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**Copper and the Chilean Economy, 1960–98**

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**Abstract**

The paper concludes that world copper prices play an important role in short-term fluctuations and probably influence long-term growth of the Chilean economy. While many mechanisms may be at work, investment seems to play a major role. In a copper price boom, the higher copper price and associated capital inflows create upward pressure on the real exchange rate. The appreciation of the Chilean peso during the first part of the copper cycle contributes to lower inflation, which could partly explain why real wages grow more rapidly in this part of the cycle.

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## I. INTRODUCTION

Chile has experienced very strong growth in the last decade, but copper continues to have a major role in the economy. The purpose of this paper is to examine the dynamic relationships between the copper price cycle, the Chilean business cycle, and the various GDP components in the country's economy.<sup>2</sup>

The Chilean economy is very dependent on copper according to several measures. In terms of exports, copper accounted for 42 percent in 1997, while the mining sector, which includes other minerals, accounted for 50 percent. In terms of GDP, the mining sector accounted for 8 percent in 1997.<sup>3</sup> In terms of fiscal revenues, CODELCO, which is the state company that manages the public copper mines (see Box 2), contributed 3.6 percentage points of GDP in 1997, representing more than 10 percent of the central government's revenues.<sup>4</sup>

While such a high dependency on a natural resource is common to other countries, a singular characteristic of Chile is that both the mining sector and the rest of the economy have grown at roughly the same pace over the last decade, even though Chile's GDP has grown at an average annual rate of 8 percent during that period.<sup>5</sup> This fact is surprising given the slightly different reasons behind growth of the mining sector and that in the rest of the Chilean economy. The mining sector grew because of the rapid expansion of production (an increment of more than 130 percent from 1988 to 1997) due to massive capital inflows, while the other sectors of the economy expanded in response to profound structural reforms and a stable macroeconomic environment.

The massive investment in the copper sector of recent years, and the large reserves of copper (28 percent of the world's proven and economically viable reserves are in Chile) indicate that copper will remain very important in the Chilean economy in the future. This has prompted a debate on several aspects of copper exploitation. This paper focuses on the positive aspects of the behavior of the Chilean economy in relation to copper.

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<sup>2</sup>Box 1, and Tables 1 to 3 provide an overview of the world copper market and of Chile's relative position in that market.

<sup>3</sup>The real importance of the copper sector is probably underestimated given that many industrial activities are related to the mining sector.

<sup>4</sup>These and several following figures are taken from the CODELCO statistical bulletin.

<sup>5</sup>Copper accounted for 42 percent of Chilean exports in 1986, which is the same share as in 1997. Also, considering the mining sector overall, the share of exports was 50 percent in 1986, and is the same in 1997. In terms of GDP, the mining sector declined steadily from 10 percent in 1986 to 8 percent in 1997.

Table 1. World Copper Reserves  
(In millions of metric tons)

Country	Basic Reserves 1/	Percent of total reserves	Reserves 2/	Percent of total reserves
Chile	163.0	25.9	88.0	27.5
United States	90.0	14.3	45.0	17.0
China	37.0	5.9	18.0	5.6
Poland	36.0	5.7	20.0	6.3
Zambia	34.0	5.4	12.0	3.8
Russia	30.0	4.8	20.0	6.3
Congo (Kinshasa)	30.0	4.8	10.0	3.1
Mexico	27.0	4.3	15.0	4.7
Peru	24.0	3.8	7.0	2.2
Canada	23.0	3.7	10.0	3.1
Australia	23.0	3.7	7.0	5.1
Other Countries	113.0	17.9	68.0	21.3
Total	630.0	100.0	320.0	100.0

Source: *U.S. Geological Survey, Mineral Commodities Summaries (January 1998)*.

1/ Basic reserves include all known reserves.

2/ Reserves include only reserves which are economically viable.

Table 2. World Copper Production by Countries or Regions  
(Percentage of world production)

	1992	1993	1994	1995	1996	1997	1998
Chile	23	24	25	27	31	32	34
United States	21	21	21	20	19	19	17
Canada	9	9	7	8	7	6	7
Zambia	5	5	4	4	3	3	4
Peru	4	4	4	4	5	5	4
Europe	4	4	4	4	3	3	3
China	4	4	5	5	4	4	3
Asia excluding China	8	8	8	9	8	8	9
Others	21	21	22	21	20	19	18

Source: *World Metal Statistics* (various issues).

Table 3. Copper Consumption by Countries or Regions  
(Percentage of the world consumption)

	1992	1993	1994	1995	1996	1997	1998
<b>Europe</b>							
Germany	10	8	9	9	8	8	9
France	5	4	4	4	4	4	5
Italy	5	4	4	4	4	4	4
UK	3	3	3	3	3	3	3
Other Europe	16	14	13	13	12	12	13
<b>Africa</b>	1	1	1	1	1	1	1
<b>Asia</b>							
Japan	13	13	12	12	12	11	10
China	8	9	7	9	9	9	8
Taiwan	4	4	5	5	4	4	4
South Korea	3	4	4	4	5	5	4
Other Asia	6	7	7	7	8	9	9
<b>America</b>							
United States	20	21	23	21	21	21	22
Canada	1	2	2	2	2	2	2
Mexico	1	2	2	1	2	2	2
Other America	3	3	3	3	3	3	3
<b>Oceania</b>	1	1	1	1	2	1	1

Source: *World Metal Statistics* (various issues).

### Box 1. Copper

**Copper** is an important input in a wide range of industries due to its thermal and electrical conductivity. It is used in the construction industry as wire and tubing for plumbing and air conditioning, in manufacturing to build electronic equipment and in the automotive industry for electrical equipment, and in telecommunications to build copper cables.

Almost half of the world's known **reserves** of copper are concentrated in two countries (Table 1): Chile accounts for 28 percent of the reserves, while the United States accounts for 17 percent. Other individual countries have considerably fewer reserves. The distribution of copper **production** is even more concentrated, with Chile producing 34 percent of the world output, and United States 17 percent.

World **demand** for copper presents wide regional variation over time (Table 3). Despite declining shares, North America and Western Europe remain the biggest users of copper with a combined share of 59 percent of world demand. Given the extensive use of copper in the construction, light automotive, and telecommunication industries, an increasing share of copper is used in newly industrialized economies. Asia, excluding Japan, increased its world share in consumption of copper from 20 percent in 1992 to 25 percent in 1997, making the region the most dynamic market for copper.

The **price** of copper is quite volatile because demand and supply are not very sensitive to price changes in the short run. Additionally, Borensztein, et al. (1994) report that commodity prices have become more volatile over the last decade. Formal tests show that the hypothesis of unit root cannot be rejected even with large critical values.

The **long-term prospects** for copper production are good. Copper's particular physical characteristics, make it appealing in a wide range of applications, and the substitution of new materials unlikely, although the metal faces increasing competition from optic fibers in the telecommunication industry, and from aluminum in the construction and automotive industries.

## Box 2. CODELCO and the Institutional Framework

**CODELCO** (*Corporación Nacional del Cobre de Chile*) is Chile's state-owned company dedicated to the extracting and selling copper from the state-owned mines. CODELCO is wholly owned by the Chilean government which receives under various forms the company's entire annual profits, which have been around US\$1 billion per year in the 1990s, representing on average 11 percent of Chile's fiscal revenues. CODELCO is also one of the largest economic players in Chile, with US\$873 million invested in 1997. Additionally, CODELCO produces more than 10 percent of the world's copper production.

Before the 1970s, Chilean copper mines were owned mainly by U.S. multinational companies, such as Anaconda, Kennecott, and Cerro corporation. In 1971 the Chilean congress voted a constitutional reform to nationalize the large mines owned by multinationals. In 1976, the military government created CODELCO to administer the nationalized copper mines (Chuquicamata, El Salvador, Andina, and El Teniente). As a consequence, in the late 1970s the Chilean government had the monopoly over large mines, which accounted for 85 percent of the national copper production.

In 1980, the military government included the public ownership of CODELCO in the constitution and readmitted foreign investment in new large mines. This and the decree on foreign investment enacted in 1974 created the legal framework for foreign investment in the mining sector. Besides the constitutional protection to the right of private ownership of mines, Chile adopted a fiscal regime for mining with no royalty payments and low tax rates on profits, and the possibility of reducing even further the tax burden through accelerated depreciation; this provided strong incentives for investment in mining. Foreign direct investment in the mining sector grew from a yearly average of US\$90 million in the period 1974-89 to US\$803 million in 1990. During the period 1989-95, the mining sector accounted for more than half of foreign direct investment to Chile.<sup>1</sup> As a result, the share of large private mines ("*mediana minería*") rose from 6 percent of output in 1980 to 54 percent in 1996, while the share of CODELCO shrank from 84 to 39 percent over the same period.<sup>2</sup> The large private investments in mining have pushed CODELCO to develop new projects. In 1996-97, investment by CODELCO almost doubled compared with the previous years in order to open the new mine "Rodomiro Tomic" and to improve productivity in its other mines.

Besides CODELCO ("*gran minería*") and the large private companies ("*mediana minería*"), there are several small companies ("*pequeña minería*") representing about 10 percent of the production, which sell their output to the public enterprise ENAMI for refining and selling in the international market. These small companies have relatively high operational costs and usually stop production when the price of copper falls below a certain level.

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<sup>1</sup> Starting in 1995, the privatization of utilities and the growth in other industrial investment has reduced the relative importance of the mining sector, so that mining accounted for less than one third of foreign investment in 1997.

<sup>2</sup> The name "*mediana minería*" (medium sized mining) is somewhat misleading because some of the mines included in this category, such as Escondida, are larger than the mines listed in "*gran minería*" (large sized mining). The denomination refers to the relative size of the mines at the time of nationalization. Now these categories only describe ownership, with "*gran minería*" including the mines owned by CODELCO, and "*mediana minería*" including privately-owned companies.

The paper is divided into five sections: Section II contains a brief review of the literature on copper and the Chilean economy, Section III presents some stylized facts on the links between copper and the Chilean business cycles, focusing on the short run, Section IV analyzes the long-run relationships between copper exports and macroeconomic variables, Section V discusses some possible transmission mechanisms, Section VI draws some policy conclusions and is followed by an Appendix.

