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Autores: Raphael Bergoeing, Alejandro Micco, Andrea Repetto

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Dissecting the Chilean Export Boom*

Raphael Bergoeing — *University of Chile*

Alejandro Micco — *University of Chile*

Andrea Repetto — *Universidad Adolfo Ibáñez*

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Abstract

Since 1975 Chilean exports have boomed growing at a 6% average rate per year in real terms. In this paper we use manufacturing Chilean data at the plant level for years 1990 to 2007 to investigate the relationship between exports, plant dynamics and productivity. Our findings are consistent with the predictions of the new heterogeneous firms' trade theories. Firstly, 64.4% of the total increase in exports is accounted for by new exporters net of failed exporters. This effect is a combination of a larger fraction of plants that export, a rising fraction of output sold abroad and a larger level of total sales. Secondly, productivity and exports co-moved over the Chilean boom, with a positive correlation of exports with both within plant productivity growth and productivity enhancing reallocation of output across plants.

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Keywords: Chilean manufacturing exports, plant dynamics, heterogeneity, productivity.

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Contact information: Alejandro Micco, Departamento de Economía, Universidad de Chile, Diagonal Paraguay 205, Santiago, Chile. E-mail: amicco@fen.uchile.cl. Telephone: (56-2) 978 3464.

1. Introduction

Recent empirical research based on plant level data has consistently shown that there is wide heterogeneity in productivity across units, even within narrowly defined sectors at any given period of time. Thus, as several studies document, the reallocation of inputs and outputs is a crucial element of aggregate productivity gains and growth.

New models based on firm heterogeneity have analyzed these intra-industry effects in the context of international trade. Melitz (2003) and Bernard et al. (2003) developed alternative models of international trade that predict that only the most productive firms export, and that the industry's exposure to trade induces aggregate productivity gains through reallocation -- an effect that is ignored by the standard representative firm framework. At the same time, a growing body of empirical literature has studied the extent and causes of productivity differentials between exporters and non-exporters.[1] There exists little evidence on the relevance of trade-driven reallocation effects.

In light of these new theoretical developments, in this paper we analyze the sources of the Chilean export boom and its relation to productivity heterogeneity at the microeconomic level. Using a sample of Chilean manufacturing plants for years 1990 to 2007, we decompose the observed aggregate export growth in two complementary sets of margins: net entry versus reallocation effects, and export intensity changes versus sales growth. We also consider the role of efficiency by correlating export growth to both within plant productivity growth and across plants productivity enhancing reallocation effects.

The Chilean experience is interesting for several reasons. On the one hand, the economy underwent a deep and extensive trade liberalization reform that started in the mid 1970s. During the 30 years that followed, Chilean exports grew on average at an annual 6% real rate. This export boom dramatically changed the level of trade as well as its composition and the productive structure of the economy. Although there was a partial reversal of the unilateral tariff reduction process after the early 1980s crisis, trade liberalization continued after 1985. Furthermore, since 1992 trade policy moved towards

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[1] See Wagner (2007 and 2008) and Eaton, Kortum and Kramarz (2008) for recent surveys. The evidence indicates that the most productive firms self-select into entering export markets. Although there is mixed evidence on export-driven learning effects, Alvarez and López (2005) confirm this hypothesis using plant-level data for Chile.

bilateral agreements. As a matter of fact, over the last two decades Chile has signed trade agreements with more than 50 countries, including the United States (U.S.), Canada, Mexico, the European Union, China and Korea. Thus the data considered in this study cover a period after major reforms had already been under way for over a decade, but at the same time, a period characterized by active bargaining of preferential trade agreements. Consequently, this time period provides a rich environment for a better understanding of the link between trade and industrial and plant dynamics.

Our findings are consistent with the predictions of the new heterogeneous firms' trade theories. First, 64.4% of the increase in exports came from larger and highly intensive new exporters, rather than from increasing export intensity at existing exporters. Second, productivity and exports have co-moved over the Chilean boom. Finally, the export expansion is associated to a productivity enhancing reallocation of resources towards more efficient plants.

The remainder of the paper is organized as follows. Section 2 overviews trade reforms and the recent trade boom in Chile. Section 3 describes the data we use and presents a number of plant-level facts that characterize manufacturing exports. Section 4 dissects exports to explore its main sources of growth. We also study the link between export growth and productivity. The final section concludes.

2. Trade reforms and the Chilean exports boom: An overview

In June 2002 Chile signed a Free Trade Agreement with the European Union; a year later, a similar agreement was signed with the U.S.. These negotiations marked the culmination of three decades of free trade policies that have consolidated Chile as one of the more open economies in the world.

As of today few question the significance of the trade liberalization program initiated in the mid 1970s in shaping the economic transformation of Chile.[2] The scenario was very different four decades ago, however. By the late 1960s, trade restrictions had practically isolated the Chilean economy from the rest of the world, exacerbating its dependence on copper exports and confining imports to intermediate and capital goods. The structure of relative prices was drastically distorted in favor of industrial goods at the expense of agricultural, mining and other tradable activities. Differential import duties exempted capital goods and high taxes were levied on final goods, creating a largely inefficient capital-intensive industrial sector. Import tariffs ranged from 0 percent for capital goods to 750 percent for luxury goods; there was a requirement of a 90-day non-interest bearing deposit of 10,000 percent of the CIF value of imported goods, and all import operations were required administrative approval. In addition, a system of multiple exchange rates prevailed reaching a 52 to 1 ration at the collapse of the economy in 1973.

In the years that followed the 1973 crisis, trade liberalization policies were to be the cornerstone of the transformation of the inward-oriented Chilean economy into a dynamic export oriented one. The initial set of trade reforms were intended to simplify the structure of the economy. Consistently, exchange markets were unified, most non-tariff barriers (quotas and prohibitions) eliminated, and tariffs drastically reduced to a uniform 10 percent that was reached by 1979.

During the years 1976 to 1980 the economy recovered at a high speed, with GDP growing at an annual rate of 7%. Moreover, the availability of foreign goods expanded markedly, and the government deficit turned into a surplus. In addition, an important number of reforms were initiated to complement and reinforce the change in relative prices induced by trade deregulation. Among them, a large number of public enterprises were privatized, labor markets were deregulated, a defined contribution social security system was set up to replace a pay-as-you-go system, and health and public education responsibilities were transferred from the ministries to the county levels.

