Productivity, Misallocation and the Labor Market

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June 2012

Abstract

A wealth of empirical research has demonstrated that reallocation of inputs and outputs across establishments with different productivity levels significantly contributes to aggregate growth. In this paper we estimate the extent of labor misallocation in Chilean manufacturing plants over the 1979-2007 period; that is, the potential gains from this reallocation process. We find that labor productivity heterogeneity has increased over the period under analysis. We show that this finding is correlated with the rise in the volatility of shocks that resulted from developments in both, the conduct of monetary policy and in the energy market. We also find that although the reallocation process is productivity enhancing, its relative incidence had diminished by the end of the period. Finally, we estimate the aggregate manufacturing losses associated to this dispersion by examining the productivity gains that would result from reallocating workers from the least productive plants. These estimates range up to 25% of aggregate productivity in the benchmark case.

Keywords: Labor productivity, productivity dispersion, labor regulation.

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[1] We thank Daron Acemoglu, Ricardo Caballero, Vittorio Corbo, Klaus Schmidt-Hebbel and seminar participants at CEP for helpful comments and suggestions. We are also grateful to Pablo Muñoz for excellent research assistance. This paper is part of a project on labor market adjustments that is financed by Fondecyt (Fondecyt Project 123).

I. Introduction

A wealth of empirical research based on longitudinal establishment data for a number of countries has consistently found large and persistent productivity differences among plants or firms producing in the same industries in any given time period.[2] A closely related literature has overwhelmingly demonstrated that the process of inputs and output reallocation that takes advantage of these productivity differences significantly contributes to aggregate productivity growth. Chile is no exception: almost half of Chilean manufacturing growth is accounted for by this process of economic restructuring (Bergoeing et al., 2010).

Jointly with the ability of the economy to reallocate inputs and output, the evolution of productivity dispersion is thus a relevant factor in understanding the dynamics of growth. There are many reasons for the existence of heterogeneity in plant-level decisions and outcomes. Differences in entrepreneurial ability, the organizational structure or the vintage of capital, may all explain cross-sectional variation in productivity. Similarly, differential access to human capital, infrastructure and credit may generate variation in the manner firms invest in technology and use their resources. Uncertainty may also underlie the observed dispersion. For instance, plant specific shocks to demand, investment opportunities, input costs and technology are the main sources of uncertainty discussed by the class of models developed in Jovanovic (1982) and Hopenhayn (1992). The development and adoption of new products or production techniques is also an uncertain process. Finally, regulation may protect some firms, by discouraging entry, reallocation or innovation, through special tax exemptions, subsidies or credit priorities (Parente and Prescott, 1994; Acemoglu et al., 2001).

Not all these reasons for plant-level heterogeneity are associated to the misallocation of inputs or outputs. For instance, reallocation may be costly due to technological barriers.

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[2] See Bartelsman and Doms (2000) and Foster et al. (2001) for surveys.

However, some of these mechanisms generate highly persistent differences in productivity across plants, whereas others bring about transitory variation only. For example, credit constraints and special subsidies and taxes typically generate permanent differences in plant-level productivity, and may explain why largely different plants produce in the same narrowly defined industries in any given time period. Similarly, shocks and adjustment costs have transitory effects on plant productivity dispersion.

In this paper we focus on the dynamics of labor productivity dispersion and its relation to the observed process of aggregate growth in Chile. In particular, we use plant-level data for the manufacturing sector from 1979 until 2007 to estimate the distribution of labor productivity and its evolution over time. Based on the method of Hsieh and Klenow (2009), we estimate the extent of labor misallocation and analyze the evolution of observed dispersion over the sample period. More specifically, we find that the dispersion of labor productivity across firms increased sharply in 2004. By 2007 –the end of our sample period– the gap had not yet been fully closed. We also show that although plants producing in all sectors experienced this jump in dispersion, the largest and most persistent change is concentrated among sectors that hire skilled labor more intensively. This finding is consistent with the hypothesis that labor market regulations mostly affect the ability of firms to adjust skilled labor; that is, the ability to adjust the employment of workers who tend to have higher average tenure and more bargaining power within firms.

We then ask whether the reallocation process in Chilean manufacturing is productivity enhancing and whether it has become more or less productivity enhancing over time. To do so, we use the cross-sectional decomposition first introduced by Olley and Pakes (1996). We find that in every year the reallocation of employment has been productivity enhancing; i.e., labor is being reallocated from less to more productive plants. However, in the latest period, the relative incidence of this process in explaining overall productivity growth has diminished.

An examination of events occurring in the Chilean economy leads us to relate the rise in productivity dispersion and the reduced relevance of the reallocation process to changes in the energy market, in particular, to cuts in the supply of natural gas imported from Argentina. We also argue that the increased volatility in the real exchange rate that resulted from the adoption of an inflation targeting monetary policy may too have affected the outcomes in the labor market. We also examine the role of jumps in the interest rate as a result of the Asian crisis that hit the Chilean economy by the end of the 1990s. A simple econometric model shows that the rise in the observed macroeconomic volatility does correlate with the observed rise in the dispersion of labor productivity, in particular among those sectors that produce traded goods and/or use gas as a source of energy more intensively.

In other words, we hypothesize that the volatility of shocks that firms face explains the observed rise in productivity dispersion. However, it is also possible that the speed at which firms adjust to these shocks has slowed down over time. Following Caballero et al. (2010) we estimate the speed of adjustment in our manufacturing data set to find that if anything, firms tend to adjust more quickly in the recent years. We do find, however, that plants producing in skilled-labor intensive sectors close the gaps in employment more slowly than the mean. Again, this finding may be related to labor market regulations that mostly affect the ability of firms to adjust skilled labor.

Finally, we estimate the aggregate effects of labor misallocation. In a simple, yet revealing exercise, we find that if half of the employees in the first quintile of plants' labor productivity distribution were reallocated to the top quintile plants, manufacturing productivity would increase by about 25%.

The remainder of this paper is organized as follows. Section II describes Chile's labor market and the regulations that may affect the responsiveness of plants to shocks. Section III presents the data set and the methodological approach we use to estimate the extent of misallocation. Section IV presents our basic estimates of labor productivity dispersion, while Section V correlates this dispersion to developments in the Chilean economy. Section VI estimates the losses associated to the observed level of labor productivity dispersion. Finally Section VII provides concluding remarks.

II. The Chilean labor market and its regulatory framework

In this section we briefly describe the stylized facts on Chile's labor market. We also describe its regulatory framework.

Chile's Labor Market

Table 1 presents the main facts on the Chilean labor market. Table 2 compares Chile's employment and unemployment rates to those of the OECD country members. Table 1 shows how rapidly Chile's GDP and income per capita grew between 1986 and 2010. The annual average rate of GDP growth equaled 4% over the period. That is, over the past two and a half decades, Chile's income per capita increased by an approximate factor of 2.5. Over the period between the mid 1980s and the mid 1990s —the so called "Chilean miracle"—this annual growth rate averaged over 6% per year. It noticeably slowed down, however, after the deterioration of terms of trade in the late 1990s, a result of the Asian crisis. The unemployment rate increased and remained stubbornly high for a number of years. At the onset of the 2008 international crisis, the unemployment rate had not yet returned to the levels observed in 1998.

Tables 1 and 2 also show that Chile is characterized by low labor force participation and employment rates, especially among women and youth. These employment rates contrast with those observed in OECD countries: while 79% of men and 59% of women in the OECD are employed, only 68% and 36% of their Chilean counterparts are. A similar pattern emerges for young workers.

A number of factors might explain these relatively low participation and employment rates: lack of job opportunities, family arrangements and the cultural role associated to women, low access to childcare provision, a rigid part time labor regulation and a relatively high minimum wage, among others.[3] The recent rise in female labor market participation is most

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[3] See, for instance, the report of the *Consejo Asesor Presidencial para el Trabajo y Equidad* (2008).

likely the result of the expansion in the provision of childcare for working women (Hernando, 2009).

Table 1. Chile's Growth and Labor Market Outcomes, 1986-2010

	All Population (15 or more)				Women		Men	
Year	GDP Growth	Unemploy-ment Rate	Labor Force	Employment Rate	Unemploy-ment Rate	Employment Rate	Unemploy-ment Rate	Employment Rate
1986		12%	50%	44%	15%	24%	11%	65%
1987	5.7%	10.9%	51%	45%	14.4%	25%	9.5%	66%
1988	7.6%	9.7%	52%	47%	13.5%	26%	8.1%	69%
1989	11.0%	7.9%	53%	48%	10.6%	27%	6.8%	71%
1990	3.2%	7.8%	53%	49%	9.7%	28%	7.0%	70%
1991	7.8%	8.2%	53%	48%	10.3%	28%	7.3%	70%
1992	12.6%	6.6%	53%	50%	8.9%	29%	5.6%	71%
1993	6.6%	6.5%	55%	52%	9.0%	31%	5.4%	73%
1994	7.2%	7.9%	55%	51%	10.3%	31%	6.7%	72%
1995	9.1%	7.3%	55%	51%	9.5%	31%	6.3%	72%
1996	8.5%	6.4%	54%	51%	7.9%	31%	5.6%	71%
1997	6.6%	6.1%	54%	51%	7.7%	32%	5.4%	71%
1998	3.3%	6.4%	54%	51%	7.6%	32%	5.8%	70%
1999	0.3%	10.1%	55%	49%	10.8%	32%	9.8%	67%
2000	4.2%	9.7%	54%	49%	10.4%	32%	9.4%	67%
2001	3.6%	9.9%	54%	49%	10.1%	31%	9.7%	66%
2002	2.2%	9.8%	54%	48%	10.1%	32%	9.6%	66%
2003	3.9%	9.5%	54%	49%	10.3%	33%	9.1%	66%
2004	6.0%	10.0%	55%	49%	11.2%	34%	9.4%	66%
2005	5.6%	9.2%	56%	50%	10.6%	35%	8.5%	66%
2006	4.6%	7.8%	55%	51%	9.5%	35%	6.9%	67%
2007	4.6%	7.1%	55%	51%	8.6%	36%	6.3%	67%
2008	3.7%	7.8%	56%	52%	9.5%	37%	6.8%	67%
2009	-1.5%	9.7%	56%	50%	10.7%	37%	9.1%	65%
2010	5.2%	8.2%	59%	54%	9.6%	41%	7.1%	67%

Source: INE. The Employment Survey and methodology were changed in 2010.

