Labor Market Distortions, Employment, and Growth: The Recent Chilean Experience

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From 1984 to 1998, the Chilean economy grew at a rate of 5.4 percent per capita, putting it among the world's most successful economies in the past twenty years. This performance can undoubtedly be attributed to the market-oriented structural reforms that took place in the 1970s, 1980s, and early 1990s. This route was far from easy, however. The period of substantial growth was preceded by a profound crisis in the early 1980s that led to an accumulated decline in per capita output of around 20 percent for 1982–1983.[1] Chile then grew steadily, and it regained its trend level in 1990.[2] In the years

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1. The Chilean crisis of 1982–1983 is considered one of the worst in the twentieth century (see Kehoe and Prescott, 2002).

2. In this study, we use output per working-age population to analyze growth processes in the Chilean economy and a 2 percent annual rate as trend. Output per working-age population (that is, the population from sixteen to sixty-four years of age) is the appropriate indicator of per capita output in the context of the theoretical economy we use, in which the entire working-age population is capable of working. The 2 percent rate used as a proxy for trend growth corresponds to average annual growth in this variable from 1960–2002 in Chile.

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that followed, the growth rate held steady at around 6 percent, bringing per capita output 30 percent above its 1980 trend level by 1998.

In the past few years, however, the Chilean economy has experienced a sharp drop in its growth rate. From 1998 to 2002, the per capita growth rate averaged a mere 0.63 percent per year. Different hypotheses have been put forth to explain this period of stagnating growth. In particular, analysts have mentioned external factors associated with the decline in the terms of trade and reduced access to external capital flows that started with the Asian crisis. The recent recession affecting the world economy—which deteriorated further after the September 11 terrorist attack—is said to have contributed to worsening the outlook for the terms of trade and dampening investors' appetite for risk. Others have argued that this fall could be the result of the excessively restrictive monetary policy stance applied by the Central Bank in mid-1998 to reduce the impacts of the Asian crisis, which were just becoming apparent at the time. The effects of this policy, combined with the direct impact of the Asian crisis itself, may have proved more lasting and harder to turn around than originally foreseen, even with the openly expansionary monetary policy that has been applied for several quarters since.

Still others argue that the country's difficulties with returning to growth rates like those of the past decade go beyond the explanations of a normal cycle. These analysts suggest that recent results reveal a decline in the economy's potential for growing at more than 3 to 4 percent annually. Furthermore, until very recently, the economy was unable to create new jobs at rates comparable to those previously observed. The combined phenomena of stagnant growth and low job creation coincided not only with an external scenario that is extremely complex for emerging economies, but also with a range of policy actions, including legal reforms, that affect production costs. Among these, two stand out: the 30 percent increase in the minimum wage implemented between 1998 and 2000 and the so-called labor code reform. The latter was passed in October 2001, but only after two years of parliamentary debate that left the impression that the reform would increase labor hiring costs by much more than it actually did. Other relevant policy changes include reforms to reduce tax evasion, which were passed toward the end of 2000, and reforms to reduce the tax burden on individuals but gradually increase the burden on companies, which were approved in mid-2001. In an opposite direction, reforms were passed in late 2001 to liberalize the capital market; these should reduce investment and capital costs in the future.

The present article focuses on the third of these hypotheses, that is, that the decline in growth and job creation are linked to changing production costs, mainly associated with more expensive labor. Taking Bergoeing and others (2002) and Bergoeing and Morandé (2002) as our starting point, we analyze the role of factor accumulation and the efficiency with which these factors were used over the past twenty years in Chile, placing output fluctuations in the context of a simple neoclassical growth model. The analysis shows that the fall in employment has been the primary determinant of the observed decline in growth in recent years. This contrasts sharply with the crisis in the early 1980s and the recovery and strong economic growth phase that followed and lasted through 1998, when the efficiency of factor use was the main engine driving economic activity.

