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The Chilean Output Gap

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The Chilean Output Gap

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Abstract

This paper estimates the potential output (and the output gap) in Chile using several different methodologies. After a structural brake in 1998, the average growth rate of potential output in Chile declined from over 7 percent to 3–4 percent in the aggregate economy, but to less than 2 percent in the natural resource sector. The contributions to aggregate potential output growth of the natural resource sector and the non-natural resource sector are estimated, finding that the contribution to growth of the natural resource sector is non-linear—increasing during the 1990s, declining during the 2000s, and turning negative in the mid-2000s—despite the monotonic decrease in the share of natural resource output in aggregate output.

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I. INTRODUCTION

It is well known fact in the growth literature that low inflation contributes to increasing long-term growth, while deflation hampers growth. When the economy is in "full employment" of factors of production the rate inflation should be, by definition, "optimal" in that it is the inflation rate that maximizes economic growth—all else equal. Economists usually refer to the level of real GDP at which the economy is functioning at full employment as potential output. However, potential output is a latent variable, as it is unobservable. As such, it can be estimated but it cannot be observed. Furthermore, there are many different methodologies to compute potential output, each encompassing a different precise definition of potential output.[2]

Once potential output is estimated, the output gap can be computed. The output gap is an approximation of the deviation in each point in time of observed output from its full potential level.[3] If the output gap is positive (negative) the economy's level of production is above (below) potential. An economy producing above potential tends to exert inflationary pressures. An overheating economy—real GDP larger than potential GDP—requires polices aimed at containing domestic demand while if the economy is below full employment, on the contrary, the country could be better off by growing at a faster rate—at potential GDP.

In order to estimate potential output several methods have been developed. Each econometric or statistical technique has its advantages and disadvantages. Thus, in this paper we use a battery of alternative methods to estimate potential output (and thus the output gap). No specific method is "the" correct method. Therefore, we estimate potential output and the output gap with different methodologies to obtain a range of values that we deem reasonable.

Using each methodology, we have estimated the output gap and the average growth rate of real GDP for three different specifications of GDP. The first one is the standard measure, using aggregate real GDP. Given Chile's importance in producing natural resource goods—with copper representing more than two thirds of the country's exports—we disaggregated real GDP into natural resource real GDP and non-natural resource real GDP.[4] Thus, we also computed the output gap for the natural resource portion of real GDP and for the non-natural resource share separately. We also computed the average growth rate of potential output for each sector.

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[2] We estimate potential output in several different ways, each having its specific definition of potential output. See Section 3 for the precise definition of potential output for each technique.

[3] It is usually computed as the percentage deviation of observed output from potential output as a percentage of potential output in any given period of time. Define observed output in period t as y_t and potential output in period *t* as $\bar{y}_t$. The output gap will be computed as $\frac{y_t - \bar{y}_t}{\bar{y}_t}$.

[4] Given data availability, natural resource real GDP includes mining (mainly copper and molybdenum), agricultural goods, and fisheries. About 80 percent of this production is related to mining.

The annual data series span from 1960 to 2009 while the quarterly series cover the period 1986–Q1:2010–Q2 for Chile. The first finding is the existence of structural brake in 1998. The structural brake could be attributable to many factors such as the Asian financial crisis—that had a sizeable impact in the Chilean economy—to a natural reduction in the growth rate of output as explained by the growth convergence theory. It is not the goal of this paper to test for the root cause of this structural brake. Depending on the estimation, the growth rate of real GDP averages between 5 and 6 percent for aggregate real GDP and the non-natural resource real GDP, while it is below 4 percent for the natural resource sector. Prior to the structural brake, real GDP growth for aggregate GDP and the non-natural resource sector were between 7 and 8 percent, declining to the 3–4 percent range thereafter. For the natural resource GDP, the rate of growth declined from 6–7 percent before 1998 down to less than 2 percent after the structural brake. Thus, potential GDP growth substantially declined after 1998 for each sector, with a much larger decline in the natural resource sector.