## II. LITERATURE REVIEW

In addition to the vast literature on natural resources and growth, there are some specific studies on copper and Chilean economic policy that consider both long-term and business cycle issues. Papers that focus on the long-term effects of copper include: Morandé and Quiroz (1996), Bande and French-Davis (1989), Romaguera and Contreras (1995), and Mognillansky (1998). Papers that focus on copper and cyclical issues include Calvo and Mendoza (1998).

Morandé and Quiroz (1996) consider the long-term effects of the mining sector on the real exchange rate, wages, and fiscal revenues. By analyzing the experience of the early 1990s, they conclude that copper has had a modest effect on the real appreciation of the exchange rate and wages, but negligible effects on inflation. Furthermore, they notice that the mining industry is capital-intensive and that capital is largely imported, so that local resources are not displaced and the possibility of a Dutch disease is very small. Additionally, copper brings considerable resources to Chile's Treasury. The authors conclude that copper is a "full-blessing" and that any "significant intervention by government authorities to try to counterbalance the small negative effects in some sectors would likely bring harmful side effects."

Bande and French-Davis (1989) find that copper contributed to the downturns of late 1974 and 1981, while the price upturn of 1987-89 was a determinant for the sharp recovery that took place in that period. They notice that the main objective of public policies on copper between 1973 and 1988 was to expand production and to set up appropriate mechanisms to offset the economy's external vulnerability. They argue that, while the first objective was partially met, the second objective has not been reached because "of the excessive reliance on the market mechanisms to counteract fluctuations of the copper price."

Romaguera and Contreras (1995) study the impact of copper in the context of structuralist analysis and conclude that the copper price cycle has had an important effect on Chilean growth in the last 40 years by determining the external and fiscal constraints. They also argue that the huge fluctuations of copper prices have made fiscal revenues and the availability of foreign currency very unstable and have had negative consequences on growth in the long run.

Moguillansky (1998) focuses on investment in the mining sector. She argues that the institutional framework (the law on foreign investment (1974) and the law on mining (1980)) created the necessary conditions for the increase of copper production in the early 1990s. She also finds evidence that foreign investment in the copper sector has had a positive effect on CODELCO, which invested heavily in the beginning of the 1990s to maintain efficiency.

Calvo and Mendoza (1998) study the effects of copper on Chilean business cycles in the period 1986 to 1997. They find that the lagged core terms of trade, which are defined as the ratio between the price of copper over the price of oil, Granger-cause IMACEC, which is a monthly indicator of economic activity. Additionally, they find that “after two years about one quarter of the variability in the growth of IMACEC is attributable to the core terms of trade.” The authors also present evidence that “changes in the exchange rate and in the performance of the external sector help explain the decline in inflation.”

Although the papers reviewed use different frameworks (neoclassical or structuralist), different methodologies (time series analysis and case studies), and different periods of analysis, they all reach the conclusion that copper has played a crucial role in the Chilean economy.

### **III. SHORT-RUN PERSPECTIVE: COPPER PRICE CYCLE AND THE CHILEAN BUSINESS CYCLE**

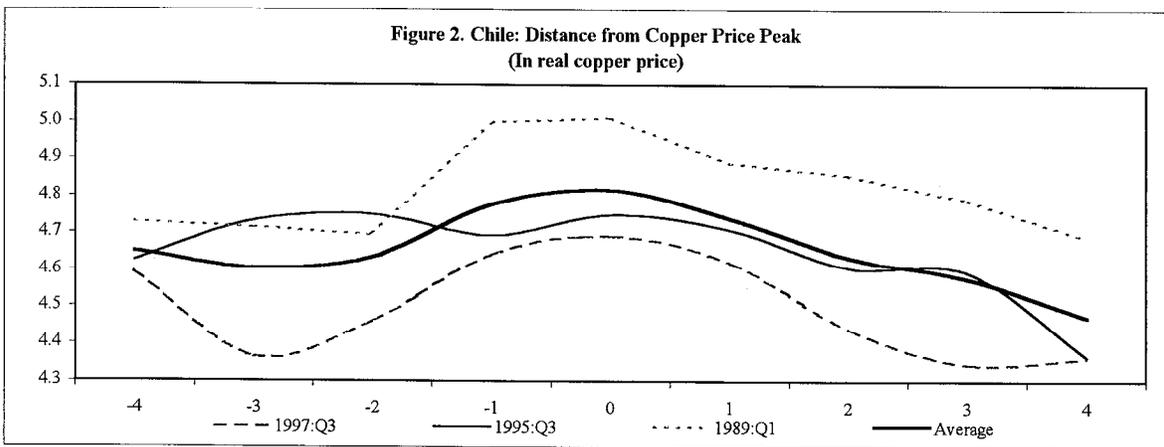
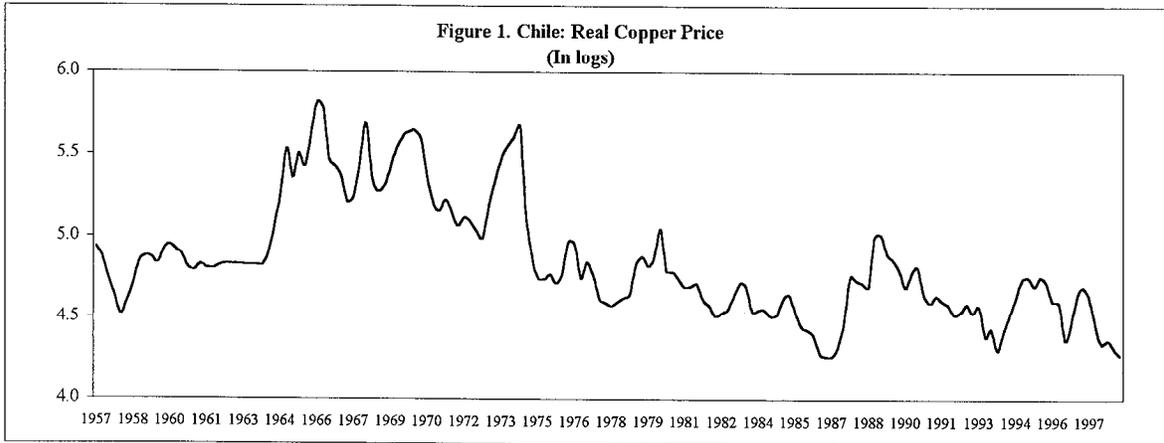
This section presents evidence on the connection between the copper price cycle and the Chilean business cycle. In the first part, the behavior of Chile’s GDP is examined and its main components are compared with the copper price cycles; in the second part, some price variables (such as wages, exchange rates, price of shares) are considered and compared with the copper price cycles. The focus is on the behavior of the economy during the copper cycles, and highlights the peculiarities of each cycle.

Figure 1 shows the evolution of the (log) real price of copper in the last 40 years.<sup>6</sup> Copper prices show a negative trend that started in the mid-1960s and lasted until the mid-1980s. Around this trend, copper prices have shown dramatic variability which is typical of a natural resource for which both demand and supply are inelastic to price changes in the short run. Variations around the trends are the focus of this section. The long-term negative trend is discussed in Section V.

The short-term analysis focuses on the period after 1986 because official quarterly data on national accounts are available only after 1986, there are relatively few economic structural breaks in this period, and the price of copper does not have a clear trend after 1986.

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<sup>6</sup> The manufacturing export unit value from *IFS* is used in order to deflate the nominal price of copper.



The absence of a trend allows us to focus on short-term fluctuations without worrying about secular movements. Since 1986, copper has had three clear cycles, which peaked in 1989:Q1, 1995:Q3, and 1997:Q3. Over the last decade, the frequency of the cycles seems to have increased, while the period between peaks and troughs has diminished. During the first cycle, the price of copper more than doubled in two years, and then halved to its original level in the following four years; during the second cycle, the copper price rose by 60 percent in seven quarters, and halved in one year; in the last cycle it rose by 40 percent in one year, to go back to its original level in less than one year. Figure 2 shows the behavior of the log of the real copper price during the three cycles, and a summary line showing the “average cycle.” The lines are centered with the respect to the horizontal axis so that the peaks of the cycles (1989:Q1, 1995:Q3, and 1997:Q3) correspond to zero.

