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CHILE

Selected Issues

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Approved by the Western Hemisphere Department

July 8, 2009

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I. The Global Financial Turmoil and Its Impact on Chilean Banks[1]

1. **This chapter assesses the impact of the global financial crisis on Chilean banks and provides a framework for analyzing government measures aimed at reducing systemic risk**. Chile, as other open emerging market economies with highly integrated financial systems and capital markets, has been affected by the global financial crisis. The crisis raised concerns about spillovers risks from foreign banks to domestic banks and within the domestic banking system. Corisk analysis, which focuses on conditional measures of default risk, is used to assess the extent of the spillovers and provide a background framework to assess measures implemented to reduce systemic risk. The corisk analysis also provides evidence that could help strengthen the work on vulnerability indicators and off-site supervision.

A. The Potential Exposure to Foreign Banks

2. **In Latin America, Chile is the most interconnected country to the global banking system**. BIS banking data shows that foreign bank claims on Chile amount to 46 percent of GDP, higher than in other Latin American countries (Brazil 17 percent; Colombia 11 percent), reflecting the openness of the country's financial system. Spanish banks held most of the claims due to the dominant presence of BBVA and Banco Santander in the Chilean banking system (Table 1). Between them, the two institutions account for 33 percent of the assets in the banking system, 24 percent of the non-derivatives financial instruments and 40 percent of the notional outstanding amount of gross derivatives positions.

Table 1. Foreign Banks' Consolidated Claims on Chile by Nationality 1/

	2002	2007	2008
Spain	48.0	56.2	52.0
United States	17.4	10.7	6.8
Germany	9.6	6.2	7.8
Netherlands	4.2	5.2	6.1
United Kingdom	3.8	0.0	0.0
Other	17.1	12.1	27.3
Total	100.0	100.0	100.0

Source: BIS and staff calculations.
1/ On an immediate borrower basis.

3. **Data on cross-country consolidated claims can be complemented with market-based risk measures to capture both direct and indirect exposures**. Cross-border claims cannot identify risks associated with "second round effects." Even in the absence of cross-border claims, for instance, Chile may be exposed to shocks originating in the U.K. due to the high exposure of Spanish banks to the U.K. economy. In contrast, market-based risk measures, such as

Table 2. EDFs and Equivalent Moody's Credit Ratings

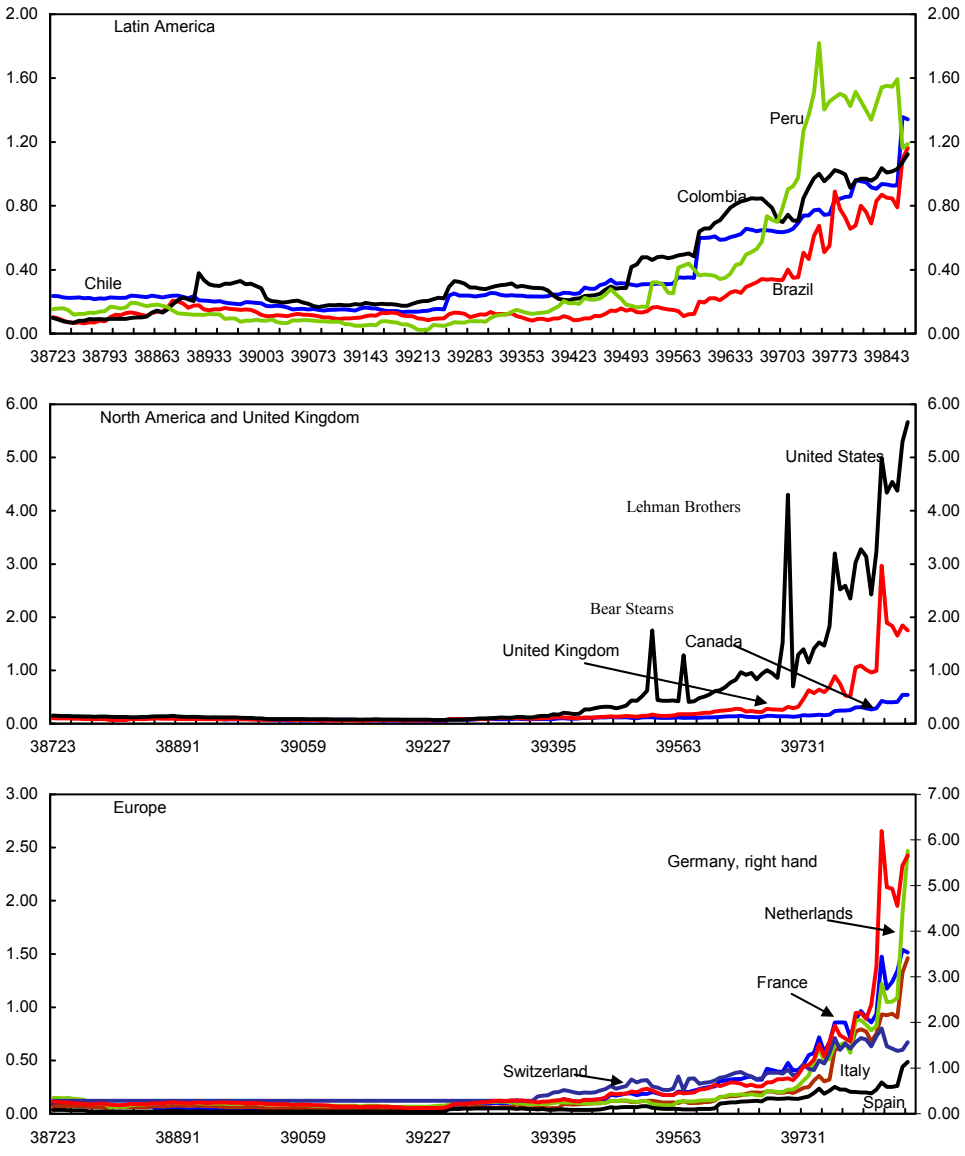
Moody's rating	EDF	Moody's rating	EDF
Aaa	0.02	Ba1	0.408
Aa1	0.032	Ba2	0.544
Aa2	0.04	Ba3	0.848
Aa3	0.056	B1	1.323
A1	0.08	B2	2.064
A2	0.114	B3	4.168
A3	0.144	Caa1	8.418
Baa1	0.182	Caa2	17
Baa2	0.23	Caa3	17.946
Baa3	0.307	Ca, C	20

The table shows the equivalence between 5-year EDFs, in percent, and Moody's credit ratings scale.

[1] This chapter was prepared by Jorge A. Chan-Lau (Ext. 34271).

Moody's KMV expected default frequencies (EDFs), should reflect the risk arising from both direct and indirect exposures and can be mapped into credit ratings (Table 2). Figure 1 illustrates the evolution of the average EDFs for Chilean and foreign banks.[2]

Figure 1. 5-year EDFs
(In percent)



Source: Moody's KMV and staff calculations.

[2] EDFs are based on the distance-to-default measure, which is a measure of the equity value of a firm normalized by the asset volatility (Crosbie and Bohn, 2003). Distance-to-default measures tend to forecast the failure of financial institutions with some success (Gropp and others, 2004, and Chan-Lau and others, 2004).

B. The Impact of the Global Crisis on Chilean Banks

4. **Corisk analysis is used to assess the impact of the global crisis on Chilean banks.** Figure 1 shows EDFs tend to move together especially during the crisis period. Corisk analysis measures risk codependence, defined as the increase in the risk of one institution conditional on the risk of a peer institution. Corisk analysis is performed for a sample of Chilean and foreign banks using weekly EDF data for the period May 2, 2003–February 27, 2009. The Chilean banks included in the analysis are those for which Moody's KMV reports EDFs. These banks are: BBVA, Banco de Chile, Banco de Crédito e Inversiones, Banco Santander, Corpbanca, and ScotiaBank. Detailed results are reported in the Annex tables.

5. **Banks in Chile have been mainly affected by aggregate risk in the global financial system and to a lesser extent by idiosyncratic shocks affecting regional and international banks.** The impact of changes in aggregate risk can be roughly approximated by the difference between the median EDF and the unconditional EDF measured at the 95th percentile (Annex Table 1). For Chilean banks, the unconditional EDF is two to three times higher than the median EDF. The impact of idiosyncratic shocks can be gauged from the difference between the conditional EDF, or corisk EDF and the unconditional EDF. The median corisk EDF exceeds the unconditional 95th percentile EDF by 15 to 100 percent, depending on the institution analyzed.

6. **When measured in terms of rating changes, idiosyncratic shocks to foreign banks induced at most a one rating downgrade on Chilean institutions after controlling for the aggregate shock.** Annex Table 2 shows the Moody's 5-year credit ratings implied by the corisk and unconditional EDFs according to the mapping reported in Table 2.[3] Compared to the median rating, the unconditional 95th percentile EDF implies a downgrade of three to four notches, which can be attributed to the aggregate shock. In contrast, idiosyncratic shocks to foreign institutions induce, on average, at most one conditional rating downgrade on Chilean institutions from the rating implied by its unconditional 95th percentile EDF.

7. **Higher corisk EDFs are associated with highly levered banks and those with high external debt ratios**. This is the case for some domestic'owned banks. Among foreign-owned banks, the percent difference between the corisk EDF and the unconditional EDF risks also appear to reflect the strength of the parent institution.

8. **Even in the absence of cross-border claims, there are second-round effects that affect the Chilean banking system.** For instance, since 2003 there have been no cross-border claims between Chile and the United Kingdom. Shocks affecting British banks, however, cause a one rating conditional downgrade in Chilean banks. This is also true, to a

[3] The shift in ratings are those implied by the changes in the EDFs (or probabilities of default). Therefore, the analysis does not refer to actual upgrades or downgrades by credit rating agencies.

Box 1. Corisk Analysis Using Quantile Regressions

Corisk, or risk codependence, can be defined as the increase in the risk of one institution conditional on the risk of a peer institution. Following the insights of Adrian and Brunnermeier (2008), the analyisis in this chapter uses the corisk analysis, a method based on quantile regressions (Chan-Lau, 2008).

Quantile regression makes possible to evaluate the response of the independent variable on particular segments of the conditional distribution and captures some of the nonlinearities associated with risk spillovers, e.g. the response may differ across different quantiles of the conditional distribution. Specifically, in a quantile regression the parameters are obtained from the minimization of the sum of residuals, $y - x\beta$, where the latter are weighted by a check function ρ_τ, that depends on the quantile of interest, τ:

$$\min_{\beta} \sum_{i}^{N} \rho_\tau (y_i - \xi(x_i, \beta)), \tag{1}$$

where y is the dependent variable, $\xi(x_i, \beta)$ is a linear function of the parameters β and the exogenous variables, x_i, and $\rho_\tau(.)$ is a weighting function for each observation (Koenker and Bassett, 1978). For analyzing corisk between Chilean and global banks, the following equation was estimated for τ set equal to the 95th quantile:

$$EDF_i = \alpha_\tau + \sum_{k}^{K} \beta_{\tau,i,k} R_k + \beta_{\tau,j} Clean\ EDF_j + \varepsilon_i \tag{2}$$

where EDF_i is the EDF of institution i, R_k denotes the k-th common aggregate risk factor, and $Clean\ EDF_j$ is the component of EDF_j that is orthogonal to the common aggregate risk factors R_k's. By using the orthogonal component, equation (2) isolates the idiosyncratic effect of institution j on institution i. The fitted values using equation (2) will be referred to as corisk EDF. Rather than relying on economic theory, the aggregate risk factor in this study was set equal to the first principal component corresponding to the EDFs of all institutions in the sample excluding the Chilean institutions.

lesser extent, in the case of Canadian banks. Put together, these results suggest how information on direct exposures, such as consolidated claims, and market-based information, such as EDFs, complement each other and are useful for assessing risks in the financial sector.

9. **The resilience of Chilean banks to institution-specific shocks is partly explained by limited reliance on external financing sources and low exposure to market and counterparty risk.** The domestic banking system is mainly funded through domestic deposits (60 percent of assets) and domestic securities issuance (13 percent of assets) while external funding accounting for only minor share (5 percent of assets). Market risk is limited

due to the small size of the trading book (4 to 5½ percent of assets), the amount of securities available for sale (7 to 8 percent of assets) and the derivatives net open position (less than 1½ percent of assets). Finally, counterparty risk within the domestic system appears limited. counterparty exposure can be roughly estimated as the sum of the trading exposure (4 to 5½ percent of assets), interbank lending (less than ½ percent of assets), and derivatives net open positions (1½ percent of assets). The reduced counterparty exposure translates into limited corisk exposure within Chilean banks, with banks experiencing at most a one ratings downgrade conditional on other banks' increase in default risk (Annex Table 3).