Although reforms advanced in various fronts, two major problems remained unsolved: unemployment levels did not decline in a significant way and inflation remained stubbornly high. Among the instruments used to control inflation, the fixing of the nominal exchange rate in June 1979 proved to have a devastating effect. The highly indexed nature of the economy, in combination with the fixed exchange rate, induced an increasing real exchange rate overvaluation, fostering imports and discouraging exports, and leading to

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[2] The Chilean economic transformation has been extensively documented by Edwards and Edwards (1991),

large current account deficits. In 1981, the external deficit reached 14.5% of GDP. Large amounts of foreign loans entered the country to finance the trade imbalance and, as a consequence, the foreign debt increased from US$6 billion in 1977 to US$14.8 billion in 1981. Two additional elements also helped induce the observed rise in indebtedness: the resistance of the real interest rate to converge to world levels and the deregulation of the financial market in 1981. The former induced a continuous flow of short-term lending; the lack of adequate supervision of the quality of the portfolio of banks in the latter, led to a generalized miscalculation of risk levels and imprudent domestic lending (Barandiarán and Hernández, 1999).

With such a large trade imbalance, confidence in the Chilean economy faltered and foreign lending ceased. In June 1982 the authorities were forced to devalue the peso by 19%, but "it was too little and too late" (Edwards and Edwards, 1991). The economy fell into a deep recession as GDP dropped by 13.4% in 1982 and a further 3.5% in 1983; unemployment, already high, skyrocketed to 34% of the labor force --including emergency employment programs--. The government deficit increased to almost 9% of GDP and the Central Bank had to rescue the financial sector from bankruptcy. Foreign debt reached 130% of GDP by 1983.

This recession led authorities to partially reverse the openness policies. In particular, the mean tariff was raised to 26% by 1985. Since then, however, the reduction in tariffs continued. In 1990, with the return to democracy, the commitment to openness was not modified. As a matter of fact, average tariffs continued to be reduced in a gradual manner from near 15% in 1988 to about 3% in 2010. Figure 1 reports the evolution of mean tariffs since 1975.

One important change defined trade policy during the 1990s: bilateral agreements were incorporated into the overall liberalization strategy. A decade later Chile had signed trade agreements with many economies in the world. Today, more than 90% of Chilean exports are subject to a trade agreement.

Summing up, only since the late 1980s the Chilean economy could fully reap the benefits from the changes in economic incentives and the new productive structure that

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and Corbo and Fischer (1994), among others.

came with trade reforms. Overall, exports evolved consistently, booming during most of the period. Figure 2 shows that from 1975 to 2010, total exports increased seven-fold, much faster than GDP which increased five-fold. Manufacturing exports followed a similar pattern almost doubling as a share of manufacturing sales, fraction that increased from 12.4% to 21.2% over the 1990-2007 period.[3]

3. Exporter facts

Since Bernard and Jensen (1995), a growing literature has described various regularities characterizing exporters' behavior. In particular, this literature finds that only a small fraction of firms sell their output in foreign markets. Moreover, exporting firms tend to be more productive and larger, and usually sell a small proportion of their output abroad. For instance, Bernard et al. (2003) use data for U.S. plants to find three sets of facts. First, only 21% of plants in the U.S. Census of Manufactures report some exports. Of those, most sell less than 10% of their total output abroad, whereas fewer than 5% of the exporting plants export more than 50% of their production. Second, exporters are larger, shipping on average 5.6 times more than non-exporters. Finally, the productivity of exporters is substantially higher than the productivity of non-exporting firms. Eaton et al. (2008) show a similar pattern using French manufacturing firm-level data.[4]

Recently developed theoretical models of international trade with heterogeneous firms and fixed and variable costs are able to account for these facts. In Melitz (2003) the economy is characterized by heterogeneous firms producing in monopolistic markets and by intra-industry selection through productivity. Firms face initial uncertainty concerning their future productivity when making an irreversible investment decision that allows them to enter the domestic market. In addition to this sunk entry cost, firms face both fixed and per-unit export costs. Arkolakis (2008) also develops a model with heterogeneous firms. In the model, firms face market penetration costs. Similarly, Bernard et al. (2003) develop a model of Ricardian differences in technological efficiency and imperfect competition with variable markups. This class of models predicts that only a subset of relatively more

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[3] In our analysis we have considered all manufacturing sectors but copper. See below for a discussion.

productive firms export, whereas the remaining, less productive firms serve the domestic market only.

In this section we analyze these exporter facts. In the next section we look into the dynamics of exports growth. We use the data from the *Encuesta Nacional Industrial Anual* (ENIA), an annual survey of manufacturing conducted by the Chilean statistics agency, the *Instituto Nacional de Estadísticas* (INE). The ENIA covers all manufacturing plants that employ at least ten individuals. Thus, it includes all newly created and continuing plants with ten or more employees, and it excludes plants that ceased activities or reduced their hiring below the survey's threshold. We observe plants and not firms in our data set and thus are unable to distinguish single-plant firms from multi-plant firms.[5]

The data available extends from 1979 to 2007 and contains detailed information on plant characteristics such as manufacturing sub-sector at the 4-digit ISIC level, sales, employment, investment, intermediate inputs and location. Data on plant-level exports were collected starting in 1990. Thus, our analysis considers the 1990 – 2007 period.[6]

All nominal variables were deflated at the 3-digit ISIC level, using deflators constructed from the wholesale price indices compiled by INE. Capital series were constructed using information on investment and depreciation following the strategy of Bergoeing et al. (2005). Our analysis considers all 29 3-digit ISIC sectors but copper production – sector 372 – since national accounts include copper in the mining sector and not in manufacturing. Moreover, copper has always been a relevant export commodity, long before trade was liberalized. Over the 18 years considered, sector 372 represents on average 22% of total value added in the ENIA.

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[4] For additional results, see Bernard and Jensen (1999), Bernard et al. (2007), Clerides, Lach and Tybout (1988) and Melitz (2008).