1. Growth Accounting

In the context of the neoclassical model, lower growth may be the result of a decline in labor factor accumulation, stemming from changes in implicit or explicit taxes that make it more expensive to hire labor and thus increase production costs. Kehoe and Prescott (2002) show that most crises during the twentieth century were the consequence of drops in the efficiency of factor use or labor contribution. In Chile from 1981 to 1998, the main source of growth was the efficiency with which labor and capital were used; since then, fluctuations in activity levels have resulted fundamentally from changes in employment.

To determine the contribution of factor accumulation and the efficiency of factor use to the change in output per working-age population, we break down the change in the latter by changes in total factor productivity (TFP), the capital-to-output ratio, and hours worked per person of working age. This breakdown is based on a Cobb-Douglas aggregate production function, that is,

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha} ,$$

where Y_t is output, K_t is capital, L_t is total hours worked, and A_t is TFP.[3] In this context,

$$A_t = \frac{Y_t}{K_t^{\alpha} L_t^{1-\alpha}} . \tag{1}$$

3. Appendix A provides a complete description of the data used and sources.

When TFP grows at a constant rate, that is, when $A_t = Ag^{(1-\alpha)t}$, the neoclassical growth model is characterized by a unique balanced growth path in which output and capital per worker grow at the same constant rate, $g - 1$. In this study, we analyze the behavior of output relative to this trend. The 2 percent trend in output per working-age person used for Chile also fits the United States data very well throughout most of the twentieth century. Kehoe and Prescott (2002) argue that this trend growth represents evidence that the world stock of useable knowledge has grown smoothly over time and is not country specific: countries differ in their institutional structures.

Labor and output series are available directly from national accounts. To obtain A_t, however, we must choose a value for the capital share in output, α, and generate aggregate capital series, K_t. Information from national accounts indicates that the labor compensation share of Chile's output is almost 0.5. This, in a competitive context, corresponds to $1 - \alpha$, so the capital share is 0.5. This fraction is stable over time and similar to many developing countries. Labor's share is much higher in developed countries, with α fluctuating around 0.3. Gollin (2002) shows that if we correct for labor's share in developing countries to allow for the underestimation of independent workers, then labor's contribution rises significantly and tends toward levels observed in developed countries—that is, 0.7. A second reason for using this figure and not the information from national accounts is that in the latter case, the growth model predicts a marginal productivity for capital that is unrealistically high.[4] The sensitivity exercises included in appendix B show that the results of the study would not be substantially different if we assumed a value of α close to that arising from the national accounts (for example, 0.45). The fraction of output attributed to the labor factor only affects the distribution of changes in output between TFP and capital; it does not affect the labor factor's contribution, which is the main element behind the behavior of output in 1998–2002. We therefore assume that $\alpha = 0.3$, particularly given that this paper centers precisely on the changes to production costs stemming from legal reforms (namely, labor laws).

Taking logarithms in the production function, we have

$$\log\left(\frac{Y_t}{N_t}\right) = \frac{1}{1-\alpha}\log A_t + \frac{\alpha}{1-\alpha}\log\left(\frac{K_t}{Y_t}\right) + \log\left(\frac{L_t}{N_t}\right),$$

4. If $\alpha = 0.45$, for example, the before-tax rate of return on capital would average 23 percent from 1960 to 2002. With $\alpha = 0.30$, however, this rate is 15 percent.

where L_t/N_t is the number of hours available for work per person of working age.[5] We then break this expression down to separate out changes in real output per working-age population for period t and $t + s$, as follows:

$$\frac{\log\left(\frac{Y_{t+s}}{N_{t+s}}\right)-\log\left(\frac{Y_t}{N_t}\right)}{s}=\frac{1}{1-\alpha}\frac{\log A_{t+s}-\log A_t}{s}$$
$$+\frac{\alpha}{1-\alpha}\frac{\log\left(\frac{K_{t+s}}{Y_{t+s}}\right)-\log\left(\frac{K_t}{Y_t}\right)}{s}$$
$$+\frac{\log\left(\frac{L_{t+s}}{N_{t+s}}\right)-\log\left(\frac{L_t}{N_t}\right)}{s}.$$

The first term on the right-hand side of the equation represents the contribution of TFP to growth; the second term is the contribution from changes in the capital-output ratio; and the third term is the contribution from changes in hours worked per person of working age. The empirical evidence reveals that in the long term, both the capital-output ratio and employment remain constant. In the short term, however, factor accumulation can be very important to growth.