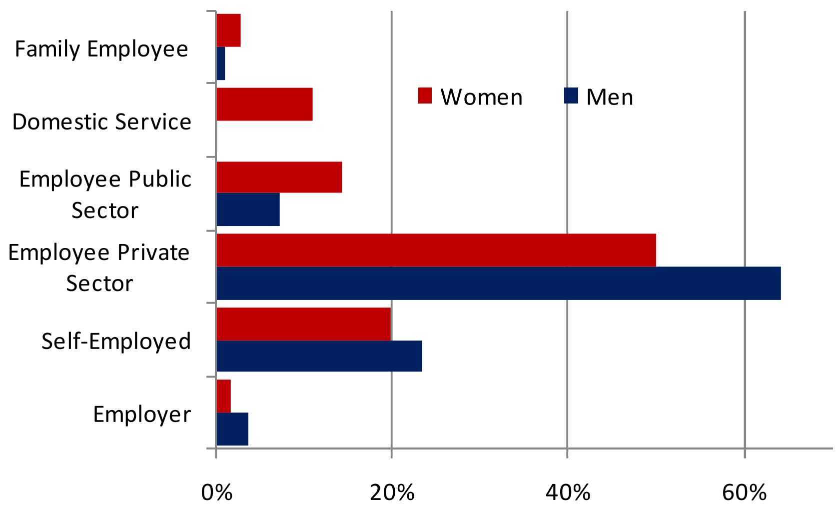
Table 2. Employment and Unemployment in Chile and the OECD, 2007

	Employment Rate			Unemployment Rate		
	Men	Women	Both 20-24 years	Men	Women	Both 20-24 years
Chile	**68.0**	**35.6**	**44.9**	**6.5**	**8.4**	**15.8**
European Union 19	74.5	59.2	55.7	6.5	8.0	13.8
European Union 17	75.8	60.3	58.1	6.3	7.8	13.0
G7	80.1	64.8	64.0	5.4	5.5	9.7
United States	81.8	63.0	65.6	4.5	4.5	7.8
OECD	**79.0**	**59.3**	**59.8**	**5.4**	**5.9**	**10.5**

Source: OECD.

Figure 1 plots the shares of employed workers by the type of job they hold[4]. Although more than half of employed workers are salaried workers in the private sector –64% of men and 50% of women–, a relevant share of employed workers are either self-employed, unpaid family workers or domestic service workers. As a matter of fact, one in four male workers and one in three female workers are employed in one of these sub categories.

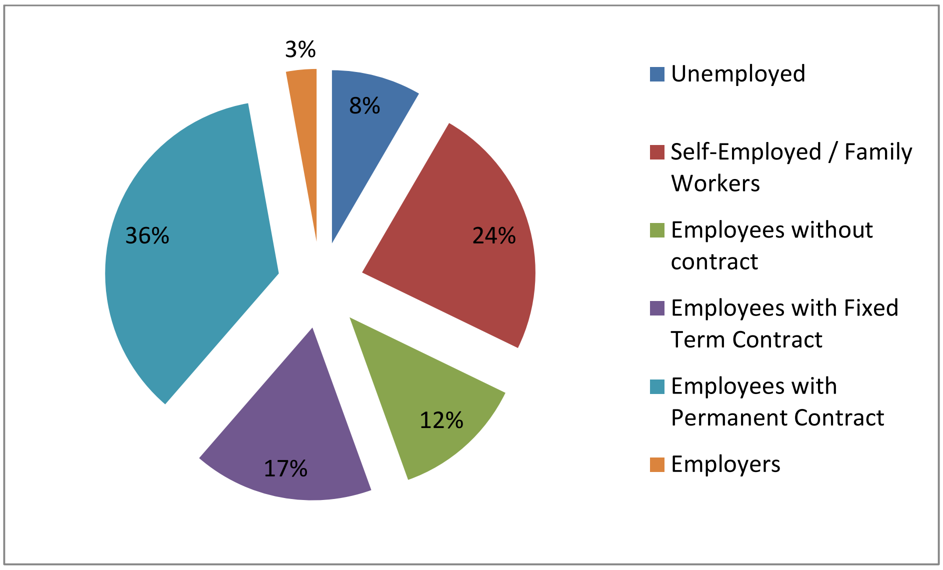
Figure 1. Workers by Job Type



[4] Data for 2008 based on INE's Employment Survey.

Individuals who participate in the labor force are classified in Figure 2 according to their employment status. The figure also classifies workers by the formality of their employment; i.e., whether there is a contract that regulates the relationship and if so, by the type of contract that has been signed[5]. During years 2004-2008, the average unemployment rate equaled 8%. Similarly, self employed and unpaid family workers accounted for 24% of the labor force, whereas employers represented 3% of the total. Among employees (65% of labor force), almost 20% of workers did not have a contract. Finally, among formal salaried workers, 32% were hired under fixed-term or temporary contracts.

Figure 2. Workers by Employment Status and Contract Type



[5] Averages for 2004-2008. The fractions of unemployed, self-employed, family workers, employers and employees are estimated from INE's Employment Survey. To estimate workers by formal contract type, we used pensions and unemployment insurance contributions data gathered by the *Superintendencia de Pensiones*.

This distribution of workers across different types of jobs implies that almost half of the labor force does not come under the Labor Code. In addition, informal workers, the self-employed and temporary workers tend to receive lower coverage from mandatory contributory programs such as pensions, unemployment insurance and health insurance.

The fraction of the labor force with indefinite contracts has increased over the past decade (Figure 3). However the share of fixed term contracts has risen even faster: it accounted for 13% of the labor force in 2004 and for 18% in 2008. During the 2009 crisis, however, the share of temporary contracts fell to 15.5%. In other words, a large fraction of the adjustment to the recession was accomplished by a reduction in the hiring rate of workers under fixed term contracts. These temporary contracts allow for more flexibility than indefinite contracts, a matter we discuss below. The share of workers without a contract also fell in 2009.

Figure 3. Share of Unemployed and Employed Workers by Contract Type

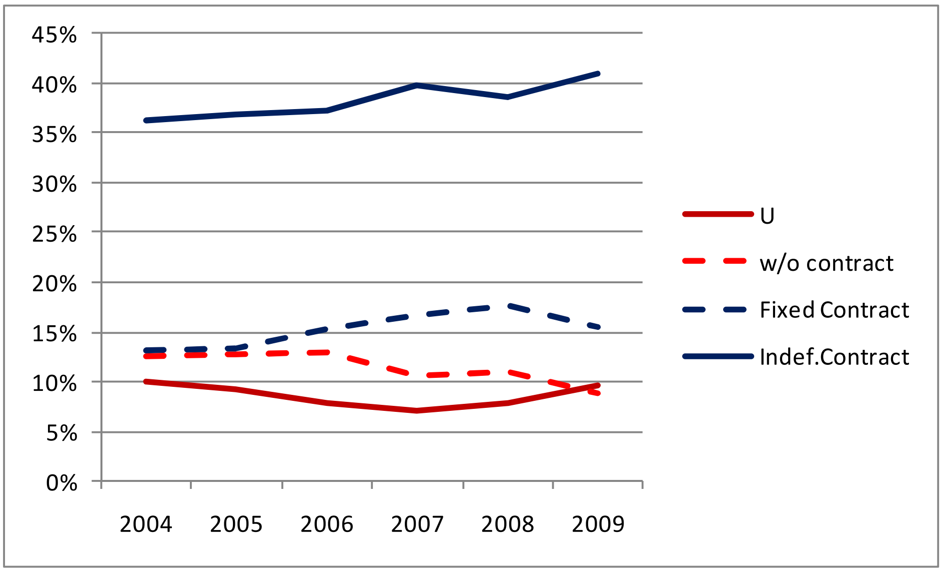
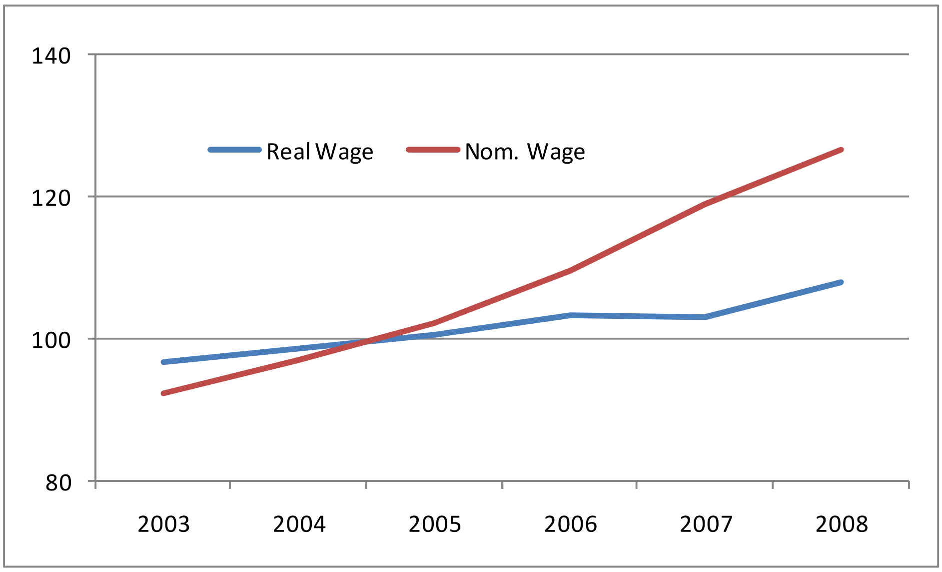


Figure 4 shows the evolution of nominal and real wages. During the period under analysis, nominal wages increased at an annual rate of at least at 5 percent, while real wages grew at a 2 percent average rate. In 2008, after the inflation shock of 2007 and at the onset of the international crisis, nominal wages increased faster, at a rate over 8 percent. In real terms, however, wages were constant due to the rising inflation rate.

Figure 4. The Evolution of Wages



The Regulatory Framework

The ability of the economy to reallocate labor depends on many factors. In this subsection we describe the main institutional aspects of the labor market that may affect the restructuring capacity of firms. The regulations described in what follows may inhibit turnover or reduce the ability of wages to adjust. Also, they may have a differential effect on the hiring and firing rates of different groups of workers. For instance, job security provisions, like severance pay, that depend on the worker's tenure will affect relatively more the rotation of workers with shorter average tenure, like the youth, women and unskilled workers. We will turn to this potential differential impact in Sections IV and V.