[5] According to information provided by Central Bank statisticians, about 3.5% of plants belong to a multi-plant firm in our data set.

[6] INE changed the plant identification method in the 1996 survey. Fortunately, we had access to three data bases that allowed us to match over time almost all of the surveyed plants. The 1979-1996 data set and the 1995-2007 do not have a common identifier, but a third survey covering years 1995 to 2007 had both identifiers for year 2000. To match plants that were not in the 2000 survey, we looked for plants that in any given year reported identical values for relevant variables such as wages, number of days in operation, ISIC code, electricity consumed, VAT paid, number of employees, gross output and machinery and equipment investment.

The data show that Chilean plants display many similarities to their U.S. counterparts as described by the literature, and also some differences. Table 1 summarizes our basic findings. On the one hand, the fractions of manufacturing plants that export are almost the same. According to the ENIA, 78.9% of plants sell all their production in domestic markets, whereas 21.1% sell some output abroad. Their export intensity, i.e., the fraction of total output exported, is much higher in Chile, however. For instance, over 25% of Chilean plants sell more than 50% of their output abroad, whereas only 5% of plants in the U.S. do so (Bernard et al., 2003). This fact suggests that local market size might play a role in shaping the distribution of export intensity.

On the other hand, just like in the U.S., labor productivity of Chilean exporters is much larger than that of non exporters'. Figure 3 shows that the distribution of plant-level productivity of exporters (relative to sector/year averages) is located to the right of their non exporting counterparts. According to the results in Table 1, the productivity of plants that export is 38% higher on average than the productivity of the typical plant producing in the same 3-digit sector, whereas the productivity of those that do not export is 10% lower. This 48 percentage point gap is much larger than the one described for the U.S. by Bernard et al. (2003), which amounts to 33%. This difference is consistent with the existence of cross-country variability in export market entry costs.

Table 1 also shows that exporters are larger than non-exporting plants when characterized by the number of employees – 89% on average. Moreover, exporters have higher capital/labor ratios and lower shares of wages in total value added on average. Chile is a low wage country; thus, one would expect exporters to be more labor intensive. Several explanations may account for this seeming anomaly. First, manufacturing goods are being mostly sold to other Latin American countries. Therefore, it is not necessarily the case that in this context Chile is defined as a labor abundant country. Second, non-exporters are more likely to be liquidity constrained and thus might face higher capital costs. Third, as explained by Trefler (1993), one should measure labor in effective units. If not, human capital, a scarce resource in Chile relative to developed economies, is included in total labor.

Finally, the table shows that these characteristics are not necessarily correlated with plant export intensity, i.e., there is no clear tendency of plants that export a larger share of their sales to be more productive, larger or more capital intensive.

In what follows, we further analyze the role of plant level heterogeneity on exports and productivity, this time looking at the mechanisms underlying their dynamics.

4. The micro dynamics of Chilean exports

The recent theories of international trade predict that increasing exposure to foreign markets due, for instance, to a fall in transport costs, leads to a reallocation of inputs and outputs towards the most productive firms. As the cost of entering export markets falls, firms that used to sell their output in domestic markets only now find it profitable to pay the costs of selling abroad. If variable costs fall, then old exporters increase their export intensity, whereas if fixed costs fall, these firms do no change their sales patterns. In any case, the least productive firms are forced to exit, as the increased demand for domestic inputs bids up real production costs. The reallocation driven by the increased exposure to trade delivers gains in terms of aggregate productivity growth.

A number of recent papers have looked at the effects of trade on productivity dynamics. Bernard et al. (2007) show that productivity growth is faster in industries with falling trade costs. Low productivity plants in these industries are more likely to exit, whereas high-productivity non-exporters are more likely to start selling abroad. At the aggregate, their results are consistent with productivity enhancing reallocation effects associated to trade growth.[7]

Bernard and Jensen (2004) study the recent export boom in the U.S. by examining the role of entry, firm expansion and export intensity. The paper finds that most of the increase in manufacturing exports came from increasing export intensity at existing exporters rather than from new entry into exporting. They also find that changes in exchange rates and rises in foreign income drove most of the export boom, while within plant productivity increases played a smaller role.

[7] It is worth noting that Bernard et al. (2007) use U.S.' import cost measures rather than export costs measures in the analysis. The correlation between these trade costs measures is not necessarily positive.

Other papers suggest a major role of entry into exporting, however. For example, Kehoe and Ruhl (2009) examine the bilateral trade patterns by commodity of countries involved in significant trade liberalization processes, finding a striking relationship between a good's pre-liberalization share in trade and its subsequent growth. The goods that were traded the least before liberalization account for a disproportionate share in trade following the reduction of trade barriers. They interpret this evidence as supportive of the new goods margin as a source of trade expansion.

The connection between trade liberalization and plant dynamics using firm level data for Chile has also been studied by Pavcnik (2002) and Irarrázabal and Opromolla (2007). Using a difference-in-difference approach and data for years 1979-86, Pavcnik (2002) shows that plants in export-oriented and import-competing sectors became more productive by the end of the sample period. An important caveat of this work is that, as Figure 1 shows, tariffs were much higher in 1986 than in 1979: the actual direction in trade openness is opposite to that assumed by the study.

Irarrázabal and Opromolla (2007) use the Bernard et al. (2003) model to simulate the effects of the Chilean liberalization. The model predicts that a 50% reduction in trade barriers leads to a 24% change in aggregate productivity. About 72% of the gains are due to within plant gains and 26% due to the exit of the less efficient plants. Reallocation and entry effects are quantitatively unimportant. Their simulation results do not disentangle the effects due to entry into export markets, however, or the reallocation towards the most productive exporters: it focuses on aggregate market effects without distinguishing exporter from non exporter behavior. Thus, one of the predicted channels of productivity gains – entry into export markets-- cannot be accounted for from their results.[8]

Table 2 suggests that heterogeneity has in fact played a relevant role in Chile's export boom. The table shows that 78.5% of the total change in the real level of exports is

[8] Moreover, the model is calibrated to account for the 1992 exporter facts (productivity and sales advantage of exporters relative to non exporters). Thus, it is implicitly assumed that 1992's productivity structure is a good characterization of the pre-liberalization structure. The model is then simulated to study the effects of trade barriers reduction, mimicking the falling trade costs between 1975 and the early 1980s. Trade barriers --and thus the advantage of exporters—were much lower in 1992 than in the early 1980s. So their results might underestimate the true gains from intra-firm reallocation that were driven by the liberalization of Chilean trade. The authors are forced to calibrate based on 1990s data, as the ENIA covers export behavior only since then.

accounted for by new exporters. That is, plants that were either not in the market or not exporting in 1990 contribute largely to the total increase in exports. As a comparison, Bernard and Jensen (2004) report that entry accounts for a 67% share of the U.S.' export boom.[9] Continuing plants contribute with the remainder 35.6% of this increase. Finally, since exiting plants reduce the rise in exports by 14.1%, net entry contributes with 64.4% of total growth, a fraction higher than that reported for the U.S. (39%).