C. Conclusions

10. **Due to the interconnectedness of the domestic banking system, it would be important to continue advancing the agenda on cross-border supervision and crisis management.** The analysis suggests that the Chilean banks are resilient to global and regional shocks. However, even in the absence of direct exposures with other countries in the region, there may be risk spillovers from other banks in the region and in advanced economies. Continued cross-border supervision (such as through regular contacts with foreign supervisors) and crisis management coordination with other bank supervisory agencies in the region and advanced economies is key to preserve the stability of the Chilean financial system.

11. **Although a formal analysis was not conducted, measures enacted by the authorities may have contributed to offset the surge in risk in the banking system.** These measures included the flexibilization of reserve requirements, swap lines, as well as government auctions of foreign currency denominated deposits for domestic banks. Indeed, as Figure 1 shows, the implementation of the measures kept the average EDF in Chile mostly flat during most of the second half of 2008, contrary to what was observed in other countries in Latin America.

12. **While the analysis would provide some support to the recommendation by the Financial Advisory Committee to make domestic banks eligible for SWF deposits, some caveats remain.** Chilean institutions appear less vulnerable to risk spillovers than foreign banks but the empirical analysis can only offer so much support especially since it did not consider a number of relevant factors and alternatives. For instance, deposits with domestic banks may contribute to "Dutch disease" problems. From a risk perspective, the recommendation should also be balanced against the alternative to invest the SWF assets or deposits in other riskless assets, such as government bonds and bills despite their lower returns. Finally, it is necessary to ensure that the domestic subsidiaries are effectively ring-fenced from weaker parent institutions to prevent the latter from draining resources from their subsidiaries.

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ANNEX I. CORISK ANALYSIS RESULTS

Table 1. Corisk Between Financial Institutions Abroad and Those Operating in Chile, Measured as Expected Default Frequency (EDF)

(In percent)

	Bank A	Bank B	Bank C	Bank D	Bank E	Bank F
Median EDF	0.71	0.12	0.08	0.20	0.12	0.32
95th percentile EDF	2.68	0.24	0.24	0.50	0.23	0.76
Latin American institutions						
Banco Bradesco, Brazil	5.94	0.27	0.31	0.71	0.30	0.91
Banco Itau, Brazil	5.75	0.27	0.30	0.68	0.31	0.88
Banco BBVA Colombia	3.02	0.26	0.23	0.60	0.36	0.86
Banco de Bogotá, Colombia	5.87	0.32	0.30	0.70	0.33	0.83
Banco de Occidente, Colombia	3.51	0.30	0.27	0.59	0.39	0.85
Banco Santander, Colombia	3.84	0.31	0.27	0.55	0.46	0.73
BanColombia, Colombia	5.07	0.27	0.24	0.67	0.36	0.83
Corporacion Financiera, Colombia	5.86	0.27	0.32	0.67	0.35	0.92
Grupo Aval, Colombia	5.52	0.34	0.34	0.70	0.41	0.85
Banco Continental, Perú	5.29	0.32	0.31	0.68	0.31	0.89
Banco de Credito, Perú	5.30	0.31	0.25	0.68	0.37	0.90
ScotiaBank Peru	5.98	0.37	0.31	0.72	0.20	0.69
Minimum	3.02	0.26	0.23	0.55	0.20	0.69
Median	5.41	0.31	0.30	0.68	0.36	0.85
Maximum	5.98	0.37	0.34	0.72	0.46	0.92
U.S. Institutions						
Bank of America	2.89	0.43	0.31	0.73	0.58	0.62
Morgan Stanley	4.02	0.31	0.31	0.68	0.33	0.90
Goldman Sachs	5.52	0.32	0.29	0.66	0.37	0.91
Citigroup	6.50	0.44	0.46	0.94	0.56	0.87
Wells Fargo	3.70	0.32	0.25	0.54	0.35	0.79
Bear Steanrs	5.42	0.26	0.24	0.68	0.37	0.80
Lehman Brothers	6.14	0.43	0.42	0.76	0.45	1.01
Merrill Lynch	6.25	0.37	0.39	0.79	0.51	0.92
Wachovia	4.52	0.25	0.17	0.65	0.38	0.85
JP Morgan	5.44	0.32	0.34	0.69	0.35	0.88
Minimum	2.89	0.25	0.17	0.54	0.33	0.62
Median	5.43	0.32	0.31	0.69	0.38	0.88
Maximum	6.50	0.44	0.46	0.94	0.58	1.01
Canadian institutions						
Bank of Nova Scotia	3.44	0.34	0.29	0.54	0.31	0.80
CIB	3.33	0.40	0.35	0.55	0.37	0.84
Royal Bank of Canada	5.58	0.26	0.24	0.68	0.38	0.78
Minimum	3.33	0.26	0.24	0.54	0.31	0.78
Median	3.44	0.34	0.29	0.55	0.37	0.80
Maximum	5.58	0.40	0.35	0.68	0.38	0.84
European institutions						
BBVA Spain	4.44	0.28	0.20	0.52	0.39	0.88
Banco Santander, Spain	4.25	0.29	0.28	0.56	0.37	0.92
Banque Nationale Paribas, France	3.82	0.33	0.29	0.59	0.30	0.89
Credit Agricole, France	5.73	0.28	0.33	0.69	0.39	0.89
Societe Generale, France	5.55	0.27	0.30	0.70	0.33	0.89
Commerzbank, Germany	6.08	0.27	0.33	0.72	0.30	0.91
Deutsche Bank, Germany	5.96	0.32	0.31	0.72	0.31	0.92
Banca Intesa, Italy	5.90	0.29	0.31	0.70	0.26	0.87
Mediobanca, Italy	5.99	0.29	0.32	0.70	0.30	0.90
Unicredito, Italy	5.54	0.30	0.31	0.70	0.42	0.87
Credit Suisse, Switzerland	5.51	0.29	0.19	0.60	0.19	0.84
UBS, Switzerland	4.49	0.32	0.27	0.71	0.35	0.84
Barclays, United Kingdom	3.73	0.31	0.28	0.63	0.38	0.84
HSBC, United Kingdom	4.29	0.31	0.28	0.62	0.37	0.86
Lloyds, United Kingdom	5.51	0.26	0.26	0.58	0.29	0.91
Royal Bank of Scotland, United Kingdom	4.41	0.36	0.31	0.62	0.36	0.84
Standard Chartered, United Kingdom	3.71	0.26	0.20	0.68	0.37	0.80
ABN Amro, Netherlands	4.24	0.27	0.20	0.68	0.37	0.87
ING, Netherlands	3.49	0.31	0.27	0.60	0.32	0.88
Minimum	3.49	0.26	0.19	0.52	0.19	0.80
Median	4.49	0.29	0.28	0.68	0.35	0.88
Maximum	6.08	0.36	0.33	0.72	0.42	0.92

Source: Moody's KMV and staff calculations.

Table 2. Corisk Between Financial Institutions Abroad and Those Operating in Chile, Measured as Moody's Credit Ratings

	Bank A	Bank B	Bank C	Bank D	Bank E	Bank F
Median rating	Ba2	A2	Aa3	Baa1	A2	Baa3
Unconditional rating, 95th percentile	B2	Baa2	Baa2	Ba1	Baa2	Ba2
Latin American institutions						
Banco Bradesco, Brazil	B3	Baa2	Baa3	Ba2	Baa2	Ba3
Banco Itau, Brazil	B3	Baa2	Baa2	Ba2	Baa3	Ba3
Banco BBVA Colombia	B2	Baa2	Baa1	Ba2	Baa3	Ba3
Banco de Bogotá, Colombia	B3	Baa3	Baa2	Ba2	Baa3	Ba2
Banco de Occidente, Colombia	B2	Baa2	Baa2	Ba2	Baa3	Ba3
Banco Santander, Colombia	B2	Baa3	Baa2	Ba2	Ba1	Ba2
BanColombia, Colombia	B3	Baa2	Baa2	Ba2	Baa3	Ba2
Corporacion Financiera, Colombia	B3	Baa2	Baa3	Ba2	Baa3	Ba3
Grupo Aval, Colombia	B3	Baa3	Baa3	Ba2	Ba1	Ba3
Banco Continental, Perú	B3	Baa3	Baa3	Ba2	Baa3	Ba3
Banco de Credito, Perú	B3	Baa3	Baa2	Ba2	Baa3	Ba3
ScotiaBank Peru	B3	Baa3	Baa3	Ba2	Baa1	Ba2
Minimum	B2	Baa2	Baa1	Ba2	Baa1	Ba2
Median	B3	Baa2	Baa2	Ba2	Baa3	Ba3
Maximum	B3	Baa3	Baa3	Ba2	Ba1	Ba3
U.S. Institutions						
Bank of America	B2	Ba1	Baa2	Ba2	Ba2	Ba2
Morgan Stanley	B2	Baa2	Baa2	Ba2	Baa3	Ba3
Goldman Sachs	B3	Baa3	Baa2	Ba2	Baa3	Ba3
Citigroup	B3	Ba1	Ba1	Ba3	Ba2	Ba3
Wells Fargo	B2	Baa3	Baa2	Ba2	Baa3	Ba2
Bear Steanrs	B3	Baa2	Baa2	Ba2	Baa3	Ba2
Lehman Brothers	B3	Ba1	Ba1	Ba2	Ba1	Ba3
Merrill Lynch	B3	Baa3	Baa3	Ba2	Ba1	Ba3
Wachovia	B3	Baa2	A3	Ba2	Baa3	Ba3
JP Morgan	B3	Baa3	Baa3	Ba2	Baa3	Ba3
Minimum	B2	Baa2	A3	Ba2	Baa3	Ba2
Median	B3	Baa3	Baa2	Ba2	Baa3	Ba3
Maximum	B3	Ba1	Ba1	Ba3	Ba2	Ba3
Canadian institutions						
Bank of Nova Scotia	B2	Baa3	Baa2	Ba1	Baa2	Ba2
CIB	B2	Baa3	Baa3	Ba2	Baa3	Ba2
Royal Bank of Canada	B3	Baa2	Baa2	Ba2	Baa3	Ba2
Minimum	B2	Baa2	Baa2	Ba1	Baa2	Ba2
Median	B2	Baa3	Baa2	Ba2	Baa3	Ba2
Maximum	B3	Baa3	Baa3	Ba2	Baa3	Ba2
European institutions						
BBVA Spain	B3	Baa2	Baa1	Ba1	Baa3	Ba3
Banco Santander, Spain	B3	Baa2	Baa2	Ba2	Baa3	Ba3
Banque Nationale Paribas, France	B2	Baa3	Baa2	Ba2	Baa2	Ba3
Credit Agricole, France	B3	Baa2	Baa3	Ba2	Baa3	Ba3
Societe Generale, France	B3	Baa2	Baa2	Ba2	Baa3	Ba3
Commerzbank, Germany	B3	Baa2	Baa3	Ba2	Baa2	Ba3
Deutsche Bank, Germany	B3	Baa3	Baa3	Ba2	Baa2	Ba3
Banca Intesa, Italy	B3	Baa2	Baa3	Ba2	Baa2	Ba3
Mediobanca, Italy	B3	Baa2	Baa3	Ba2	Baa2	Ba3
Unicredito, Italy	B3	Baa2	Baa3	Ba2	Ba1	Ba3
Credit Suisse, Switzerland	B3	Baa2	Baa1	Ba2	Baa1	Ba2
UBS, Switzerland	B3	Baa3	Baa2	Ba2	Baa3	Ba2
Barclays, United Kingdom	B2	Baa3	Baa2	Ba2	Baa3	Ba2
HSBC, United Kingdom	B3	Baa2	Baa2	Ba2	Baa3	Ba3
Lloyds, United Kingdom	B3	Baa2	Baa2	Ba2	Baa2	Ba3
Royal Bank of Scotland, United Kingdom	B3	Baa3	Baa3	Ba2	Baa3	Ba2
Standard Chartered, United Kingdom	B2	Baa2	Baa1	Ba2	Baa3	Ba2
ABN Amro, Netherlands	B3	Baa2	Baa1	Ba2	Baa3	Ba3
ING, Netherlands	B2	Baa3	Baa2	Ba2	Baa3	Ba3
Minimum	B2	Baa2	Baa1	Ba1	Baa1	Ba2
Median	B3	Baa2	Baa2	Ba2	Baa3	Ba3
Maximum	B3	Baa3	Baa3	Ba2	Ba1	Ba3

Source: Moody's KMV and staff calculations.

