Macroeconomic Consequences of International Commodity Price Shocks

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DOCUMENTO DE TRABAJO 2008-27

Programa de Investigación Energía y Cambio Climático
Fedea – Focus Abengoa

July 2008

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June, 2008

Abstract

Chile and Mexico, two Latin American countries that shared similar economic conditions in early '80s are studied in order to shed light about the role commodities play. In a general equilibrium growth accounting framework over the period 1980-2000 we show that Adjusted Total Factor Productivity net of oil and copper, has correspondingly decreased and increased less than $TFP$, suggesting that commodities are a relevant growth factor.

Previous works have shown that Chile recovered more quickly than Mexico did. However, when commodity price changes are taken into account, we show that copper and oil have played a major role in the depressions and recoveries for both economies. We propose a neoclassical growth model where we distinguish between the role of commodities and the rest of the economy. The results complement the findings in Bergoeing et al. (2002).

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*We thank Antonia Díaz and Omar Licandro for very helpful comments. Financial support from the Dirección General de Investigación, project SEJ2007-65552 is gratefully acknowledged.
1 Introduction

Latin American countries are the only “western countries” that are poor. Why Latin America has not replicated Western economic success? Several authors as Cole, et al. [12] find that this failure is primarily due to TFP differences. Latin America’s TFP gap reflects inefficient production.

In a seminal work, Parente and Prescott[23] study the differences in TFP across countries. They find that although countries have access to the same stock of knowledge, they do not all make equally efficient use of this knowledge because policies in some countries lead to barriers that effectively prevent firms from adopting more productive technologies and from changing to more efficient work practices. These barriers exist in a large number of instances to protect interests of specialized suppliers of inputs to a particular production process. They show how the granting and protection of monopoly rights of industry insiders leads to the inefficient use of inferior technologies. This is an argument to explain the different roles copper and oil have played in the Chilean and Mexican economies during the last decades1.

Especially, two Latin American countries that shared similar economic conditions in the past are studied in order to shed light about the role commodities play in the crisis and recoveries of emergent economies. Previous works, leaded by Bergoeing, et al.([6],[7]) have concluded that among several economic theories, the one that explains economic crisis and recoveries in Mexico and Chile, is the structural reforms one.

Other works, like Cole, et al.[12] suggest that big increases in barriers to competition are followed by large productivity decreases, and big decreases in these barriers are followed by large productivity increases. The authors suggest that the link between competition and productivity is one of the leading channels for understanding low productivity in Latin America. The latter applies to the Mexican and Chilean economies given that for many years both countries had state-owned enterprises. CODELCO was the

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1Copper production takes place at private and public firms while oil production occurs in a state-owned firm.
main copper producer in Chile and PEMEX is the state monopoly for oil production in Mexico. Both commodities are important for these economies. For the Chilean economy, copper exports represented 36% of total exports while 8% of total GDP for the period 1985-2000. During the nineties, copper exports accounted for about 40% of Chilean exports, equivalent to 9% of its GDP.

International oil and copper prices have been studied to explain economic growth. Increases in oil prices have been held responsible for recessions, periods of excessive inflation, reduced productivity and lower economic growth for the USA economy. Oil price shocks may also have long-term consequences for economic growth. Notably, the rise in the price of oil in 1974 has been blamed for the productivity slowdown, which is often dated as beginning in 1973 [Barsky and Killian[4]]. Even though the relationship between oil price increases and changes in total factor productivity has been explored extensively, the evidence has not been kind to oil-based explanations of the productivity slowdown. The fundamental problem is that the cost of energy is too small as part of GDP to explain the productivity slowdown[Olson[22]]. Barsky and Killian[4] and Reberlo[27] conclude that disturbances in the oil market are likely to matter less for U.S. macroeconomic performance than has commonly been thought.

The events of the past decade, however, seem to call into question the relevance of oil price changes as a significant source of economic fluctuations. The reason is that since the late 1990s, the global economy has experienced two oil shocks of sign and magnitude comparable to those of the 1970s. Blanchard and Gali[9] analyze the major industrialized countries and isolate the component of macroeconomic fluctuations associated with exogenous changes in the price of oil. They find that the price of oil explains only part of the stagflation episodes of the 1970s and that the effects of a given change in the price of oil have changed substantially over time.

