IMF Working Paper

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WP/97/104
Correction 1

Subject: **Potential Output Growth in Emerging Market Countries: The Case of Chile**

CORRIGENDUM

Pages 6 through 8 of WP/97/104 (September 1997) are reissued to correct equations 1, 2, and 4. Corrected pages are attached.

Att: (3)

Other Distribution:
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Jorgenson and Grilliches, 1967; Harberger, 1990; and Young, 1995). An index of labor quality for Chile was developed by Jadresic and Sanhueza (1992), and it displays a clear upward trend, reflecting improvements in human capital and a shift to higher-skilled jobs following the deep recession of the early 1980s. In this paper, an index of the quality of capital is estimated, as a weighted average of investment in machinery and equipment, on the one hand, and structures on the other, where the weights are estimated relative rental rates. The index of capital quality shows a steady growth pattern during the last decade, as the share of machinery and equipment in the total capital stock rose to 31 percent in 1995 from 21 percent in the mid-1980s.

An aggregate production function is estimated using cointegration techniques that are particularly appropriate for uncovering long-run relationships between output and inputs. Total GDP is cointegrated with quality-adjusted capital and labor, once we allow for a break in the deterministic trend that captures technological progress. This break in TFP is confirmed by the estimation of Solow residuals, which begin to trend upwards around 1985 after two decades of persistent decline. The existence of constant returns to scale could not be rejected, and the share of imported capital goods in total capital appears to be one of the factors behind TFP growth.

The concept of potential output is central to the analysis of cyclical developments and medium-term growth prospects and plays an important role in the assessment of the stance of macroeconomic policies. To estimate potential output, the cyclical component of TFP and employment needs to be removed. The Hodrick-Prescott filter was used to smooth the TFP series, and two approaches were used to remove the cyclical component of employment. The first approach, also followed by Jadresic and Sanhueza (1992), assumes the natural rate of unemployment to be 5.5 percent, while the second one also smooths the labor input by applying the Hodrick-Prescott filter to the actual employment figures. The latter procedure permits us to capture a possible increase in the natural rate of unemployment in the late 1970s—related to the initial frictional costs of structural reforms—as well as the relatively large trend component in labor force participation found in micro studies of the Chilean labor market (see García, 1995).

Both estimates of potential output show a positive output gap in the years when the economy was deemed to be overheated (1989, 1992–93 and 1995–96), leading the Central Bank of Chile to tighten monetary policy. However, we could not find the positive association between output gaps and inflation typically found in industrialized countries, and more recently in several Asian countries (Coe and McDermott, 1996). This is consistent with the more general result that in most Latin American countries neither current nor lagged output gaps—estimated using statistically smoothing techniques on GDP data only—show any significant correlation with inflation (IMF, 1996). Indeed, the contemporaneous correlation between inflation and the output gap is negative for Chile in the sample period under study, presumably reflecting the very high levels of inflation in a large fraction of the sample, as well as the influence of two fairly long periods (1975–80 and 1985–96) of GDP growth

acceleration and gradual disinflation. This result is also consistent with the evidence found in Hoffmaister and Roldos (1997) for a large sample of Latin American countries.

Finally, the sources of growth are studied, weighing the changes in inputs by the estimated factor shares. Introducing quality change in factor inputs brings into sharper focus the relative roles of these inputs in the growth experience of Chile in the last decade. In particular, in 1986–90 the quality-adjusted labor variable explains close to 60 percent of the growth rate of GDP, as the effect of the increase in the share of skilled labor in total employment is superimposed on the fall in unemployment. In 1991-95 the accumulation of capital is the main engine of growth, explaining 55 percent of output growth owing to the increase in the investment rate as well as the rising share of machinery and equipment in total capital. With these changes, TFP growth is reduced significantly compared with the figures that do not adjust for quality change in inputs: for the period 1986–90, it falls to 0.9 percent from 2.2 percent (without adjustment), while in the period 1991–95 estimated TFP growth falls to 1.4 percent from 3.3 percent.

The fact that increases in TFP account for a small share of the growth process in developing countries is documented in Bosworth, Collins and Chen (1995). It was originally shown by A.Young (1995) for the East Asian countries and has led to a controversial debate on the sustainability of high growth rates in these countries (see Krugman, 1994; Sarel, 1995; and World Bank, 1993). This paper's results show a similar pattern for Chile. Comparing Chile's recent growth experience to that of the East Asian countries and also to the European countries in post World War II, the paper discusses the prospects for growth in Chile for the next five years.