We also find that as of Q2–2010 (the latest observation in our sample) the output gap in Chile is nearly closed, regardless of the real GDP measure. The natural resource sector seems to be already producing above potential.

Finally, we analyze the contributions to potential output growth of the natural resource sector and the non-natural resource sector. We find that these contributions are not linear. The contribution of the natural resource sector increased during the 1990s, to then decline in the 2000s. This path could be reflecting the surge of investment in the natural resource sector brought about by the return to democracy—and the expectations on more stable rules that accompanied it.[5] The paper is organized as follows. The following section describes the models used to estimate potential output. Section III describes the data while Section IV presents the results. Section V concludes.

II. Models

This section briefly describes the different models used to compute the output gap and the average growth rate of real GDP for each type of real GDP. For further details, the interest reader is referred to Fuentes et al (2007), Medina (2010), and Magud and Medina (2010).

Univariate Methods

Four univariate methods have been used. These include a piece-wise linear trend, a Hodrick‑Prescott filter, a Baxter and King bandpass filter, and the filtering methods in Christiano-Fitzgerald (2003).

[5] This is consistent with the effects of political stability on faster economic growth, as documented in OECD (2005) and Jadresic and Zahler (2000).

- **Piece-wise linear trend (LT).** A linear trend is fitted through the log of GDP. The series is tested for structural breaks using the Chow and the Quandt-Andrews tests.

- **Hodrick-Prescott (HP) filter.** This filter provides a more flexible approach to discerning potential output. It calculates potential output as the series that minimizes the deviation of actual output and potential output, subject to a penalty on the maximum allowable change in potential growth between two periods. Following standard practices we adopt a smoothness parameter equal to 1,600, for quarterly data, and equal to 100 for annual data.

- **Baxter-King (1999, BK) and Christiano-Fitzgerald (2003, CF) band-pass filters.** These methods adjust business cycles using a range of business cycles frequencies to compute the cyclical component.

Multivariate Methods

Among the multivariate procedures, we use statistical filters and econometric methods. Three different versions of the Kalman filter have been estimated. The econometric approaches include a production function method, a structural vector auto-regression, and the IMF's Global Projection Model.

- **Kalman filter. Univariate filter estimations are improved by adding macroeconomic information is added.** Here we follow Fuentes et al (2007) and consider three alternative macro relations—other than an HP filter: a Phillips curve, a IS curve, and Okun's law[6]. The first restriction considers a backward-looking Phillips curve such that inflation deviations are positively linked to the output gap. The (backward-looking) IS curve model incorporates a relationship between the output gap and the central bank's monetary policy rate. Okun's law approach adds a relation between the output gap and deviations of the unemployment rate from the NAIRU.

- **Production function. We work with two different approaches here.** One approach follows the implementation of Menashe and Yakhin (2004) in Fuentes et al. (2007), taking a Cobb-Douglas production function in terms of capital and labor. Using logs, deviations of real GDP from potential output are a function of deviations of the capital stock utilization from its steady state (since the total capital stock is potentially available) and deviations of labor from full employment. Menashe and Yakhin (2004) elaborate on the irrelevance of deviations of TFP from its potential level in these estimations. Another approach follows Estevao and Tsounta (2010). The latter computes total factor productivity (TFP) given real GDP, labor, and capital. An HP