Severance pay: Workers hired under permanent contracts that are laid off for no fault of their own are entitled to severance pay of at least one month of pay per year of work up to eleven years. There is a surcharge of 20% if the dismissal cause of economic need cannot be demonstrated in court. The maximum number of years of work covered was increased in the early 1990s from five months. Since workers hired under temporary contracts and those who quit voluntarily are not entitled, the effective coverage of severance pay is relatively low --about 6% of formal workers can expect to receive severance pay--. This by no means implies that severance pay is irrelevant, as it affects the hiring decisions of firms, the type and length of contracts and wages paid. As a matter of fact, Montenegro and Pages (2004) estimate that severance pay regulation in Chile reduces the employment opportunities of young, female and under skilled workers.

Firing regulations: In addition to severance pay, workers under indefinite contracts are entitled to one month advance notice prior to termination. Employers must justify the cause for termination. Temporary contracts can be terminated at no cost at expiration, but must be paid in full if terminated before its expiration date. Fixed-duration contracts cannot last longer than a year and allow for one single renewal. The second renewal entitles the worker to an indefinite contract. The worker is also automatically entitled to a permanent contract if he is employed under a fixed term contract for 12 months or more in any 15 month period.

Regulations on hours worked: Full time employees cannot work more than 45 hours per week --distributed over not less than and not more than 6 days per week--, and no more than 10 hours per day. Additional hours must be negotiated in advance with a maximum of two extra working hours per day. These are paid with a 50% surcharge. Exceptions to these norms are allowed, but they must be approved by the Labor Inspectorate (*Dirección del Trabajo)*. The currently conceded exceptions are mainly concentrated in the mining industry.

Size related regulations: A number of regulations discriminate across firms depending on the size of the firm. The main ones relate to the hiring of foreign workers and to the provision of child care. The first one requires that at least 85% of hired workers are Chilean nationals if the firm employs 25 or more individuals. The second one mandates firms to provide child care services whenever there are 20 or more female workers hired in the firm. The age of the worker, the age of their children and the hours per month worked are not relevant dimensions of this mandate. Anecdotal evidence suggests that a relevant fraction of small firms have 19 female employees.

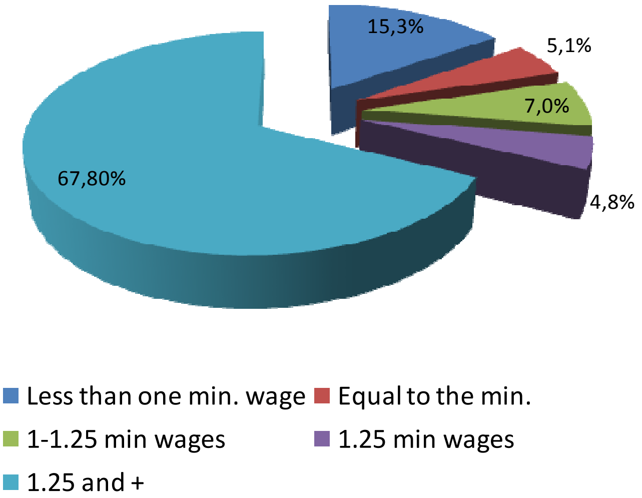
Minimum wage: The minimum wage is set on a yearly basis. There is no explicit regulation on the level at which it should be set. Typically, it is set on the basis of a bargaining process held by the government and employers' and workers' organizations, since annual minimum wage adjustments require the approval of Congress. As of today the minimum wage equals 182 thousand Chilean pesos per month, a level that represents about 60% of the median wage. A lower level is set for workers under the age of 18. According to the Minimum Wage Commission (2010), 15.3% of workers contributing to the Unemployment Insurance system earn less than the minimum wage; 5.1% earn exactly the minimum wage, and 11.8% earn between one and 1.25 minimum wages (Figure 5)[6].

Profit sharing: Firms that earn profits are mandated to distribute 30% of profits minus the 10% of the value of its capital to workers. There is no explicit regulation on how capital should be valued to determine the amount of profits that has to be distributed among workers. Alternatively, firms can choose to pay a surcharge of 25% of wages to all workers with an annual maximum of 4.75 minimum wages. According to the *Dirección del Trabajo*, the overwhelming majority of firms choose to pay the surcharge, as less than 7% of firms distribute profits. Most likely, this regulation explains why 4.8% of workers

[6] Part time contracts may earn less than the minimum wage. Informal workers may too, but they do not contribute to the UI system and hence are not included in the statistics of the figure.

contributing to the Unemployment Insurance system earn exactly 1.25 minimum wages (Figure 5).

Figure 5. Minimum Wage Incidence



Payroll taxes: Pensions and unemployment insurance are financed by a tax on wages. Although these deductions are deposited in an individual account that is owned by the worker, employees may not fully consider them as a deferred compensation (Edwards and Cox-Edwards, 2002). In addition a fraction of wages is dedicated to health insurance finance and pension funds management fees. In total, over 20% of wages must be deducted to finance social security.

III. Data and Methodology

In this paper we use 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. Employment in the ENIA represents about 50% of total manufacturing employment.[7]

The data available extends from 1979 to 2007 and contains detailed information on plant characteristics such as manufacturing sub-sector at the 3-digit ISIC level, sales, employment, investment, intermediate inputs and location.[8]

All nominal variables were deflated at the 3-digit ISIC level, using deflators constructed from the wholesale price indices compiled by INE.[9] Our analysis considers all 29 3-digit ISIC rev.2 sectors. However, we have excluded copper production – sector 3721 – from the analysis, which is classified under the mining sector by national accounts. We also exclude oil refineries –sector 3530--.

Table 3 provides basic statistics characterizing the plants in our data set over the sample period. The first column presents the number of respondent plants in each year. The next two columns show the average value added and gross output produced by the plants in ENIA over time, expressed in 1992 millions of Chilean pesos. The average wage bill paid is also measured in millions of 1992 Chilean pesos. Employment includes all workers in the plant, with no distinction by skill level or type of job. On average, value added and output per plant have grown at an annual 5.5% rate between 1979 and 2007, whereas employment

[7] We observe plants and not firms in our data set and thus we are unable to distinguish single-plant firms from multi-plant firms. According to information provided by Central Bank statisticians, about 3.5% of plants belong to a multi-plant firm in our data set.

[8] 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 and the 1995-2007 data sets do not have a common identifier, but a third survey covering years 1995 to 2007 had both identifiers for year 2000. As a double check on the common identifier, we compared 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, for year 1995 and 1996. In 97% of cases these variables were identical. For plants that were in 1995 and 1996 but not in the year 2000, we matched plants by these same variables. Using this method, 97% of plants reported identical values of these variables in both surveys. We excluded plants we could not find a match for four or more of these variables.

[9] Most of our results below do not require the use of deflators as we estimate differences with respect the average plant in any given sector defined at the 3 digit ISIC rev.2 level.

and total wages per plant have grown at a 2.2% and 2.3% per year, respectively. These rates vary largely over the sample period, ranging from a 20% growth rate in value added in 2005 relative to 2004, and a 4.2% drop in year 2003 relative to year 2002. In what follows, we show that productivity also presents wide variation across and within sectors, a fact consistent with idiosyncratic technology and efficiency differences.

Based on ENIA's data, in this paper we analyze the evolution of the potential misallocation of labor in Chilean manufacturing over the 1979-2007 period. Olley and Pakes (1996), Levinsohn and Petrin (2003), Caballero et al. (2004), Micco and Pagés (2004) and others have, in different contexts, estimated the potential gains from inputs and outputs reallocation across plants. Hsieh and Klenow (2009), for instance, estimate the extent of misallocation in China and India relative to the United States based on a model of heterogeneous firms and monopolistic competition. According to their model, under full efficiency firms should display equal marginal productivity in equilibrium. If not, aggregate output would be higher if inputs were reallocated from firms with low marginal productivity to firms with high marginal productivity. Under certain assumptions, the observed dispersion in marginal productivity can thus be used to estimate a measure of the distortions faced by firms.

In this paper we do not impose the structure of Hsieh and Klenow (2009) to our data. However, we do follow their study in relating the dispersion of productivity across plants to labor misallocation. In our benchmark estimates, we proxy marginal labor productivity by the ratio of value added to the wage bill. We do not directly estimate total factor productivity to avoid imposing the strict conditions that are needed to measure TFP. We use the wage bill and not employment to approximate the level of human capital within plants. As a robustness check, we also estimate the distribution of average productivity using value added over employment at the plant level[10].

[10] The results of this robustness exercise can be found in the Appendix.

Table 3. ENIA 1979-2007, Basic Statistics

Year	Number of Plants	Value Added per Plant $92 millions	Output per Plant $92 millions	Total Employees per Plant	Total Wages per Employee $92 millions	Average Deflactor (1992=100)
1979	5,139	461	983	54	1.5	8
1980	4,764	470	988	55	1.7	11
1981	4,242	536	1,118	56	2.1	13
1982	3,830	525	1,049	52	2.2	14
1983	3,715	525	1,116	54	1.9	18
1984	4,119	527	1,143	56	1.7	22
1985	4,123	531	1,189	60	1.5	31
1986	3,890	541	1,315	67	1.4	38
1987	4,270	558	1,370	70	1.3	45
1988	4,208	645	1,540	76	1.3	54
1989	4,255	735	1,705	82	1.5	63
1990	4,291	739	1,692	81	1.6	75
1991	4,426	776	1,787	82	1.7	90
1992	4,653	845	1,917	83	1.9	100
1993	4,745	910	2,017	84	2.0	112
1994	4,761	934	2,072	84	2.2	122
1995	5,055	946	2,086	81	2.3	133
1996	5,295	988	2,176	76	2.5	138
1997	5,097	1,084	2,353	77	2.7	138
1998	4,877	1,175	2,454	75	2.7	143
1999	4,484	1,276	2,605	74	2.8	147
2000	4,353	1,380	2,772	76	2.7	153
2001	3,963	1,378	3,087	76	3.0	162
2002	4,230	1,353	3,088	75	2.9	169
2003	4,257	1,297	3,010	76	2.9	179
2004	4,494	1,301	3,025	74	2.9	183
2005	4,205	1,566	3,739	87	2.9	187
2006	4,004	1,645	3,953	88	3.0	194
2007	3,785	1,947	4,456	98	2.8	206

Source: Author’s calculations based on ENIA.

