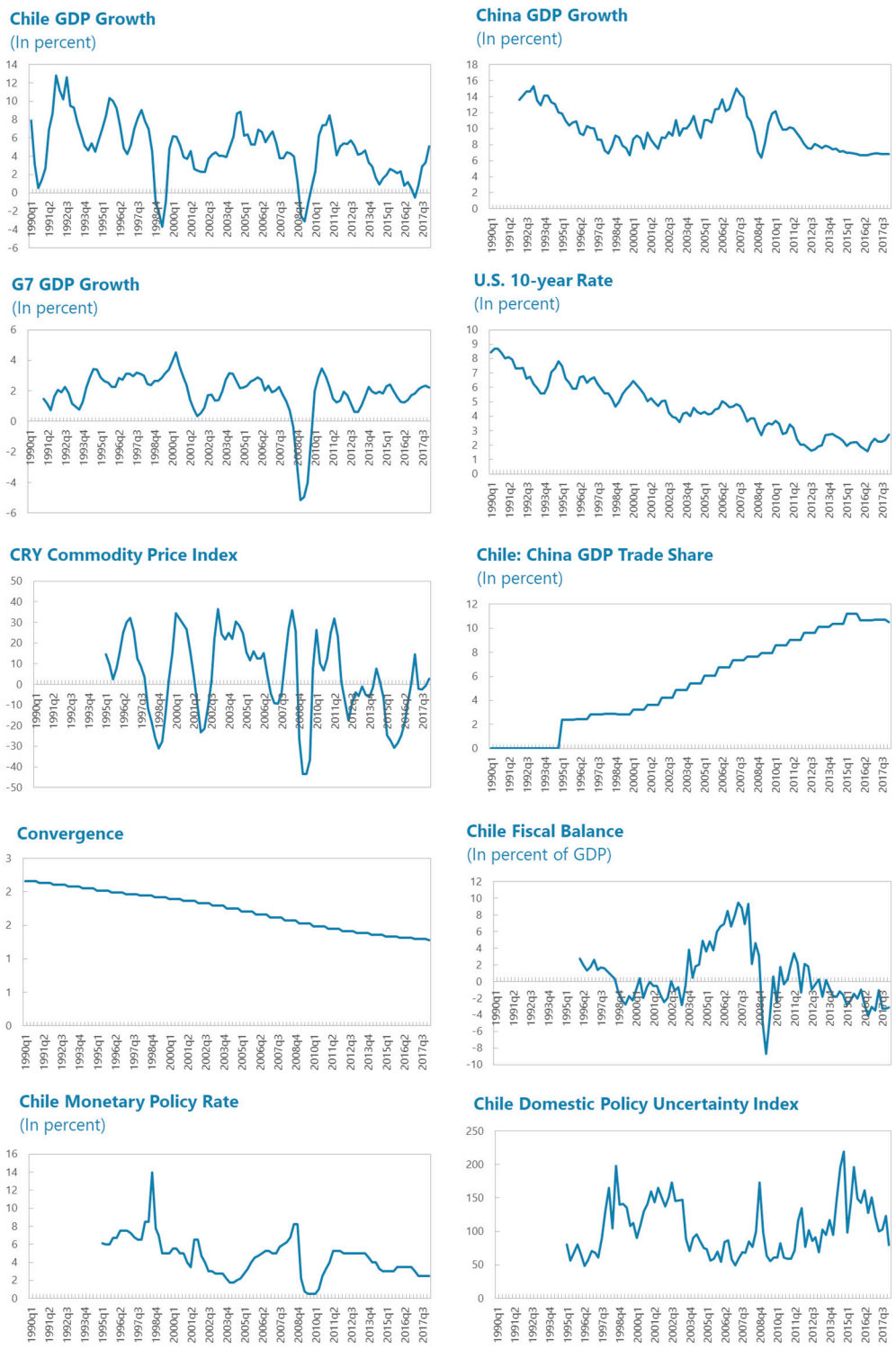


Figure 2. Two-Step Multivariate Regression. Chile's GDP Growth Decomposition



The BVAR includes an external block with global variables and Chile's mining output while the domestic block includes Chile's domestic variables (see text and Appendix).

Figure 3. Regression Variables



Sources: Haver, Bloomberg, 2018 WEO and IMF staff calculations.

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