In this section we use Chilean plant data in order to further analyze the role of this micro level heterogeneity in explaining the recent export boom. We perform three main exercises, each focusing on different aspects of plant behavior and its consequences for aggregate growth. In the first we ask whether the aggregate export boom is mostly explained by changes in export intensity --the fraction of total output that is sold abroad— or by a growing fraction of plants that export. Second, we examine whether there are differences in this export intensity across new, continuing and failing exporters that can account for the aggregate dynamics. In the third and final exercise we look into aggregate productivity behavior and how it correlates with the evolution of exports.

4.1 Entry and export intensity effects

The bold line in Figure 4 depicts the evolution of aggregate manufacturing exports in the ENIA over our sample period. The graph shows that exports rose steadily over most of the sample period.

The figure also shows the evolution of the fraction of firms that export and of the aggregate export intensity. The fraction of exporting firms grew steadily until 1995. It then stayed almost constant until the early 2000s, when it started to increase again. By 2002 it had reached the levels of 1995 with a fraction of firms selling output abroad at about 21.8%. By 2007, the share had increased to 24.8%.

[9] Bernard and Jensen (2004) reports that the U.S.' export boom is mostly explained by existing exporters rather than by entry. However, the paper defines new exporters as plants that were exporting in 1992 and were not producing in 1987, not even for the domestic market. We believe that classifying new exporters that were previously producing as continuers understates the relevance of entry into export markets. Once we relax this second restriction, entry accounts for 67% of the U.S.' export boom, instead of 29% as reported in the paper.

Total exports and the proportion of sales sold abroad evolved similarly over the sample period. Table 3 presents the evolution at the 3 digit ISIC level. The table shows that in most sectors, exports grew much faster than sales leading to a rising export intensity. Overall, in only ten years, the ratio of manufacturing exports over sales grew from 0.12 to 0.21. Similarly, Table 4 presents the evolution of the export intensity distribution. Clearly, the distribution had shifted to the right by the end of the sample period. The fraction of total firms that export also rose over the period, increasing from 17.5% in 1990-91 to 24.4% in 2006-2007.

Table 5 disentangles the total growth of exports into the percent growth of the number of exporters and the growth of average exports per firm. Columns (2)-(4) present this decomposition for total real sales, whereas columns (5)-(7) show the real export figures, both in thousands of 2000 U.S. dollars. Total sales (sold both in domestic markets and abroad) grew by a 96% over the whole period. This growth is mostly explained by changes in the average sale per firm, as the number of firms decreased during the period. Interestingly, the results for export growth are significantly different. First, total exports grew much more: 149%. Second, more than 80% of this growth is explained by the expansion of exports per firm, whereas only less than 20% is due to the number of firms that export. The rapid growth of exports per firm relative to sales per firm confirms the fact that exporters are much larger than average.

These facts, however, do not allow for differences across plants according to their export status (new, old and failing exporters). To estimate their relative contribution we measure the significance of each margin by plant type as a source of the export boom. That is, we look not only at the number of firms and the fraction of sales exported, but also at the contribution of continuing, exiters and new exporters. For instance, if new exporters export a larger share of their sales than previous exporters, even a small entry of firms may end up contributing largely to export growth. To examine this decomposition, we disentangle the increase in aggregate exports into three components:

$$\Delta X_{1990-2007} = \left(\frac{X_{c,2007} - X_{c,1990}}{C} \right) C + \left(\frac{X_{EN}}{EN} - \frac{X_{EX}}{EX} \right) EN + \frac{X_{EX}}{EX} \left(EN - EX \right)$$

where ΔX is the aggregate change in exports during the period; C, EN and EX denote the number of continuing exporters, new exporters and failed exporters, respectively; and X_{it} is exports by plant type i, i = old, new and failed exporters, at period t. Thus, exports may rise because continuous plants get larger on average, because new exporters are larger than failed exporters, or because the number of exporting plants increases.

In addition, we decompose the increase in exports into changes in intensity and changes in sales of continuing exporters, and the net entry of exporting plants – the contribution of new exporters minus failed exporters --. That is,

$$\Delta X_{1990-2007} = \left(\frac{X_{2007}}{S_{2007}} - \frac{X_{1990}}{S_{1990}}\right) S_{1990} + \left(\frac{X_{2007}}{S_{2007}}\right)\left(S_{2007} - S_{1990}\right) + \left(\frac{X_{EN}}{S_{EN}}\right) S_{EN} - \left(\frac{X_{EX}}{S_{EX}}\right) S_{EX}$$

where S_t denotes sales in period t. The first and second terms represent the contribution of the changes in the intensity and sales of continuing plants, respectively; the third term is the contribution due to new exporters and the final terms represent the (negative) contribution of the failed exporters.

Tables 6 and 7 display these decompositions. When the total export change is decomposed into the contribution of changing size, intensity and number of exporters, net entry contributes 64.4% of export expansion as already shown in Table 2. Of this total net entry contribution, 48.3 percentage points are driven by the higher export intensity of the new net exporters. The remainder 16.1 percentage points are due to a rise in the net number of exporting firms. In other words, the net entry contribution is the combined result of two elements. First, entering plants are larger (average exports per firm) than failing exporters, accounting for 48.3 out of 64.4 percentage points. Second, there is a positive net entry of plants, an effect that accounts for the remaining 16.1 percentage points. Similarly, 35.6% of the change in exports is explained by the growth of continuous plants. For sales, the findings are similar, although the contribution of net entry due to changes in the number of producers is 29.8 percentage points, almost twice as large as for exports.