Table 1 provides the breakdown of output per working-age population (henceforth per capita output) for the Chilean economy from 1980 to 2002. These data reveal that employment was the most relevant factor behind the level of economic activity in 1998–2002, which contrasts with the period of sustained growth from 1983 to 1998.[6] Employment explains an average annual decline in per capita output of around 2.31 percent in the more recent period.[7] Per capita

5. We obtain N_t by multiplying the population aged sixteen to sixty-four years by the number of hours available for work in the year, assuming a hundred hours per week for fifty-two weeks; L_t corresponds to the number of people working in Chile for the average number of hours worked in Greater Santiago. This breakdown is based on Hayashi and Prescott (2002).

6. During the crisis in the early 1980s, employment and TFP accounted for similar percentage drops in per capita output.

7. We are using a logarithmic approximation of growth. This allows us to carry out an additive decomposition of growth factors.

output rose, however, by an average of 0.63 percent per year during this period because TFP was 1.51 percent and the capital-output ratio contributed 1.42 percent. In previous years, TPF appears to have been the main determinant of growth.

Table 1. Growth Accounting in Chile, 1981–2002

Period	*Total change in Y/N*	*Contribution of TFP*	*Contribution of K/Y*	*Contribution of L/N*
1981–1983	–10.93	–7.81	5.26	–8.38
1983–1998	4.76	3.36	–0.34	1.73
1998–2002	0.63	1.51	1.42	–2.31

Source: Authors' calculations.

Alternative calculations for the growth accounting confirm our main finding, namely, that the drop in per capita output in 1998–2002 is mostly explained by a fall in the contribution of labor (see table 2). This result is robust to different specification for capital and labor: our results remain qualitatively unchanged if we use capital utilization instead of capital stock or the number of workers instead of hours worked.

Table 2. Growth Accounting in Chile, 1998–2002: Robustness to Alternative Measures

Indicator	*Total change in Y/N*	*Contribution of PTF*	*Contribution of K/Y*	*Contribution of L/N*
Base case	0.63	1.51	1.42	–2.31
Number of people	0.63	1.04	1.06	–1.61
Capital utilization and number of people	0.63	1.29	0.81	–1.61

Source: Authors' calculations.

2. Deterministic Growth Model

This section uses a simple deterministic version of the neoclassical growth model, which considers a single good that is consumed or used in investment. The representative household solves the following problem:

$$\max \sum_{t=1980}^{\infty} \beta^t \left[\gamma \log C_t + (1-\gamma)\log\left(N_t - L_t\right)\right],$$

$$\text{s.a.} \quad C_t + K_{t+1} - K_t = \left(1-\tau_t^l\right) w_t L_t + \left(1-\tau_t^k\right)\left(r_t - \delta\right) K_t + T_t,$$

where C_t is consumption, $N_t - L_t$ is leisure, r_t is the real return on capital before taxes, w_t is real wages, $\tau_t^{\,l}$ is the labor tax rate, $\tau_t^{\,k}$ is the tax on net capital minus depreciation, and T_t is a transfer that the government pays the consumer. Moreover, $\beta \in (0, 1)$ is the discount factor, and δ is the depreciation rate.

The representative firm solves the problem,

$$\max \Pi_t = A_t K_t^{\alpha} L_t^{1-\alpha} - r_t K_t - w_t L_t \,.$$

The government's problem is to balance its budget, that is,

$$T_t = \tau_t^l w_t L_t + \tau_t^k \left(r_t - \delta\right) K_t \,. \tag{2}$$

Finally, the equilibrium requires market clearing:

$$C_t + K_{t+1} - \left(1-\delta\right) K_t = A_t K_t^{\alpha} L_t^{1-\alpha} = Y_t \,. \tag{3}$$