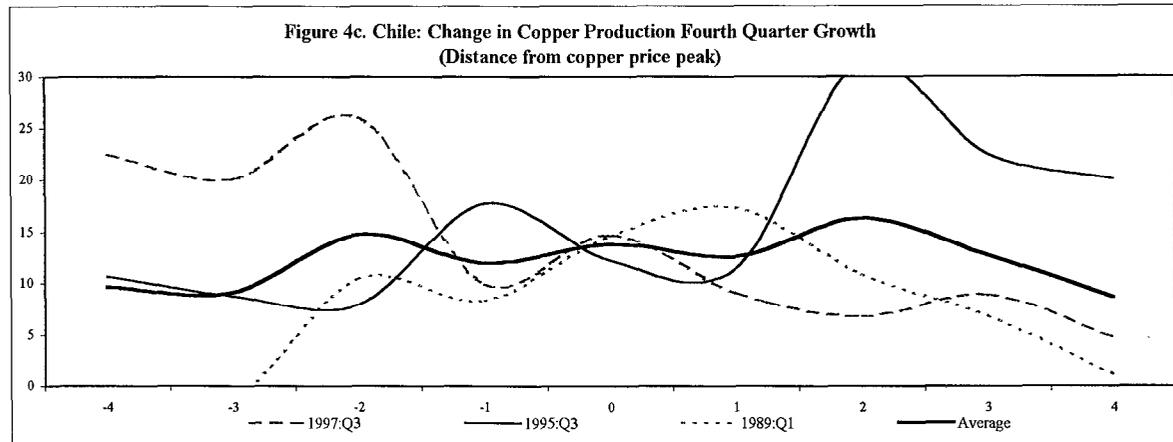
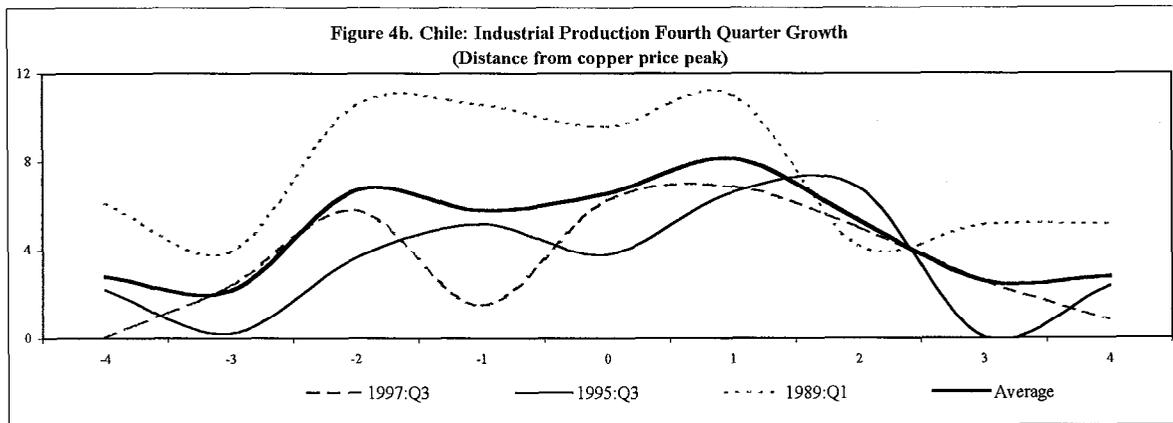
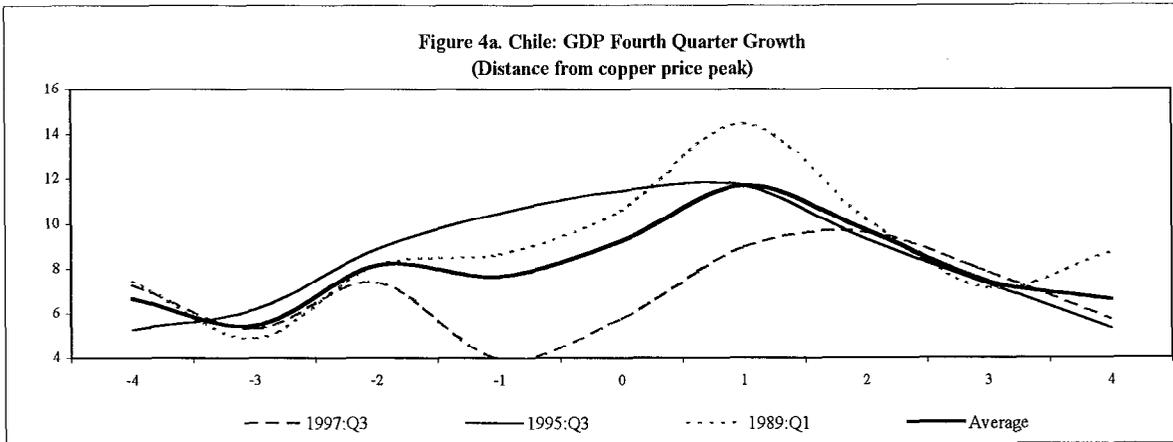
Figure 3 shows the strong correlation that exists between fourth-quarter GDP growth and the real price of copper.<sup>7</sup> In all three copper price cycles, GDP growth peaked one or two quarters after the copper price peaked. The expansion starting in 1990:3 and peaking in 1992:3 was the only recent Chilean business cycle that was not anticipated by the copper price cycle. However, this business cycle is atypical both for internal and external reasons. Internally, there was the transition from the military regime to a democratic government. Externally, the expansion corresponded to the wave of capital flows to emerging markets. Schadler, Carkovic, Bennett, and Kahn (1993) explain that countries that received large capital inflows in the early 1990s experienced an economic boom, although the surge in economic activity in Chile took place with some lag. In addition, Moguillansky (1998) reports that there was considerable investment in the mining sector in the early 1990s following the previous price boom of the late 1980s. The analysis here concentrates on the three business cycles that are directly correlated with the copper price cycles.

Figure 4a shows the four-quarter real GDP growth in the three episodes under consideration. While in the first two cycles economic activity accelerated rapidly as the copper price increased, the last cycle is atypical because economic activity did not increase very fast during the expansionary phase. All three cycles share a sharp decline in the rate of growth of real GDP starting one or two quarters after the peak of the copper price.

Before analyzing the behavior of the GDP components, it is useful to clarify two issues. First, the strong relationship between GDP growth and the copper price cycle could reflect the impact of copper prices on copper output since mining, which is mostly copper, accounts for about 10 percent of Chile’s GDP. To examine this issue, industrial production is used as an indicator of economic activity which does not include the copper sector directly; Figure 4b shows the fourth-quarter growth of industrial production during the copper cycles. Also, in this case, there is a strong correlation between the copper cycle and the cycle of economic activity. So it can be concluded that the relationship between copper cycles and

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<sup>7</sup>For an overview of the stylized facts of the Chilean business cycle in the period 1986-97 see Belaisch and Soto (1998).



GDP growth is not merely a reflection of the evolution of the mining sector. Second, it is important to clarify how a short-run shock in the copper sector is identified; the alternatives are price changes and revenue changes. This analysis uses prices because they are largely out of Chile's control in the short run. In fact, the growth of copper production does not change significantly over the copper cycle (Figure 4c), reflecting the fact that it is difficult to increase production in the short term. This allows us to focus on prices in the short-run analysis, rather than on export revenues, which is appropriate for long-run analysis when supply is responsive to price.

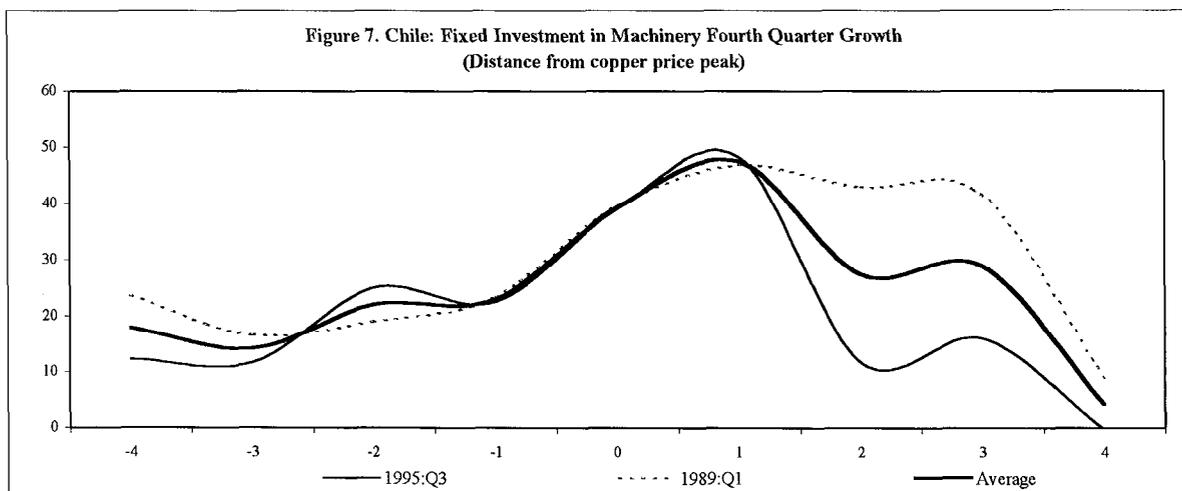
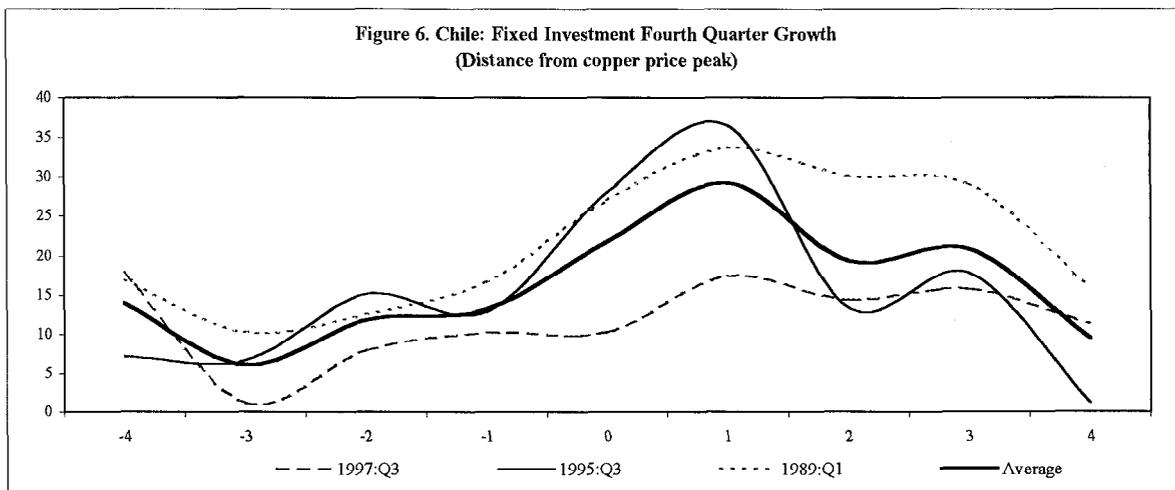
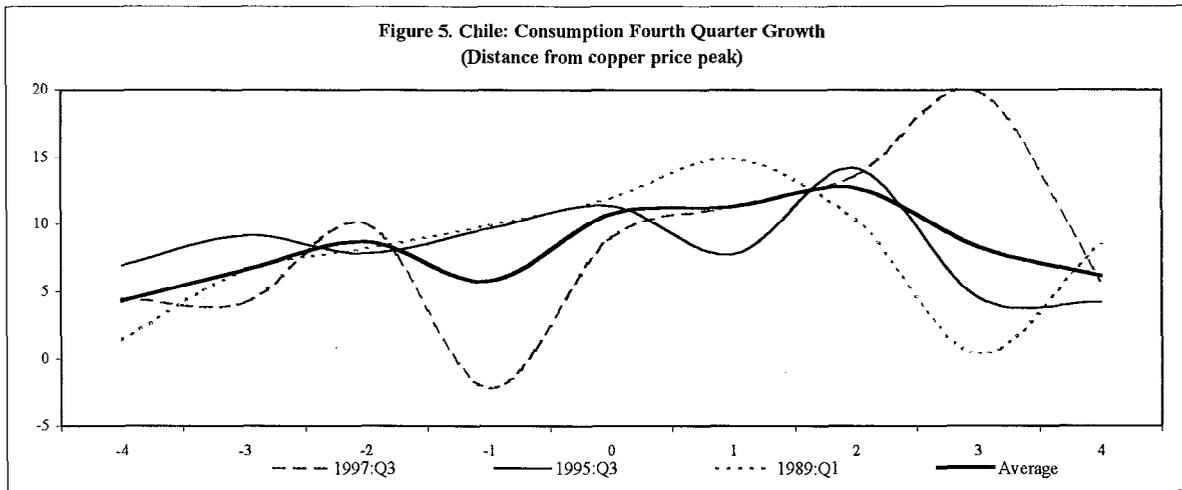
Figures 5 to 8 show the behavior of the domestic components of GDP through the three copper price cycles. All percentage changes are with respect to the same quarter of the previous year. Even though all components of GDP are procyclical, the different components show different patterns around the cycle. Private consumption tends to be smoother and to lag so that the peak in consumption is on average two quarters after the peak in the copper price. Even though private consumption is smoother than the other components of aggregate demand, its variability is quite remarkable and is difficult to reconcile with standard models of aggregate consumption behavior. The excess volatility of consumption could be explained by liquidity constraints, which are eased during periods of high copper prices.<sup>8</sup>