To correct for common shocks and differences in productivity across sectors, we estimate the distribution of plant level natural logarithm of productivity relative to the average natural logarithm of the productivity of the plants producing in the same 3-digit ISIC sector in the same period of time. That is, we estimate the fraction of plants that produce X% less than the typical plant in its industry in a given year. We then estimate the distribution of these gaps for each year of our sample after weighting by the number of employees hired in each plant. That is, the distributions below represent the density of workers' relative productivity in manufacturing in any given year; i.e., the fraction of workers that display a certain level of relative productivity.

We use a number of statistics as a measure of productivity dispersion in our data set. That is, in addition to following the evolution of the standard deviation, we also provide information on the difference between various percentiles of this distribution.

IV. The evolution of dispersion

Tables 4a and 4b displays several points in the distribution of relative productivity for the full sample period. The table describes the distribution of

$$\ln(VA_{jst} / w_{jst} e_{jst}) - \ln(\sum_{j\in S} \frac{1}{n_{st}} (VA_{jst} / w_{jst} e_{jst}))$$

where VA_{jst} represents value added, w_{jst} represents wages and e_{jst} employment, all for plant *j* producing in sector *s* in year *t*. Recall that plants' productivity is weighted by the number of workers, so the distribution actually depicts employees and their productivity within plants. The statistics in the Table confirm the existence of wide differences in productivity across plant employees even within narrowly defined industries. Employees in the first percentile are 65% less productive than the average,[11] whereas employees in the 99th percentile are 529% more productive. Large gaps are still observed at less extreme points of the distribution. For instance, percentile 20th is 31% less productive than the mean, whereas percentile 80th is 76% more productive.

Table 4a. The distribution of productivity gaps

	Deviation from the Mean	
	Natural logarithm	%
Percentile 1	-1.06	-65%
Percentile 5	-0.78	-54%
Percentile 10	-0.59	-45%
Percentile 20	-0.37	-31%
Percentile 30	-0.22	-19%
Percentile 70	0.36	44%
Percentile 80	0.57	76%
Percentile 90	0.90	147%
Percentile 95	1.23	243%
Percentile 99	1.84	529%

Table 4b. Average deviation of productivity gaps

	Deviation from the Sectoral Mean	
Average	Ln Deviation	Implied % Deviation
1th Quintile	-0.64	-47%
2th Quintile	-0.23	-20%
3th Quintile	0.05	5%
4th Quintile	0.34	41%
5th Quintile	0.91	149%

[11] Note that productivity is expressed in natural logarithm, so the gap is calculated as 67%=exp(-1.06)-1.

As a benchmark, Table 5 reproduces the results of Hsieh and Klenow (2009) for China, India and the United States. The table provides revenue TFP dispersion statistics for years 1998, 2001 and 2005[12]. For comparison, we estimated the dispersion of this measure of productivity using our data set for Chile.

Table 5. Dispersion of Revenue TFP in Chile, China, India and the United States

Chile	1990	1995	2000	2005
SD	0.59	0.58	0.65	0.61
p75-25	0.73	0.70	0.79	0.74
p90-10	1.50	1.44	1.60	1.52
China	1998	2001	2005	
SD	0.74	0.68	0.63	
p75-25	0.97	0.88	0.82	
p90-10	1.87	1.71	1.59	
India	1987	1991	1994	
SD	0.69	0.67	0.67	
p75-25	0.79	0.81	0.81	
p90-10	1.73	1.64	1.60	
USA	1977	1987	1997	
SD	0.45	0.41	0.49	
p75-25	0.46	0.41	0.53	
p90-10	1.04	1.01	1.19	

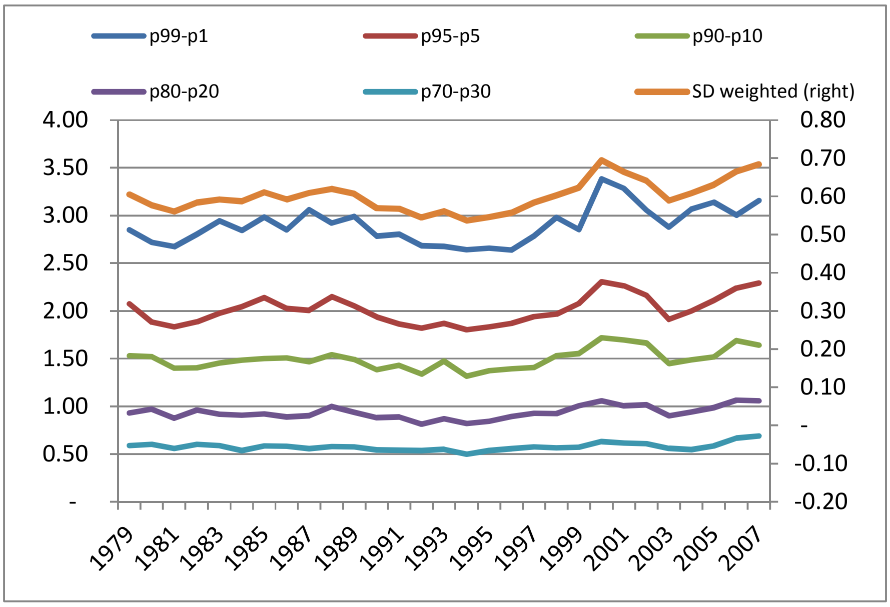
Dispersion measures estimated by Hsieh and Klenow (2009) for China and India are much larger than for the United States. According to our estimates, dispersion in Chile lies in between the dispersion in these Asian countries and the dispersion in the United States.

[12] Revenue TFP is calculated on the basis of value added using a sector-specific (instead of plant-specific) deflator. See Foster et al. (2008).

Although these differences may reflect data sampling, they are also consistent with the relative extent of distortions in these economies.

Figure 6a plots the evolution of alternative measures of labor productivity dispersion in our sample of plants without weights (the standard deviation[13], and the difference between percentile 99 and percentile 1, between percentile 90 and percentile 10, and so on)[14].These alternative series are highly correlated; e.g., the simple correlation of the standard deviation and the gap between the 95th and the 5th percentiles is 0.96. Figure 6b shows that the unweighted standard deviation follows a very similar time pattern than its weighted counterpart.

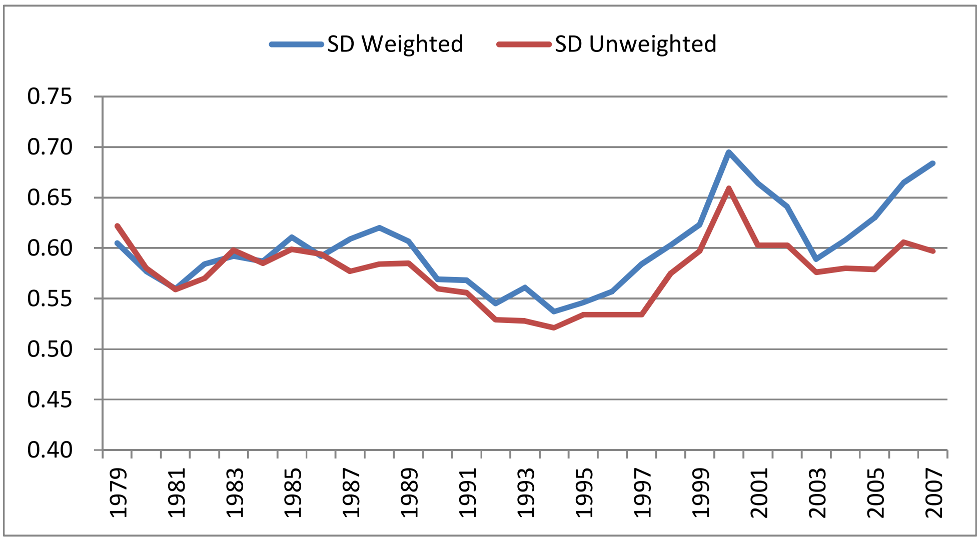
Figure 6a. Evolution of Labor Productivity Dispersion



[13] To estimate the standard deviation we excluded the extreme 0.4% of observations from each tail of the distribution.

[14] Weighting the mean to define relative productivities leads to very similar results. The estimates are available from the authors upon request.

Figure 6b. Weighted and Unweighted Productivity Dispersion

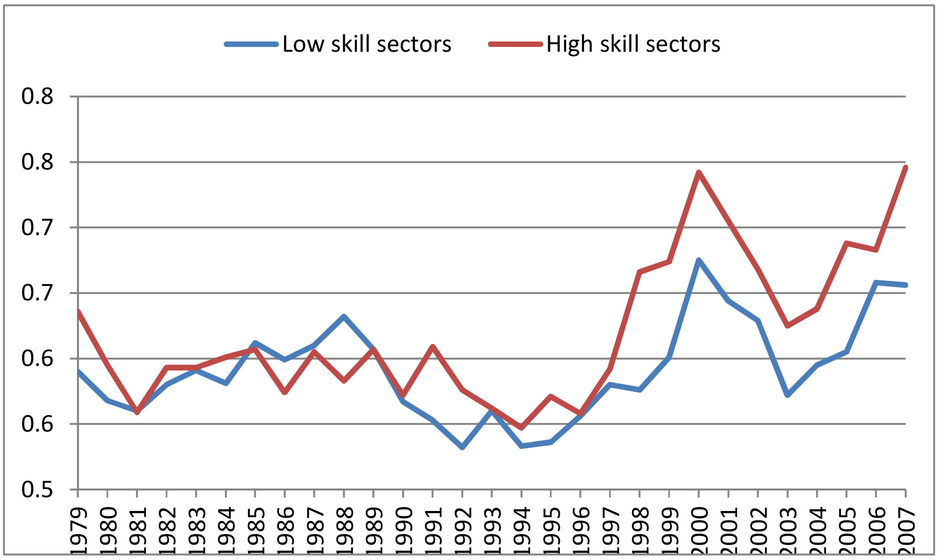


As the figures show, dispersion in the early 1980s was highly volatile. The international crisis of 1981-1982 hit Chile hard: the economy fell in a deep recession as GDP dropped by 13.6% in 1982 and a further 2.8% in 1983. Unemployment, at already high levels, swelled to 34% of the labor force (including as unemployed those working under emergency employment programs), and the government deficit increased to almost 9% of GDP when the Central Bank had to rescue the financial sector from bankruptcy. At the end of the 1980s, dispersion started to steadily fall, reaching its lowest levels in the mid 1990s. This period has been dubbed by many as the "Chilean miracle" with GDP growth rates reaching annual averages near 7% (Table 1). Dispersion abruptly increased as the Asian crisis hit Chile and the international markets, coupled with a large increase in the monetary policy interest rate set by the Central Bank. Dispersion, however, declined rapidly: by 2003 it had already returned to its pre crisis level.