The consumer's problem is characterized by a condition requiring intertemporal optimization for consumption and an intratemporal consumer-leisure optimization condition. These are represented, respectively, by the following equations:

$$\frac{C_{t+1}}{\beta C_t} = 1 + \left(1-\tau_{t+1}^k\right)\left(r_{t+1} - \delta\right) \text{ and} \tag{4}$$

$$\frac{C_t\left(1-\gamma\right)}{\gamma} = w_t\left(1-\tau_t^l\right)\left(N_t - L_t\right). \tag{5}$$

The problem of firms is characterized by conditions of equality between marginal productivity and factor prices:

$$r_t = \alpha A_t K_t^{\alpha-1} L_t^{1-\alpha} = \alpha \frac{Y_t}{K_t} \text{ and} \tag{6}$$

$$w_t = (1-\alpha) A_t K_t^{\alpha} L_t^{-\alpha} = (1-\alpha)\frac{Y_t}{L_t}. \tag{7}$$

Equations (2) through (7) are necessary and sufficient to completely characterize the equilibrium. To simulate the model, we must parameterize our theoretical economy. The parametric specification is given by $\beta = 0.98$, $\delta = 0.05$, and $\gamma = 0.28$. We specified the discount factor and the depreciation rate using the values typically assigned in the literature. The parameter for labor disutility, γ, was calibrated according to equation (8), assuming zero labor tax and considering an average value for the 1960–1998 period consistent with data for consumption, employment, and output. This parameter thus implicitly includes distortions associated with the labor market, and it is consistent with the values reported by McGrattan (1994) for the United States and Bergoeing and Soto (in this volume) for Chile. To evaluate the plausibility of an increase in distortions in the consumption-leisure decision associated with labor market policies, we calibrate the labor tax for equation (8) so as to replicate the behavior of employment in 1998–2002 in Chile. The capital tax is calibrated in equation (9), given β and δ.

$$\gamma = \frac{C_{t+1}}{C_t + w_t\left(N_t - L_t\right)\left(1-\tau_t^l\right)} \text{ and} \tag{8}$$

$$\beta = \frac{C_t}{C_{t-1}\left[1+\left(1-\tau_t^k\right)\left(r_t-\delta\right)\right]}. \tag{9}$$

Finally, C_t corresponds to total private and governmental consumption and exports.

3. Simulations

We used the growth model described above to carry out five simulation exercises, which serve as the basis for analyzing whether changes in factor prices resulting from distortionary tax policies were relevant to Chile's recent economic growth performance. Each exercise consists of simulating the model from 1980 to infinity using actual values for TFP and different values for taxes, associated with unexpected reforms.[8] We then report the impacts of TFP, the capital-output ratio, and the ratio of employment to the working-age population on growth for the 1980–2002 period, in a manner consistent with the growth accounting breakdown presented in the previous section. The first simulation consists of solving the equilibrium with a capital tax of 49 percent for the entire period under analysis. The second exercise takes into consideration the income tax reforms implemented in Chile in the mid-1980s, which is simulated as a fall in the capital tax from 49 percent to 18 percent in 1987.[9] These values were calibrated for the periods 1960–1980 and 1987–2002, respectively, based on the consumption-investment decision implicit in the data—that is, using equation (9). Because the decline in the capital tax rate is unexpected, the equilibrium of the simulation remains unchanged for the first six years. The actual income tax rates in Chile during this period underwent a reduction from 45 percent to 10 percent in 1985 and then an increase to 15 percent in 1991. The capital tax rates calibrated from the data using equation (9), while they represent the set of distortions implicit in the consumption data, are surprisingly similar to the rates actually observed during this period.

The third simulation is perhaps the most interesting for the purposes of this paper. It assumes that the debate about changes to labor legislation that started in 1999 and the significant hike in the minimum wage increased the likelihood of labor becoming more expensive, which is expressed as a hiring tax in the model. This tax is calibrated so as to replicate the decline in employment's contribution to growth as observed in the previous four years and is maintained from then on.

The two final exercises consist of calibrating the capital tax and TFP, respectively, for the 1998–2002 period so as to replicate the observed decline in employment (thereby assuming away the hiring tax of the third exercise).