Investment is more sensitive to the cycle, and in all cases peaks one quarter after the copper price peaks. On average, fixed investment grew by more than 30 percent on a four-quarter basis at the peak of the cycle. Given the importance of investment for the subsequent analysis, fixed investment is divided into two components: machinery and construction (Figures 7 and 8).<sup>9</sup> Taken singularly both components show an even more remarkable similarity across cycles than aggregate investment. In particular, the investment in machinery, which is mostly imported, surged virtually at the same rate in both cases for which the data are available.

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<sup>8</sup> In the United States, the smoothness of consumption is mostly due to low volatility in the consumption of nondurable goods, which is roughly half as volatile as GDP, while durable goods are more volatile than real GDP (Kydland and Prescott, 1990). In the case of a developing country, most durable goods are imported and are very sensitive to the real exchange rate. As reported below, Chile's real exchange rate is linked to the copper cycle. This could explain why in periods of copper booms, consumption of imported durable goods increases, explaining the "excess volatility" of consumption over the cycle. Unfortunately, there are no disaggregated data on consumption of durable versus nondurable goods to check this hypothesis.

<sup>9</sup> Disaggregated data on investment in construction and machinery are not available on a quarterly frequency. The quarterly data were constructed assuming that the shares of investment in the two categories were the same during the year.



The foreign components of GDP and the aggregate GDP changes behave differently in relation to changes in copper prices. Imports, which are highly correlated to investment and consumption of durable goods, show a pattern similar to investment. Figure 9 shows that imports surged in tandem with every cycle and peaked one or two quarters after the peak in the price of copper. Figure 10 shows no clear pattern for the fourth-quarter growth of exports.<sup>10</sup> This is not surprising given that copper output is not responsive to copper price changes in the short run, while other exports are not influenced by the mining sector and could be damaged by the appreciation of the real exchange rate.

The behavior of the **trade balance** is ambiguous in principle because it depends on revenue from copper exports, on other exports (which are hurt by the appreciations accompanying a higher price of copper), and on imports (which surge during a copper price boom). Figure 11 shows no marked pattern of the trade balance across copper cycles.<sup>11</sup> However, the trade balance seems to be stable during the copper boom, while worsening significantly after the copper price peak by an average of two GDP percentage points. Figure 12, which analyzes four-quarter differences in the trade balance, also shows a progressive worsening of the trade balance starting one quarter before the peak.

The **current account** as a share of GDP does not present a clear pattern over the three cyclical episodes (Figure 13). Figure 14 shows the **capital account** as a share of GDP; as the copper price increases, there is a surge of capital inflow which is largely due to the increase of foreign direct investment (Figure 15). This observation matches the observation that there is a surge in investment during the first phase of a copper boom; Figure 15 shows that foreign direct investment has played an important role in financing these surges. Copper booms spur an investment boom in the mining sector, especially after the mining law of 1980 (see Mogueillansky, 1998) which provided the legal framework for foreign investment in the mining sector. Since the quarterly data in the analysis start in 1986, the full effect of the investment booms are observed to correspond with the copper booms.

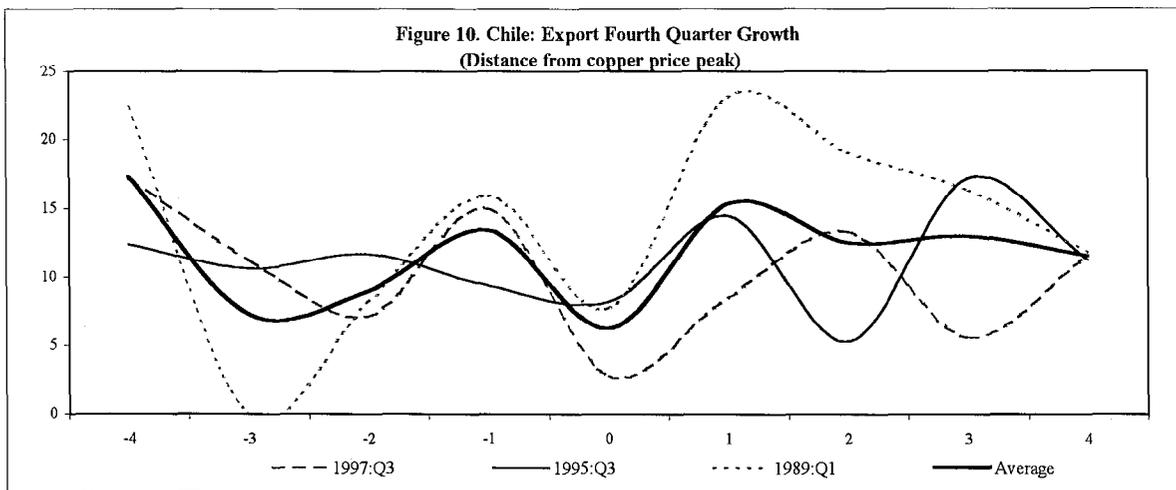
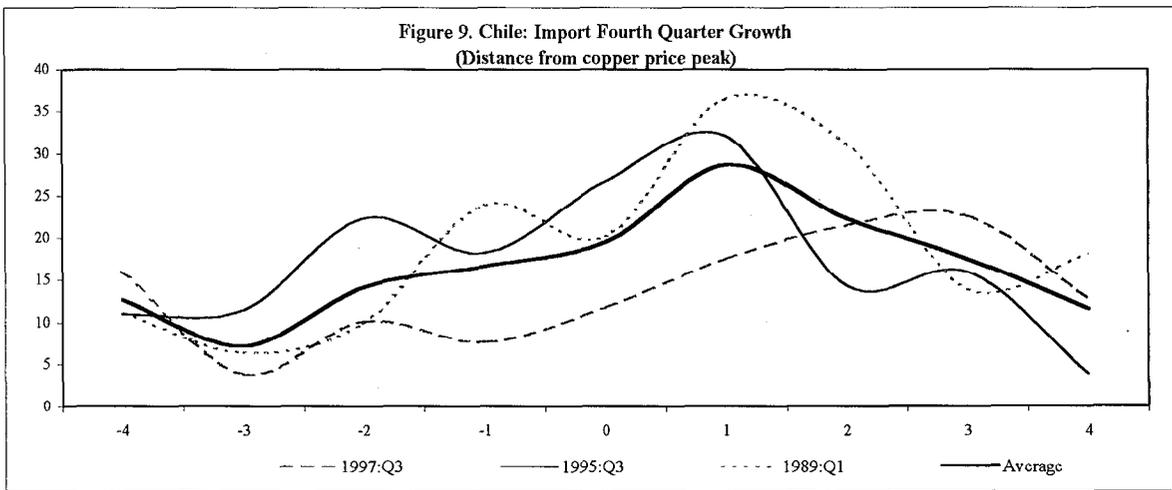
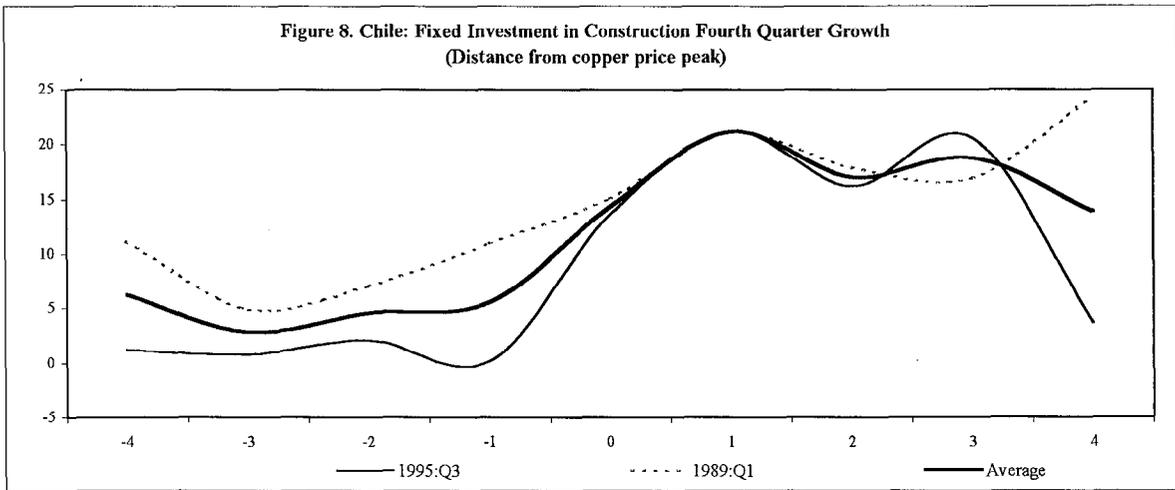
The effects of copper cycles on the **exchange rate** are quite strong. Figure 16 shows that the changes in the nominal exchange rate are strictly correlated with the copper cycle.<sup>12</sup> In all three cases, the nominal exchange rate appreciates (or depreciates less) during the copper boom and depreciates (or appreciates less) as the price of copper declines. On average,