The paper is organized as follows. The next section discusses the estimation of the indices of the quality of inputs. Section III presents estimates of an aggregate production function as well as of potential output for Chile over the period 1965–95, using annual data. Section IV examines the sources of growth in Chile, compares Chile's experience with that of other countries and discusses the projections of potential output growth for Chile over the medium term. Finally there is an appendix Table with the estimated rental prices of capital and the capital quality indices.

II. THE QUANTITY AND QUALITY OF INPUTS

The basic growth accounting framework measures the contribution of the growth of inputs and of technological progress to output growth . The analysis starts from a neoclassical production function, which defines GDP (Y) as a function of total factor productivity (A) and factor inputs (capital, K, and labor, L):

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha} \qquad (1)$$

Taking logs and time derivatives on both sides and assuming perfect competition, Solow (1957) shows how one can use estimates of the share of capital to weigh the contribution of the growth rates of inputs and obtain straightforward estimates of total factor productivity growth as a residual. However, the estimates of the Solow residuals are quite sensitive to adjustments to factor inputs for utilization and quality as well as to assumptions on the share of capital.

In order to improve the estimates of total factor productivity, the present study allowed for quality change in factor inputs by using indices that reflect changes in the composition of the capital stock and the labor force which make aggregate inputs more productive (see Jorgenson and Grilliches, 1967; Harberger, 1990; and Young, 1995). The production function can be redefined as:

$$Y_t = A_t (K_t z_t)^{\alpha} (L_t h_t)^{1-\alpha} \tag{2}$$

where z and h are the indices of quality of capital and labor respectively. These indices are weighted averages of inputs of different quality (say, skilled and unskilled labor) and they provide an adjustment to the quantities of inputs similar to that obtained by translog indices of subinputs.

The index of *quality of labor,* h, is defined as a weighted average of labor with different levels of education

$$h_t = \Phi (L_1, L_2, ..., L_n) = \sum_j \omega_j (L_j/L) \tag{3}$$

where the weights ω_j are relative wages. This index was estimated for the case of Chile by Jadresic and Sanhueza (1992) and recently updated by the Central Bank of Chile.[2] [3]

Changes in the index of *quality of capital*, z, are computed as a weighted average of investment in machinery and equipment on the one hand, and in buildings and structures on

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[2]The author wishes to thank Eduardo Lopez for the updated series on the labor quality index. The data on the labor force and unemployment is from the National Statistics Institute of Chile, and from Jadresic and Sanhueza (1992).

[3]It is interesting to note that this type of index encompasses increases in human capital due to schooling as well as to on-the-job training or learning by doing—deemed crucial in the performance of the East Asian economies, see Lucas (1993).

the other, where the weights are relative rental rates.[4] The index z was estimated for Chile following the definition used in Christensen, Cummings and Jorgenson (1980):

$$\log z(t) - \log z(t-1) = \sum_i v_i [\log K_i(t-1) - \log K_i(t-2)] - [\log K(t-1) - \log K(t-2)] \quad (4)$$

where the weights v_i are the relative capital rental rates. While data on investment (and capital stocks) for machinery and equipment and for structures are available from the Central Bank of Chile, data on the rental rates of both types of capital are not available and estimates were produced using the arbitrage relation (see Barro and Sala-i-Martin, 1995; and Young, 1995):

$$R_i(t) = [1 + r(t)] P_i(t) - (1 - \delta_i) P_i(t+1) \quad (5)$$

where R is the rental rate, P is the price, and δ the depreciation rate for a capital good of type i, and r(t) is the economy-wide real interest rate. Estimates of the rentals and the index are presented in the Appendix Table. In order to take into account the volatility of the real exchange rate in Chile, which affects directly the relative price of both types of capital, two estimates of z are presented: one that excludes the effect of relative price changes, and the other, which includes a five-year moving average of relative price changes.[5] Index z (quality of capital) reflects the fact that assets with higher depreciation rates and declining relative prices should command comparatively higher rentals.

The estimated indices of the quality of labor (h) and capital (z) are presented in Figure 1. The index of labor quality displays a clear upward trend, reflecting improvements in human capital and a shift to higher-skilled jobs, as the economy came out of the deep recession of 1982-83. The quality of capital index shows a more uneven pattern, mainly reflecting the changes in the share of machinery and equipment in the capital stock, which dropped slightly over most of the 1970s before rising to 31 percent in 1995, from less than 20 percent in the late 1970s. It should be noted that these indices do not account for the differential productivity of capital and labor of different "vintages"—which remains to be captured in the residual TFP.

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[4]The data on the capital stock, derived from investment figures at 1986 prices, is from the Central Bank of Chile.

[5]The relative price of both types of capital goods is computed as the ratio of the respective deflators relative to the GDP deflator.