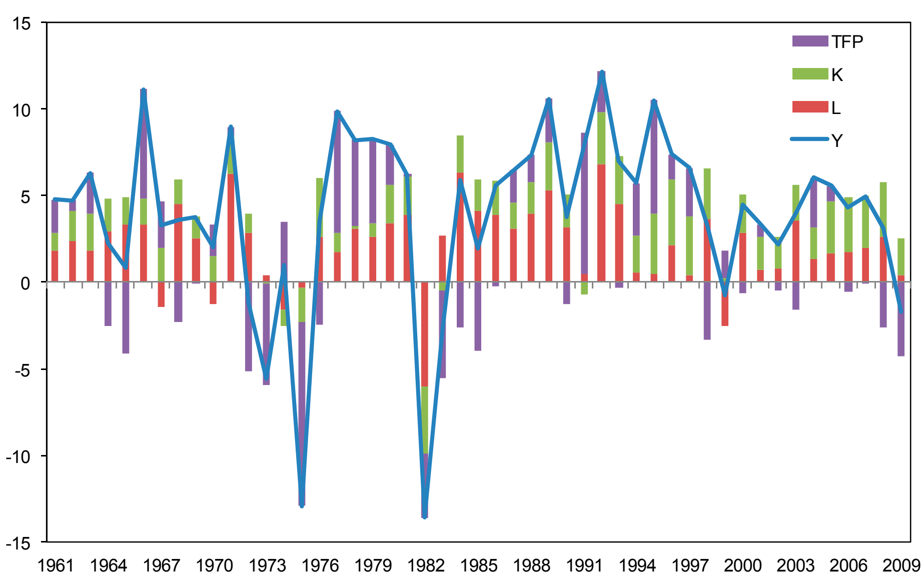
[6] See Fuentes et al. (2007) and Medina (2010) for details on these restrictions.

filter is applied to each series to compute potential values of capital, labor, and TFP. The latter are then used to compute potential output. The estimation was done in two different versions and for different data frequencies. The first one uses labor, whereas the second one corrects labor for years of schooling. We have used quarterly and annual data where available. Figure 1 shows the contribution to GDP growth of labor, capital, and total factor productivity over the period 1961-2009. Figure 2 presents an index of total factor productivity (TFP). It shows that TFP increased in the 1990s—consistent with Fuentes et al. (2007).

- **Blanchard-Quah (SVAR, 1989).** This method imposes structural restrictions to an otherwise standard Vector Auto-Regression (VAR) model. Blanchard-Quah decomposes demand and supply shocks. According to theory demand shocks should be considered temporary while supply shocks should be characterized as permanent. In order to obtain potential output, the VAR is estimated on GDP and the unemployment rate[7]. Following Fuentes et al. (2007), variables are de-meaned to account for the structural brake in late 1998.

- **IMF's Global Projection Model (GPM).** This is a Bayesian model in five stochastic behavioral equations. It estimates an output gap equation, an inflation equation, an interest rate equation, an expected real exchange rate equation, and a dynamic Okun's law equation.[8]