Table 3. Corisk Between Chilean Banking Institutions, Measured as Expected Default Frequency and Implied Moody's Ratings 1/

	Bank A	Bank B	Bank C	Bank D	Bank E	Bank F
Median EDF	0.71	0.12	0.08	0.20	0.12	0.32
95th percentile EDF	2.68	0.24	0.24	0.50	0.23	0.76
Bank A		0.30	0.26	0.55	0.36	0.81
Bank B	5.41		0.26	0.60	0.32	0.90
Bank C	3.46	0.33		0.57	0.35	0.84
Bank D	3.98	0.33	0.27		0.37	0.80
Bank E	3.73	0.33	0.28	0.58		0.81
Bank F	4.66	0.32	0.31	0.62	0.38	
Minimum	3.46	0.30	0.26	0.55	0.32	0.80
Median	3.98	0.33	0.27	0.58	0.36	0.81
Maximum	5.41	0.33	0.31	0.62	0.38	0.90
Median rating	Ba2	A2	Aa3	Baa1	A2	Baa3
Unconditional rating, 95th percentile	B2	Baa2	Baa2	Ba1	Baa2	Ba2
Bank A		Baa2	Baa2	Ba2	Baa3	Ba2
Bank B	B3		Baa2	Ba2	Baa3	Ba3
Bank C	B2	Baa3		Ba2	Baa3	Ba2
Bank D	B2	Baa3	Baa2		Baa3	Ba2
Bank E	B2	Baa3	Baa2	Ba2		Ba2
Bank F	B3	Baa3	Baa2	Ba2	Baa3	
Minimum	B2	Baa2	Baa2	Ba2	Baa3	Ba2
Median	B2	Baa3	Baa2	Ba2	Baa3	Ba2
Maximum	B3	Baa3	Baa2	Ba2	Baa3	Ba3

Source: Moody's KMV and staff calculations.

1/ The table reports corisk measured as the EDF and rating of banks listed in the upper row conditional on the EDF and rating of the banks listed in the first column.

II. A Longer-Term Approach to Fiscal Policy in Chile[1]

1. **Fiscal policy in Chile has been designed, since 2001, around the structural balance rule**. The structural rule (SBR) has aimed at generating a central government structural surplus of 1 percent of GDP per year until the 2008 budget, when it was changed to 0.5 percent, and temporarily to balance in January 2009. The objective of such a rule is to design fiscal policy within a medium-term perspective that isolates revenues from its cyclical factors due to business cycle and copper price fluctuations.

2. **The original target for the structural rule was established on the basis of, mainly, three important fiscal risks facing Chile**.[2] One was related to the contingent liabilities of the central government, particularly related to social pensions and minimum pension guarantees; another was the negative net worth of the Central Bank of Chile (BCCh), and also the external vulnerabilities due to lack of domestic currency borrowing. As noted by Engel, Marcel and Meller (2007), these risks have diminished since the structural rule adoption, and the surplus target was, therefore, reduced to ½ percent of GDP in 2008.

3. **A Fiscal Responsibility Law (FRL) was enacted in 2006 that further strengthened the fiscal policy framework**. The FRL formalized several aspects of the fiscal framework that were previously voluntarily adopted by the government, but still kept the SBR out of the legal framework. In particular, although the law does not bind governments to a specific structural target, it forces to analyze fiscal policy and present budget documents in the framework of the structural surplus balance, discussing the effects of these policies on the structural surplus, within a 2-3 year policy horizon that is recalibrated annually. It also regulates the management of the flows of fiscal surpluses (or deficits) with the creation of two funds, the Economic and Social Stabilization Fund (FEES) and Reserve Pension Fund (FRP).

4. **This chapter presents options for further strengthening Chile's fiscal framework**. In particular, the paper looks at fiscal policy within a longer-term perspective, that could complement and enhance the current fiscal framework in Chile. The longer-term perspective incorporates trends associated with demographic and specific spending pressures in Chile, particularly in health, education and social protection, to assess its impact on public finances over the long-term. As these long term trends are essentially uncertain, the baseline fiscal projections are also complemented with a stochastic analysis that allows to underscore the risks inherent to any fiscal policy decision.

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[1] Prepared by Borja Gracia (ext. 36085), Gabriel Di Bella (ext. 37483), and Martin Cerisola (ext. 38314).

[2] See Velasco, Compromisos Fiscales y la Meta de Superávit Estructural (2007).

5. **This approach follows to a large extent, those adopted by other advanced economies, such as Australia and Norway**. In these economies, several reforms to their fiscal policy frameworks were precipitated by demographic and health care pressures over the medium term, and by how these pressures were expected to be translated into contingent fiscal liabilities and affect the sustainability of fiscal policy.

- ***Australia.*** An intergenerational report is prepared every 5 years, beginning in 2002, to assess the long-term (over 40 years) sustainability of current policies. The 2007 report, builds on other relevant documents such us *Australia's Demographic Challenges* (2004) and the research report from the Productivity Commission *Economic Implications of an Aging Australia* (2005). Although the baseline assumption in the report is that current policies are maintained in the future, broad policy choices to address the fiscal sustainability challenges are also discussed. Fiscal sustainability is defined as spending per capita relative to income per capita and their implications for net public debt.

- ***Norway.*** Budget documents are complemented with an analysis of the *Long-Term Perspectives for the Norwegian Economy*. This report discusses long-term economic and social challenges, including their implications for future economic policy, including the challenges stemming from the expected decline in oil production and how its wealth can have lasting contributions to financing the budget. An emphasis is also placed on achieving sustainable development given "*global environmental considerations, an ageing population, and increased globalization*." Projections are presented for up to 50 years with detailed discussion about productivity, and labor market trends, global economic factors, demographic trends, and expected long-term trends in public finances with, a discussion on potential policy options to face these challenges.

A. Long-Term Fiscal Policy

6. **The current framework in Chile could be strengthened by incorporating more long-term considerations into short-term policy formulation**. While the structural balance rule has reinforced Chile's traditional prudent fiscal policy, it does not fully incorporate a longer-term analysis on likely spending and demographic pressures and their implications for public net assets. The current framework for fiscal policy has a 2-3 year policy horizon, which is recalibrated annually during the budget process. The paper attempts to take a step in bringing more of a long term to fiscal policy formulation, by analyzing long-term demographic and other Chile-specific spending pressures, with special focus on health, education, social protection and environmental spending. This analysis could help strengthen the link between spending per capita relative to income per capita, and its implications for the net public position of the government.

Assessing Long-Term per capita Public Spending based on the Structural Balance Rule

A baseline macroeconomic scenario for the next 40 years

- The baseline macroeconomic scenario (Table 1) assumes that the SBR outcome for 2009 is set at -0.4 percent of GDP, as recently announced by the authorities, with the target returning to 0.5 percent of GDP over the medium-term.

- The non-mining GDP deflator and non-mining real GDP growth are assumed to stabilize at 3 percent over the medium term. The growth of real mining GDP is assumed to have a negative trend towards zero after growing at more than 3 percent per year until 2020.

- Copper prices are assumed to converge to the long-term equilibrium (assumed at 160 USc/lb in 2010) over the medium-term and then grow at around 2 percent per year.[3]

- Population data is obtained from Chile's National Statistical Agency (INE) and show a declining population growth rate. However, the number of people 65 years old or older is projected to increase significantly over the medium-term, but not enough to compensate the reduction in the population of younger ages.

Table 1. Chile: Long-Term Macroeconomic Assumptions
Under the Baseline Scenario

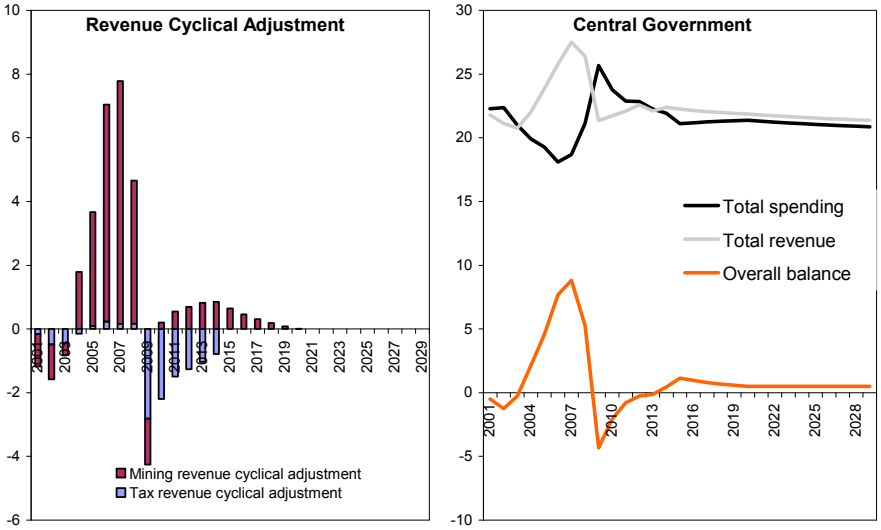
	2001–08	2010–19	2020–29	2030–29	2040–50
Nominal GDP	10.3	7.2	6.9	6.0	6.0
Real GDP	4.2	4.5	3.8	3.0	2.9
Real mining GDP	0.2	3.3	0.3	0.0	0.0
Real non-mining GDP	4.5	4.6	3.9	3.0	3.0
GDP deflator	5.9	2.6	3.0	3.0	3.0
Non-mining GDP deflator	4.1	2.9	3.2	3.1	3.0
Real spending 1/	5.3	2.3	3.4	2.7	2.8
Real revenue 1/	9.0	4.5	3.4	2.7	2.8
Copper price	22.0	2.1	1.8	2.0	2.0
Copper volume	-1.0	3.3	0.3	0.0	0.0
Population growth					
Total	*1.1*	*0.8*	*0.6*	*0.3*	*0.1*
0-14	*-1.1*	*-0.3*	*-0.2*	*-0.5*	*-0.4*
15-64	*1.6*	*0.8*	*0.1*	*0.0*	*-0.1*
65+	*3.3*	*3.6*	*3.9*	*2.3*	*1.0*
Productivity	0.2	0.3	0.4	0.4	0.4
Capital stock	2.7	3.0	2.7	2.6	2.6
Labor force	1.2	1.0	0.6	0.0	-0.1

1/ Deflated using the non-mining GDP deflator.

[3] Consistent with the BCCh's Monetary Policy Report (May 2009).

- Potential growth is based on the assumption of a long-term growth rate of total factor productivity twice that observed over the period since the SBR was introduced (2001–08).[4] The capital stock is assumed to grow at similar rates to those recently observed; hours worked follows demographic trends, with a relatively constant participation rate.

Figure 1. Chile: Medium-Term Macroeconomic Dynamics



Source: Fund staff estimates.

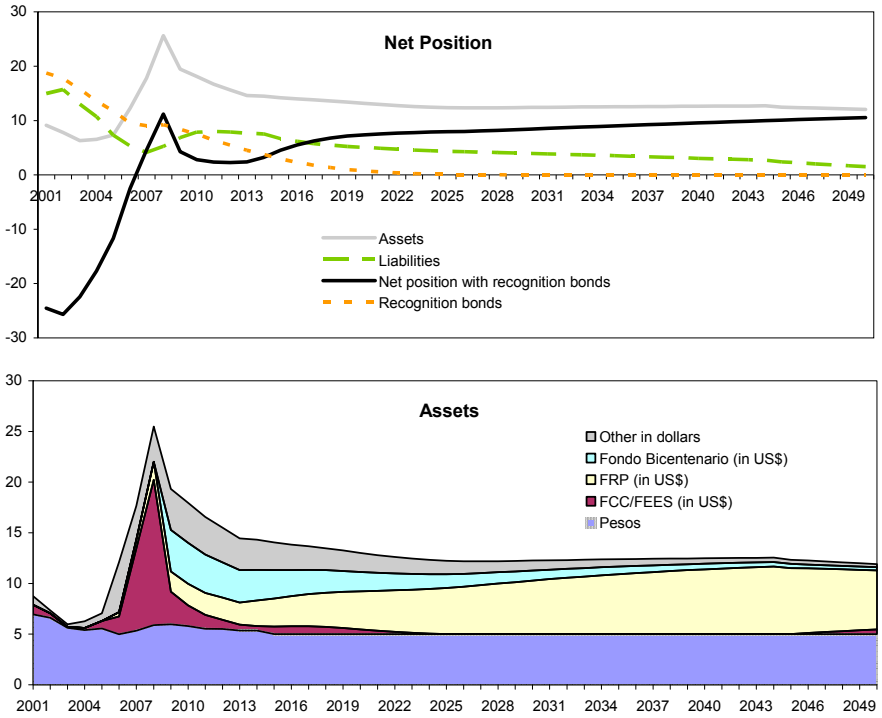
7. **Copper price projections play a critical role over long-term revenue trends**. Over the next few years, copper prices are projected to be above its long-term level, resulting in a positive copper revenue gap (Figure 1). On the other hand, the negative output gap generated by the current crises is assumed to be eliminated only by 2014, resulting in negative non-mining tax revenue gaps. Since non-mining tax revenues are assumed to grow in line with GDP, the long-term evolution of total tax revenues (in percent of GDP) will depend on the difference between GDP growth and the growth of copper production and prices. Under the baseline scenario, copper revenues (the combination of its price and output) grow above GDP until around 2020, but slightly below subsequently. Thus, the share of tax revenues to GDP decline gradually over the medium- and long-term, to 20.8 percent by 2050, slightly above the average level over 2001–08, 20.4 percent of GDP.