Table 7 disentangles total export growth into export intensity and sales effects by the exporting status of the plant. The results provide further support for the fact that new exporters are the most relevant source of the observed exports rise, because almost all the exports' expansion is associated to new exporting plants. In the meantime, the continuing plants 35.6 percentage point contribution is explained by a 6.1 percentage point rise in export intensity and a 29.5 point rise in sales.

4.2. Productivity gains

New trade theories stress that the exposure to foreign competition induces productivity enhancing resource reallocation across economic units. In this section we analyze the relevance of reallocation in generating productivity gains over the Chilean export boom. This hypothesis is contrasted to the role of within-plant productivity gains that may result from international competition. Knowledge flows from international markets and the exposure to more intense competition, may both induce exporting plants to become more productive.[10]

In order to do so we generate aggregate industry measures of labor productivity as the weighted average of plant level labor productivity; i.e.,

$$prod_t^s = \sum_{j \in S} f_{jst} \, prod_{jst}$$

where $prod_t^s$ is aggregate labor productivity in period t at sector S, and f_{jst} is the share of plant j's output in the total output of sector S at t. Finally, $prod_{jst}$ is plant's j producing in sector S labor productivity at time t.

We quantify changes in this aggregate productivity measure that is due to reallocation of output across plants and within plant productivity gains by using Olley and Pakes (1996) cross-sectional decomposition. That is, we can write $prod^s_t$ as

$$prod^s{}_t = \overline{prod^s}_t + \sum_{j=1}^{J} \left(f_{jst} - \overline{f_{st}} \right) \left(prod_{jst} - \overline{prod^s}_t \right)$$

The first term of the decomposition is the average cross-sectional (unweighted) mean of productivity across all plants in sector S and year t. The second term describes whether production is disproportionately located at plants with higher productivity. In other words, the first term is associated with within plant productivity gains whereas, the second term is a covariance term that indicates whether the largest share of output is being produced by the most productive plants.

Table 8 depicts the evolution of $prod_t$, averaged at the sectoral level, in manufacturing, with *prod* normalized in 1990 to 1. The table also shows the relative importance of the evolution of the simple average and the cross term as described in the decomposition above. The figures indicate that reallocation towards more productive firms has become more relevant over the last two decades. That is, not only this covariance term is positive, but its contribution to aggregate productivity has become larger over time. In what follows we examine whether the observed total growth in productivity and each of its components is associated to export behavior. Although we are not able to identify causal effects, the regressions below can be interpreted as describing the correlation between aggregate productivity growth, reallocation effects and exports.

In order to do so, we estimate models such as

$$\ln prod_{st} = \alpha_s + \beta \ * \ln X_{st} + \delta * trend_t + \varepsilon_{st}$$

where X_{st} denotes exports in sector S at period t, α_s is a sector fixed effect, $prod_{st}$ is a measure of productivity, and $trend_t$ is a time trend.

[10] In a complementary study, Alvarez and López (2008) analyze whether there are spillover effects from exporting plants, finding a positive impact on the productivity of local suppliers.

Regression results are displayed in Table 9. The left-hand side panel of the table uses Ordinary Least Squares as the estimation method. The first column of the table estimates an elasticity of aggregate productivity to exports equal to 0.052. Thus growth in exports is actually correlated with growth in aggregate labor productivity. The effect is statistically significant and economically relevant especially given that exports doubled over the sample period.

The second column uses the simple average of labor productivity as the endogenous variable to find an elasticity of 0.04. This finding indicates that export growth is correlated within firms' productivity gains. The third column replicates the first exercise now controlling for the natural log of the simple average of productivity. Thus, the estimated elasticity of weighted productivity to exports captures the covariance term in the decomposition. Our result shows that this reallocation term is indeed significantly correlated with export growth; that is, as exports grow, output is increasingly produced by the most productive firms. The fourth column uses directly the relative importance of the covariance term as the dependent variable. Now we find no evidence of a significant elasticity, although the estimated effect is positive.

The right-hand side panel of the table repeats these exercises using a robust regression framework to down-weight outliers. We now find that all estimated elasticities are positive and statistically significant.

Summing up, our results suggest that productivity and exports have co-moved over the Chilean boom. Moreover, as exports have expanded, there has been a productivity enhancing reallocation of resources towards the more efficient plants. These facts are consistent with the predictions of the new heterogeneous firms' trade theories.

5. Concluding remarks

This paper uses almost two decades of Chilean plant-level manufacturing data to empirically investigate the relationship between exports, plant dynamics and productivity. We find that 64.4% of the increase in exports over the years 1990 to 2007 is due to the net entry of new exporters. About two thirds of this net entry contribution is associated to the larger size – average exports per firm – of new exporters; only a third is related to the increase in the number of exporters. Additionally, the export intensity (exports over sales) of new exporters is much higher than that of continuing and failing exporters.

We also show that productivity and exports have co-moved over the Chilean boom. Moreover, the exports expansion is associated to a productivity enhancing reallocation of resources towards more efficient plants.

The aggregate effect on productivity is a topic that requires further research, however, as other margins not analyzed here may be affected. For instance, Atkenson and Burstein (2010) suggest that there may be countervailing effects, since increases in exporters' innovative activity might diminish productivity innovation undertaken by smaller companies primarily serving domestic markets.

Finally, future research should address the role of natural resources as a driver of Chile's export boom. Even though non-copper exports have shown increasing diversification in terms of markets and products (Berthelon, 2011), when compared to other liberalization experiences, natural resources still predominate in Chile's exports expansion.