There is a strong relation between the Chilean business cycle and the price of its main export product [Caballero [11]]. There is a close correlation in time series between the spot price of copper and quarterly GDP
growth. The high copper price gave the Chilean economy enough "liquidity" to ride the crisis and experience fast domestic growth despite the large international tight experienced by emerging countries. There is for some authors a representation of Mexico’s sources of volatility that rests on two idiosyncratic factors: even though government finances are in order, the oil revenue dependence has created fiscal fragility and the lack of credibility in monetary policy [Caballero [11]]. For the Mexican economy, the oil revenues represented two thirds of total revenues on average respect total between 1980 and 2000 and oil production represented 5% on average respect total GDP for the same period of time.

In early eighties the Mexican and Chilean economies suffered economic crisis. However, in 1983 while the Chilean economy recovered, the Mexican one stagnated. At the same time, crude petroleum price fell 21% and the copper price fell 39% between 1981 and 1982. After those years the copper price recovered while the oil price remained low after 1981’s oil shock and recovered until the beginning of the present decade. Chile and Mexico have taken advantage of copper and oil endowments and the evolution in international prices for these commodities. In this paper we explore the role copper, oil and commodities prices play in the crisis and recoveries for both economies.

The paper is organized as follows. In section 2 we analyze the hypothesis that have been studied in literature to explain crisis and recoveries for emergent economies. We briefly present oil and copper importance for the economies along time and a hypothesis related to the commodities international prices.

In section 3 we present Mexican and Chilean economic evidence data that is useful to motivate the analysis. Section 4 includes a growth accounting exercise where we decompose into growth determinants to analyze the differences between TFP net of commodities for each economy. Sections 5 and 6 present the neoclassical growth model and calibration respectively. Finally, we present the conclusions of the model.
2 The Commodities Hypothesis

2.1 Previous Studies

Bergoeing's[6] work study the different hypothesis related with the economic crisis and recoveries in Chile and Mexico for the period 1980-2000. Four possible explanations are proposed by the previous authors: (i) Monetarist theory\(^2\), (ii) Corbo and Fischer's theory[13]\(^3\), (iii) Debt Overhang Story\(^4\), (iv) Structural Reforms and (v) Competitive Barriers\(^5\).

Bergoeing, et al.\([6, 7]\) find that even though the first three theories are satisfactory independently, is the fourth theory - the one of the structural reforms - that jointly explains crisis and recoveries in both countries. After comparing macroeconomic variables for both economies, they discard the first three explanations coinciding with Edwards[14] that the timing of the reforms was crucial for the economic recoveries of the countries. In the 1970s Chile had undertaken structural reforms that set the stage for successful performance of the economy in the 1980s. These reforms covered trade policy, fiscal policy, privatization, banking, and bankruptcy. In contrast, Mexico only undertook such reforms in the 1980s or later. It was the bankruptcy policy, in retrospect, that was crucial in making the initial phase

\(^2\)The traditional view is that short of inducing a hyperinflation, the more rapidly a country in a severe recession expands its money supply, the faster it recovers. However, in most Latin American countries, high inflation is often associated with large drops in output, not with substantial recoveries.

\(^3\)One of the principal causes of Chile's crisis in the early 1980s was the government's policy of fixing the nominal exchange rate for the four years before the crisis, while at the same time mandating that wages be adjusted at least one-for-one with past inflation. If declining real wages and a depreciating real exchange rate generated an export boom in Chile, they had even more pronounced effects in Mexico. Yet, after 1983, Chile's economy recovered rapidly while Mexico's stagnated. Consequently, we need to look elsewhere for an explanation of the differences in the recoveries.

\(^4\)Sach's[28] argues that Mexico's large external debt led new investors to fear that most of the returns on any new investment would be taxed to pay off old loans. Hence, new investors were discouraged from investing, and both investment and output remained low.