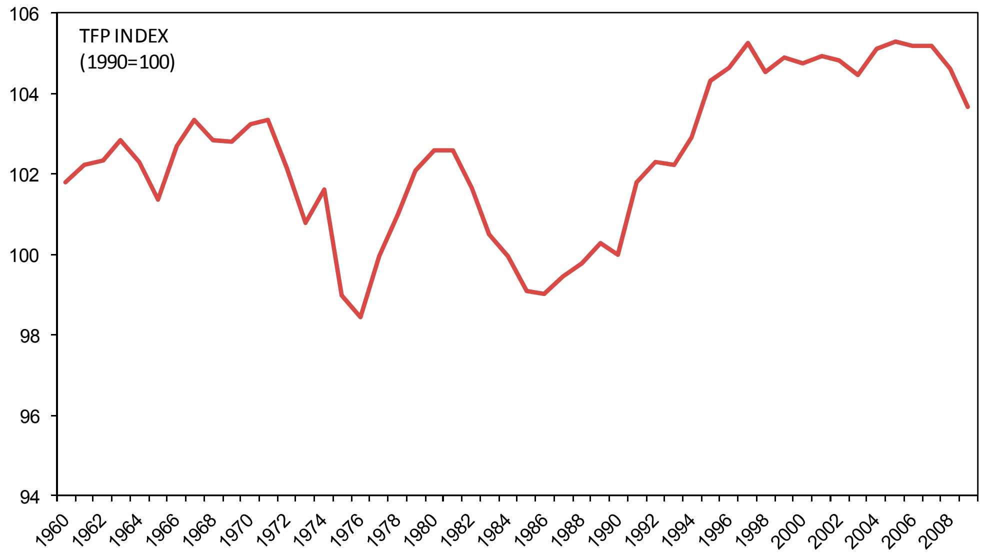
Figure 1. Contributions to Growth



[7] Two lags are used, consistent with the standard lag order selection criteria (Akaike, Schwarz, and Hannan‑Quinn). We have also added the price of copper as a third component in the VAR. However, the results were unaltered, so we decided to drop the latter configuration.

[8] See Canales Kriljenko, Freedman, Garcia-Saltos, and Laxton (2009) for details.

Figure 2. Total Factor Productivity Index



III. Data

Quarterly data spanned 1986–Q1:2010–Q2. Annual data covered 1960–2009. The variables used in the computation of the latent potential output, and thus the output gap are seasonally adjusted real GDP (aggregate real GDP, natural-resource real GDP, and non-natural resource real GDP), hours of labor, capital stock, and a factor to correct labor for education. These data series were kindly provided by the central bank of Chile. For the Kalman filters, we used the following data from Haver Analytics: central bank of Chile monetary policy rate, the rate of inflation and the unemployment rate.

IV. Results

A. Growth rates

Table 1 presents the results of each method using, alternatively, aggregate real GDP, non-natural resource real GDP, and natural resource real GDP—and the corresponding capital stock, hours worked, etc. We observe that the average growth rates for non-natural resource real and aggregate real GDP are roughly similar. A break is detected in the last quarter of 1998. For the period before the structural brake, average real GDP growth is in the 6–7 percent range. After the 1998 crisis average real GDP growth declines to 3–4 percent. Non-natural resource real GDP growth tends to be higher than aggregate real GDP growth, while natural resource real GDP growth is lower than aggregate real GDP growth before and after 1998. Larger declines in real GDP growth are observed for natural resources real GDP after the structural brake. For the quarterly data series, annualized growth rates are below 2 percent. We hypothesize that this could be explained by the natural reduction in productivity gains of the natural resource sector, as the large volume of investment triggered by the return of democracy in 1990 reached a stage of decreasing returns.

Table 1. Average GDP Growth Rates

	Aggregate Real GDP			Non-Natural Resource Real GDP			Natural Resource Real GDP		
	86Q2-10Q2	86Q2-98Q3	99Q1-10Q2	86Q2-10Q2	86Q2-98Q3	99Q1-10Q2	86Q2-10Q2	86Q2-98Q3	99Q1-10Q2
Univariate									
Piece-wise linear de–trending	5.6	7.8	4.0	5.7	7.9	4.4	4.8	7.0	1.3
Hodrick and Prescott	5.4	7.2	3.6	5.6	7.3	3.8	4.2	6.8	1.5
Baxter and King	5.3	7.4	3.7	5.4	7.2	4.0	4.5	7.3	1.9
Christiano and Fitzgerald	5.2	7.4	3.6	5.3	7.1	3.9	4.3	7.3	1.9
average	5.4	7.4	3.7	5.5	7.4	4.0	4.5	7.1	1.6
Economic Models									
Kalman 1	5.4	7.2	3.5	5.6	7.3	3.8	4.3	6.8	1.5
Kalman 2	5.4	7.2	3.5	5.5	7.3	3.7	4.3	6.8	1.5
Kalman 3	5.1	6.5	3.6	5.6	7.3	3.8	4.3	7.0	1.5
Production Function Approach		-	3.8		-	3.8		-	3.8
Production Function Approach-2	5.4	7.2	3.5	5.6	7.2	3.8	4.3	6.8	1.5
Production Function Approach-2 1/	5.2	6.3	3.9	5.2	6.3	3.9	5.2	6.3	3.9
Production Function Approach-2 1/ 2/	6.0	7.3	4.5	6.0	7.3	4.5	6.0	7.3	4.5
Blanchard and Quah	5.4	7.5	3.6	5.4	7.3	3.9	4.1	7.1	1.6
GPM 3/			3.7			3.7			3.7
average	5.4	7.0	3.7	5.6	7.1	3.9	4.6	6.9	2.6

Source: Authors' calculations.