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Figure 1: Average Nominal Tariffs

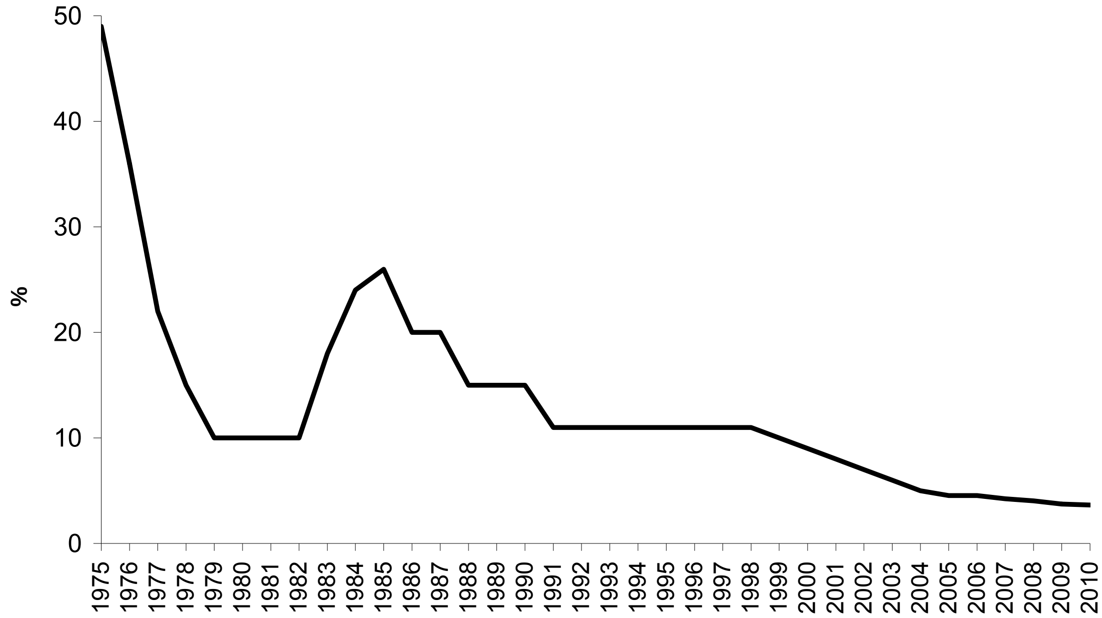

Figure 2: GDP and Total Exports

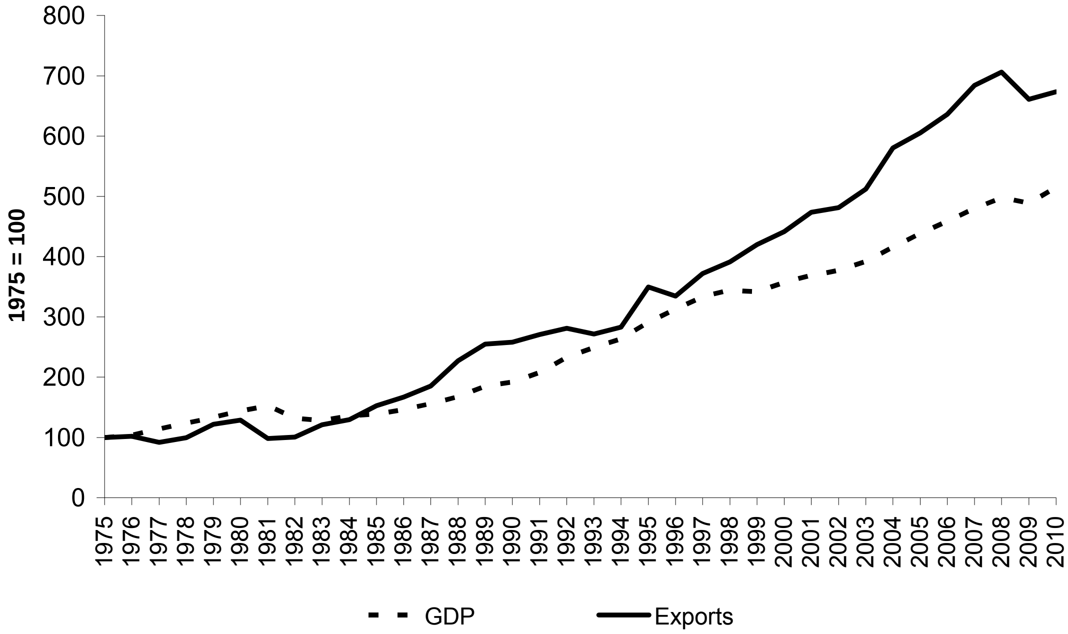

Figure 3: Distribution of Plant-Level Productivity

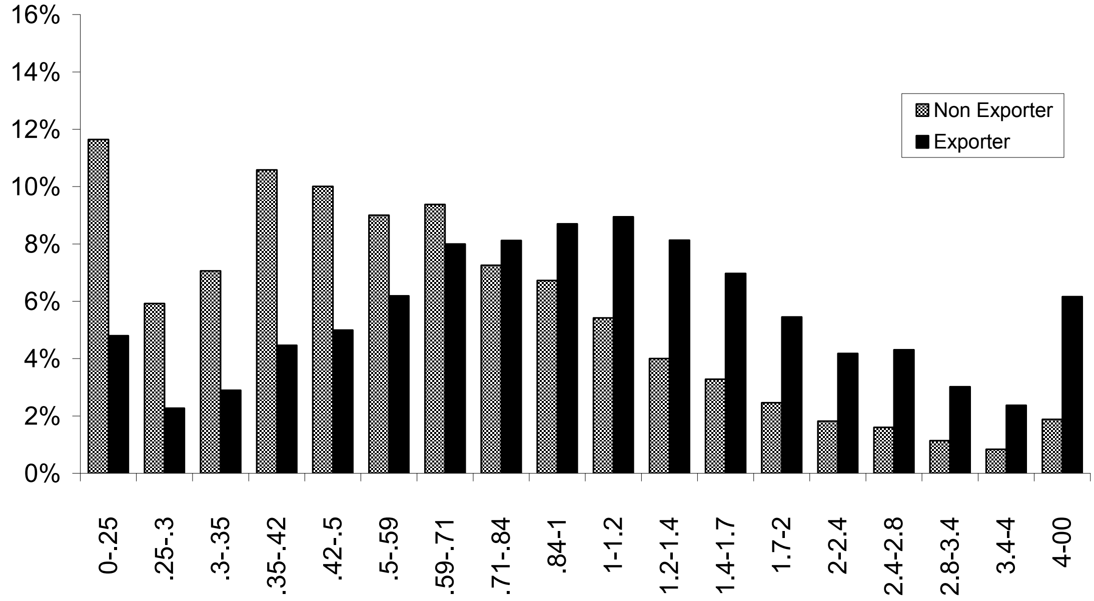

Figure 4: Fraction and Intensity of Plants Exporting

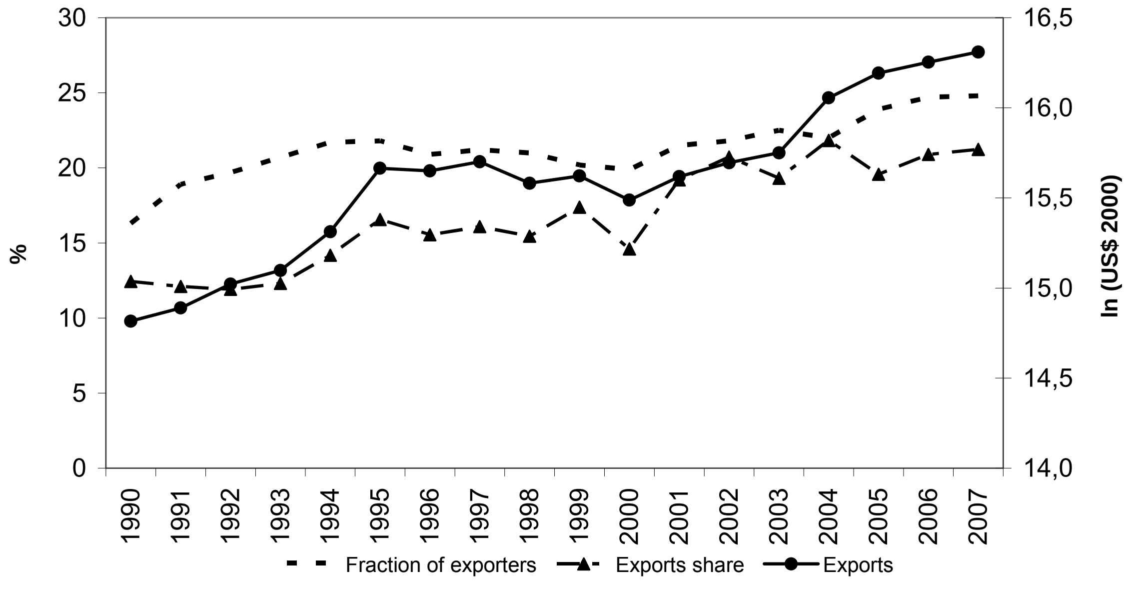

Table 1: Plant-Level Export Facts in Chile during the 1990 - 2007 period

Sectors	Plants	Labor Productivity	Capital per Employees	Labor Share	Size Employees
		Gap Relative to Sector Simple Average (3dig ISIC)			
No Exports	78,9%	-10%	-15%	1,03	-19%
Positive Exports	21,1%	38%	58%	0,88	70%
Export Intensity of Exporters (percent)	% of Exporting	Gap Relative to Sector Simple Average			
0 to 10	48,8%	42%	54%	0,88	76%
10 to 20	11,0%	36%	58%	0,91	70%
20 to 30	5,8%	37%	65%	0,90	76%
30 to 40	5,0%	25%	42%	0,95	55%
40 to 50	4,2%	36%	65%	0,86	72%
50 to 60	4,2%	27%	51%	0,92	69%
60 to 70	4,5%	44%	68%	0,83	57%
70 to 80	5,0%	30%	53%	0,86	60%
80 to 90	5,4%	38%	55%	0,82	61%
90 to 100	6,1%	37%	57%	0,81	54%

Authors' calculation

Table 2: Export Decomposition

	1990 (MM US$ 2000)	2007 (MM US$ 2000)	Difference (MM US$ 2000)	Contribution (%)
All Sectors				
All	2.720	12.113	9.392	100,0
Continuing	1.391	4.736	3.344	35,6
Entering		7.377	7.377	78,5
Exiting	1.329		-1.329	-14,1
Net Entry	1.329	7.377	6.048	64,4

Exports and sales divided by nominal exchange rate and deflated by US GDP deflator