8. **The baseline scenario suggests that the net position of the government remains relatively stable**. In this scenario, spending is derived as a residual, in the sense that the spending ceiling is determined based on the assumptions on tax revenue and growth and the application of the SBR. Under the baseline scenario of unchanged tax policy and a return to an SBR target of 0.5 percent of GDP by 2012, the net position of the central government deteriorates moderately from its peak of 11.2 percent of GDP in 2008 to around 2.5 percent

[4] Acta Resultados del Comité Consultivo del PIB Tendencial (August 2008).

in 2012. Subsequently, with the economy returning to potential, the net position is steadily restored back to around 11 percent of GDP over the medium-term.

Figure 2. Chile: Assets and Liabilities of the Central Government
(SBR target of 0.5)



Source: Fund staff estimates.

9. **However, the FEES would shrink to zero and remain at that level until the capitalization needs of the FRP are satisfied by around 2045** (Figure 2). Under the FRL, the FRP should receive contributions equal, in steady state, to the surplus of 0.5 percent of GDP minus the interest accrued by the fund the previous year.[5, 6] This scenario also assumes that $8 billion from the FEES will be used to finance the budget and the 2008 Bicentennial Fund would be fully capitalized in 2009, with $6 billion.[7] Thus, under the assumption that half of financing needs are financed by the FEES from 2010 and the other half are covered

[5] Every year the FRP should receive no more than 0.5 percent of previous year's GDP and no less than 0.2 percent even if there is an overall fiscal deficit. The FRP will be used to finance pension spending starting in 2015, by a third of the difference of the increase in pension spending associated with minimum and social pensions between any given year and 2015.

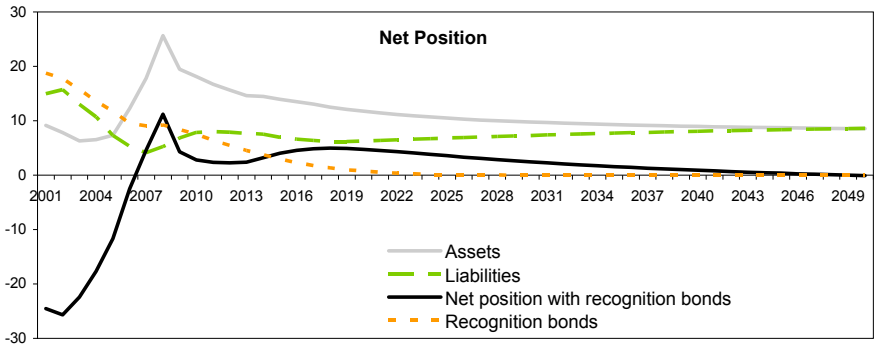
[6] The FRP should receive contributions until the Fund reaches 900 million *Unidades de Fomento*, indexed to inflation and currently valued at around 21.000 pesos.

[7] The Bicentennial Fund, announced in 2008, will be used to finance up to 6500 postgraduate scholarships and 3000 professional training outside Chile.

by issuing inflation indexed and dollar denominated debt, the size of the FEES declines to zero in 2025 and remains at this level until 2046, when it starts to be recapitalized again. At the same time, and without receiving further capital injections, the FRP subsequently declines as a percent of GDP.

10. **A permanent zero structural balance would imply a gradual deterioration in the net position of the government**. If a zero structural balance target were to be maintained indefinitely, the capitalization requirements of the FRP would worsen the fiscal position in the long-run (Figure 3). The reason is that yearly contributions to the FRP would have to be financed by issuing debt, which will exponentially increase the liabilities of the government and the associated interest payments. The net asset position of the central government would deteriorate slowly and turn into debtor status after 2050, with FEES assets declining to zero by 2019.

Figure 3. Chile: Assets and Liabilities of the Central Government
(SBR target of zero)



Source: Fund staff estimates.

11. **The capitalization requirements of the FRP suggest a structural balance target of no less than around 0.2 percent of GDP**. The requirement under the FRL of minimum contributions to the FRP of 0.2 percent of GDP would require a structural surplus target of approximately 0.2 percent of GDP or higher, to ensure a non-negative path for the net position of the central government. This is particularly true over the medium-term when, even if returns under the FRP are capitalized, they would not be enough to reach legal capitalization requirements. Furthermore, any surplus in excess of 0.2 percent of GDP would be consistent with the need to face contingent liabilities other than those related to pension spending.

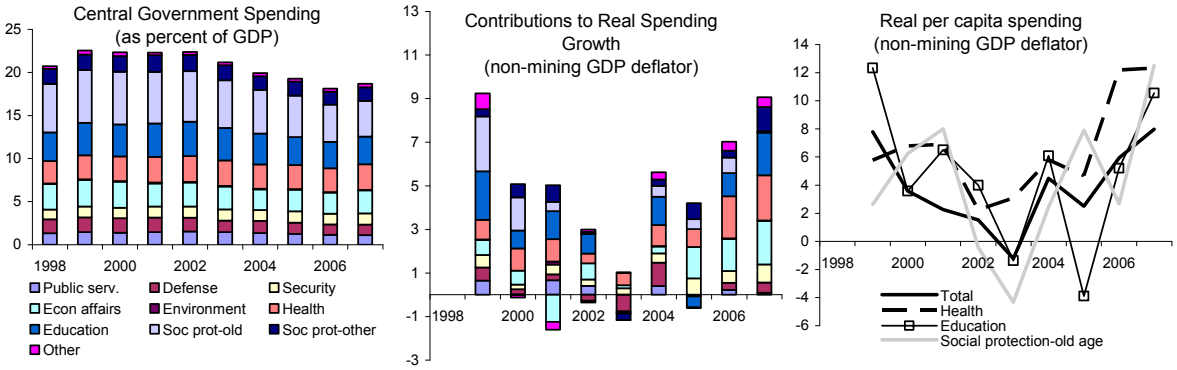
An "exogenous" look at per capita public spending

12. **The SBR results in an expenditure path that serves to frame a more detailed discussion on expenditures by categories and their potential long-term trends**. In a way, the analysis under the structural fiscal rule treats expenditures as a residual. However, this path may not be consistent with reasonable projections about spending based on demographics and other Chile-specific spending pressures.

Some Stylized Facts on Public Spending

13. **A look at past trends in public expenditure reveals an important decline relative to GDP**. Over the period 1998-2007, central government spending declined by more than 3 percentage points of GDP, from above 22 percent of GDP in 1999 to below 19 percent by 2007. This trend is generally observed across most spending categories, except for health spending that remains relatively stable at around 3 percent of GDP. Notably, whereas the share of the different spending categories to total spending is relatively stable over this period, spending on social protection falls from 36 percent to 31 percent of total spending. Half of that space is taken up by health spending that increases from 13 to 16 percent of total spending over the same period. A similar pattern is observed if we focus on real per capita spending growth.[8] The average growth rate of total expenditure over the period was 4 percent with health increasing by 6.6 percent and education and social protection for old age by 4.8 and 1.5 percent respectively.

Figure 4. Chile: Central Government Expenditure 1998-2007



Source: Fund staff estimates.

14. **Comparing with other advanced economies, Chile's public per capita spending is relatively low**. This reflects to a large extent, a smaller general government in Chile, as the average size of the general government in OECD countries was equivalent to 43 percent of GDP, twice the size of Chile's.[9] Among the OECD, México is the only economy with a smaller public sector than Chile. It is important to bear in mind that different government sizes do not fully translate into different levels of provision of public services. Countries with pay-as-you-go pension systems tend to channel significant contributions and pension payments through the budget. This would not happen if the pension system is fully or

[8] All real variables considered in this paper for Chile are obtained by using the non-mining GDP deflator.

[9] Chile's figures refer to the central government which represents around 93 per content of the general government.

partially capitalized and in the hands of the private sector, as in Chile. A similar trend is observed when comparing trends in real PPP per capita spending among OECD economies.

A Closer look at the Composition of Public per capita Spending

Chile long-term spending and demographic pressures (Exogenous Spending scenario)

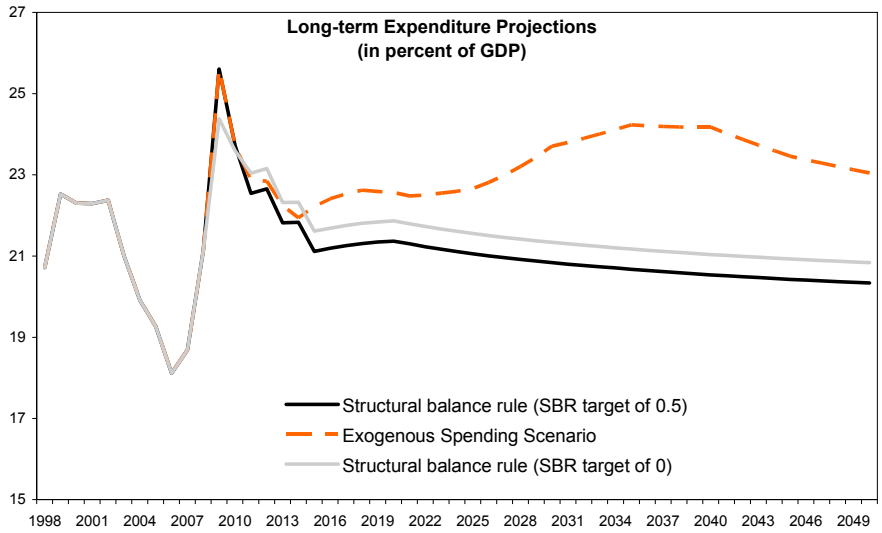
15. **This scenario assumes the baseline macro-framework presented before and makes assumptions about each spending component in Chile's budget** (Table 2). Long-term projections for some spending categories, such as defense, public order, economic affairs, and sports, are assumed to be constant in percent of GDP—at the average level of 1998–2007. The path for the other categories is based on more specific assumptions about the growth of real per capita spending. This generally reflects demographic trends, whenever spending can be clearly linked to some specific demographic group of the population, like primary, secondary and higher education. In other cases, the assumption for spending growth is based on existing official projections, such as those for the 2008 pension reform, presented by Arenas de Mesa (2008).

Table 2. Medium- and Long-Term Expenditure Assumptions

	Medium-term 2009–14	Long-term 2015–50
Total	Art. IV spending envelope	*Sum of each components*
General public services	As percent of total spending	*Real per capita spending = population growth + 2*
Defense	As percent of total spending	*As percent of GDP (average 1998-2007)*
Security and public order	As percent of total spending	*As percent of GDP (average 1998-2007)*
Economic affairs	As percent of total spending	*Steadily falling to 3 percent of GDP (average 98-07 is 2.7)*
Environmental	As percent of total spending	*Real per capita spending = real GDP growth + 2*
Housing and community services	As percent of total spending	*Real per capita spending = population growth + 2*
Health	As percent of total spending	*Real per capita spending = growth of population over 65 + 2*
Sports, culture, religion	As percent of total spending	*As percent of GDP (average 1998-2007)*
Education	As percent of total spending	*Real per capita growth = weighted average of primary, secondary and tertiary, and real non-*
Primary and secondary	*As percent of total spending*	*Real per capita spending = growth of population under 19 + 1*
Tertiary	*As percent of total spending*	*Real per capita spending = growth of population 20/24 + 1*
Social protection		*Sum components*
Old age	*Using spending projections from Mesa et al for 2009–25*	*Per capita real growth = growth of population over 65 + 2*
Family and sons	*As percent of total spending*	*Real per capita spending = growth of population under 19 + 1*
Unemployment	*Nominal growth (50, 25, 3, -8, -6)*	*Some initial nominal decrease and then constant in nominal terms*
Other	*Residual*	*As percent of GDP (average 1998-2007)*

16. **This scenario would suggest a marked deceleration in public per capita spending**. Although total spending as percent of GDP increases significantly, average growth in per capita spending in real terms, which was 4 percent over the period 1998–2007 in Chile, would average 2.8 percent over 2010–2050. Lower projected growth rates are obtained for every expenditure component, with the exception of social protection for old age, with its per capita spending growth rate rising from 1.5 percent to 3.4 percent, due to the pension reform of 2008.