1/ Annual.

2/ Corrected for education.

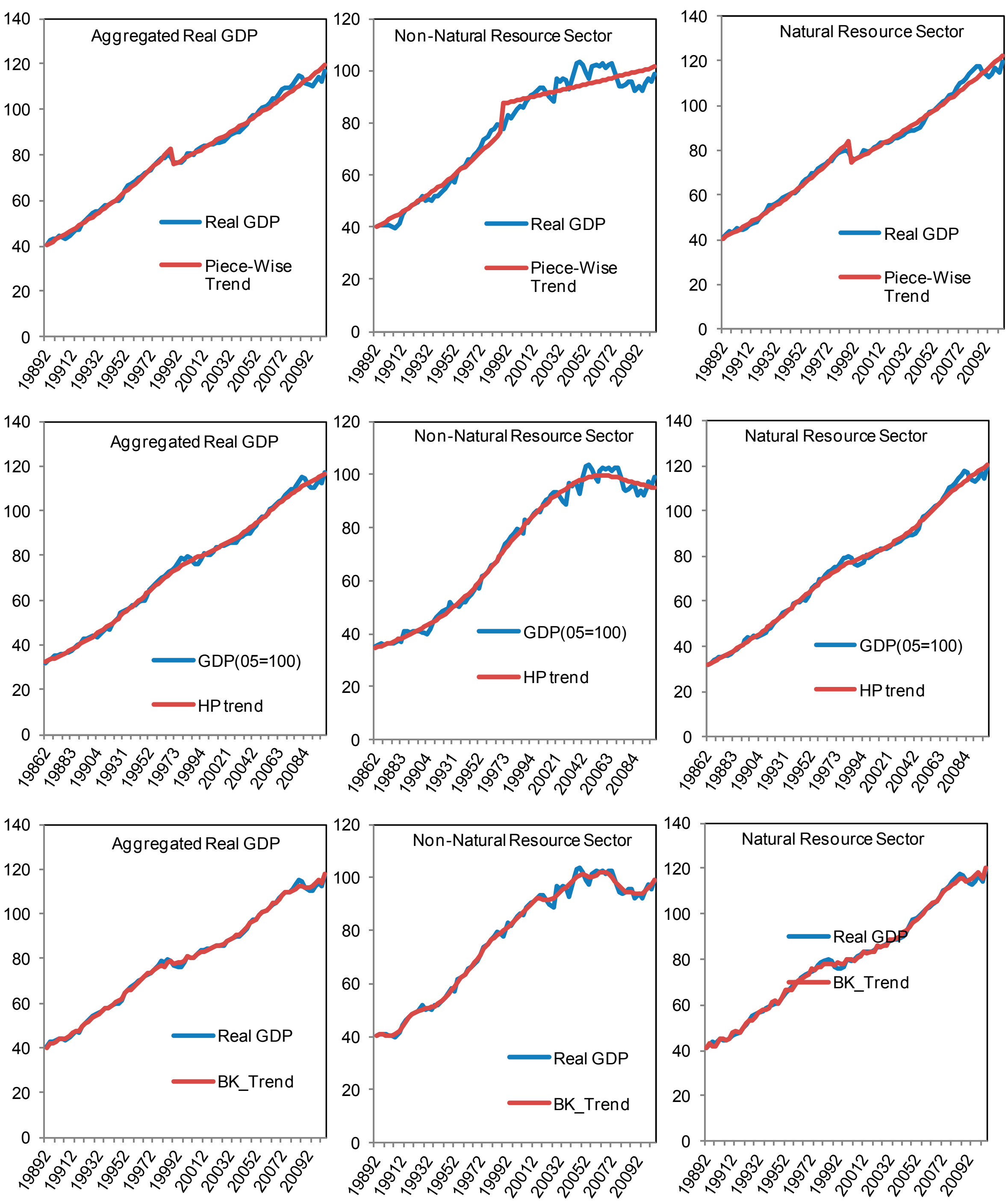
3/ 2001-2009.