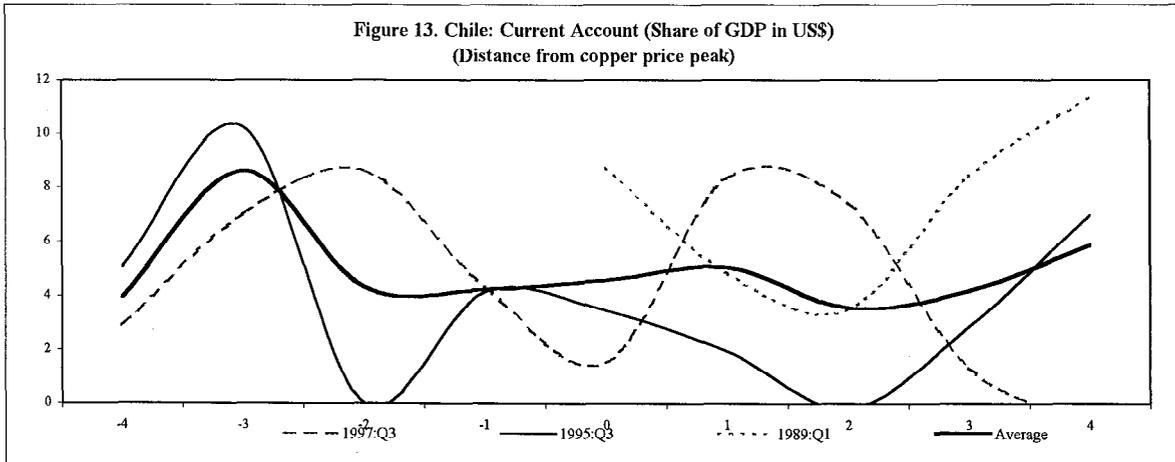
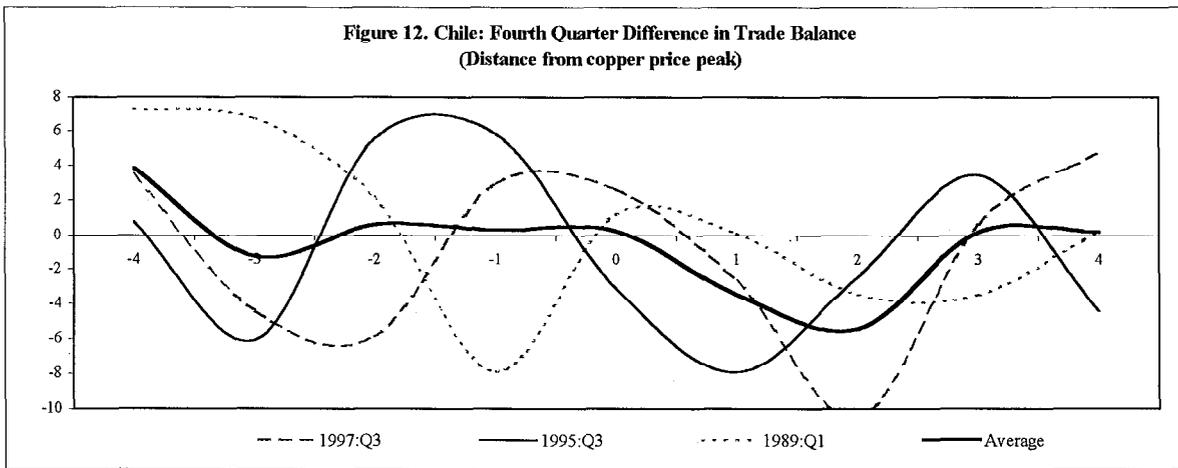
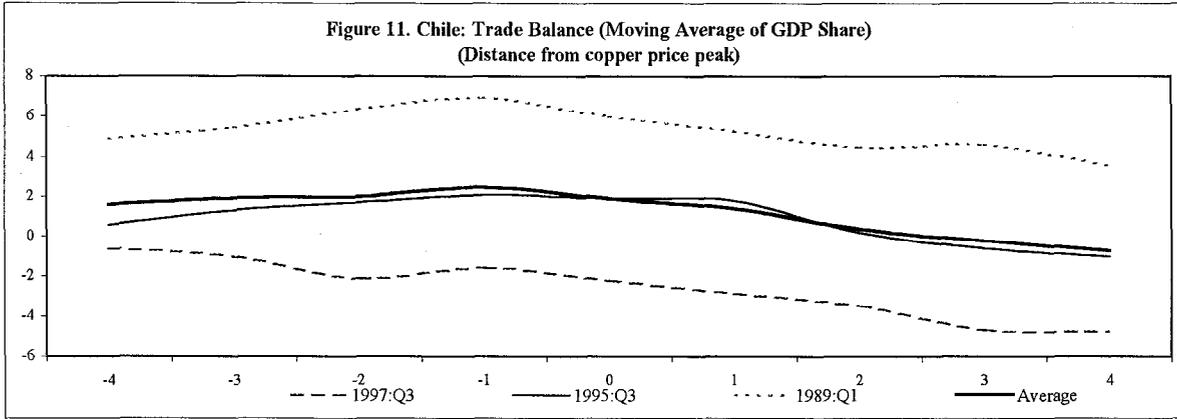
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<sup>10</sup> Both imports and exports are measured in constant Chilean peso terms.

<sup>11</sup> Figure 11 shows a moving average of the trade balance in order to control for the strong seasonal variations that characterize imports and exports. For this reason, Figure 12 also shows the four quarter differences instead of the quarter-to-quarter differences. Finally, these pictures are in terms of local currency; by using dollars, a slightly different picture emerges.

<sup>12</sup>The nominal exchange rate is expressed as pesos per U.S. dollar so that a depreciation of the peso increases the nominal exchange rate.





the turning point corresponds to the peak in the price of copper and precedes but one or two quarters the peak of the business cycle. Figure 17 shows the behavior of the real exchange rate during the copper cycles.<sup>13</sup> In all cases, there is a strong appreciation. On average, the real exchange rate appreciated by 8 percent with respect to the peak of the business cycle of the previous year.

The behavior of the nominal and real exchange rates during the cycles shows that the early phase of the copper cycle is characterized by an increase in foreign currency inflows due both to the direct effect of copper revenues and the indirect effect of the increase in foreign investment. Both factors put upward pressure on the exchange rate which in all cases appreciate until the peak of the copper price cycle. When the copper price declines, the upward pressure fades out and the appreciation of the real exchange rate slows until it stabilizes about one year after the peak of the cycle.