In 2004 all our dispersion measures experienced again a relevant rise. By 2007, the weighted standard deviation had risen by 16% and the 90^{th}-10^{th} percentiles gap had increased by 13%. In Section V below we relate this rise of the observed dispersion to a number of developments in the Chilean economy.

Figure 7 follows the evolution of the weighted standard deviation of the natural logarithm of labor productivity after classifying sectors according to the intensity of use of skilled *versus* unskilled labor. According to our exercise, a sector is defined as skilled labor intensive if the ratio of skilled labor over total employment is larger than the median in our data base. The figure shows that dispersion among both sets of sectors was volatile but slightly declining until 1996-1997. The pattern starting in 1998 is remarkably close to that of the aggregate dispersion depicted in Figure 6b. However, the rise is much sharper among sectors that use skilled labor more intensively, generating a gap that does not close by the end of our sample period.

Figure 7. Productivity Dispersion and Skilled *vs.* Unskilled Labor Intensity



This result is consistent with the literature that examines the effects of labor market regulation on the employment rates of different sub populations of workers. According to this literature, labor market regulations, particularly job security provisions that increase with tenure, reduce the cost of dismissal of workers with short tenures relative to those with more seniority. More generally, policies or institutions may generate heterogeneity in the costs or benefits of adjusting through different sub populations of workers. Thus firms that need to adjust employment find it easier to do so by rotating workers that are relatively less protected. This is likely the case of skilled workers, who tend to be better protected by the provisions in the Labor Code and possibly by unions.

Productivity enhancing reallocation

After estimating the dynamics of productivity dispersion, we provide estimates intending to evaluate the extent of misallocation and the aggregate impact of gaps in the marginal product of labor across plants. In order to do this, we take two approaches. In this section we ask whether the observed reallocation process is productivity enhancing and whether it has become more or less productivity enhancing over time, using the cross-sectional decomposition first introduced by Olley and Pakes (1996). In Section VI below we estimate the aggregate losses of associated to differences in labor productivity across plants.

For a 3-digit manufacturing sector in year t, we decompose average weighted labor productivity as

$$LP_t = \sum_j s_{jt}(LP_{jt}) = \overline{LP}_t + \sum_j (s_{jt} - \bar{s}_t)(LP_{jt} - \overline{LP}_t)$$

where LP_{jt} stands for average labor productivity of plant *j* in year *t* (value added over employment) and s_{jt} is its share in total sector employment. Variables with upper bars describe the simple mean of the variable within the sector and year. This decomposition shows that aggregate labor productivity can rise either because plants are becoming more productive over time (the simple mean term) or because inputs and outputs are disproportionately being reallocated towards their most productive use (the cross term).

Table 6 presents this decomposition for the Chilean manufacturing sector in period 1979 – 2007. Similarly, Figure 8 shows both, the average labor productivity and the share explained by the allocation term. The weighted average productivity remains stagnant until 1986 and then rises quickly. As a matter of fact, labor productivity increases at an annual rate of 6.2% between 1987 and 1999, the golden period of GDP growth. After the Asian crisis productivity slowed down, and even declined in years 2002-2004, recovering after 2005.

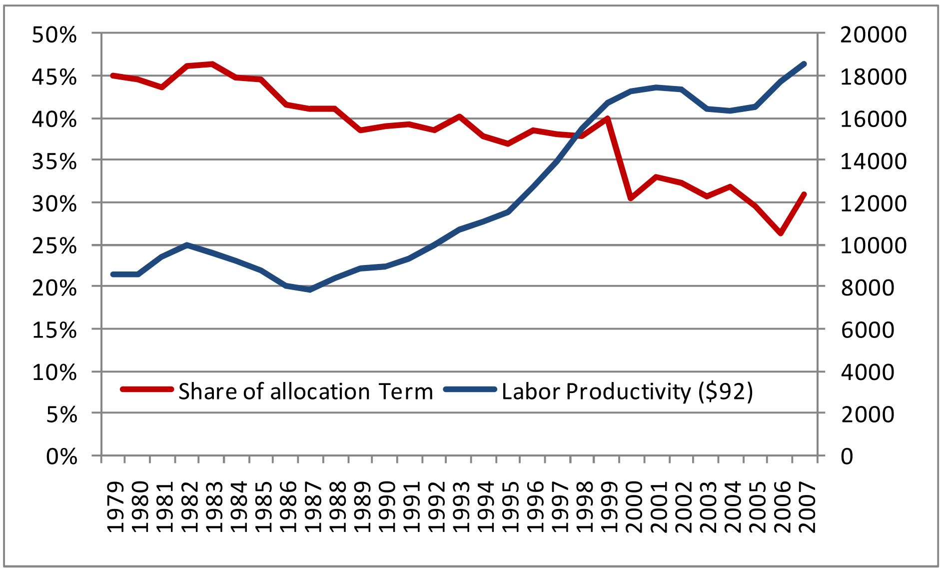
The cross term is positive during the full period under analysis implying that the ongoing process of reallocation has been productivity enhancing in every single year; i.e., labor is being reallocated from low productivity to high productivity plants[15]. Nevertheless, it is important to note that after 1999, the share of labor productivity explained by the allocation term starts to fall from an initial level of 40% to around 30%. These results are in line with the increasing dispersion observed in productivity post Asian crisis.

[15] Appendix 2 decomposes mean productivity at the sector level. Not all estimated reallocation terms are positive. However, these results must be analyzed with caution, in particular in those sectors where a very small number of plants are in production.

Table 6. Labor Productivity Decomposition

Year	Weighted Average (1992 Ch$)	Fraction explained by Simple Average	Cross term
1979	8549	0.550	0.450
1980	8567	0.554	0.446
1981	9422	0.563	0.437
1982	9985	0.539	0.461
1983	9547	0.537	0.463
1984	9261	0.554	0.446
1985	8750	0.554	0.446
1986	7990	0.584	0.416
1987	7803	0.590	0.410
1988	8424	0.590	0.410
1989	8817	0.615	0.385
1990	8982	0.609	0.391
1991	9321	0.608	0.392
1992	9998	0.616	0.384
1993	10730	0.599	0.401
1994	11047	0.621	0.379
1995	11565	0.631	0.369
1996	12739	0.614	0.386
1997	13930	0.618	0.382
1998	15504	0.621	0.379
1999	16744	0.600	0.400
2000	17213	0.696	0.304
2001	17445	0.669	0.331
2002	17312	0.678	0.322
2003	16393	0.693	0.307
2004	16313	0.682	0.318
2005	16481	0.704	0.296
2006	17749	0.738	0.262
2007	18547	0.690	0.310

Figure 8. Labor Productivity and the Reallocation Term



V. Understanding the Rise in Dispersion

The late 1990s and the 2004 rise in dispersion seem related to a number of developments occurring in Chile over those years. One has to do with the surge in real interest rates as a response to the Asian currency crisis. The other has to do with changes in monetary policy and the volatility of the real exchange rate, along with developments in the energy market. Table 7 reports the evolution of the 90-365 days real interest rate, the oil price, the nominal exchange rate and the CPI, along with their standard deviation.

Table 7. Interest Rate, Exchange Rate and Oil Price Evolution

Year	Real Interest Rate [%]	Oil Price Brent $/bbl	Nominal Exchange rate $/US$	Consumer Price Index	Real Interest Rate StdDev/Mean	Oil Price Brent StdDev/Mean	Nominal Exchange rate StdDev/Mean
1984			98.5	13.5			0.143
1985			160.9	17.6			0.121
1986		2754.7	192.9	21.1		0.212	0.033
1987		3951.3	219.4	25.3		0.060	0.049
1988		3666.9	245.0	29.0		0.093	0.010
1989		4869.7	267.0	33.9		0.102	0.066
1990	13.28	7232.3	304.9	42.7	2.152	0.363	0.044
1991	8.48	6987.4	349.2	52.0	0.483	0.089	0.033
1992	8.13	7006.5	362.6	60.0	0.383	0.072	0.036
1993	9.23	6858.3	404.2	67.7	0.181	0.077	0.028
1994	9.27	6623.4	420.2	75.4	0.273	0.072	0.020
1995	8.53	6770.4	396.8	81.6	0.363	0.059	0.037
1996	9.34	8534.1	412.3	87.6	0.199	0.109	0.012
1997	8.77	8030.5	419.3	93.0	0.238	0.089	0.017
1998	11.93	5873.2	460.3	97.8	2.612	0.101	0.018
1999	8.19	9160.2	508.8	101.0	0.924	0.331	0.047
2000	7.48	15368.8	539.5	104.9	0.249	0.142	0.049
2001	6.33	15419.8	634.9	108.7	0.759	0.108	0.079
2002	4.39	17264.6	688.9	111.4	1.658	0.144	0.042
2003	4.30	20033.5	691.4	114.5	1.157	0.117	0.065
2004	3.17	23346.7	609.5	115.7	1.175	0.162	0.039
2005	3.95	30367.0	559.8	119.2	1.292	0.097	0.045
2006	5.18	34554.8	530.3	123.3	1.244	0.092	0.015
2007	4.64	37767.9	522.5	128.7	0.903	0.142	0.028

Source: Real interest rate (90 days-1 year), CPI and Exchange rate: Central Bank. Oil price: Platt´s, OLADE
Note: Nominal exchange rate and oil price in ln divided by the year average CPI.