B. Output Gaps

Figure 3 shows real GDP (aggregate, natural resource, and non-natural resource) and its corresponding trends using the linear trend, the HP, and the BK filters. Some of the estimations show symptoms of real GDP being above trend.

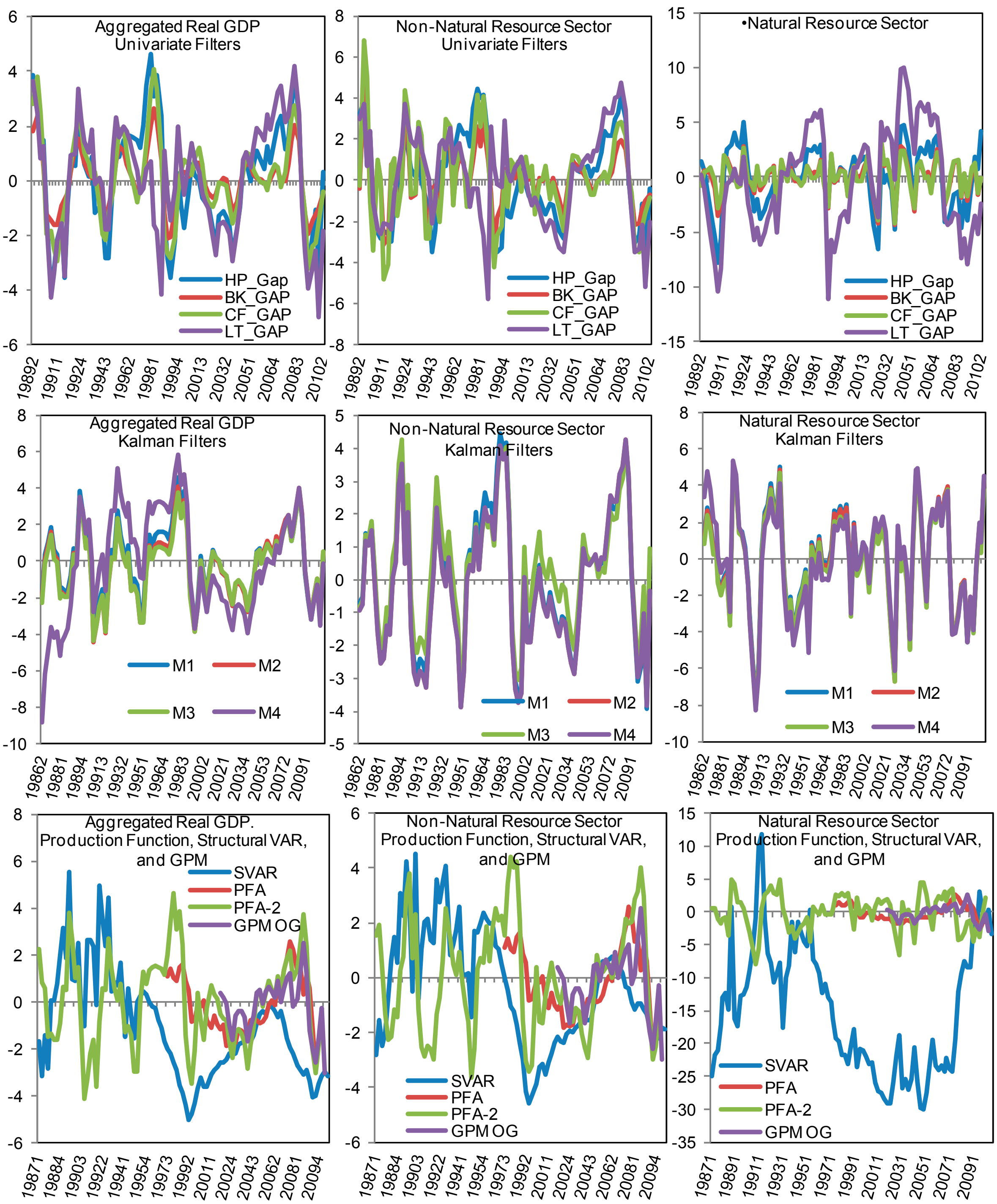
Figure 4 depicts the output gap for each model. The estimation of the aggregate economy's output gap suggests that these gaps are about to close as of Q2–2010. Most of the estimates depict an output gap not larger than 2 percent of potential output. The Kalman filters suggest the gap to be already closed as of Q2–2010. Some of the univariate filters are very close to a zero output gap too. The production function and the structural VAR still show some slack, yet diminishing and close to zero as well—the SVAR showing the larger gap around 2 percent of potential output. The Kalman filter methodology suggests that the non-natural resource GDP is above full employment, while the output gap is very close to zero in the other cases. The natural resource estimation, using Kalman filters, and most of the univariate and multivariate estimations, suggest a closing output gap in Q2–2010, if not before.