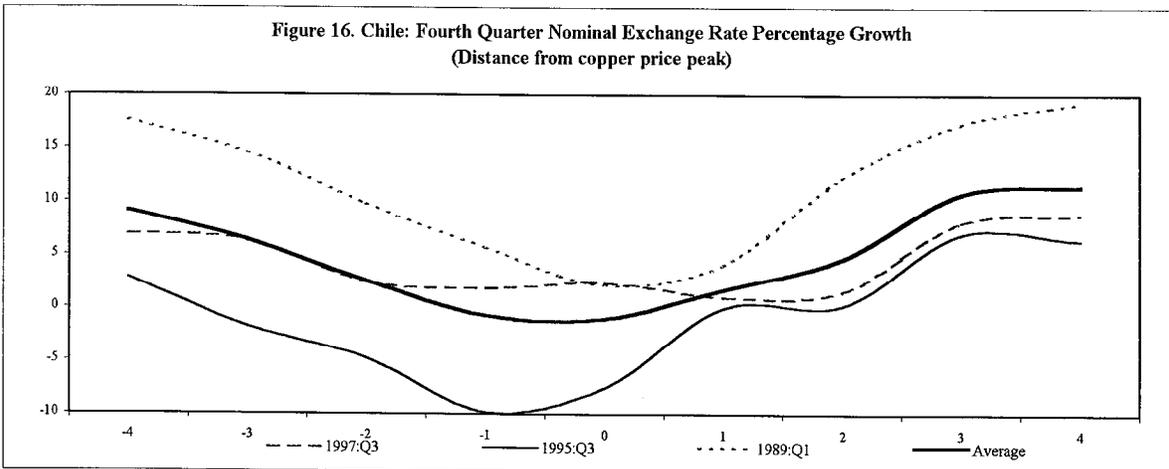
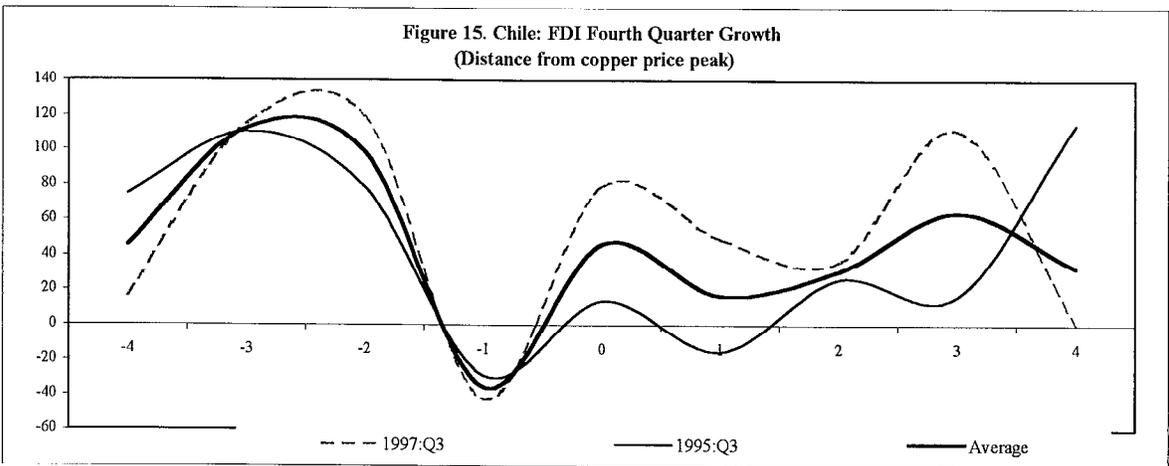
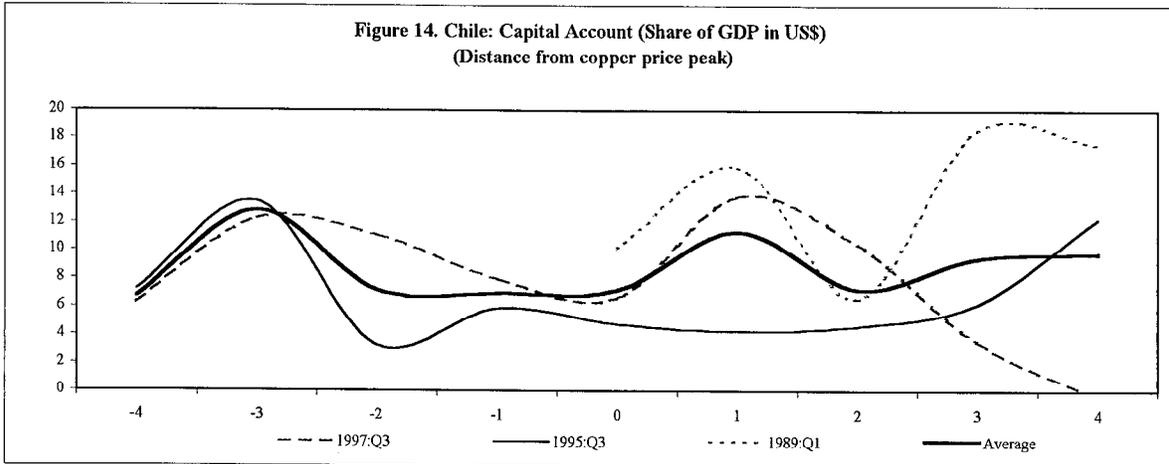
The behavior of the exchange rate has some effect on the inflation rate. Figure 18 shows the behavior of inflation during the copper cycle. During the first phase of the copper cycle, when the real exchange rate is rapidly appreciating, inflation declines in all three episodes. During the second phase, when the copper price falls and the rate of appreciation declines, inflation stops declining in two episodes and increases abruptly in the 1989:Q3 episode. In conclusion, there is an asymmetry in the relationship between inflation and copper price changes: while inflation always goes down as the price of copper increases, inflation does not go up as the price of copper decreases. This asymmetric behavior of inflation with respect to the business cycle can reflect an asymmetric response of the monetary authorities to the copper cycle as is elaborated below.

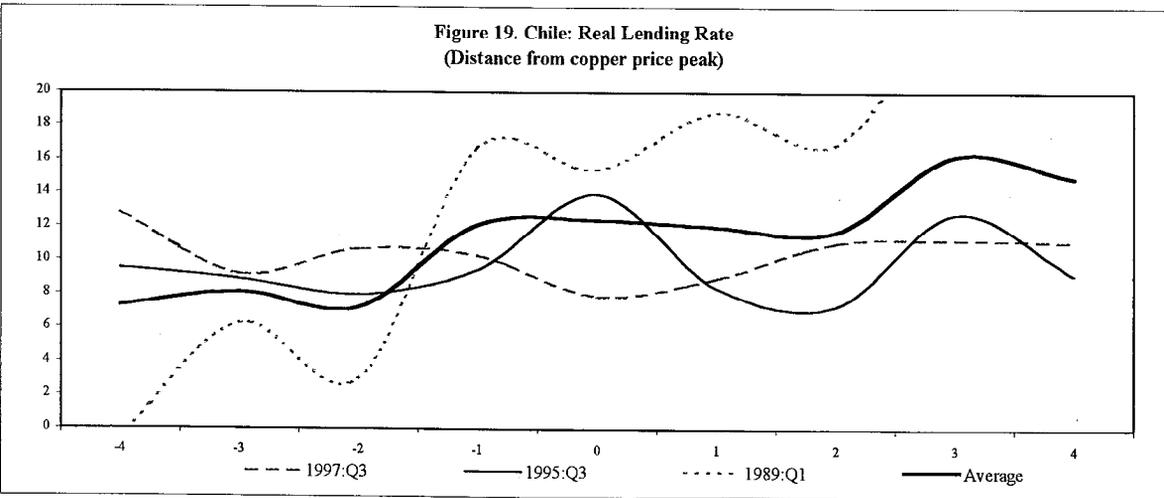
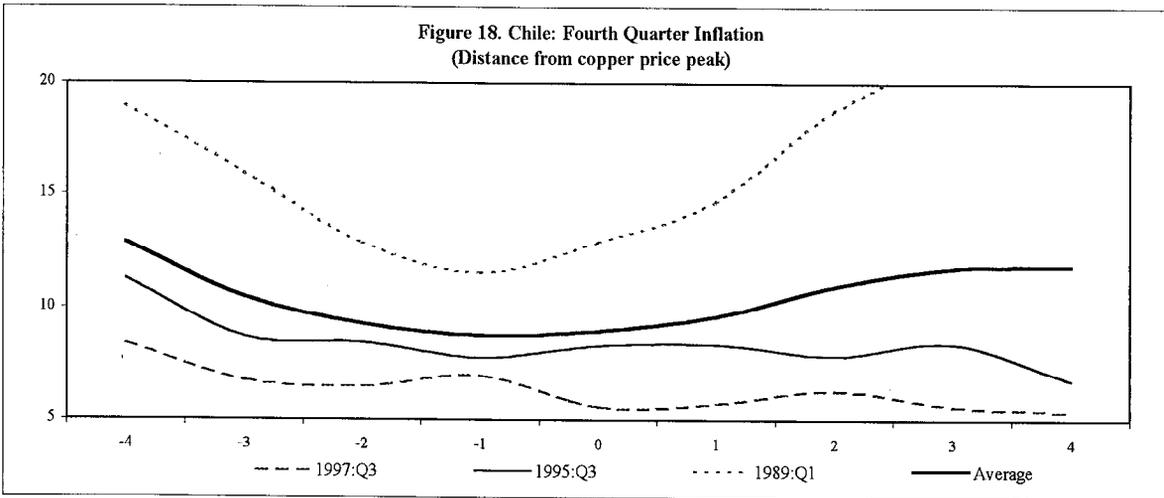
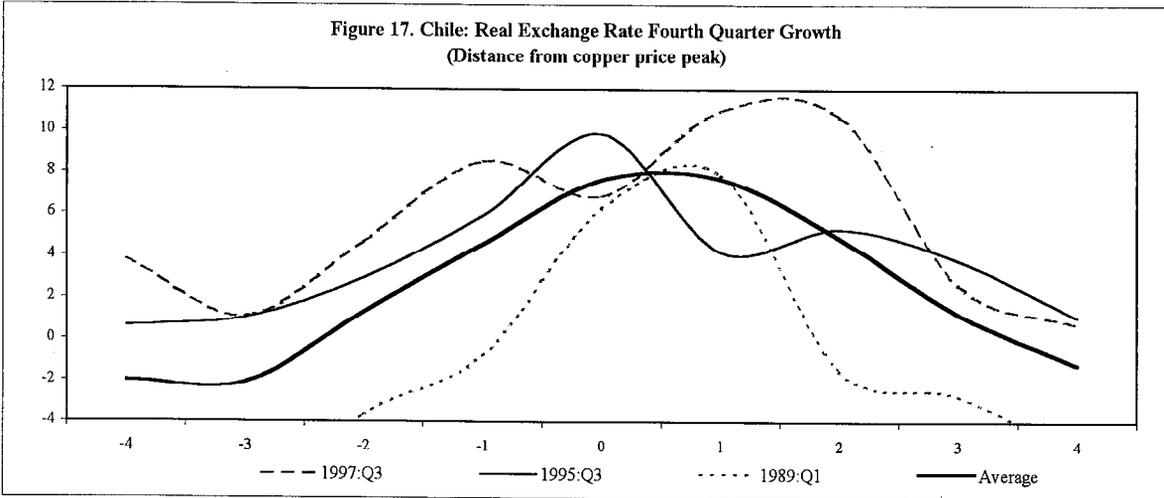
Figure 19 shows the real lending rate in the three episodes.<sup>14</sup> While during the last two copper cycles there is no clear pattern, there is an interesting behavior in the first cycle. During the first phase of the cycle, in the presence of strong capital inflows, the lending rates are quite low, while in the second phase the real lending rates rise. The behavior of the interest rates may also reflect to some extent the policy response of the central bank to a weakening of the current account. During the second phase of the copper price cycle, when the copper price declines, the current account deteriorates, the peso tends to depreciate, and inflation to increase, and monetary policy tends to tighten. This interpretation of events is of course very

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<sup>13</sup>The real exchange rate is defined as an increase in the exchange rate indicates a real appreciation.

<sup>14</sup>Real lending rates are obtained from line 60p of *IFS* and subtracting the inflation rate. This is the rate charged by banks on loans of 30 to 89 days. For this reason, this is a good indicator of the stance of monetary policy.