\(^5\)Cole, et al.\([12]\) find that the channel between competition and productivity is one of the leading channels for understanding low productivity in the theoretical TFP literature. Government policies restricted competition. Policy is central for sustaining persistent competitive barriers. This hypothesis complements the one of Bergoeing, et al.[6] regarding to structural reforms.
of the crisis more severe in Chile than in Mexico. Bankruptcies increased five times between 1980 and 1982 in Chile, but quickly returned to average levels. In contrast, Mexico had an obsolete and unwieldy bankruptcy law from 1943 in place until 2000. The 2000 bankruptcy law includes features similar to Chile's 1982 law, particularly the establishment of bankruptcy specialists, who are intended to play much the same role as "sindicosen" in Chile. Bergoeing's interpretation is that Chile paid the short-term costs of letting many firms fail and this led to a sharp, but short, fall in output followed by a strong recovery. Mexico, in contrast, attempted to muddle through the crisis. It had a less severe initial downturn, but a much weaker recovery.

2.2 The Role of Commodities

We suggest a sixth factor to those previously proposed by Bergoeing, et al.[6] and Cole[12]: copper and oil prices have played a decisive role to explain economic crisis and recoveries for the Mexican and Chilean economies. Can commodities international price shocks explain the different time recoveries for the economies? Apparently, they can. A brief comparison to the data helps us to bring forward some hypothesis. Figures N. [1] and [2] show copper and oil international prices (index) and the ratio of exports of copper and oil to GDP (%) for both countries. We note the following: (i) The highest share of copper exports to GDP takes place in 1989 (with 18% copper exports to GDP), the same year that international copper prices reached its maximum and (ii) the same happens with crude oil for the Mexican economy: the highest oil international price took place in 1981; in the same year the maximum share of oil exports to GDP happened (11% oil exports to GDP).

We present a real price measure for both commodities and is estimated as the commodity price deflator to GDP deflator:

\[ P_{it} = \frac{Q_{it}P_{it}}{Q_{it}P_{i0}} \]  

6Poorly paid public officials
where $i$ refers to copper and oil commodities respectively. We present on graph N. [3] the logarithm of the ratio of copper and oil price deflator to GDP price deflator for each country. The figure shows that for the Mexican economy, the price of oil was higher than for the general index price until 1981, year of the oil price shock. For the Chilean economy, we see that since 1970, the real price measure starts to decrease. That is, even if international copper prices began to increase in early 70's, it was the general price index of the economy the one that increased more than the commodity one.

Figure 1: Crude petroleum and Copper prices. Mexico and Chile.

The intuition for both economies is that international oil and copper price shocks have influenced GDP growth.
Figure 2: Crude petroleum and Copper Exports/GDP. Mexico and Chile

Figure N. [4] shows Total Productivity Factor (TPF)\textsuperscript{7} for both countries. What is striking is that the recovery for the Chilean economy coincides with the years when the international copper price started to retrieve. Figure N. [5] shows copper and oil GDP between 1980 and 2000. We observe that the Chilean economy started to recover in 1983 and the copper production value did it almost at the same time, result of the increase in international prices. For the Mexican economy, the increase in TFP coincides with the increase in international oil prices at the beginning of the eighties. However, after 1981 oil price shock, oil GDP started to decrease coinciding with the Mexican economic crisis.

Is it possible that commodities play an important role on countries eco-

\textsuperscript{7}Taken from Bergoeing, et al.[6]
The following questions arise:

1. What is the contribution of commodities price shocks over Chile and Mexico’s economic performance?

2. Has the positive evolution of copper price shocks influenced the Chilean recovery?

3. Has the mild evolution of oil price shocks influenced the Mexican stagnation?
3 The Data

In this section we briefly present some of the data that is useful to prove our hypothesis. Table N.[4] at the end of the paper shows the Chilean shares of several economic variables. What’s interesting is that copper GDP respect to total GDP has gained share in the last decade. A possible explanation for the previous facts could be the increase in international copper prices. Copper exports respect total exports are approximately two thirds for all the period for which we have data. Table N.[5] shows the shares of the variables for the Mexican economy. We note that the share of oil exports regard to total exports has declined since 1980. The second oil shock took place in 1979 when crude oil price per barrel increased in 48% with respect the previous year; it had a 58% increase also in 1980. These oil price shocks
were transitory: a year after, prices started to decrease sharply. Since the 1979 oil shock, given the unexpected rise in oil prices, the Mexican government decided to increase investments in oil exploration and extraction. As international oil price didn’t recover its 1980 levels, the Mexican economy began to increase its non oil exports and decreased the oil ones. For the case of the Chilean economy, even though international copper prices decreased in the same year as oil prices did; the decrease in this commodity was more severe but it recovered in mid eighties. So copper exports share regard total exports maintained approximately in one third. This can be seen in Figures N. [1] and [2].

Figure N. [6] shows, TFP for both economies. The variable is plotted with and without copper and oil. TFP (see next section for technical notes)
differences are outstanding. From 1980 on, we graph for both economies non copper and non oil TFP. What is stricking is that TFP excluding copper decreased 37% more than TFP in 1990, coinciding with the decline in international copper prices. Starting in 1982, however, the worldwide recession and increasing copper prices led to a recovery in the Chilean economy. Total TFP though decreasing in early eighties, it recovered attaining eighties TFP levels. A preliminary conclusion of these observations is that international copper prices have played a mayor role in the Chilean economy. This view complements Bergoeing’s, et al.[6] findings.

For the Mexican economy, from 1983 on, a gap for both TFP measures starts. International oil prices after 1981 started to decrease steadily (Figure N.[1]). TFP and adjusted TFP (excluding oil) decreased being the latter deeper than the former. The intuition here is that the Mexican economic crisis could have been deeper but oil resources cushioned it, even though the drop of international oil prices.

4 Growth Accounting

For the growth accounting exercise we exclude oil and copper rents from our TFP measures. Although growth accounting shows that most of the changes in output in Mexico and Chile were due to changes in TFP, the contributions of changes in the capital-output ratio and changes in hours worked per working-age person were not negligible. How much of these changes can we account for as equilibrium responses to the observed productivity shocks in a growth model?

4.1 Growth Accounting with Commodities

Let $A_t^{NC}$ be Adjusted Total Factor Productivity (TFP) meaning that this measure does not include the commodities considered for both countries, $Y_t^{NC}$ the output excluding oil and copper GDP for Mexico and Chile respectively ($NC$ refers to non - commodities), $K_t$ is capital, $L_t$ is labor and $N_t$ the number of hours available for work by working - age persons. Equation N.
Figure 6: Chile and Mexico TFP.

[4.1] shows the Cobb-Douglas production function that we employ for the growth accounting exercise.

\[ Y_{t}^{\text{NC}} = A_{t}^{\text{NC}} K_{t}^{\alpha_{K}} L_{t}^{1-\alpha_{K}} \]  
(4.1)

\[ A_{t}^{\text{NC}} = \frac{Y_{t}^{\text{NC}}}{K_{t}^{\alpha_{K}} L_{t}^{1-\alpha_{K}}} \]  
(4.2)

To compute \( A_{t}^{\text{NC}} \) given series for \( Y_{t}^{\text{NC}} \) and \( L_{t} \) we need a value for \( \alpha_{K} \), the capital share of output and to generate series for the capital, \( K_{t} \). To generate series for the last variable, we choose the standard perpetual inventory method (equation n. [4.3]). The depreciation rate used to generate capital series is 5% for both economies. For \( K_{0} \) (the initial condition for capital) we assume that the capital-output ratio grew from 1960 to 1961 by the same amount that it did over the period 1961-1970.
Given the choice of $\alpha_K$ and $K_t$ we computed Adjusted TFP series ($A_t^{NC}$).