Figure 3. Real GDP and Trends



Source: Authors' calculations.

Figure 4. Output Gaps



Source: Authors' calculations.

To understand the role of the natural resource sector and the non-natural resource sector in potential output we computed the contributions to growth of each sector to potential output. On the back of the estimated potential output in the non-natural resource sector, the natural resource sector, and aggregate real GDP, we constructed contributions to growth of each sector to the growth rate of aggregate potential output.[9] Formally, the contribution to growth of sector x to total output is defined by:

$$Contr_t = 100 * \left(\frac{GDP^x_{t+1}}{GDP^x_t} - 1\right) * \left(\frac{GDP^x_t}{GDP_t}\right)$$

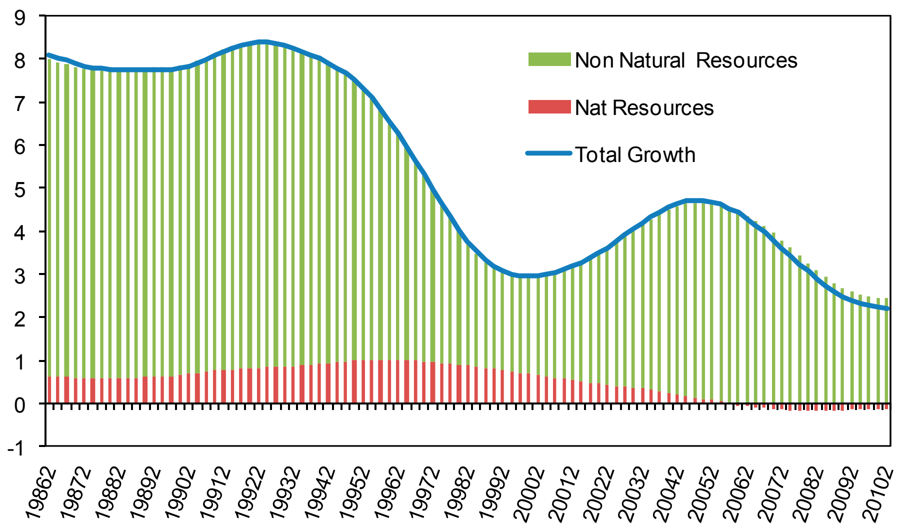
As an example, Figure 5 shows the results for the estimation with the production function approach—the results using the rest of the approaches are available from the authors upon request. We observe a deceleration in potential output starting in the mid-1990s. On the back of the decline in potential growth, however, we find that the contribution of potential natural resource output to potential output growth increased in the 1990s, starting to decline around 1998. It has turned negative since 2005.