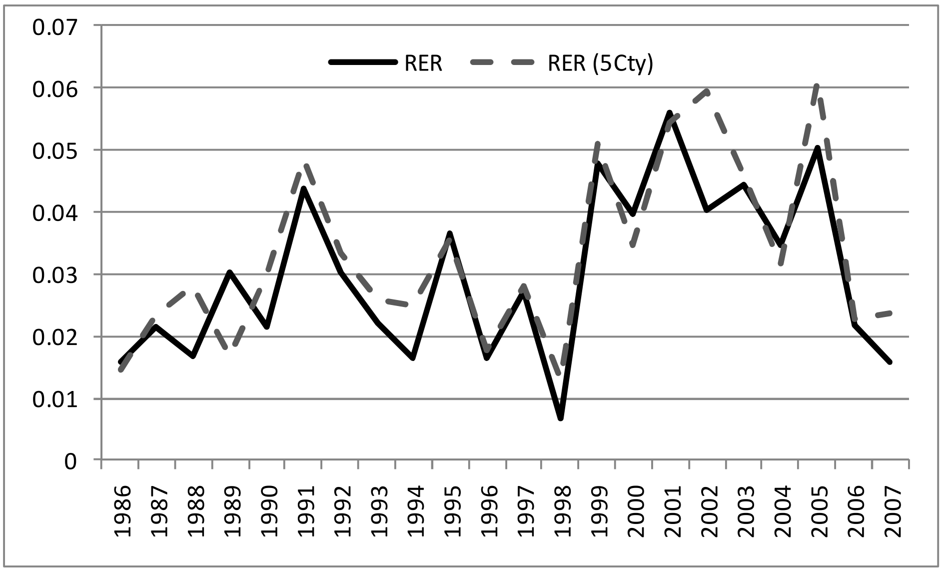
Interest Rate Hikes

Firms in Chile mainly rely on banks for finance, especially small firms who have no access to the equity market or the domestic corporate bond market (Caballero, 2000). So large interest rate fluctuations, as the one observed in 1998, leave firms with little access to funding sources. This in turn limits the ability of the economy to efficiently reallocate resources and to smooth shocks when needed.

Real Exchange Volatility

Another possible factors behind the increased volatility observed in the labor market is the new monetary policy adopted by the Central Bank since 1998. Inflation targeting targets nominal inflation at a two year horizon at the expense of not targeting nominal or real exchange rates. Figure 9 shows the observed real exchange volatility measured within years. Two indices are constructed: RER is the rate relative to all of Chile's commercial partners whereas RER(5Cty) only uses the 5 most relevant ones. During the period 1986 and 1997, the average real exchange rate volatility, measured by the monthly standard deviation, is 2.5%. This measured mean volatility jumped sharply to 3.8% during the period 1999-2007. Real exchange rate volatility affects both, demand and total costs. This higher volatility requires more labor adjustment and therefore, under the presence of adjustment costs, labor productivity dispersion increases.

Figure 9. Real Exchange Rate Volatility



Energy Prices

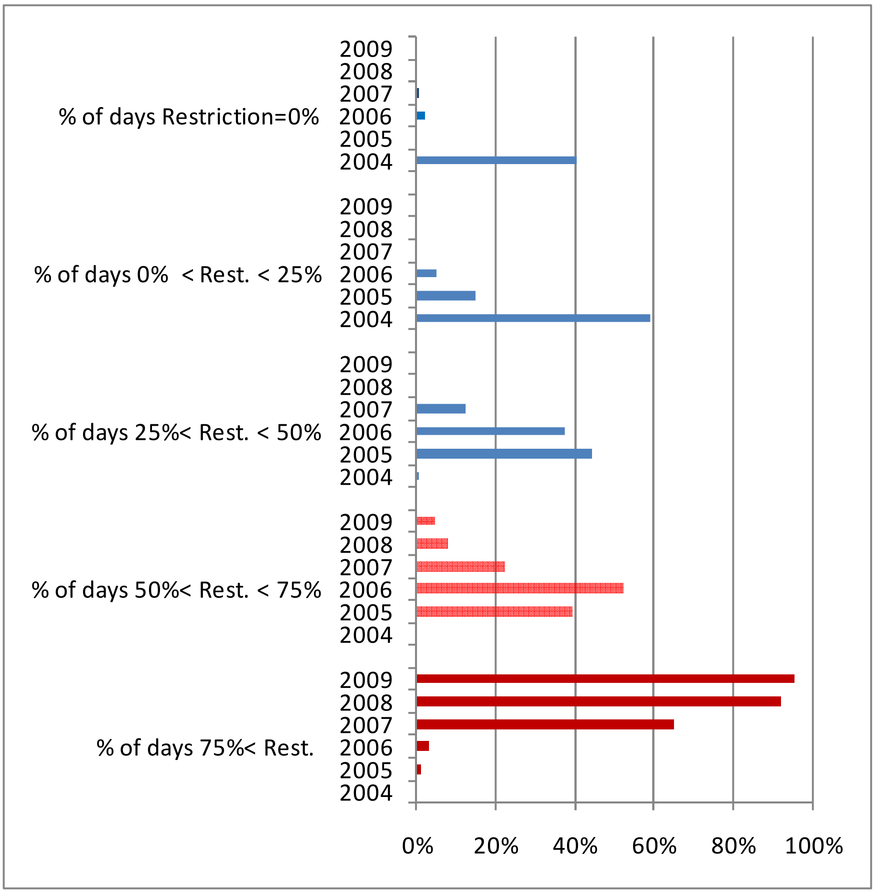
Since the 1990s, Chile invested in natural gas power plants and in cross-border pipelines in order to import energy from Argentina. The economy also invested in the conversion of industries and homes to the use natural gas. In April 2004, however, in response to a local energy shortage, the Argentina authorities cut natural gas exports to Chile. Production had to switch to diesel and old coal powered plants had to be brought back to service. Since then, gas supply has been erratic. Figure 10 reports the fraction of days that gas imports have been restricted classified according to the fraction of contracted supply that was not delivered. The Figure shows how supply cuts have become more frequent over time.

These developments led many firms to switch to oil. During this period, oil prices were also characterized by a higher level of volatility. Oil price volatility within a year –measured by the standard deviation-- increased from an average of 9.9% during years 1996 and 1997 to an average of 14.4% during the period 1998-2007 (Table 7). Plants have different energy requirements; thus this increasing uncertainty in energy prices mainly affects the most energy intensive plants.

Accounting for the rise in dispersion

In this subsection we provide a very simple test of our hypothesis by estimating the relationship between the described macroeconomic shocks and changes in the observed dispersion of productivity. More specifically, this simple model relates the standard deviation of the natural log of our productivity measure at the sector/year level to a number of variables describing whether the sector is relatively open to international trade, export oriented, capital intensive, energy intensive and oil intensive. These sectorial characteristics are then interacted with variables proxying shocks; i.e, the volatility of the exchange rate, the interest rate and oil prices, as well as the fraction of days in a given year experiencing gas cuts and the level of the interest rate. We define a sector as open if, according to the input-output matrix of 1996, the sum of exports and imports over total supply (domestic output plus imports) is higher than the median. Similarly, a sector is export intensive if the average ratio --across plants and years in the ENIA-- of exports over gross output is higher than the median. Capital intensity is defined by the ratio of value added minus the wage bill over gross output. Oil intensity is defined by the value of oil expenses over gross output whereas gas intensity is measured by energy expenses different than electricity and oil over gross output[16]. Finally, the variable gas cuts measures the percent of gas that was not delivered using the contracted level as the benchmark, averaged across days.

Figure 10. Restrictions on Imports of Argentinean Natural Gas



[16] Note that this definition assumes that only these three sources of energy are used. If, for instance, coal is also used in production, our intensity definition will incorrectly associate these expenses to gas consumption.

The results of this simple exercise are shown in Table 8. According to our estimates, a rise in the dispersion of the exchange rate does not affect significantly the dispersion of labor productivity unless the sector is classified as open. Our point estimate indicates an effect equal to 11.7% of one standard deviation of labor productivity when the exchange rate dispersion increases by one standard deviation (keeping the mean constant). Similarly, a rise of one standard deviation in the dispersion of interest rates leads to a rise of 5.88% of one standard deviation of labor productivity in capital intensive sectors (again, keeping constant the average interest rate). The effect of rises in the interest rate itself (now keeping its volatility constant) on overall labor productivity dispersion is positive, although the estimated effect is attenuated among capital intensive sectors. The effect of rises in the dispersion of oil prices is also positive among oil intensive sectors (10.4% of one standard deviation), whereas a one standard deviation rise in the gas cuts measure is correlated with a rise of 14.9% of one standard deviation in the dispersion of labor productivity among gas intensive sectors.

Summing up, the results of this very simple econometric exercise are consistent with the hypothesis that labor productivity dispersion rose as a result of the increased variance of shocks in both the exchange rate and the price and availability of energy. Plants that suffered most are those producing in traded sectors and those that use oil or gas relatively intensively.

However, an alternative hypothesis that this exercise cannot account for is that the increased dispersion responds to a slowdown in the speed at which plants adjust when they face disequilibria. We examine this alternative hypothesis by estimating the evolution of the speed of adjustment as in Caballero et al. (2010). According to this view, firms face adjustment costs that can be the result of technological and/or institutional constraints. That is, firms may not fully adjust immediately to a shock, so the observed level of employment may not be equal to its frictionless level. The speed of adjustment is thus a measure of how long does it take to close the gap between current employment and its frictionless level.

Table 8. The Dispersion of Labor Productivity and the Volatility of Shocks

	Est. Deviation Ln(VA / Remuneration)			
Open Sector	1,616	1,617	1.685	1.684
SD Exchange Rate	(0.736)**	(0.708)**	(0.773)**	(0.773)**
Capital Intensive Sector	0.049	0.049	0.050	0.050
SD Nom. Interest Rate	(0.020)**	(0.020)**	(0.044)	(0.044)
Capital Intensive Sector	-0.008	-0.008	-0.001	-0.001
Nom. Interest Rate	(0.004)*	(0.004)*	(0.009)	(0.009)
Export intensive Sector	-0.019	-0.015	0.533	0.533
SD Exchange Rate	(0.617)	(0.602)	(0.734)	(0.718)
Oil Intensive Sector	0.225	0.225	0.104	0.104
SD Oil Price	(0.128)*	(0.126)*	(0.149)	(0.149)
Gas Intensive Sector	0.142	0.141	0.102	0.102
Gas Cuts (%)	(0.054)***	(0.054)***	(0.074)	(0.075)
SD Exchange Rate	-0.401		-1.035	
	(0.796)		(0.631)	
SD Real Interest Rate	-0.034		-0.033	
	(0.015)**		(0.014)**	
SD Oil Price	-0.195		-0.040	
	(0.114)*		(0.101)	
Exchange Rate (year average)	0.080		0.043	
	(0.138)		(0.111)	
Real Interest Rate (year average)	0.021		0.018	
	(0.007)***		(0.007)***	
Oil Price (year average)	0.010		0.025	
	(0.038)		(0.041)	
(mean) corte_gas	-0.061		-0.095	
	(0.073)		(0.081)	
Year	0.012		0.012	
	(0.005)**		(0.005)***	
Sample	All	All	Low Skill Sector	Low Skill Sector
Observations	484	484	252	252
R-squared	0.52	0.55	0.61	0.64
FE Year	No	Yes	No	Yes

Robust standard errors in parentheses. Regressions include sector dummies.
* significant at 10%; ** significant at 5%; *** significant at 1%

Following Caballero et al. (2010) we estimate the observed changes in employment of plants producing in sector *s* at time *t* as a function of the gap between actual and frictionless employment and a sector-year dummy. The gap is in turn estimated as a function of changes in the labor productivity. Table 9 reports our estimation results. As a benchmark, column (1) estimates the average speed of adjustment in our data set. We find that on average 70.9% of the employment gap is closed in each period.