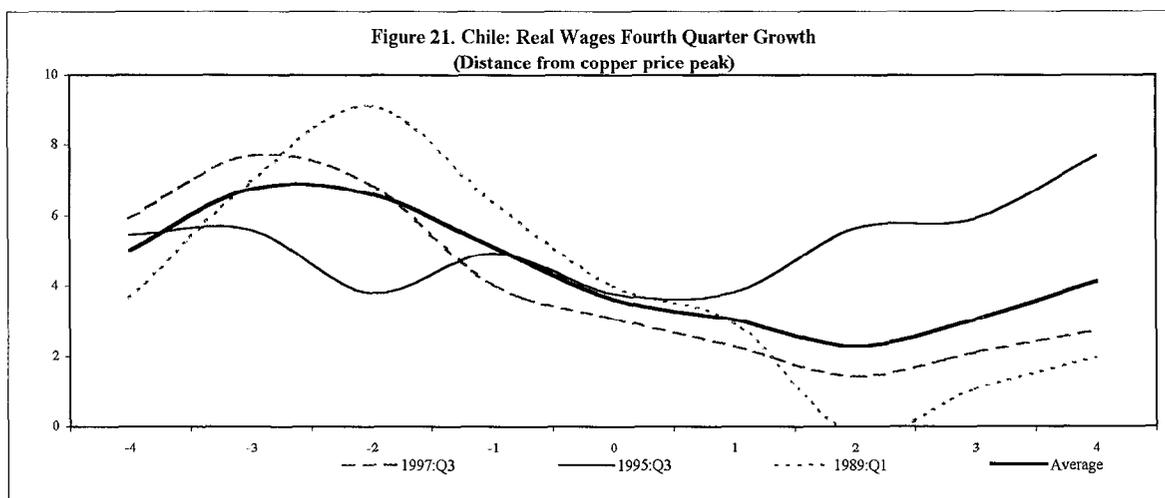
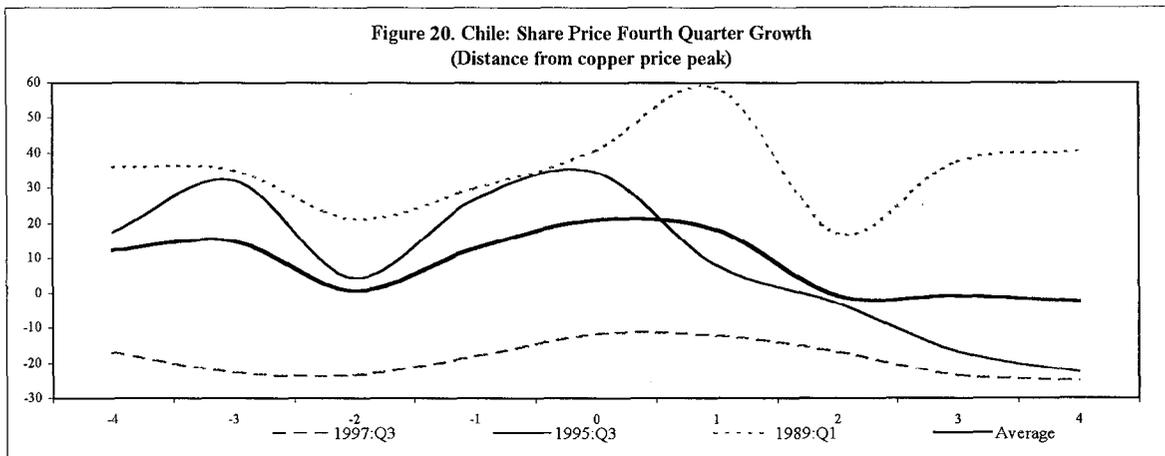
tentative, as it is based on the three copper cycles under review and cannot be formally tested. Nevertheless, this interpretation would be consistent with official statements indicating that reducing external imbalances has been an important concern of monetary policy during the 1990s.

The behavior of **share** prices (Figure 20) shows some pattern as shares always peak together with the copper cycle or after one quarter later. This pattern probably reflects the behavior of the interest rate and the external sector and is only indirectly influenced by copper. The pattern of **real wages** is more clear (Figure 21). Real wages have had an upward trend during the period considered, but their rate of growth rises as the price of copper increases. This could reflect an increase in nominal wages, and the slowing down of inflation in the presence of backward-looking indexation. Jadresic (1997) finds evidence that "Chilean private aggregate wages during the 1980s are well described by two-year contracts that are revised every six months according to 100 percent of past inflation." Whatever the reason for the increase in the rate of growth at the beginning of the copper cycle, real wages typically slow down after the peak of copper cycles. Rising real wages could explain the increase in private consumption that is observed one or two quarters after the copper cycle peak.

Overall, the analysis of the last three copper cycles has shown that all three copper cycles anticipated the Chilean business cycle by one or two quarters. Moreover, all GDP components behaved similarly in the three episodes. In particular, investment, which has a high component of imports and foreign financing, seems to be particularly sensitive to the copper cycle. Copper cycles, either directly or indirectly through policy responses, have been associated with real exchange rate appreciation and disinflation.

#### **IV. LONG-RUN PERSPECTIVE: COPPER TRENDS AND THE CHILEAN ECONOMY**

This section analyzes the long-run effect of copper on the Chilean economy. While in the previous section the focus was on the business cycle using quarterly data, this section focuses on annual data from the beginning of the 1960s to 1997 to study the statistical relationship between developments in the copper sector and the Chilean economy. Moreover, the unit of analysis in this section is real copper export revenues, not prices, given that in the long run the copper supply is elastic. Finally, the log difference of real copper export revenues (LRCOEX) is taken in order to have a stationary explanatory variable.



As in the previous section, we first look at the general relationship between copper exports and the Chilean economy. Regression 1 shows how LRCOEX anticipates changes in real GDP growth. The short-term effect (annual effect) is simply the coefficient on LRCOEX, while the long-term effect takes into account the lags of the dependent variable.<sup>15</sup> The elasticity of GDP growth to real copper revenues growth is 0.1 in the same year and 0.19 in the long run, meaning that an increase in real copper revenue growth of 10 percent increases GDP growth by 1 percent in the short run and by 1.9 in the long run. The short-term response could be due to the fact that the mining sector accounts for about 10 percent of GDP, so that a 1 percent increase in mining output means that GDP grows by 0.1 percent. However, in the long run the elasticity doubles, showing that the copper sector has a strong multiplier effect, which almost doubles its short-term impact. This result is quite robust to the time period and the specification chosen.

The result that LRCOEX has an effect on GDP growth both in the short- and long-term periods is complementary to the finding of the previous section that copper cycles have preceded Chilean business cycles in the last decade. Not only has copper determined fluctuations around a long-term trend, but it has also influenced this trend. Generally, the factors that determine long-term growth (such as productivity and factor accumulation) are different from the factors that determine fluctuations around the trend (such as aggregate demand), so the channels through which copper influences the Chilean economy could be different in the long and short runs. The rest of this section examines the channels through which copper influences the Chilean economy in the long run and contrasts them with the analogous channels in the short run.

LRCOEX does not have an influence on **private consumption** growth in the long run (see Regression 3 in the technical appendix). This result and our previous finding that private consumption is sensitive to the copper cycle in the short run show that copper has only a short-term effect on consumption.

LRCOEX has an influence on **investment** growth in the long run (see Regression 4 in the technical appendix). While a 10 percent increase of the rate of growth of copper exports has only a moderate immediate effect on investment, it increases real investment growth by 93 percent in the long run. This matches the finding of the previous section, in particular, the high volatility of investment growth and its strong correlation with the copper cycle.

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<sup>15</sup>Since both series (real copper exports and Chile's real GDP) have a unit root and are not cointegrated, first differences in the regression are used; the lags are chosen according to standard criteria. Log is used so that the estimated results are easily interpreted as elasticities. For other information on the regression see the technical appendix.

Another way of looking at the effect of copper on the components of GDP is to look at income shares. Regression 5 shows that a 10 percent increase of real copper export growth does not have any effect on the investment share in the short run, but it increases the investment share by 6.6 percentage points in the long run. Since investment has an upward trend, part of this increase could be spuriously attributed to copper. However, Regression 6, which controls for a time trend, confirms the results although the size of the effect is smaller than before: a 10 percent increase in real copper export growth increases the investment share only by 1.7 percentage points in the long run. This finding confirms the results on the business cycle of the previous section.

Regression 7 shows that real copper export growth has little effect on the **import** share in the short run, but a large effect in the long run.<sup>16</sup> In the short run, the effect of copper on the import share is negative and not very robust. In the long run, a 10 percent increase in the growth of copper revenues increases the import share by 5.1 percentage points. If the sample is restricted to the years after 1975 to avoid clear structural breaks, this coefficient is much smaller.

Regression 8 provides an alternative way of looking at the effect of copper on imports by using the share of copper exports in GDP as the independent variable. In the short run, the copper export share is not correlated with import share. But, in the long run, each additional percentage point of copper exports increases imports by 0.7 percentage points. If the sample is restricted from 1975 onwards, the long-run import response decreases to 0.3 percentage points. These results merit two observations. First, they are consistent with the previous findings that an increase in copper exports translates into an investment boom which, in turn, increases imports. Second, the analysis is limited to partial equilibrium. In particular, higher investment in the mining sector means higher capacity, and so higher exports in the future. For this reason, it is not correct to say that in the long run one percentage point of higher copper revenues improves the current account only by 0.3 percentage points because this does not take into account all the secondary effects such as higher investment, or the effects on the real exchange rate.

In Regressions 9 to 13, the long-run fiscal position is examined. In order to have a consistent measure over the entire period, the surplus of the central government as a share of GDP is used. An increase of real copper export growth by 10 percent improves the fiscal surplus by 0.27 percentage points in the short run, and by 1.62 percentage points in the long

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<sup>16</sup>There is a missing observation for imports; given that two lags of the dependent variable are used, the number of usable observations is reduced from 36 to 33. In principle, it is not advisable to use time series data with a gap in the middle. Nevertheless, the results of this regression are presented for completeness of the analysis

run. Even if the results go in the right direction and have plausible magnitudes, they are estimated imprecisely; this is because there were important structural breaks in the relation between copper and fiscal behavior in the 1970s. If the sample is restricted to the first 13 years, 1963-75 (Regression 10), the relationship between copper export growth and the fiscal position becomes stronger (a 10 percent increase of copper revenue growth improves the fiscal position by 3.3 percentage points in the long run) and is measured more precisely. Conversely, taking the last 21 observations, 1976-96 (Regression 11), a 10 percent increase of copper export growth is found to improve the budget only by 1.2 percentage points in the long run. These results should be taken only as an indication of a trend, given that they are based on a partial equilibrium analysis and on a limited number of observations. Nevertheless, the finding that the role of copper in public finances has been diminishing over time may reflect the introduction of the copper stabilization fund, and the increased importance of other sources of revenues.