Table 3 presents our results. The simulation of an economy without capital tax reform significantly underestimates output growth from 1983 to 1998 and overestimates it for the next four years. The main reason for the underestimation is that the drop in the capital-output ratio and employment is overestimated. The opposite occurs in the last four years of the sample period: the

8. From 2003 on, we assume that TFP grows at the same average rate as it did in 1960–2002.

9. Although the reform started in 1985, it wasn't fully implemented until 1989.

model underestimates the increase in capital and the drop in the fraction of total hours worked. The fall in employment is so dramatic that output growth in this period is overestimated by about 1.9 percent.

Table 3. Growth accounting in Chile: Simulations with $\alpha = 0.30$[a]

Period and source of change in Y/N	*Data*	*Simulation 1*	*Simulation 2*	*Simulation 3*	*Simulation 4*	*Simulation 5*
1981–1983						
Total change in Y/N	–10.94	–9.20	–9.20	–9.20	–9.20	–9.20
Contribution of TFP	–7.81	–7.81	–7.81	–7.81	–7.81	–7.81
Contribution of K/Y	5.25	5.60	5.60	5.60	5.60	5.60
Contribution of L/N	–8.38	–6.98	–6.98	–6.98	–6.98	–6.98
1983–1998						
Total change in Y/N	4.76	2.80	4.05	4.05	4.05	4.05
Contribution of TFP	3.36	3.36	3.36	3.36	3.36	3.36
Contribution of K/Y	–0.34	–1.12	–0.33	–0.33	–0.33	–0.33
Contribution of L/N	1.73	0.56	1.02	1.02	1.02	1.02
1998–2002						
Total change in Y/N	0.63	2.53	1.81	0.74	0.20	–6.72
Contribution of TFP	1.51	1.51	1.51	1.51	1.51	–8.02
Contribution of K/Y	1.42	1.11	1.28	1.54	0.99	3.60
Contribution of L/N	–2.31	–0.72	–0.98	–2.31	–2.31	–2.31

Source: Authors' calculations.

a. Simulation 1, our base case, considers a capital tax and no reforms. Simulation 2 includes a capital tax reduction to 18 percent as of 1987. Simulation 3 adds to simulation 2 a labor tax of 6.17 percent as of 1999. Simulation 4 adds to simulation 2 a capital tax increase to 35.16 percent as of 1999. Simulation 5 replicates the exercise in simulation 4, but TFP in 1998–2002 is calibrated to replicate the observed fall in employment (specifically, TFP falls by 5.6 percent annually).

Incorporating the capital tax reform significantly improves the results for the 1983–1998 period. This time, capital falls almost as much as in the data, and the underestimation of employment is only 0.7 percentage points. For the 1998–2002 period, however, the increase in output is overestimated, mainly because the model doesn't capture the fall observed in employment.

Consequently, the third and fourth simulations apply increases in taxes on employment and capital, respectively, to replicate the behavior observed in employment. These exercises test the hypothesis that higher production costs may be responsible for the lower growth observed in Chile in the recent past. The simulations demonstrate that increasing the labor tax from zero to 6.17 percent or the capital tax from 18.0 to 35.2 percent can produce this effect. The second tax, however, worsens the overall prediction while improving the approximation of output performance. In particular, the unreformed model from 1999 overestimates the fall in the capital contribution, so that a higher capital tax worsens the model simulation even further.

Our final simulation imposed a TFP during the 1998–2002 period so as to replicate the observed fall in employment. The rationale for this exercise is that TFP may be mismeasured as a result of unobserved shocks to the economy. The simulation shows that a fall in TFP like the one considered generates a deep fall in output per capita, similar to that observed in 1981–1983, whereas the data show that output per worker actually increased during the period, albeit slightly.