We interpret this as follows. As a consequence of the return to democracy and the establishment of transparent investment rules, the early nineties experienced a surge in capital inflows to the natural resource sector. This is reflected in the strong growth in the contribution to potential output in the same time period—see Figure 5.[10] However, as the marginal productivity decreases—given the existence of a quasi fix amount of natural resources—the contribution to growth of this sector declined. Figure 6 shows that the contribution to potential output growth of the natural resource sector increased in the 1990s despite the decline in the share of natural resource GDP to aggregate GDP.

[9] By definition, potential output is composed of natural resource potential output and non-natural resource potential output.

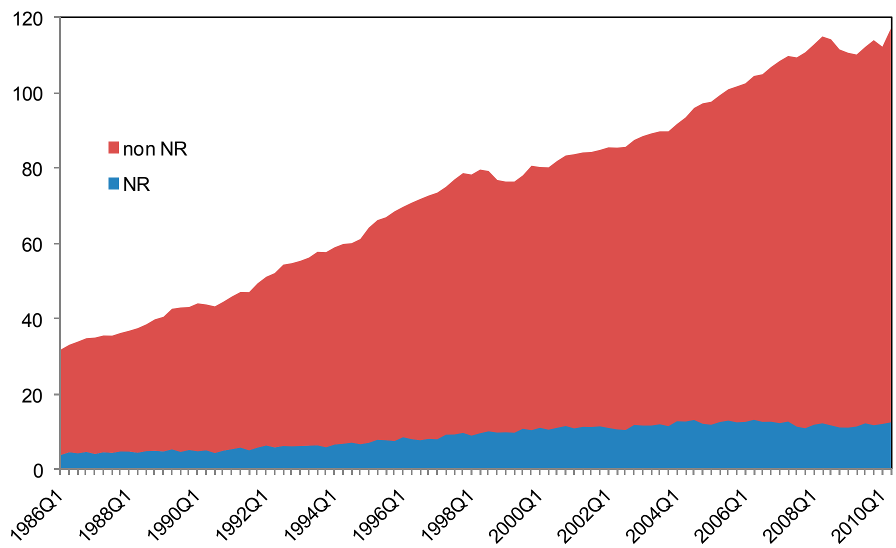
[10] Jadresic and Zahler (2000) show that political stability contributes to explain fast economic growth in the 1990s in Chile (in statistically and economically significant way).

Figure 5. Contributions to Potential Output Growth--Production Function



Source: Authors' calculations.

Figure 6. Real GDP Shares



Source: Authors' calculations.

V. Concluding Remarks

Using standard methodologies we have computed potential output for Chile up to the second quarter of 2010—latest observation at the time of writing. We utilized a battery of alternative methods to compute a range of values of the output gap given that potential output, by definition, is not an observable variable.

We find that the output gap is currently close to zero in Chile. The largest estimated output gap is around two percent of potential output. Some measures show an already closed output gap. The estimations of the growth rate of potential output for the sample period averages between 5 and 6 percent. A structural brake has been found in 1998, with an average growth rate of above 7 percent before the Asian crisis and 3–4 percent thereafter.

We have also separately estimated potential output for the natural resource sector and the non-natural resource sector. The non-natural resource sector's growth rates are of similar order of magnitude to the aggregate economy. The natural resource sector, however, had much higher average growth rates before the 1998 structural brake and much lower ones after the crisis—the latter consistently below 2 percent. Regarding the output gaps, the natural resource sector estimations suggest that this sector is already producing above potential.

We computed the contributions to potential output of the natural resource sector and the non-natural resource sector. We observe that despite the monotonic decline in the share of the natural resource sector in total output, this sector increased its contribution to potential output during the 1990s. This contribution, however, started to decline after the 1998 structural brake, becoming negative in the mid-2000s.

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