Taking natural logarithms of the production function, we follow Hayashi and Prescott[16] in rearranging terms to obtain:

$$\log\left(\frac{Y_{t+1}^{NC}}{N_t}\right) = \frac{1}{1 - \alpha_K} \log A_t^{NC} + \frac{\alpha_K}{1 - \alpha_K} \log\left(\frac{K_t}{Y_t^{NC}}\right) + \log\left(\frac{L_t}{N_t}\right)$$  \hfill (4.4)

where $N_t$ is the number of hours available for work by working-age persons. To decompose the change in real GDP per capita over the period $t$ to $t + s$ we use equation [4.4]:

$$\frac{[\log(Y_{t+s}^{NC}) - \log(Y_t^{NC})]}{s} = \frac{1}{1 - \alpha_K} \left[\log A_{t+s}^{NC} - \log A_t^{NC}\right]$$  \hfill (4.5)

$$+ \frac{\alpha_K}{1 - \alpha_K} \left[\log\left(\frac{K_{t+s}}{Y_{t+s}^{NC}}\right) - \log\left(\frac{K_t}{Y_t^{NC}}\right)\right] + \frac{\log(L_{t+s}) - \log(L_t)}{s}$$

The first term on the right-hand side of equation [4.5] is the contribution to growth of TFP changes, the second is the contribution of changes in the capital-output ratio and the third is the contribution of changes in hours worked per working-age person. On a balanced growth path, output per worker and capital per worker grow at the same rate, and the capital-output ratio and hours worked per working-age person are constant. On such a path, our growth accounting would attribute all growth to changes in TFP. In our growth accounting, therefore, the second two terms measure the contributions of deviations from balanced-growth behavior: changes in the investment rate and changes in work effort.

Figure N. [6] plots the series for TFP and Adjusted TFP detrended 1.4% per year.

The growth accounting exercise let us observe growth and its main components as changes in inputs or $TFP^{NC}$. This is a previous step for
economic growth determinants analysis. We take capital, TFP and hours worked by working-age person series for both countries. The commodities hypothesis is an argument that explains crisis and recoveries for the Mexican and Chilean economies.

<table>
<thead>
<tr>
<th>CHILE</th>
<th>BKKS[6]</th>
<th>GA without Copper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crisis 1981-1983</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in Y/N</td>
<td>-11.19</td>
<td>-16.2</td>
</tr>
<tr>
<td>Due to TFP</td>
<td>-9.61</td>
<td>-13.24</td>
</tr>
<tr>
<td>Due to K/Y</td>
<td>5.29</td>
<td>3.92</td>
</tr>
<tr>
<td>Due to L/N</td>
<td>-6.87</td>
<td>-6.87</td>
</tr>
<tr>
<td>Recovery 1983-2000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in Y/N</td>
<td>4.43</td>
<td>3.74</td>
</tr>
<tr>
<td>Due to TFP</td>
<td>3.57</td>
<td>2.68</td>
</tr>
<tr>
<td>Due to K/Y</td>
<td>-0.17</td>
<td>0.024</td>
</tr>
<tr>
<td>Due to L/N</td>
<td>1.03</td>
<td>1.03</td>
</tr>
</tbody>
</table>

Table 1: Chile’s Growth Accounting. Decomposition of Average Annual Changes.

When we exclude oil and copper in the growth accounting exercises, we detect some differences in the results with respect to those of the work of Bergoeing, et al. What we’re studying are the growth rates of the copper and oil sectors and the rest of the economy. We observe that the commodities sector is more stable than the rest of the economy, even though international commodities price shocks. However, Bergoeing’s result that most of the economic fluctuations in output per working-age person \( \frac{Y_t}{N_t} \) in the two countries were due to changes in TFP, rather than to changes in the capital-output ratio \( \frac{K_t}{Y_t} \) or the hours per working-age person \( \frac{L_t}{N_t} \) is the same. We’re using logarithmic approximations to interpret our results growth rates, which are accurate for small rates, but not for large ones. The logarithmic approximation says, for example, that Mexico’s output per working-age person grew by 13.25% between 1995 and 2000; it actually

15
### Table 2: Mexico’s Growth Accounting. Decomposition of Average Annual Changes.