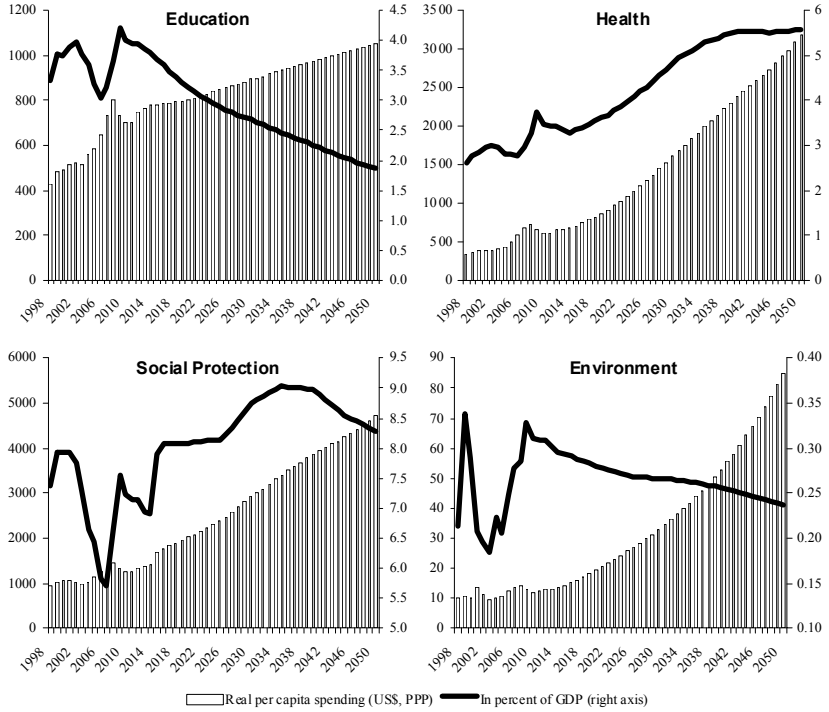
Figure 5. Chile: Long-Term Expenditure Projections (Exogenous Spending Scenario)



Source: Fund staff estimates.

17. **The expenditure envelope in this scenario exceeds the ones derived under the SBR with targets of 0.5 and 0 percent of GDP, respectively**. Spending pressures intensify over the next 20 years and then stabilize at a higher level in terms of GDP (Figure 5). The spending paths of the different scenarios differ significantly, with higher spending pressures under the 'exogenous spending' scenario. The difference exceeds 3.5 percent of GDP at its peak in 2040. Note that by the end of the projection period, the share of health, education and social protection (as percent of total spending) remains close to its initial share, two thirds, in line with the OECD average. However, the path of spending for these variables over the medium- and long-term varies significantly (Figure 6).

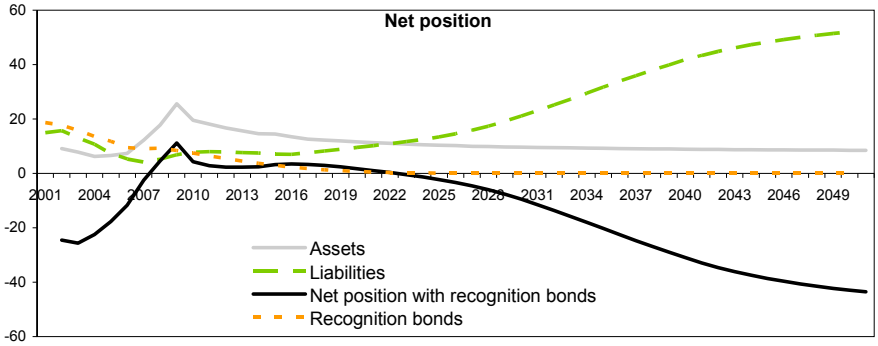
Figure 6. Chile: Long-Term Expenditure Projections



Source: Fund Staff estimates

18. **Health expenditure pressures could intensify over the long-term**. Although real per capita spending increases for all categories, health expenditure growth could exceed that of GDP, bringing its share from around 4 percent of GDP in 2009 to 6 percent of GDP by 2050. On the other hand, education spending, driven by a decrease in the population under 24, could decrease significantly as percent of GDP. A somewhat less dramatic trend is obtained for environmental spending. After a large initial increase, the trend, as percent of GDP, is moderately negative. In the case of social protection, spending pressures increase markedly in the short- and medium-term, on account of the increase pension-related spending due to the 2008 pension reform and the large increase in the number of retirees combined with larger spending on other social measures such us unemployment benefits. Furthermore, the downward pressure on social protection after 2035 is mostly due to the fall in the growth rate of the retiree population from rates above 4 percent over the period 2021–25, to around 2 percent from then until 2040 and below or around 1 percent thereafter.

Figure 7. Chile: Assets and Liabilities of the Central Government
Exogenous Spending Scenario



Source: Fund staff estimates.

19. **Under the 'exogenous spending' scenario, the fiscal stance would deteriorate significantly.** Structural deficits would emerge and additional financing requirements would be needed to capitalize the FRP (Figure 7). As a result, the net position of the central government would become negative by 2022, and reach a net debtor position above 40 percent of GDP around 2045.

Table 3. Chile: Long-Term Fiscal Stance

	2009	2015	2020	2030	2040	2050
	Strcutural balance rule scenario					
Total spending	25.7	21.1	21.4	20.8	20.5	20.3
Total revenue	21.6	22.3	21.9	21.3	21.0	20.8
Overall balance	-4.1	1.1	0.5	0.5	0.5	0.5
Structural balance	-0.4	0.5	0.5	0.5	0.5	0.5
Net poistion	4.3	4.5	7.4	8.4	9.6	10.5
	Exogenous spending scenario					
Total spending	25.7	22.2	22.6	23.7	24.2	23.0
Total revenue	21.6	22.3	21.9	21.3	21.0	20.8
Overal balance	-4.1	0.0	-0.7	-2.4	-3.1	-2.2
Structural balance	-0.4	-0.6	-0.7	-2.4	-3.1	-2.2
Net poistion	4.3	3.4	0.3	-11.5	-32.9	-43.5

Incorporating a Stochastic Dimension into the Analysis

20. **This section incorporates a stochastic dimension into the previous analysis.** The long-term fiscal analysis so far considered paths for real and potential GDP, the effective and long-term copper prices, and copper production (among other) that were chosen as reasonable representations for the variables' future evolution. This section complements such analysis by adding a measure as to how likely (in a statistical sense) such paths may turn out to be.

21. **The projected paths for macroeconomic variables are now derived from a data generating process (DGP) based on a structural VAR (SVAR).** The SVAR was estimated using quarterly data for the period 1986-2008 and includes three variables: real GDP, the unemployment rate and the copper price (expressed in real terms). Following Blanchard and

Quah (1989), shocks were decomposed into those having a temporary effect and those having a permanent effect on output, and thus, to "recover" potential GDP, based on the actual historical behavior of the variables analyzed.[10] The use of such DGP allows to generate alternative paths for future output gaps, (each associated with a specific cumulative probability), which in turn allows to produce alternative paths for (non mining) effective and structural fiscal revenues.[11] The combination of the alternative paths of effective and structural revenues, together with an assumption regarding the size of the structural fiscal balance, allows to generate alternative paths for the effective fiscal position and the government's net financial worth (NFW). The consideration of alternative paths for fiscal and macroeconomic variables allows policymakers to assess the risk, in terms of the increased contingent vulnerability that comes with a lower NFW, behind any decision in terms of the size of the structural surplus balance.[12]

22. **The analysis illustrates the importance of assessing the impact of policy decisions across a number of scenarios, including some with perceived low probability.**[13] Specifically:

- *Based on the history of macroeconomic shocks through end-2008, 2009 was a low-probability scenario ex-ante.* As suggested by information upto December 2008, a closing of the output gap, a reasonable baseline for 2009 (i.e. a scenario consistent with a cumulative 50 percent probability) would entailed assuming a GDP growth rate lower than potential, but still positive (Figure 8). In line with this, and with the decision of the government to reduce the structural fiscal surplus from 0.5 percent to balance, the effective fiscal balance would have gone to a slight deficit (in percent of real GDP). Instead, the latest economic data suggest that GDP would likely contract in 2009 and, and that the effective fiscal deficit will be larger, both of which were *ex ante* relatively unlikely events.

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[10] Following Blanchard and Quah (1989),demand shocks are assumed to have no long-term impact on GDP, while supply and copper price shocks are assumed to have a long term impact on real GDP. Details on the estimated SVAR are available upon request.

[11] To complete the calculation of effective and structural fiscal revenues, long term copper production was assumed to remain stable around 2008 levels, with a standard deviation of 2.5 percent. In this connection, using historical values to pinpoint the parameters of a DGP does not yield reasonable results, given the large increase in copper production during most part of the 1990s associated with new mine exploitations coming into stream (in particular Escondida). Consequently, the DGP parameters were chosen based on what is considered to be a reasonable long-term trend.

[12] For a similar approach see Garcia and Rigobon (2004), and Di Bella (2008).

[13] The results that are reported assume that the structural balance target is maintained over the long term horizon. Alternative results (including with a structural budget surplus of 0.5 percent, and/or declining copper production), are available upon request.

- *A worse than expected macroeconomic scenario in 2009 has decreased the likelihood of positive NFW over the medium term.* Choosing the path consistent with 50 percent cumulative probability as the baseline, the NFW is projected to decrease from about 12 percent of real GDP at end-2008 to about 6 percent by 2030, provided the structural balance target remained at zero beyond 2010. Note however, that the materialization of a more negative macroeconomic scenario (such as in 2009) results in a more rapid decline in the NFW. For instance, if macroeconomic outcomes were to be consistently in the range between (the worst) 25th and 50th percentiles, the NFW could turn negative by 2030, reaching about a net debtor status of 6 percent of GDP. Relatedly, the expected reduction of FEES assets in 2009 (of about US$ 8 bn) implies that the actual NFW path for 2009-10 will be somewhere between the worst 5th and 25th percentiles (Figure 8). Thus, the incorporation of data for the full 2009 year (as it becomes available) would point to a larger probability that the NFW could turn negative in the medium term.

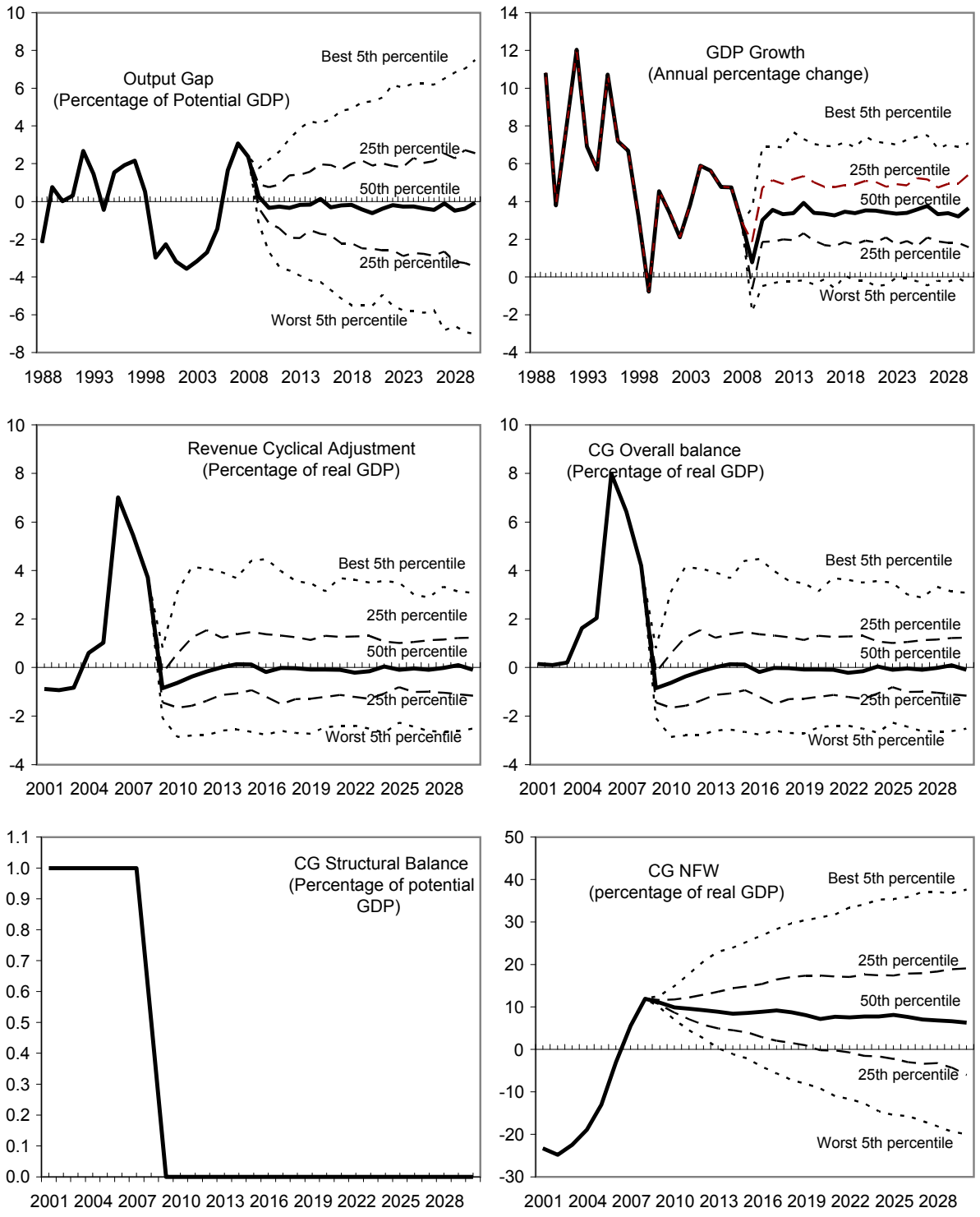
B. Conclusions

23. **Chile could benefit from adopting a longer-term approach to short-term fiscal policy formulation**. This would help consolidate the current 2–3 year planning horizon and incorporate productivity and demographic factors in the context of fiscal policy discussion and formulation. As these long-term trends are esencially uncertain, the implications of alternative fiscal policy decisions should be evaluated within a stochastic framework.