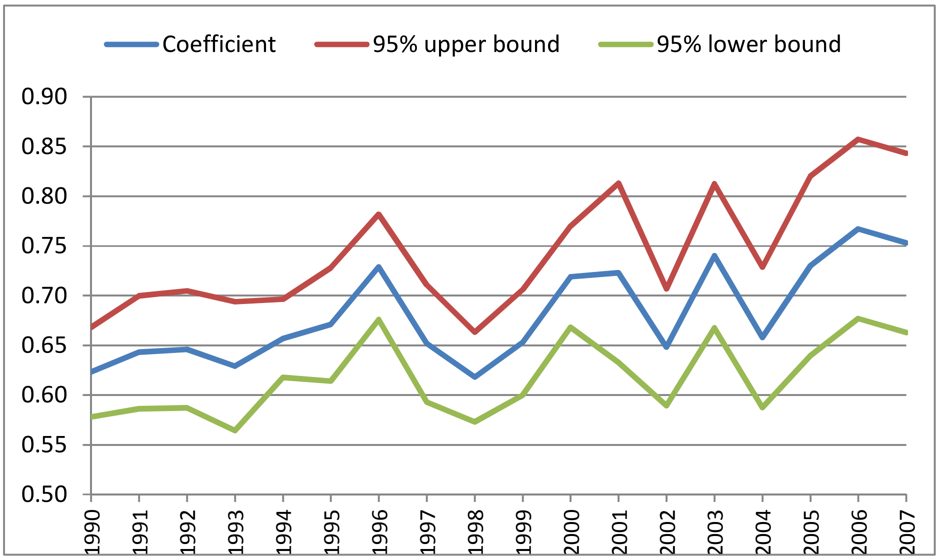
Table 9. Speed of Adjustment Estimation Results

	(1)	(2)	(3)
Gap	0.709		
	(0.008)**		
Gap^3		0.370	0.364
		(0.056)**	(0.056)**
Gap*Skilled Labor Intensive			-0.078
			(0.014)**
Gap_1990		0.623	0.643
		(0.023)**	(0.020)**
Gap_1991		0.643	0.661
		(0.029)**	(0.025)**
Gap_1992		0.646	0.666
		(0.030)**	(0.028)**
Gap_1993		0.629	0.647
		(0.033)**	(0.030)**
Gap_1994		0.657	0.676
		(0.020)**	(0.019)**
Gap_1995		0.671	0.690
		(0.029)**	(0.027)**
Gap_1996		0.729	0.750
		(0.027)**	(0.026)**
Gap_1997		0.652	0.674
		(0.030)**	(0.025)**
Gap_1998		0.618	0.640
		(0.023)**	(0.021)**
Gap_1999		0.653	0.675
		(0.027)**	(0.027)**
Gap_2000		0.719	0.742
		(0.026)**	(0.022)**
Gap_2001		0.723	0.746
		(0.046)**	(0.042)**
Gap_2002		0.648	0.674
		(0.030)**	(0.027)**
Gap_2003		0.740	0.764
		(0.037)**	(0.033)**
Gap_2004		0.658	0.683
		(0.036)**	(0.031)**
Gap_2005		0.730	0.754
		(0.046)**	(0.042)**
Gap_2006		0.767	0.792
		(0.046)**	(0.043)**
Gap_2007		0.753	0.780
		(0.046)**	(0.043)**
Observations	88086	60389	60389
R-squared	0.50	0.49	0.49

Robust standard errors in parentheses. Regressions include year fixed effects.
* significant at 5%; ** significant at 1%.

Column (2) allows for nonlinearities by controlling for the cubic of the gap. The positive estimated coefficient implies that plants facing larger gaps adjust more quickly. The column also allows for a time varying average speed of adjustment. Figure 11 presents the estimated coefficients of the gap interacted with year dummies, along with the respective 95% upper and lower bounds. The Figure shows relevant variation in the average speed of adjustment. More important, it suggests that the speed at which manufacturing firms adjust in Chile if anything has increased over time. This result is consistent with our main hypothesis: that the observed rise in labor productivity dispersion is mostly related with an increased variance of the shocks firms face.

Figure 11. Average Adjustment Speed over Time



The final column of Table 9 estimates again the model, now allowing for a difference in the adjustment speed of plants producing in sectors that are relatively skilled labor intensive. We find a negative coefficient; that is, plants in these sectors find it harder to adjust and take more time to close gaps between actual and frictionless employment. In turn, this finding is consistent with the idea that labor market regulations are not neutral. They affect differently the hiring and firing rates of different worker populations, and at the same time they affect differently the ability of firms to respond to shocks.

VI. The aggregate implications of misallocation

As a second approach to quantifying the extent of misallocation, we estimate the potential gains in aggregate manufacturing value added that would be obtained if the lowest productivity workers were to move to higher productivity plants. More specifically, in our exercise we estimate the effect of reallocating half of the workers employed in plants in the first quintile of labor productivity, to plants in superior quintiles. We define labor productivity in the first quintile as the weighted average of labor productivity of plants in the quintile. That is,

$$LP_{1q} = \ln\left(\sum_{i \in \Omega} \frac{L_i}{L_{1q}} A_i \left(\frac{K_i}{L_i} \right)^{\alpha} \right) \quad \Omega_{1q} = \text{set of plants in the first quintile}$$

where L_{1q} denotes total employment in the quintile. LP_{iq}, the average labor productivity in the ith quintile, is defined in similar fashion. We assume that all plants produce under constant returns to scale and that the value added capital elasticity equals to α. Our estimates are a lower bound of the potential gains of reallocation as we have assumed that capital does not move across plants.

Four effects on aggregate productivity occur, two within the group of lowest productivity plants and two within the highest. The first is the loss of production of workers that were moved away from the first quintile. The second is the gain in productivity that experience workers left in the lowest productivity plants, as they now produce with a larger capital per worker ratio. Each of these workers now produces with twice the capital. The third is the gain in production of workers that have now moved to higher productivity plants. The final effect is a loss due to the fall in the capital per worker ratio that experience workers at these higher productivity plants. In these plants, the new capital/worker ratio is now two thirds of what it used to be before the reallocation of workers. Therefore the gain in total productivity is estimated as

$$\Delta LP = 0.1(-LP_{1q}) + 0.1\,(2^{\alpha} - 1)LP_{1q} + 0.1\left(\left(\tfrac{2}{3}\right)^{\alpha} LP_{jq}\right) - 0.2\,(1 - \left(\tfrac{2}{3}\right)^{\alpha})LP_{jq}$$
$$= 0.1\,(2^{\alpha} - 2)LP_{1q} + \left(0.3\,\left(\tfrac{2}{3}\right)^{\alpha} - 0.2\right)LP_{jq}$$

Table 4b above reported the average labor productivity in each quintile. Based on these estimates, Table 10 presents the gains in productivity of reallocating half of the first quintile workers to plants in higher labor productivity quintiles for different values of α. Recall that labor productivity is measured in natural logarithms, so the figures in the Table present the estimated percent gain due to reallocation. Under our preferred estimates (with α=0.4), these gains range from -0.1% to 22.1% depending on the quintiles of the distribution to which workers are reallocated.[17] As the share of capital in value added rises, however, the net gains fall, as the effect of a lower capital ratio at the higher productivity plants becomes more relevant. The effect on aggregate productivity can be negative, as shown by the high α cases with workers being reallocated to the second quintile.

Table 10. Productivity Gains from Reallocating Half of First Quintile Workers

	Capital Share in Value Added		
Workers moving to	0.2	0.4	0.6
2th Quintile	0.005	-0.001	-0.009
3th Quintile	0.064	0.052	0.039
4th Quintile	0.129	0.110	0.091
5th Quintile	0.252	0.221	0.190

[17] See Bergoeing and Repetto (2006) for micro level estimates of the production function using the ENIA.

VII. Concluding remarks

In this paper we have analyzed the evolution of labor productivity dispersion over time as a proxy for labor misallocation. We have found that while downturns are associated to an increase in dispersion, the golden period of Chilean growth was characterized by a reduction in observed dispersion. Moreover, our results show that the recent rise in dispersion may be attributed to a rise in the variance of shocks that firms face.

Although not conclusive, our results also suggest that labor market regulations are not neutral, as they affect the allocation of labor across plants. We provide suggestive evidence that these regulations and institutions decrease the adjustment speed of firms that hire intensively labor that is relatively more protected, which in turn leads to larger and more persistent dispersion in firms using intensively this type of labor. These results imply that there may be space for efficiency enhancing labor market reforms. One aspect that should be considered is the rigidity of hours, possibly by defining the length of the workday not at the weekly level, but at the monthly or even annual level. Another has to do with transforming the current severance pay system into a compensation scheme that finances job loss independently of the reason for separation, possibly financed through the individual accounts of Chile’s UI system. Also, childcare should be financed by general revenues, replacing the current system of an implicit tax on female employment at medium sized and large firms. These and other proposals are the subject of ongoing debate in Chile. Future work could estimate the potential efficiency effects of these reforms.