a Only plants with export and sales data are included.
b Total sales for exporters only.

Table 3. Dynamics of Total Exports and Export Intensity

Sector	Exports Growth Annual Rates[a]	Export Intensity			
		% of Sales Exported		Difference	
	1990/91-2006/07	1990-91	2006-07	Perc. Points	%
311	1,78	18,81	28,28	9,47	50,3
312	3,45	3,16	4,85	1,68	53,2
313	8,39	7,95	21,34	13,39	168,4
314	-1,00	3,15	0,00	-3,15	-100,0
321	0,49	4,85	13,15	8,30	171,1
322	-0,49	5,73	2,35	-3,38	-59,0
323	18,84	1,08	26,13	25,05	2.329,0
324	-0,93	9,27	0,81	-8,46	-91,3
331	3,61	30,14	46,07	15,93	52,9
332	-0,37	6,33	5,19	-1,14	-18,0
341	3,77	29,88	53,71	23,82	79,7
342	0,18	3,41	3,06	-0,35	-10,3
351	6,58	34,63	12,90	-21,73	-62,8
352	1,10	6,49	8,02	1,53	23,6
353	-1,00	3,26	0,00	-3,26	-100,0
354	-0,89	2,62	0,49	-2,14	-81,4
355	2,80	13,52	29,54	16,02	118,5
356	13,35	1,47	7,40	5,94	405,2
361	3,66	14,20	24,36	10,16	71,6
362	9,11	2,14	7,15	5,01	234,3
369	1,94	1,23	1,35	0,12	9,5
371	5,81	31,39	45,48	14,09	44,9
381	2,74	2,71	4,88	2,17	80,3
382	12,34	1,33	9,44	8,12	611,6
383	8,63	1,87	9,31	7,43	396,8
384	3,33	5,82	15,43	9,62	165,3
385	30,17	2,90	15,75	12,84	442,5
390	13,10	2,65	13,17	10,52	396,4
All	3,17	12,26	21,08	8,81	71,9
Mean	5,4	9,0	14,6	5,6	62,5
25th pertl.	0,4	2,6	4,4	1,8	66,3
50th pertl.	3,4	4,1	9,4	5,2	126,9
75th pertl.	8,5	10,3	22,1	11,8	113,8

Nominal Chilean Pesos were converted in 2000 US dollars deflating by annual average nominal exchange rate and US GDP deflator.