<table>
<thead>
<tr>
<th></th>
<th>BKKS[6]</th>
<th>GA without Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Crisis 1981-1987</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in Y/N</td>
<td>-3.28</td>
<td>-6.41</td>
</tr>
<tr>
<td>Due to TFP</td>
<td>-5.22</td>
<td>-7.96</td>
</tr>
<tr>
<td>Due to K/Y</td>
<td>2.06</td>
<td>1.66</td>
</tr>
<tr>
<td>Due to L/N</td>
<td>-0.12</td>
<td>-0.12</td>
</tr>
<tr>
<td><strong>Stagnation 1987-1995</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in Y/N</td>
<td>-0.66</td>
<td>-1.39</td>
</tr>
<tr>
<td>Due to TFP</td>
<td>-0.98</td>
<td>-1.90</td>
</tr>
<tr>
<td>Due to K/Y</td>
<td>0.63</td>
<td>0.82</td>
</tr>
<tr>
<td>Due to L/N</td>
<td>-0.31</td>
<td>-0.31</td>
</tr>
<tr>
<td><strong>Recovery 1995-2000</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in Y/N</td>
<td>3.04</td>
<td>2.65</td>
</tr>
<tr>
<td>Due to TFP</td>
<td>2.59</td>
<td>2.14</td>
</tr>
<tr>
<td>Due to K/Y</td>
<td>-0.74</td>
<td>-.68</td>
</tr>
<tr>
<td>Due to L/N</td>
<td>1.19</td>
<td>1.19</td>
</tr>
</tbody>
</table>

8. $\exp^{0.1325} = 1.1416$
9. $\exp^{0.6358} = 1.8885$

Grew by 14.16%. On the other hand, the logarithmic approximation says that Chile’s output per working-age person grew by 63.58% between 1983 and 2000; it actually grew by 88.85%. The major advantage of using logarithms is that they allow us to do an additive decomposition of the determinants of growth. Tables N. [1] and [2] show the growth accounting results. In the second column we present Bergoeing’s[6] results. In the third column we present our’s. Figures [7] and [8] show the results of the growth accounting exercise with and without copper for the Chilean economy. As the figures show, adjusted TFP falls more than TFP. Figures [9] and [10] show the results of the growth accounting exercise with and without oil for the Mexican economy.
In a balanced growth path, capital and labor grow at a constant rate. The same figures confirm that capital and labor were not the major sources of growth for this period. This evidence coincides with Bergoeing’s work. It was not changes in inputs that were responsible for the crises and recoveries in Mexico and Chile, but rather the efficiency with which these factors were used.

Figure 7: Chile Y/N, TFP, K/Y, L/N. Detrended. Copper included

Crisis, recoveries and stagnation periods that run between 1980 and 2000 differ slightly for both economies regarding Bergoeing’s results. When we make our growth accounting with GDP net of commodities, we find that for the periods studied, crisis are more severe and recoveries are less optimistic.

For the Chilean crisis the economy without copper would have had more
severe consequences. During the crisis for the Chilean economy, our growth accounting exercise suggests that the Chilean crisis would have been deeper than it really was\textsuperscript{10}. In real terms, this means that the copper endowment let the Chilean economy grew more than it would without the commodity during the crisis period. At the same time, copper gained share on GDP. This suggests Chile took advantage of international copper prices.

For the Mexican economy, oil is also important as a source of economic growth. During the crisis period, the economy without oil would have decreased 46.9\% instead of the 21.75\% that it did considering this resource.

The second period analyzed in the growth accounting exercise; the

\textsuperscript{10}Actually, the Chilean economy fall in 39.89\% but it would have fallen in 62.58\% without copper.
Figure 9: Mexico Y/N, TFP, K/Y, L/N. Detrended. Oil included

1987-1995 for the Mexican economy and the 1983-2000 for the Chilean one, shows again that $T F P^{NC}$ was the main source of the economic crisis and recoveries for the Mexican and Chilean economies, respectively. Actually, the Chilean economy during its recovery period grew 123.6% but it would have grown 88.85% without copper. In the stagnation period, the Mexican economy had a fall on its economic growth of 5.42%. However, it would have decreased in 11.76% not considering the oil commodity. These results, according to our growth accounting exercise.