24. **Under certain plausible scenarios, the path for long-term public spending could exceed those associated with different targets for the structural rule**. While the outlook for contingent liabilities does not appear to present significant risks, demographic and other Chile specific spending pressures over the medium- and long-term could result in a significant deterioration of the government's net assets position.

25. **The materialization of a number of downside risks during 2009 underscores the need to continue allowing for contingencies in fiscal policy planning**. Official projections during 2007-08 expected a continuation of the upward trend in FEES asset accumulation through the medium-term. In contrast, the events of 2009 would suggest a significantly different path for FEES assets and for the net asset position over the medium term.

Figure 8: Risks to the Medium-term Fiscal Forecast 1/



Source: Chilean authorities and Fund staff calculations.
1/ It assumes that copper production remains stable and that the structural balance is kept at zero.

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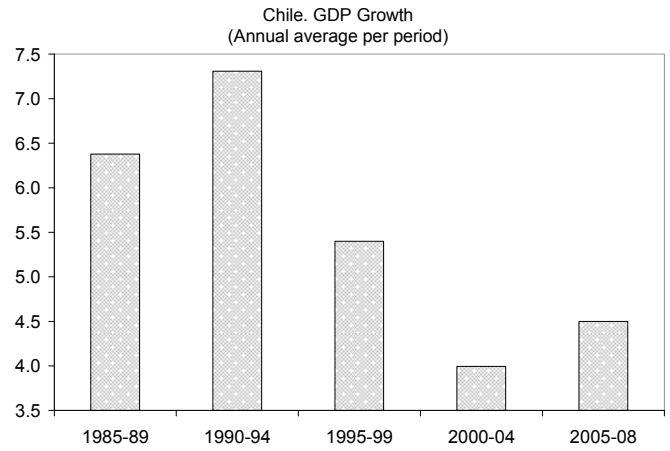
III. Investment-Specific Productivity Growth: Chile in a Global Comparative Perspective[1]

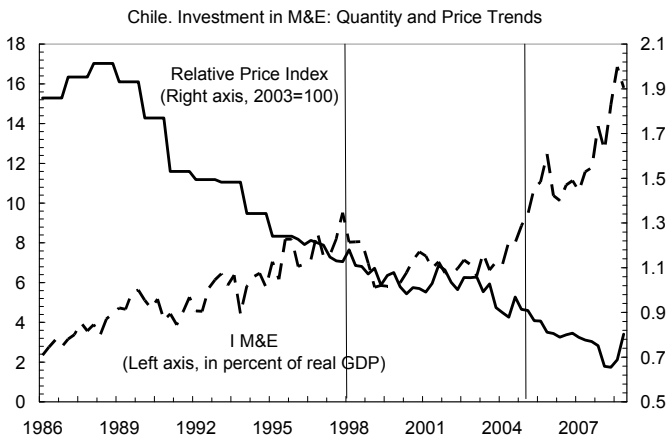
1. **Chile's productivity growth has been lackluster during the last decade.** According to official estimates, total factor productivity (TFP) at end-2007 was lower than that at end-1997, by about 2 percent (Ministerio de Hacienda, 2008). This performance contrasts strongly with the performance during 1986–97, when productivity grew by a cumulative 30 percent. Most importantly, the decrease in TFP growth in the past decade has occurred in tandem with a decrease in average GDP growth.



2. **In addition to the strong change in trend that occurred in 1998, the behavior of productivity has been especially puzzling since 2004.** Given Chile's strong integration with the world economy, some attributed the post-1997 slowdown in productivity growth to the effects of the Asian crisis and the September 11, 2001 aftermath. Indeed, beginning in 1998, investment rates in Chile decreased with respect to those observed earlier in the decade. However, since 2004 investment has picked up dramatically, but productivity growth has continued to be lackluster.

3. **This puzzle stems from the marked increase of investment in machinery and equipment since 2004.** In this connection:

[1] This chapter was prepared by Gabriel Di Bella (37483).



- *Investment in machinery and equipment (IM&E) has almost doubled (as percentage of GDP) since 2004, and by 2008 amounted to about half of total investment:* The strong increase in IM&E observed since late 2004 is part of a longer trend initiated in the 1980s, and which has coincided with a secular decrease in the relative price of M&E in terms of consumption goods, as technological advances made M&E less expensive. This trend seems to be shared by a group of high income and emerging economies (Figure 1).

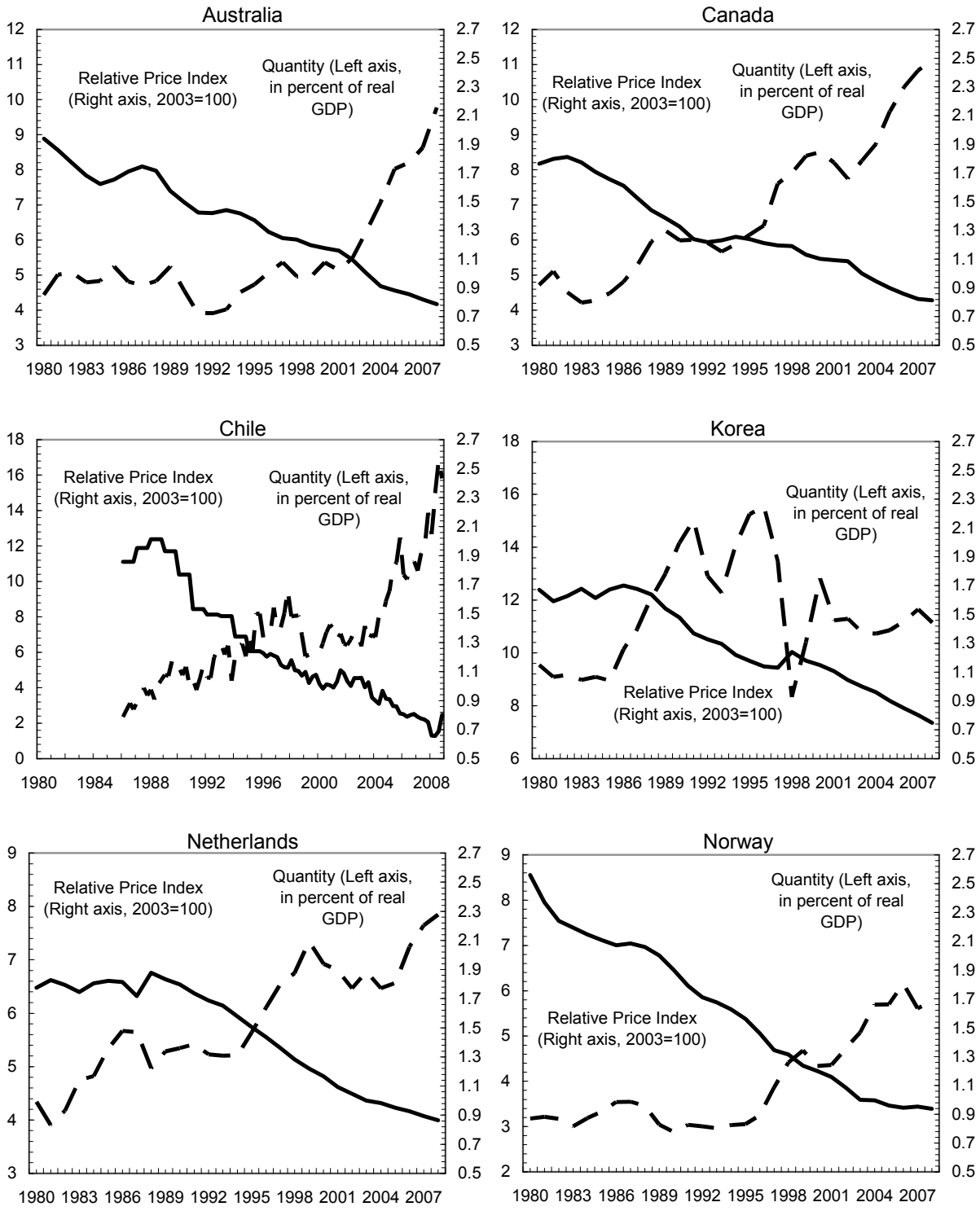
- *New M&E usually incorporates the latest technological advances.* New M&E is embedded with investment-specific productivity (ISP) improvements that makes them more productive than the existing stock of M&E; this is especially true in Chile, where more than 80 percent of M&E purchases are imported. In addition, IM&E is also more productive than other types of investment, like housing.

4. **This chapter looks at Chile's productivity trends over the past 25 years, including from a global comparative perspective**. Chile's experience with investment and productivity is also compared with a group of OECD countries, including net commodity exporters (Australia, Canada, and Norway), as well as importers (Korea and Netherlands).[2] A more accurate measure of total factor productivity, that explicitly accounts for the productivity embedded in Chile's large share of IM&E, allows to decompose growth in output per (effective) hour into two sources: (i) Investment-specific productivity increases (linked with technological improvements in M&E); and, (ii) neutral factor productivity changes.

5. **Productivity trends are analyzed in the context of a general equilibrium model.** In this regard, the model used here slightly adapts that used by Greenwood, Hercowitz and Krusell (GHK, 1997) to analyze similar developments for the U.S economy. The production function in GHK was modified to allow for (exogenous) increases in labor-specific productivity, as well as to incorporate an index of utilization of the capital stock (Annex I). Both modifications were introduced in order to better account for country-specific issues, and to make the results more comparable to those produced by the Chilean authorities (Ministerio de Hacienda, 2008).

[2] For countries other than Chile, the analysis extends from 1980 to 2008.

Figure 1. Investment in Machinery and Equipment:
Quantity and Price Trends



Source: Fund Staff calculations.

6. **Needless to say, an accurate assessment of factors contributing to growth is relevant for a number of issues**. These include long-run fiscal policy, the solvency of entitlement programs, as well as potential GDP growth forecasting (Gordon, 2003).

7. **The results suggest that ISP improvements have contributed significantly to long-term growth in Chile.** In particular:

- *Like in all countries analyzed, ISP growth has been significant in Chile.* It has averaged about 3.8 percent per year, which is similar to that of Norway (3.6 percent per year). ISP growth in rest of the countries analyzed averaged about 3 percent per year.

Output, ISP and TNP Growth
(Average percent per year)

	Ouput per effective hour	Ouput per hour	ISP	TNP
Australia	1.0	1.6	3.3	0.1
Canada	0.7	1.3	2.8	0.2
Chile 1/	**2.8**	**3.9**	**3.8**	**0.7**
Korea	4.3	4.9	2.9	2.4
Netherlands	1.5	1.9	2.6	0.9
Norway	1.6	2.1	3.6	0.7

Source: Fund Staff calculations.

1/ 1986-2008

- *Neutral, factor productivity (TNP) growth has been, on average, lower than ISP growth in all countries considered.* In the case of Chile, it has averaged 0.7 percent per year, similar to that in Norway. For the net commodity exporters (Australia, Canada, Chile and Norway) the lower average TNP growth masks differing behaviors in two periods, with TNP growth being positive until late 1990s or early 2000s and turning negative afterwards (Figure 2).

Long-Run Contribution to Growth
(In percent)

	Ouput per effective hour		Ouput per hour		
	ISP	TNP	ISP	TNP	HK
Australia	74	26	46	16	38
Canada	73	27	44	17	39
Chile 1/	**43**	**57**	**28**	**37**	**35**
Korea	18	82	16	73	12
Netherlands	26	74	21	61	18
Norway	32	68	25	54	21

Source: Fund Staff calculations.