The labor tax option thus appears to be the most plausible explanation for what occurred in Chile after 1998. This labor tax could imply that economic agents perceived an increase in hiring costs as a result of both the large increase in the minimum wage between 1998 and 2000 and the debate surrounding labor reforms.[10] This perception of an increase in the relative price of labor was apparently enough to generate a significant drop in short-term growth in Chile.[11] Labor markets were also reformed in Chile in 1992, when an increase in the required severance pay raised the cost of firing. Labor did not fall, however, the way it did in the last four years of the sample period. The macroeconomic scenario was dramatically different, as the economy was growing at a much faster rate and capital inflows were booming.

We modeled the increased cost of hiring labor as the result of several labor market distortions associated with the observed debate on the labor code and the actual increases in the minimum wage that occurred in Chile in 1999–2002. Our simulations fully

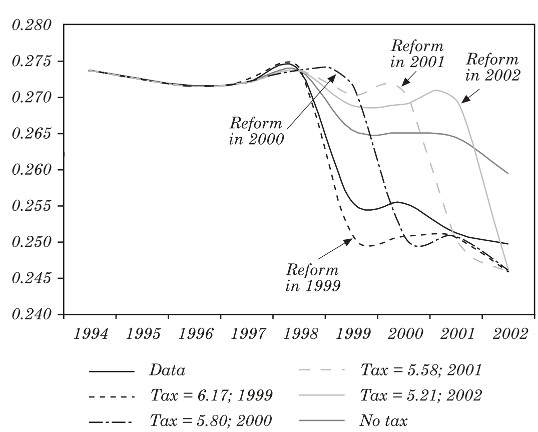
10. Cowan and others (2003) also document the effect of the minimum wage on employment in 1999 and 2000, using a very different approach. In addition, Martínez, Morales, and Valdés (2001) show that a structural break in the labor demand occurred in Chile in 2000. That is, given the aggregate production and relative prices, the Chilean economy demanded less employment at the end of 2000 than in previous years. This downward displacement in labor demand could be explained by an increase in hiring costs, as mentioned above.

11. Beyer (2001) finds that the expected cost of layoffs associated with the new labor structure would rise by about 16 percent.

incorporate the higher cost of labor as of 1999, however. When we simulated this policy distortion as being perceived to happen some periods in the future, the increases in the cost of labor needed to replicate the observed fall in employment were smaller than if the reform was fully implemented in 1999. This simulation captures the timing of the discussion generated in Chile during the period and the uncertainty with respect to the period in which the authority would implement the labor reform. Our results show that the labor tax required to match the fall in employment drops as the expected date of implementation moves farther into the future. Specifically, if the reform is expected to be implemented in 1999, a 6.17 percent tax is required to replicate the actual fall in employment; the required tax falls to 5.8 percent when the reform is expected to occur in 2000, 5.58 percent for 2001, and 5.21 percent for 2002. In a dynamic general equilibrium model with no frictions, agents substitute intertemporally to optimize. Since the reform is expected to become binding in the future, firms decide to temporarily increase their hiring of labor until their labor costs effectively increase.

Figure 1 shows the equilibrium paths of employment for alternative scenarios with respect to the date when the reform is expected to be fully in place. The plotted lines illustrate the actual data for the proportion of hours worked between 1998 and 2002, the simulated

Figure 1. Future Taxes and the Fall in Employment, 1998–2002
Proportion of hours worked



Source: Authors' calculations.

path in the economy without labor taxes, and the employment paths calibrated for labor reforms implemented at alternative dates in the future. If the reform is expected to be binding in the future, the simulated economies with the required taxes match the average fall in employment for the period, but it occurs later that actually happened. Moreover, as discussed above, the further away the expected reform, the lower is the required increase in the cost of labor needed to match the fall in employment.

These results crucially depend on the assumption of fully flexible labor markets until the reform is effectively implemented. Another possibility is that labor markets have frictions—as a result of firing costs, for instance—so that even when the reform is expected several years in the future, the fall in employment is observed in the present. This possibility is not considered here since our simulations in which the reform is assumed to be expected immediately and markets are fully flexible (table 3) generate the same equilibrium as that obtained when the reforms are expected in the future and rigidities are binding in the present.