Table 4: Export Intensity and Exporters

Period	1990-2007	1990-1991	2006-2007
Plants:			
No Exports	78,9%	82,5%	75,6%
Some Exports	21,1%	17,5%	24,4%
Export Intensity of Exporters (percent)	Percentage of Exporting Plants		
0 to 10	48,8%	52,2%	43,2%
10 to 20	11,0%	8,3%	11,7%
20 to 30	5,8%	6,0%	6,9%
30 to 40	5,0%	4,1%	5,5%
40 to 50	4,2%	3,3%	4,3%
50 to 60	4,2%	4,3%	4,0%
60 to 70	4,5%	4,5%	4,4%
70 to 80	5,0%	5,9%	5,3%
80 to 90	5,4%	5,7%	5,9%
90 to 100	6,1%	5,7%	8,9%

Authors' calculation

Table 5: Sales, Exports, and Exporters
(th. US$ 2000)

Year	Total Sales	Sales per Plant	Total Plants	Total Export	Export per Plant	Plants that Export
1990	21.876.062	4.810	4.548	2.720.005	3.671	741
1991	24.176.018	5.112	4.729	2.927.437	3.282	892
1992	28.062.938	5.724	4.903	3.342.719	3.468	964
1993	29.274.228	5.854	5.001	3.601.731	3.477	1.036
1994	31.495.799	6.237	5.050	4.467.098	4.072	1.097
1995	38.376.925	7.168	5.354	6.353.077	5.444	1.167
1996	40.262.537	7.088	5.680	6.262.309	5.271	1.188
1997	40.930.461	7.498	5.459	6.585.138	5.696	1.156
1998	37.872.972	7.268	5.211	5.850.343	5.348	1.094
1999	35.032.950	7.182	4.878	6.090.689	6.171	987
2000	36.476.860	7.773	4.693	5.328.199	5.693	936
2001	31.574.216	7.414	4.259	6.066.539	6.623	916
2002	31.596.902	6.946	4.549	6.547.966	6.601	992
2003	35.851.179	7.911	4.532	6.925.204	6.776	1.022
2004	43.035.311	8.984	4.790	9.397.054	8.899	1.056
2005	55.024.890	12.357	4.453	10.768.812	10.121	1.064
2006	54.779.590	12.865	4.258	11.445.921	10.901	1.050
2007	57.034.922	14.202	4.016	12.112.502	12.186	994
Δ1990-2007	96%	108%	-12%	149%	120%	29%

Exports and sales divided by nominal exchange rate and deflated by US GDP deflator

Table 6: Contribution of Average Exports and Exporters

	Exports	Sales
Continuing exporters		
Total change (th. US$ 2000)	3.344.414	10.308.396
Amount per firm (th. US$ 2000)		
1990	6.562	27.066
2007	22.338	75.690
Number of firms	212	212
Net entry into export markets	6.048.083	24.850.464
Total change (th. US$ 2000)		
Amount per firm (th. US$ 2000)		
Entering	9.433	52.415
Exiting	2.512	30.507
Number of firms		
Entering	782	782
Exiting	529	529
Contribution (% of total change)		
Continuers	35,6	29,3
Net entry	64,4	70,7
Due to Δ in average exports - sales	48,3	40,9
Due to Δ in number of exporters	16,1	29,8

Table 7: Contribution of Export Intensity and Exporters

	Export intensity (%)		Sales (th. US$ 2000)		Contribution to Export Rise (%)		
	1990	2007	1990	2007	Δ Intensity	Δ Sales	Total
Continuing	24,2	29,5	5.737.916	16.046.312	6,11	29,50	35,6
New exporters		18,0		40.988.610			78,5
Failed exporters	8,2		16.138.146				-14,1
Net entry	-8,2	18,0	-16.138.146	40.988.610			64,4

Table 8: Labor Productivity OP Decomposition
Simple Average by Sector

Year	Total	Simple Avg.	Cross Term
1990	1,00	0,85	0,15
1991	1,08	0,83	0,17
1992	1,17	0,81	0,19
1993	1,26	0,80	0,20
1994	1,27	0,82	0,18
1995	1,40	0,81	0,19
1996	1,55	0,79	0,21
1997	1,60	0,80	0,20
1998	1,65	0,79	0,21
1999	1,71	0,81	0,19
2000	1,82	0,78	0,22
2001	1,96	0,77	0,23
2002	2,08	0,81	0,19
2003	2,09	0,82	0,18
2004	2,16	0,75	0,25
2005	2,40	0,76	0,24
2006	2,52	0,77	0,23
2007	2,74	0,80	0,20

Table 9: Exports and Labor Productivity

	Labor Productivity (Deflated)			Cross Term	Labor Productivity (Deflated)			Cross Term
	Weigthed	UnW	Weigthed	Fraction	Weigthed	UnW	Weigthed	Fraction
Exports (ln)	0.052	0.040	0.025	0.004	0.026	0.052	0.017	0.011
	(3.70)**	(2.73)**	(2.46)*	(0.41)	(2.20)*	(4.94)**	(2.44)*	(2.39)*
LP UnWeigthed			0.679				0.809	
			(17.72)**				(29.89)**	
Year	0.049	0.041	0.021	0.007	0.051	0.039	0.013	0.004
	(18.51)**	(14.94)**	(8.51)**	(3.61)**	(22.75)**	(19.64)**	(7.73)**	(4.62)**
Observations	336	336	336	336	336	336	336	336
R-squared	0.98	0.98	0.99	0.76	0.98	0.99	0.99	0.93
Regression		OLS				Robust Regression		

Absolute value of t statistics in parentheses
* significant at 5%; ** significant at 1%