Regression 12 considers the effect of copper export revenues, expressed as a share of GDP, on the position of the central government. An additional GDP percentage point of copper exports improves the central government position by 0.5 percentage points in the short run, while the improvement rises to 0.78 percentage points in the long run. As before, the reader is cautioned that this analysis is based on a partial equilibrium and does not take into account second-order effects.

The fiscal position is strongly linked to the business cycle, which in turn is associated with the copper price cycle. Regressions 9 to 12 considered the total effects of copper on the fiscal position, including not only additional revenues accruing to the central government as a result of higher copper exports but also the higher tax revenues coming from stronger economic activity. In Regression 13, controls for the second effect by introducing GDP growth. When controlling for the business cycle, the effects of copper export growth are similar and still significant. In the long run, a 10 percent increase of copper export growth improves the fiscal position by 1.6 percentage points.

Overall, the analysis of the annual data between 1963 and 1997 suggests that copper exports have a significant effect on long run growth, especially through investment. The increase in investment in turn explains higher imports. Private consumption growth seems not to be affected by copper, while the fiscal position improves significantly as copper revenues increase. The effect on the fiscal position has become less relevant in the last decade, reflecting structural changes that have diminished the dependency and sensitivity of the fiscal accounts with respect to copper.

As the previous analysis is based on regressions with a limited number of observations, it also precluded the use of many control variables. For this reason, the analysis was limited to a partial equilibrium analysis and the results must be considered with care.

## V. TRANSMISSION CHANNELS

In the previous sections, it was established that the copper cycles have strong implications for the Chilean economy both in the short and the long runs. This section takes an alternative approach by looking separately at different possible transmission mechanisms and checking whether they are compatible with the stylized facts outlined in the previous sections.

### A. Private Consumption—Wealth Effect

A higher price of copper increases the national wealth of Chile. This could happen either directly if Chilean nationals own copper mines, or indirectly through a Ricardian equivalence if the government owns the copper mines and nationals anticipate fewer taxes in the future. In both cases, the private sector should increase consumption in response to a higher copper price. This effect should be particularly noticeable in the long run because the private sector would lag by several periods before updating its long-term consumption path.<sup>17</sup> Regression 3 shows that there is no evidence of changes in consumption growth due to changes in copper export growth so a simple wealth effect mechanism can be ruled out. There are several possible reasons why the wealth effect does not play a major role: a failure of the Ricardian equivalence, credit constraints, perception that the innovations in the price of copper are not permanent, and the fact that large part of the mines in Chile are now foreign-owned.

### B. Private Consumption—Higher Wages

Many studies have shown that the wages of an industry are influenced by the profitability of that industry, and is probably the case for the mining industry in Chile, so a higher copper price should push higher wages for the mining workers. Eventually, the wage increase should spread to workers in other sectors. However, this hypothesis is not very appealing because workers in the mining sector are not numerous, and are concentrated in a few regions. For these reasons, the labor market is fragmented and it is difficult to imagine the mining sector as a wage setter for the other sectors. Nevertheless, real wages have increased more as the price of copper has risen. This could be due to the fact that inflation is negatively correlated with the price of copper, which, in the presence of backward-looking indexation, leads to an increase in real wages. Additionally, the public sector, which has more resources during copper booms, could give higher nominal wage increases.

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<sup>17</sup>Given that the innovations in the price of copper are quite persistent, the textbook response of consumption to an innovation in the price of copper in the absence of credit constraints is an almost immediate update to the new long term path. Considering the high volatility and uncertainty, an immediate response should not be expected.

### **C. Investment Component—Mining Sector**

If the innovations in the price of copper are (or are perceived) as permanent, higher prices will bring new investment to the mining sector. There is strong evidence of this channel. Both short-term (Figures 7 and 8) and long-term evidence (Regression 4) show that investment is quite sensitive to the price of copper. Since the late 1980s and early 1990s (Moguillansky, 1998), foreign direct investment has been concentrated in the mining sector so that there has been a strong link between the copper cycle and foreign direct investment. Moreover, the cycle starting in 1990:3 and peaking in 1992:3, which was the only recent Chilean business cycle not anticipated by the copper cycle, was characterized by a surge in foreign investment mainly in the copper sector. The drawback of the high responsiveness of investment to the business cycle has been the increase in imports that accompanies every copper cycle.

### **D. Capital Inflows—Perceived Stability**

During the 1990s, Chile has followed prudent economic policies which have created a favorable framework for long-term economic growth. It is difficult to evaluate how the high copper prices have contributed to this favorable scenario. The high price of a commodity is not an automatic blessing. In fact, there are many countries for which a natural resource is a mixed blessing that leads more to rent-seeking behavior than to sound investment and development. Keeping this in mind, it is fair to say that copper export revenues, which have been wisely administered, have favored Chile's economic stability in the long run.

### **E. Investment—Through Monetary Authority Response**

Since the beginning of the 1990s the central bank of Chile has been concerned not only with internal inflation but also with external stability, trying to limit the size of the current account deficits. During the first phase of a copper cycle, the tendency is for the current account position to improve, the exchange rate to appreciate, and inflation to diminish, thus monetary policy can be more expansive. During the second phase, however, when the price of copper declines, the current account tends to worsen, the exchange rate tends to depreciate, and inflation does not go down, monetary policy is more restrictive. The pattern of the real lending rate during the copper cycles is compatible with this hypothesis.

### **F. Fiscal Component**

CODELCO gives all of its profits under various forms to the treasury. The higher copper price can thus increase public revenues and make the budget constraint less stringent. The analysis here shows that this has happened even though this channel has probably worked more effectively in the past. In the last ten years, new institutional innovations such as the copper fund and the increased importance of alternative forms of financing, have progressively limited the importance of copper in public financing.

## VI. CONCLUSIONS

This paper has examined how the Chilean economy has responded to the copper cycle both in the long run and the short run. Tailoring the analysis to the availability of data (annual data between 1960 and 1997 and quarterly data between 1986 and 1998), statistical analysis was used for the long run, and graphic and case-by-case analysis for the short run. The two kinds of analysis are complementary since short-term and long-term adjustments are potentially different.

The main conclusion of the analysis is that copper prices are important for short-term fluctuations and probably have an influence on long term growth. While many mechanisms can be at work, investment seems to play a major role. During periods of high copper prices, both internal and external factors favor investment. Internally, lower current account deficits probably lead to less stringent monetary policy. Externally, international investors are attracted by the high copper price and by the enhanced long-term external stability. Additionally, the high copper price and capital inflows have typically created upward pressure on the real exchange rate in the first phase of the copper cycles. The rapid appreciation and increased demand for investment goods have, however, partially offset the positive effects of copper on the current account.

The appreciation of the Chilean peso during the first part of the copper cycle has also favored the policy of progressive disinflation pursued by the central bank of Chile. Typically, the fastest gains in the disinflation policy have been obtained when the copper price was increasing, while the central bank has consolidated the gains in disinflation during periods of a decreasing copper price. In the presence of backward-looking indexation, this also may explain how real wages have grown more rapidly during the phase of increasing copper prices.

Unlike other countries endowed with natural resources, there is only limited evidence of consumption booms induced by the copper cycle in the short run. In the short run, part of the increase in consumption could be indirectly due to the higher real wages and decreasing inflation at the beginning of the copper cycle. Moreover, there is little evidence of share booms during the cycles probably because foreign capital has not been invested through the stock market. Copper cycles have also been very relevant for the fiscal balance, even though their importance has been decreasing thanks to the development of alternative sources of revenue and the introduction of the copper stabilization fund.

This paper has described the stylized facts about the correlation between the Chilean economy and the copper cycle. Copper has played an important role in the Chilean economy but the reasons for Chile's success in the last decade are much more complex and go beyond the development in the copper sector.



**Regressions**

<b>Regressions</b>	<b>IX</b>	<b>X</b>	<b>XI</b>	<b>XII</b>	<b>XIII</b>
<b>Dependent Variable</b>	gvt surplus				
<b>period</b>	63-96	63-75	76-96	62-96	63-96
lag gvt surplus	1.04 (6.14)	-.12 (-.20)	.87 (4.42)	1.02 (4.40)	1.04 (4.91)
second lag gvt surplus	-.39 (-2.31)	.17 (0.30)	-.39 (-2.17)	-.29 (-1.63)	-.39 (-2.02)
copper export growth	.03 (1.51)	.06 (1.73)	.03 (1.56)		.03 (1.04)
lag copper export growth	.01 (.50)	.13 (1.48)	.01 (.77)		.01 (.54)
second lag copper export growth	.02 (1.04)	.13 (2.08)	.02 (1.13)		.02 (1.30)
copper export share				.50 (2.09)	
lag copper export share				-.28 (-1.19)	
gdp growth					.01 (.07)
<b>Long term effects</b>					
copper export share				.78 (.10)	
copper export growth	.16 (.18)	.33 (.05)	.12 (.13)		.16 (.15)

Note: t-statistics are in parentheses beside the coefficients; while p-values are below the coefficient for the long term effects.

- gdp growth                      log difference of real GDP at 1986 constant prices.
- gdp                                log real GDP at 1986 constant prices.
- consumption growth        log difference of private consumption in constant 1986 prices.
- Investment growth        log difference of investment in constant 1986 prices
- Investment share        real investment as a share of real GDP
- Import share                real imports as a share of real GDP
- gvt surplus                surplus of the central government as share of GDP
- copper export growth    log difference of real copper export revenues
- copper price growth    log difference of real copper price
- copper export share    copper export revenues as a share of GDP

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