Finally, we analyze the recovery period for the Mexican economy for the period 1995-2000. The results are similar to the ones previously analyzed. The Mexican economy in real terms, grew 16.4% but without the oil commodity, it would have grown in 14.17%.
Figure 10: Mexico Y/N, TFP, K/Y, L/N. Detrended. No oil included

The changes in capital and labor accumulation also contributed to growth. However, their participation is negligible. Finally, growth accounting estimations suggest that oil and copper are important sources of economic growth. However, it would be important to consider the substitution of capital and labor between sectors of the economy to make an accurate analysis.

5 The Model

The results of the growth accounting exercise strongly suggest that TFP differences were primarily responsible for the difference in economic performance in Mexico and Chile. We follow Bergoeing, et al.[6] and calibrate a
simple growth model of a closed economy in which consumers have perfect foresight over the sequence of TFP shocks to Mexico and Chile. The model clearly separates commodities ($Y_{it}^C$) and non-commodities GDP ($Y_{it}^{NC}$) for each of the economies. The representative consumer chooses $C_t$, capital $K_t$ and hours worked $L_t$ to maximize

$$\max_{t=1980}^{\infty} \beta^t [\gamma \log C_t + (1 - \gamma) \log (N_t - L_t)]$$  (5.1)

subject to the budget constraint in each period

$$C_t + K_{t+1} - K_t = w_t L_t + (r_t - \delta) K_t + T_t$$  (5.2)

and the initial condition on capital $K_0 = K_{1980}$ given. $N_t$ is hours available and $r_t$ and $w_t$ are factor prices. Given the production technology that we have used for growth accounting, the feasibility constraint for this model is

$$C_t + K_{t+1} - K_t = A_t K_t^{\alpha_K} L_t^{1-\alpha_K}$$

5.1 Environment

In this section we describe the environment. We build upon Bergoeing’s[6] model with the introduction of commodities (oil and copper). In each country, we set $K_{1980}$ equal to its observed value in 1980 and compute the perfect foresight equilibrium path where the sequence of adjusted TFP, $\{A_t^C\}_{1980}^{2000}$ and $\{A_t^{NC}\}_{1980}^{2000}$ is given by data and TFP after 2000 is assumed to grow at the same average rate as it did over the period 1980-2000.

5.1.1 Households and Technology

The economy is populated by a large number of infinitely lived households. A key issue of the model is whether it is consistent with some features of the data. Households own capital ($K_t$) and labor ($L_t$) and receive their marginal products, $w_t$ and $r_t$. There exists an oil sector and a copper sector for these economies. We assume that oil and copper resources can be treated as a pure rent associated to transfers from abroad. The output of
the oil sector is partially sold in international markets at a given price $p_{O,t}$. The output of the copper sector is partially sold in international markets at a given price $p_{C,t}$. Where $O$ is oil for the Mexican economy and $C$ is copper for the Chilean one.

Agents are identical in both countries. Households income is devoted to consumption ($C_t$) and investment ($I_t$). The representative consumer maximizes utility according to [5.1] subject to the aggregate resource constraint of the economy.

$$C_t + K_{t+1} - (1 - \delta) K_t = Y_t^{NC} + Y_t^C$$

(5.3)

where $Y_t^{NC}$ refers to GDP not including commodities production (oil and copper) and $Y_t^C$ is commodities GDP.

5.1.2 Commodities

We assume that oil and copper production do not need capital or labor to be produced so they can be treated as rents.

$$Y_{t,CHL} = C_t p_{C,t}$$

(5.4)

$$Y_{t,MEX} = O_t p_{O,t}$$

(5.5)

where $p_{C,t}$ is copper price and $p_{O,t}$ is oil price.

The technology of the economy is specified as,

$$Y_t^{NC} = F(K_t, L_t) = A_t^{NC} K_t^{\alpha_K} L_t^{1-\alpha_K}$$

(5.6)

where $\alpha_K$ is the capital's share on product. $A_t^{NC}$ describes the state of technology in the non-commodity sector.

5.2 Social Planner’s Problem

The representative agent maximizes [5.1] subject to [5.3] given [5.6], $p_{O,t}$ and $p_{C,t}$.
6 Calibration

The complete list of parameters to estimate is the depreciation rate $\delta$, the inter temporal discount factor $\beta$, labor $s_L$ and capital $s_K$ share on product.