Our model simplifies reality on several dimensions, one of which is potentially relevant to the analysis. By using a closed economy, we do not explicitly take into account the effect of changes in the terms of trade or other external variables that may be relevant in the case of a small, open economy like Chile. These variables mainly affect what is referred to here as TFP, that is, the residual that remains after considering the accumulation of labor and capital (in other words, all other input factors).[12] The data for 1998–2002 show, however, that the decline in employment, rather than TFP, was the dominant element behind trends in per capita output. Moreover, our exercises include actual TFP, thus capturing the impact of the terms of trade on output. In this context, the relation between growth and employment is not dependent on the assumption of a closed economy. Finally, when we generated the observed fall in employment based exclusively on a drop in TFP (the fifth simulation of table 3), the induced changes in per capita output and the capital-to-output ratio were inconsistent with the observed patterns: the simulation generates a fall in either variable, whereas the data show that both increased.

12. Appendix C demonstrates that our closed-economy model captures fluctuations in the terms of trade through the TFP parameter, A_t. Comparing 1983–1998 with 1999–20002 shows that the contribution of TFP to per capita growth fell by almost 50 percent. This fall is undoubtedly the result of the lower terms of trade since 1998.

4. Conclusions

This study suggests that the recent decline in economic activity in Chile may have been the result of the increased cost of hiring labor perceived by economic agents, here simulated as a labor tax of 6.17 percent. This perception may have stemmed from the combination of the substantive increase in the minimum wage between 1998 and 2000 and the debate that started in 1999 over the labor code reform. The final bill passed by Congress in October 2001 did include provisions that increased the cost of hiring.

Although establishing a connection between the recently observed fall in employment in Chile and the perception of an increase in the hiring cost of labor requires further analysis, this study shows that small expected changes in relative input prices may generate a large substitution of inputs, causing a detriment to short-term economic growth. If the expected increases in input prices remain over time, the fall in economic activity may reduce long-run growth.

Appendix A
Data Sources and Description

For the 1981–2002 period, the gross domestic product series is taken from the Central Bank of Chile. The investment series is from gross capital formation and inventory changes in the International Monetary Fund's *International Financial Statistics*. Capital was generated using the investment series, corrected for the assumed depreciation rate. The working-age population corresponds to people from sixteen to sixty-four years of age, as reported by the World Bank's *World Development Indicators*. Employment series are from the National Statistics Bureau (INE). Finally, total hours worked were calculated using employment per average hours worked in urban Santiago, according to results from the employment and unemployment survey carried out by the Universidad de Chile's Economics Department.

For the 1998–2002 robustness simulations in table 2, we use employment from INE and capital utilization from the Central Bank of Chile.

Appendix B
Alternative Simulation

Table A1 provides the results of growth accounting for the data and for each of the five simulation exercises presented in table 3, assuming $\alpha = 0.45$. Simulations were carried out using $\beta = 0.98$, $\delta = 0.05$, and $\gamma = 0.33$. Capital tax rates, calibrated in equation (9), were in this case $\tau_t^{k} = 0.71$ until 1986 and $\tau_t^{k} = 0.53$ thereafter. The labor tax that replicates employment's contribution (fall) in 1999–2002 is $\tau_t^{l} = 0.0469$.

Table A1. Growth Accounting in Chile: Simulations with α = 0.45[a]

Period and source of change in Y/N	*Data*	*Simulation 1*	*Simulation 2*	*Simulation 3*	*Simulation 4*	*Simulation 5*
1981–1983						
Total change in Y/N	–10.94	–10.15	–10.15	–10.15	–10.15	–10.15
Contribution of TFP	–12.58	–12.58	–12.58	–12.58	–12.58	–12.58
Contribution of K/Y	10.03	10.20	10.20	10.20	10.20	10.20
Contribution of L/N	–8.38	–7.76	–7.76	–7.76	–7.76	–7.76
1983–1998						
Total change in Y/N	4.76	2.08	3.86	3.86	3.86	3.86
Contribution of TFP	3.66	3.66	3.66	3.66	3.66	3.66
Contribution of K/Y	–0.64	–2.19	–0.99	–0.99	–0.99	–0.99
Contribution of L/N	1.73	0.60	1.18	1.18	1.18	1.18
1998–2002						
Total change in Y/N	0.63	1.12	1.46	0.80	0.26	–8.02
Contribution of TFP	0.22	0.22	0.22	0.22	0.22	–13.60
Contribution of K/Y	2.71	1.66	2.53	2.88	2.34	7.90
Contribution of L/N	–2.31	–1.04	–1.29	–2.31	–2.31	–2.31