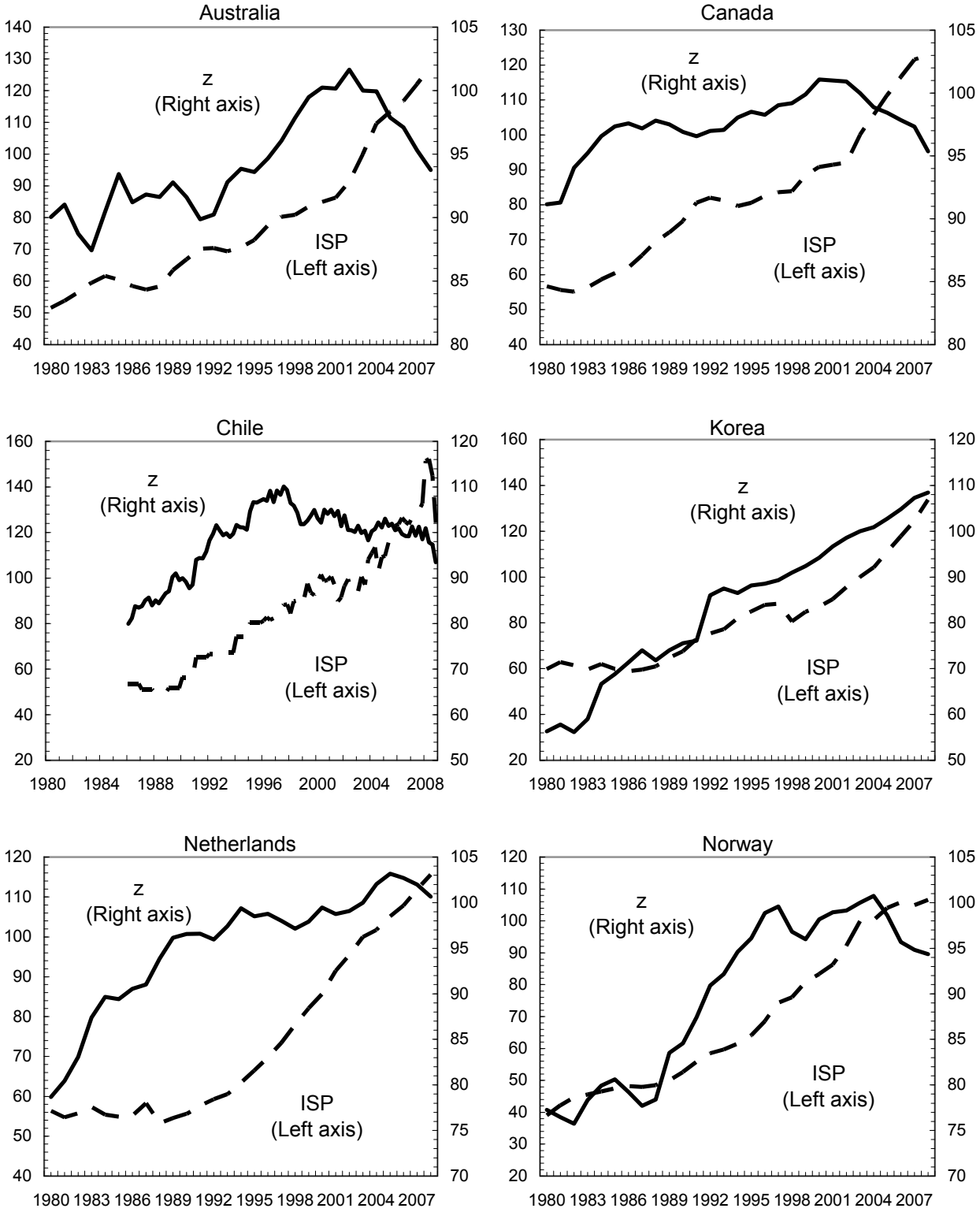
1/ 1986-2008

- *ISP growth contributed to 43 percent to the long-term growth in output per effective hour in Chile.* ISP contribution to growth appears largest in Australia and Canada (exceeding 70 percent), and is lower in Netherlands and Korea.[3]

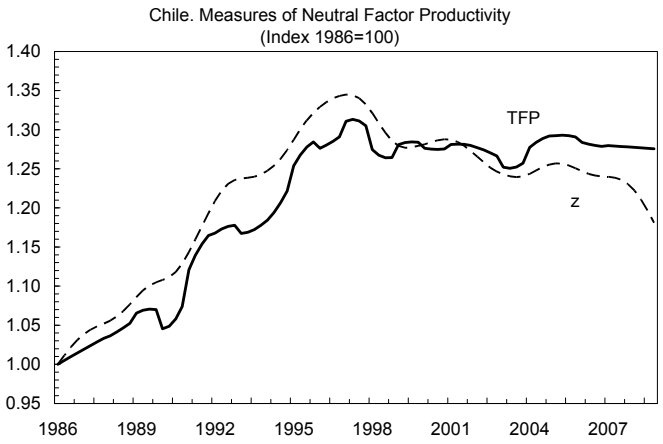
- *In turn, ISP growth contributed to 28 percent to the long-term growth of output per hour in Chile;* TNP contributed to 37 percent, and growth in human capital (HK) to the remaining 35 percent. The contribution of HK to long-term output per hour in Chile appears similar to that in Australia and Canada, and higher than in Korea, Netherlands and Norway.

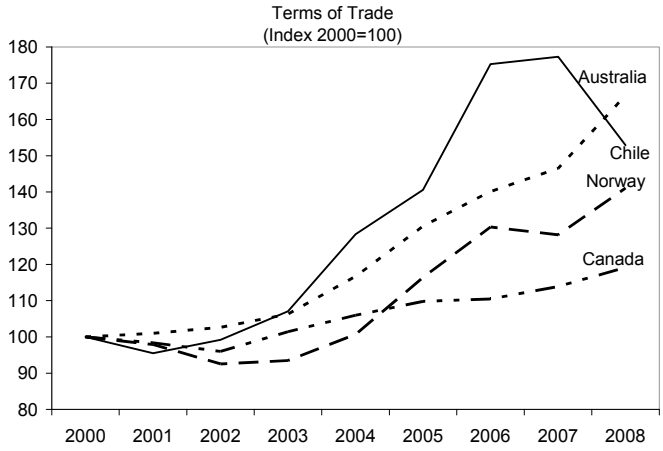
[3] Output per effective hour is defined as output per hour deflated by an index of human capital, which is proxied by the average number of schooling years of the labor force, (Ministerio de Hacienda, 2008).

Figure 2. Investment-Specific Productivity and Total Factor Productivity
(Index 2003=100)



Source: Fund Staff calculations.





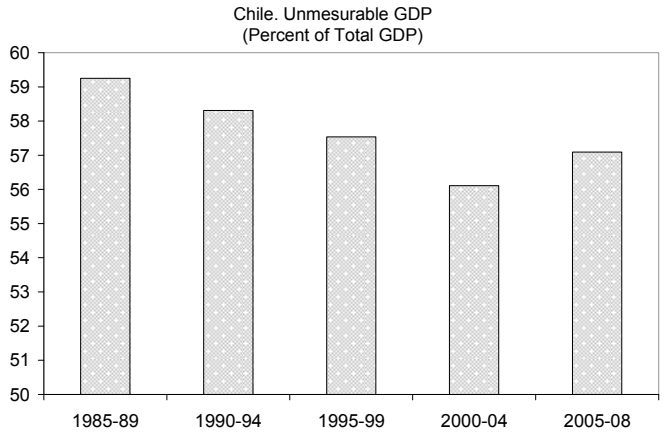
- *The contribution of ISP to output growth has increased significantly since the second half of the 1990s.* This is especially the case in Chile and the net commodity exporters. (Figure 2). The contribution of TNP to growth has decreased during the last decade. In the case of Chile, the decrease in the contribution of total, or neutral, factor productivity to growth results in a productivity measure (depicted as z in the model presented in this chapter) that is lower than the official estimates (depicted as TFP).

- *There appears to be some simultaneity in the behavior of TNP of net commodity exporters during, especially during the last 5 years or so*. Indeed, TNP (depicted as z in Figure 2) decreased in Australia, Canada, Chile and Norway since about 2004. The observed decreases are simultaneous, in all cases with significant increases in IM&E as percentage of GDP (Figure 1) and with large improvements in their terms of trade.

8. **In general, there are a number of possible explanations for a TNP slowdown.** Poor TNP growth may reflect a combination of factors, most notably:

- *The size of the effective capital stock (both in structures and M&E) could be overestimated.* Growth accounting exercises usually assume that current investment is incorporated immediately to the capital stock. However, the construction of some investment projects require more than one year. In such cases, the investment corresponding to those projects should not be incorporated to the economy's capital stock until the project is finalized and ready to operate. Failure to do so would result in an overestimation of the contribution of capital to growth, and a simultaneous underestimation of TFP contribution. In the case of Chile, the Ministry of Finance reports that during the period 2006-08, there was an increase in the number and importance of projects whose maturity exceeds one year, in particular in the Energy and Mining Sectors (Ministerio de Hacienda, 2007). In this connection, and according to official estimates, the amount of current investment that should be added to the effective capital stock decreased from an average of about 75 percent during

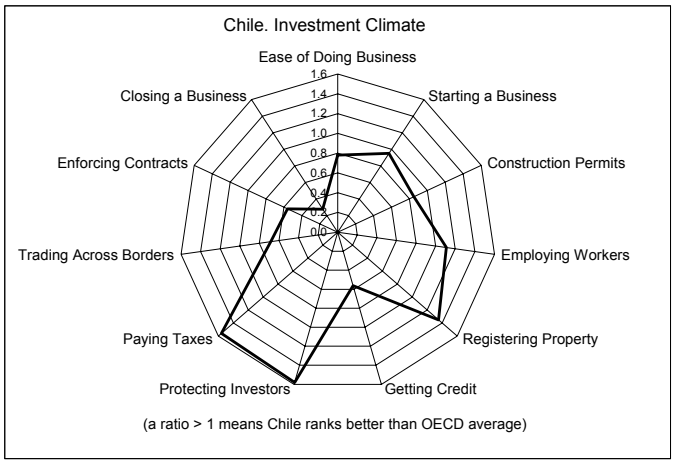
2001-2005, to less than 60 percent in 2008. This could also be a factor that could explain decreasing TNP in other net commodity exporters as, following the large increase in their terms of trade, a substantial portion of their marginal investment has gone to commodity-related projects with maturity periods exceeding one year.



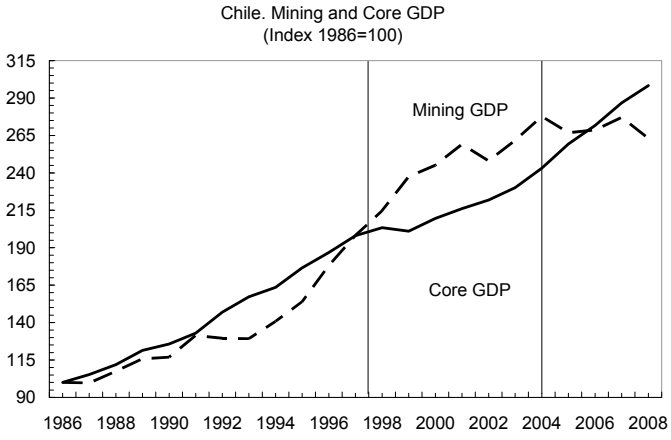
- *The size of output could be underestimated.* Hornstein and Krusell (1996) underscore that in the case of certain economic activities (including construction, trade, finance, insurance, real estate, other services and government), output as well as quality improvements are more difficult to measure than those of others (including agriculture, mining, manufacturing, transportation and communications). Griliches (1994) refers to the former as part of the "unmeasurable sector" of the economy and the latter as the "measurable sector". Thus, productivity slowdowns may reflect output mismeasurements, a problem that would be compounded if the unmeasurable sector in total output were to increase through time. The latter, however, does not appear to be the case for Chile, as the proportion of the unmesurable sector in total GDP (at factor cost) has remained relatively stable.

- *Labor and business management might be adapting to the introduction of new, more productive, technologies.* Hornstein and Krusell (1996) and Greenwood and Yorukoglu (1997) point out that the adoption of new technologies involves a significant cost in terms of learning; only when labor has developed the necessary skills, technology could be successfully implemented. In other words, as the learning needed to fully take advantage of a new technology occurs, there is a transition period in which output and TFP growth could decrease. Such transition period is characterized by an increase in wage dispersion and an increase in the premium paid for skilled labor. Available wage data for Chile indicate that the premium paid to the most skilled workers (upper firm/public sector management and liberal professions) with respect to that of unskilled workers has increased by about 10 percent during the period 1997-2008, while the relative wage of technical workers (machine operators and artisans) to that of unskilled workers has remained fairly constant. Even though these results suggest some increase in wage dispersion, the stability of the relative wage of technical to unskilled workers seems to suggest that costly learning has not been the primary cause of the productivity slowdown.