The calibration of parameters $\beta$ and $\delta$ is given by the first-order conditions for maximization problem of the representative consumer in the model economy

$$\beta = \frac{C_t}{C_{t-1}[1 + (r_t - \delta)]}$$

$$\gamma = \frac{C_t}{C_t + w_t(N_t - L_t)}$$

The rest of the parameters are taken from Bergoeing's [6] work. Table N. [3] shows the parameters used for the simulations.

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Table 3: Calibration Parameters

7 Findings

Figures [11] and [12] present the simulations of the model. We present the results of TFP and the $\frac{K_t}{Y_t}$ ratio with and without commodities. For the Mexican economy, the model with non-oil TFP always underestimates the data. However, the model simulations are better than those when TFP is used. For all the period considered, the $\frac{K_t}{Y_t}$ ratio is about 9% below the data ($A_{t}^{NC} < A_{t}$ until 1987). For the Chilean economy, the predictions of the model are better. The model with non-copper TFP starts above the data but immediately goes below. Nevertheless, the model predictions are better.
than those when TFP is considered ($A_t^{NC} < A_t$ until 1983). In this case, the results of the model predict that detrended output in 2000 should be about 20 percent below its value in the data in both countries. In terms of the model’s results, it seems equally surprising that Chile did so well in its recovery period and that Mexico did not do worse.

Figure N. [12] shows the $\frac{K_t}{Y_t}$ ratio with and without commodities for both countries. For the Mexican economy, we appreciate that the adjustment in the $\frac{K_t}{Y_t}$ ratio of the model with non-oil GDP is better than the model with total GDP. The predictions of the models until 1987 are similar, however, from then on the predictions of the model indicate that the capital-product ratio should be about 20% below the data. The capital-product ratio simulations of the model for the Chilean economy are worst than for the Mexican one. For all the period, the models predictions (considering $Y_t^C$ and $Y_t^{NC}$) are below the data.

The model proposed is consistent with data. The results of our numerical experiments coincide with those of Bergoeing’s[6]: differences in TFP, including induced effects on factor inputs, drive all of the differences in the economic experiences of Chile and Mexico. Tax reforms together with international commodities price shocks made Chile’s recovery stronger and Mexico’s depression less severe than they would have been otherwise. There is no significant role left to be played by frictions in factor markets that do not show up in TFP.

The message is clear: changes in tax policy were undoubtedly important in both countries, but they cannot explain more than a small fraction of the differences in the recoveries. Within the context of our model, introducing the role of copper and oil commodities in the economies helps to explain in a better way the recoveries and crisis for both Latin American countries. Consequently, to explain the different experiences in Mexico and Chile, we need to explain the different performances of TFP.
Final Comments

The challenge of Bergoeing’s et al. [6] work was to use their same model to explain why Chile boomed while Mexico stagnated. In this sense, the main contribution of this paper is to complement the results they obtained. This paper provides a direction pointing to where an explanation is. We follow Bergoeing’s model and introduce the role commodities (oil and copper) play in the recoveries and crisis of two Latin American economies. The aim of the model was to help to understand if introducing these commodities, the model predicts the crisis and recoveries in Chile and Mexico. The main result of the neoclassical growth model presented in this chapter is that non commodities TFP helps to explain crisis and recoveries of the Chilean and Mexican economies during the period 1980-2000. The result complements
Bergoeing’s et al.[6] work.

The results suggest that part of the recovery in Chile was because copper international prices were doing it well. For the Mexican economy, part of the non recovery was because oil international prices were low.

The message is clear: copper international prices and fiscal reforms joined together to make the Chilean economy recover. In this sense, oil and copper as commodities are not ruled out as a source of economic growth for both economies.

Several questions remain open. First, was the economy doing it well because the commodities were doing it well? and second, we need to introduce factor substitution between sectors to make a more accurate analysis of economic performances for both economies.
### CHILE

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Table 5: Mexico’s Variables Shares
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