Source: Authors' calculations.
a. Simulation 1, our base case, considers a capital tax and no reforms. Simulation 2 includes a capital tax reduction to 53 percent as of 1987. Simulation 3 adds to simulation 2 a labor tax of 4.69 percent as of 1999. Simulation 4 adds to simulation 2 a capital tax increase to 60.35 percent as of 1999. Simulation 5 replicates the exercise in simulation 4, but TFP in 1998–2002 is calibrated to replicate the observed fall in employment (specifically, TFP falls by 5.6 percent annually).

As with the case reported in the text ($\alpha = 0.30$), the simulations without tax reforms (columns 1 and 2 in the table) considerably underestimate growth in output per person of working age during the period of sustained growth and overestimate this output during the period beginning in 1998. The capital tax reform that began in 1987 allows us to accurately replicate the factor accumulation process observed in the data. Finally, the labor tax rate necessary to replicate actual employment trends from 1998–2002 is almost equal to the result of the simulation exercise reported in table 3.

From a qualitative point of view, therefore, the results reported in table A1 do not differ from those presented in table 3. The sole difference lies in the relevance of capital and TFP in each case. Nonetheless, $\alpha = 0.45$ is not only implausible from an empirical perspective (see Gollin, 2002), but also suggests an annual before-tax return on capital averaging 23 percent in 1960–2002. This rate of return is too high.

Appendix C

Terms of Trade and TFP in a Closed-Economy Growth Accounting

Assume a small open economy that produces two types of goods: exportable and importable. The aggregate production function in terms on importable goods would then be as follows:

$$Y_t = A_t^M KM_t^{\alpha_M} LM_t^{1-\alpha_M} + P_t^X A_t^X KX_t^{\alpha_X} LX_t^{1-\alpha_X} , \tag{C.1}$$

where KM_t and LM_t are employment and capital in the importable sector and KX_t and LX_t are employment and capital in the exportable sector. P_t^X is the relative price of exports and imports (terms of trade), which is exogenously determined since the economy is assumed to be small. To calculate TFP as in equation (1)—that is, assuming that there is only one good—the actual production function is given by equation (C.1). We thus obtain

$$A_t = \frac{Y_t}{K_t^{\alpha} L_t^{1-\alpha}} = \frac{A_t^M KM_t^{\alpha_M} LM_t^{1-\alpha_{;M}}}{K_t^{\alpha} L_t^{1-\alpha}} + \frac{P_t^X A_t^X KX_t^{\alpha_T} LX_t^{1-\alpha_X}}{K_t^{\alpha} L_t^{1-\alpha}} , \tag{C.2}$$

where $K_t = KM_t + KX_t$ is the aggregate capital stock measured in terms of the importable good and $L_t = LM_t + LX_t$ is total employment expressed in hours of work. Equation (C.2) can then be presented as

$$A_t = A_t^M w_t^M + A_t^X w_t^X P_t^X , \tag{C.3}$$

where $w_t^M = \dfrac{KM_t^{\alpha_M} LM_t^{1-\alpha_M}}{K_t^{\alpha} L_t^{1-\alpha}}$ and $w_t^X = \dfrac{KX_t^{\alpha_X} LX_t^{1-\alpha_X}}{K_t^{\alpha} L_t^{1-\alpha}}$.

Equation (C.3) shows that the changes in TFP estimated under this assumption include not only the actual changes in the productivity level in the economy (given by A_t^M and A_t^X) , but also the efficiency gains or losses stemming from input reallocations (measured by w_t^M and w_t^X) and changes in the terms of trade.

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