- *Business regulations might be constraining growth:* There is an abundant literature linking lackluster productivity performance with excessive and/or inadequate regulations affecting the investment climate (e.g., World Bank, 2004). The rationale is that heavy regulation makes it more difficult for business to operate smoothly, which results in poorer



economic outcomes. The results of the 2009 World Bank's *Doing Business* survey indicate that though Chile outranks the countries in the region, it ranks below the OECD average in the (general) "Ease of doing business" indicator. Moreover, Chile ranks below the OECD average in several areas. A closer look at the components of each of the specific categories in the case of Chile shows that there have been no substantial absolute changes in the results of the survey over the period 2004-2009. This has also been the case for Australia, Canada and Norway, which also experienced productivity slowdowns, but whose rankings exceed those of Chile for most indicators. Indeed, the experience of these countries shows that a better regulatory environment would not have necessarily prevented a productivity slowdown in Chile (i.e., productivity slowdowns may occur for reasons different than an inadequate regulatory environment). That said, the indicators for Chile also suggest that there is scope to improve existing regulations, so they would not affect the functioning of some markets, especially at times of economic stress. In this connection, the increase in the average rate of unemployment after 1998 appears to suggest that there still are some rigidities that might be affecting the economy's capacity to absorb shocks, which could have a bearing in the productivity behavior.[4]



- *The growth of traditional sectors might have entered a "declining stage".* This could be significant for economies in which non-renewable resources constitute a large share of output. The exploitation of such resources usually implies that marginal costs eventually rise, with production and productivity eventually decreasing. In the case of Chile, mining GDP has fluctuated around a constant level since 2004 (in line with copper production), while a measure of "core" GDP (excluding mining, electricity gas and water and fishing), has increased at an annual average rate of 5.2 percent. However, it is important to note, that the productivity slowdown in Chile began

[4] Regulatory rigidities may be behind the observed increase in the natural rate of unemployment after 1998 (See Restrepo, 2008).

in 1998, period in which mining GDP, and the physical production of copper, were expanding very strongly. Indeed, during 1998-2004, mining GDP increased at an average annual rate of 4.9 percent, while the physical copper production expanded at annual average rate of 6.9 percent. This seems to suggest that, though the deceleration observed in the mining sector may have had a bearing in the continuation, after 2004, of the productivity trend that began in 1998, there were other factors at play at the outset of such trend.

- *Market concentration might be stifling competition and growth:* Acemoglu, Aghion and Zilibotti (2002) argue that limits on product market competition are important for middle-income countries trying to converge to the world technology frontier. In this connection, according to the World Economic Forum's *Global Competitiveness Report* for 2008, Chile ranks 28 among 137 countries, better than any country in the region, but below the OECD average. As Engel and Navia (2006) indicate, corporate activity in Chile is dominated by a limited number of conglomerates, and it is frequently the case for key industries to be dominated by a small number of corporations (Chile ranks 57th in the "market dominance" indicator). In particular, they point to some lack in competition in the financial sector (banks and pension fund manager companies); this may be constraining the access to funds for middle and low-sized firms, perpetuating market concentration, and limiting the economy's dynamism. However, market concentration does not preclude intense competition; indeed Chile has made important progress since the creation of an "Anti-monopoly Court" in 2004 (Chile ranks 19th in the "intensity of local competition" indicator).

9. **To sum up, the productivity slowdown in Chile's has likely been caused by a number of factors and seems to share some common trends with other net commodity exporters.** Regulatory rigidities, that limited the capacity of the economy to absorb the external shocks of 1998 and 2001, were likely behind the initial phase the productivity slowdown. Beginning in 2004, a combination of causes were probably added up, including the growth deceleration in the mining sector, as well as some overestimation of the size of the effective capital stock (as the boom in commodity prices provided the incentives to invest in the energy and mining sectors, in projects that take more than one year to become operational). Other causes, including costly learning following the adoption of new technologies, as well as market concentration may have had a bearing too. The slowdown in Chile's productivity seem to share some common trends, since 2003, with other net commodity exporters, such as Australia and Canada.

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ANNEX I. THE ECONOMIC ENVIRONMENT

1. The economy is deterministic and is populated by a representative household, a representative firm and a government. The representative household maximizes (discounted) utility over leisure and consumption:

$$\sum_{t=0}^{\infty} U(c_t, l_t) \tag{1}$$

$$U(c_t, 1-l_t) = \theta \ln(c_t) + (1-\theta)\ln(1-l_t), \tag{2}$$

where c_t is consumption, l_t is labor effort and $0 < \theta < 1$.

2. Final output is produced by a representative firm that maximizes profits operating a constant returns to scale Cobb-Douglas production function:

$$y_t = z_t F(u_{k,t}k_{e,t}, u_{k,t}k_{s,t}, l_t) = z_t (u_{k,t}k_{e,t})^{\alpha_e} (u_{k,t}k_{s,t})^{\alpha_s} (l_t)^{1-\alpha_e-\alpha_s}, \tag{3}$$

where, y_t is output of final consumption goods, z_t is a measure of total-factor, or neutral, productivity and $0 < \alpha_e, \alpha_s, \alpha_e + \alpha_s < 1$. There are two types of capital: machinery and equipment, $k_{e,t}$, and non-housing structures $k_{s,t}$; the utilization of the capital stock is denoted by $u_{k,t}$, which is assumed to be known, exogenous, and the same for both equipment and structures. Note that $z_t = \gamma_z^{\ t}$, where γ_z denotes the (gross) growth rate of neutral productivity.

3. Final output can be used for consumption and investment in equipment and machinery, $i_{e,t}$,and structures, $i_{s,t}$:

$$y_t = c_t + i_{e,t} + i_{s,t}. \tag{4}$$

4. The stock of structures evolves according to,

$$\gamma_{H,N} k_{s,t+1} = k_{s,t}(1-\delta_s) + i_{s,t}, \tag{5}$$

where, $\gamma_{H,N} = \gamma_H \gamma_N$ denotes the combined growth (gross) rate of working age population, γ_N, and human capital, γ_H, both assumed to be exogenous and known, and δ_s is the depreciation rate.

5. The stock of machinery and equipment evolves according to,

$$\gamma_{H,N} k_{e,t+1} = k_{e,t}(1-\delta_s) + q_t i_{e,t}, \tag{6}$$

where, q_t is an index of investment-specific productivity (ISP), that measures the quality of new equipment, and δ_e,is depreciation rates of equipment and structures. There is also a government that levies taxes on labor income, τ_l,and on both forms of capital, τ_k. The government transfers back to the consumer, in the form of a lump-sum transfer, τ, the revenue raised in the form of taxes:

$$\tau = \tau_k \left(r_{e,t} k_{e,t} + r_{s,t} k_{s,t} \right) + \tau_l w_t l_t, \tag{7}$$

where, r_e represents the return for the services of equipment, r_s represents the return for that of structures and w denotes wages paid to labor.

Balanced Growth Path Conditions and Calibration

6. The variables y, c, i_e, i_s, k_e, k_s in (1)-(7) are normalized in terms of effective available labor, e.g., in the case output, $y_t = Y_t / N_t H_t$, where Y_t is aggregate output, N_t denotes non-sleeping hours of the working age population and H_t represents a measure of human capital. Note that $N_t = \gamma_N{}^t$ and that $H_t = \gamma_H{}^t$. As finding a balanced growth path (BGP) requires an adequate transformation of variables, note that (4) implies that, along a BGP, output, consumption, and investment all grow at the same rate, γ_y; note also that γ_y denotes the (gross) growth rate of output per available effective hour. From (5) the stock of structures should also grow at rate γ_y; however, (6) implies that the stock of equipment will grow faster, at (gross) rate γ_e. The production function (3) implies that $\gamma_y = \gamma_z \gamma_e{}^{\alpha_e} \gamma_y{}^{\alpha_s}$; thus, as GHK point out, the following restrictions are imposed on a BGP:

$$\gamma_y = \gamma_z{}^{1/(1-\alpha_e-\alpha_s)} \gamma_q{}^{\alpha_e/(1-\alpha_e-\alpha_s)}, \text{ and,} \tag{8}$$

$$\gamma_e = \gamma_z{}^{1/(1-\alpha_e-\alpha_s)} \gamma_q{}^{(1-\alpha_s)/(1-\alpha_e-\alpha_s)}, \tag{9}$$

where γ_q is the (gross) growth rate of q_t. In turn, if one is interested in output per available hour, equation (8) should be modified to incorporate the rate of growth of human capital, as follows:

$$\gamma_y = \gamma_z{}^{1/(1-\alpha_e-\alpha_s)} \gamma_q{}^{\alpha_e/(1-\alpha_e-\alpha_s)} \gamma_H. \tag{10}$$

7. Using (8)-(9), the transformation of the problem into one in which all variables are stationary, requires first defining $\tilde{x}_t = x_t / \gamma_y^{\,t}$, with *x* equal to output, consumption, investment and the stock of structures; then one should define $\tilde{k}_{e,t} = k_{e,t} / \gamma_e^{\,t}$, $\tilde{z}_t = z_t / \gamma_z^{\,t}$ and finally $\tilde{q}_t = q_t / \gamma_q^{\,t}$. Assuming that the economy behaves competitively, the BGP conditions for the transformed problem are as follow:

$$\gamma_q = (\beta / \gamma_{H,N}\gamma_y)[(1-\tau_k)\alpha_e \cdot \tilde{y} / \tilde{k}_e + (1-\delta_e)], \tag{11}$$

$$1 = (\beta / \gamma_{H,N}\gamma_y)[(1-\tau_k)\alpha_s \cdot \tilde{y} / \tilde{k}_s + (1-\delta_s)], \tag{12}$$

$$\tilde{i}_e / \tilde{y} = \tilde{k}_e / \tilde{y}\left[\gamma_q\gamma_{H,N}\gamma_y - (1-\delta_e)\right], \tag{13}$$

$$\tilde{i}_s / \tilde{y} = \tilde{k}_s / \tilde{y}\left[\gamma_{H,N}\gamma_y - (1-\delta_e)\right], \tag{14}$$

$$(1-\tau_l)(1-\alpha_e-\alpha_s)\frac{\theta(1-l)}{(1-\theta)\tilde{c}/\tilde{y}} = l, \tag{15}$$

$$\tilde{c} / \tilde{y} + \tilde{i}_e / \tilde{y} + \tilde{i}_s / \tilde{y} = 1, \tag{16}$$

8. The 18 unknowns associated with the balanced growth conditions are $\gamma_y, \gamma_N, \gamma_H, \gamma_q, \theta, \beta, \tau_K, \tau_L, \delta_e, \delta_s, \alpha_e, \alpha_s, l, \tilde{c}/\tilde{y}, \tilde{i}_e/\tilde{y}, \tilde{i}_s/\tilde{y}, \tilde{k}_e/\tilde{y}$, and $\tilde{k}_s/\tilde{y}$; thus, the solution of the system (11)-(16) requires calibrating 12 parameters. Following GHK, the calibration procedure implies choosing the values of the unknowns in the BGP so they coincide with their average values observed during the period considered. The variables chosen for calibration are: $\gamma_y, \gamma_N, \gamma_H, \gamma_q, \tau_K, \tau_L, \delta_e, \delta_s, (\alpha_e+\alpha_s), l, \tilde{i}_e/\tilde{y}$, and $\tilde{i}_s/\tilde{y}$. In particular, with respect to γ_q, note that ISP is proxied by the ratio of the implicit price deflator for personal consumption expenditures to the implicit price deflator for equipment and machinery.

9. Once the parameters are determined, total neutral productivity, z, can be calculated from equation (3), and the contributions to long-term growth can be calculated either from (8) or (10), depending on whether one is interested in output per *effective* hour worked, or output per hour worked. The calibration results are shown in Table 1.[21]

[21] Datasets are available upon request. A more detailed version of this paper (including a thorough description of data definitions and related data issues) is forthcoming as IMF Working Paper.

Table 1.Calibration Results

	Australia	Canada	**Chile**	Korea	Netherlands	Norway
ie/y	0.06	0.07	**0.07**	0.12	0.06	0.04
is/y	0.07	0.07	**0.08**	0.14	0.08	0.08
alfa e + alfa s	0.40	0.33	**0.40**	0.40	0.35	0.40
tao L	0.52	0.44	**0.32**	0.45	0.62	0.57
tao k	0.30	0.46	**0.15**	0.29	0.33	0.28
l	0.21	0.24	**0.23**	0.33	0.19	0.25
delta e	0.15	0.15	**0.13**	0.15	0.15	0.13
delta s	0.04	0.04	**0.04**	0.04	0.04	0.04
gamma y	1.01	1.01	**1.03**	1.04	1.02	1.02
gamma H	1.01	1.01	**1.01**	1.01	1.00	1.00
gamma N	1.02	1.01	**1.02**	1.02	1.01	1.01
gamma q	1.03	1.03	**1.04**	1.03	1.03	1.04
gamma H,N	1.02	1.04	**1.03**	1.04	1.00	1.04
c/y	0.87	0.86	**0.85**	0.73	0.85	0.88
theta	0.45	0.42	**0.38**	0.52	0.45	0.53
k s / y	0.97	0.99	**0.84**	1.34	1.24	1.20
k e / y	0.26	0.37	**0.31**	0.50	0.31	0.21
beta	0.89	0.98	**0.96**	0.99	0.95	0.90
alfa e	0.13	0.16	**0.14**	0.18	0.12	0.09
alfa s	0.27	0.17	**0.26**	0.22	0.23	0.31

Source: Fund Staff calculations.