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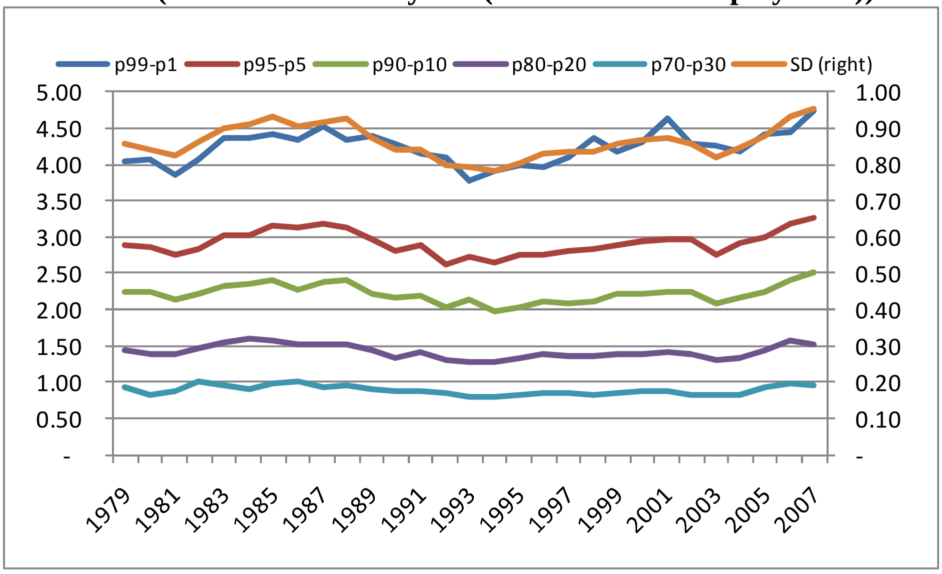
Appendix 1. Robustness Exercises

In this Appendix we analyze the robustness of our main estimates to assuming a different definition of labor productivity, and to limiting the analysis to continuous firms.

1. The definition of labor productivity:

In the main text we approximated labor productivity by the ratio of value added to the wage bill. We used the wage bill as a proxy for human capital within the firm. In this Appendix we estimate the evolution of dispersion using value added over total employment. Figure A.1. shows that our main conclusions are robust to these measurement decisions.

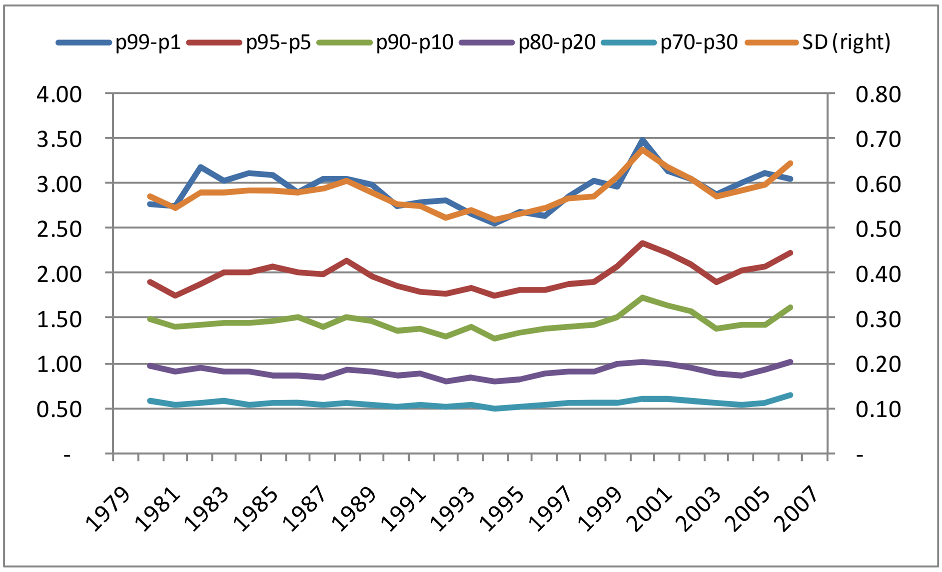
Figure A1. Evolution of Productivity Dispersion
(Labor Productivity= ln (Value Added /Employment))



2. Continuous firms:

The data shows an important turnover of plants. In order to account for this fact, in this Apendix we compute the labor productivity dynamics using only plants that are present in the sample in years t-1, t and t+1. Figure A.2 reports these results. Labor dispersion is again mainly unaffected by this sample redefinition.

Table A.2. Evolution of Productivity Dispersion
Continuous Firms



Appendix 2. Cross Term of Olley and Pakes (1996) decomposition by sector (as a % of sector level mean labor productivity)

Sector	311	312	313	314	321	322	323	324	331	332	341	342	351	352	353	354	355	356	361	362	369	371	372	381	382	383	384	385
Obs	35284	1927	3294	76	9076	7786	1343	3492	9258	3479	2339	5892	1912	4934	129	429	1623	6101	422	659	4009	1239	638	11407	5348	1867	2923	635
1979	47.5%	39.6%	31.0%	35.2%	16.7%	29.9%	29.9%	49.1%	32.3%	40.0%	53.9%	45.6%	49.0%	16.4%	-10.5%	35.7%	31.4%	23.8%	44.1%	37.9%	50.4%	50.2%	26.5%	29.9%	17.1%	28.2%	51.8%	5.2%
1980	48.5%	40.0%	39.7%	31.5%	21.8%	25.4%	26.5%	43.3%	25.6%	41.6%	54.0%	47.5%	11.3%	24.0%	-24.8%	6.3%	31.8%	13.2%	16.5%	42.3%	54.4%	20.8%	16.1%	25.8%	22.0%	24.0%	46.3%	-1.8%
1981	43.9%	34.6%	34.0%	28.4%	18.7%	19.1%	27.4%	47.5%	20.6%	30.9%	48.9%	46.1%	12.2%	23.4%	4.9%	25.6%	34.6%	12.9%	42.6%	34.3%	56.7%	4.6%	45.4%	22.2%	16.6%	23.4%	48.8%	6.5%
1982	44.2%	30.5%	33.9%	35.0%	19.9%	22.2%	25.7%	48.3%	39.1%	28.4%	54.0%	48.1%	6.8%	25.9%	7.2%	26.4%	39.3%	17.3%	27.7%	42.8%	53.1%	10.9%	31.8%	28.5%	27.6%	24.8%	39.1%	4.8%
1983	44.3%	30.3%	32.3%	0.0%	21.6%	25.5%	21.3%	35.0%	38.0%	28.3%	52.4%	46.6%	19.5%	20.7%	-16.4%	30.3%	51.3%	19.3%	28.2%	44.0%	52.6%	37.9%	51.3%	26.8%	2.9%	24.4%	34.9%	11.0%
1984	44.9%	13.2%	33.5%	33.8%	27.3%	30.8%	20.1%	37.4%	37.4%	26.3%	57.1%	47.6%	7.3%	23.9%	11.7%	17.2%	40.1%	11.3%	23.9%	38.3%	50.6%	30.7%	48.7%	24.7%	11.4%	30.9%	38.8%	6.9%
1985	45.0%	19.8%	35.4%	30.5%	26.6%	33.0%	19.7%	37.4%	34.7%	24.8%	55.2%	45.5%	12.6%	23.8%	0.1%	-26.2%	40.3%	13.3%	16.0%	38.6%	51.2%	24.4%	52.4%	22.8%	19.1%	33.7%	45.5%	14.8%
1986	42.9%	19.1%	27.1%	34.0%	30.2%	25.4%	16.6%	37.1%	27.1%	33.3%	56.3%	42.4%	15.5%	19.6%	1.0%	-23.4%	42.0%	10.7%	0.9%	30.4%	53.8%	31.4%	34.6%	22.5%	20.7%	23.4%	32.1%	1.5%
1987	44.6%	23.6%	31.0%	36.6%	22.9%	22.6%	21.9%	41.7%	26.9%	36.2%	59.2%	44.9%	10.3%	19.3%	1.0%	-55.5%	49.9%	9.7%	21.5%	17.4%	54.9%	39.4%	42.8%	22.6%	26.9%	19.7%	25.8%	15.2%
1988	45.1%	22.2%	31.2%	39.6%	19.6%	32.0%	19.1%	37.7%	35.7%	29.5%	60.2%	42.8%	0.1%	19.2%	-0.1%	-8.9%	40.5%	11.6%	-11.1%	18.6%	47.1%	46.6%	20.3%	21.9%	14.7%	27.0%	31.2%	14.6%
1989	43.7%	22.6%	23.0%	42.1%	21.7%	22.7%	3.6%	38.8%	28.6%	37.8%	54.4%	38.3%	-1.9%	20.3%	-0.3%	-0.6%	36.1%	12.6%	17.2%	36.0%	44.2%	47.3%	34.5%	22.9%	7.7%	28.3%	28.9%	13.9%
1990	41.6%	23.4%	25.7%	0.0%	15.9%	20.8%	10.9%	35.2%	26.9%	27.9%	51.7%	45.2%	11.4%	28.9%	0.2%	-64.4%	46.0%	13.8%	31.2%	30.3%	54.1%	40.1%	20.4%	28.4%	10.9%	20.0%	24.9%	10.5%
1991	37.7%	28.6%	24.3%	0.0%	15.7%	24.7%	4.1%	32.9%	24.1%	29.2%	50.6%	42.8%	4.6%	30.0%	-0.2%	-33.5%	43.8%	13.6%	12.2%	34.6%	45.8%	16.6%	48.6%	22.9%	12.7%	29.4%	29.9%	21.7%
1992	39.9%	30.8%	21.5%	0.0%	14.8%	21.1%	15.2%	34.2%	23.5%	34.4%	44.2%	44.0%	0.1%	28.2%	0.1%	-20.9%	33.2%	7.6%	23.7%	30.4%	51.2%	45.7%	38.9%	26.1%	23.0%	25.5%	24.9%	19.2%
1993	41.9%	27.6%	22.2%	48.1%	10.1%	34.3%	18.5%	34.4%	18.4%	28.6%	36.1%	43.0%	6.9%	22.2%	0.0%	-48.5%	41.7%	17.9%	18.9%	21.0%	51.1%	37.2%	34.8%	21.1%	20.3%	29.9%	26.3%	25.9%
1994	37.8%	18.7%	29.0%	0.0%	9.6%	29.7%	23.0%	35.5%	21.7%	29.4%	47.7%	47.2%	-8.3%	21.0%	0.1%	-21.4%	40.0%	18.7%	15.7%	26.0%	42.4%	36.8%	29.9%	20.0%	21.0%	25.1%	24.9%	17.8%
1995	37.6%	11.0%	28.0%	0.0%	13.0%	31.3%	18.5%	40.0%	22.8%	26.8%	47.8%	45.9%	-15.0%	23.4%	-0.2%	-34.9%	39.3%	16.9%	31.9%	39.5%	42.7%	7.6%	39.1%	19.5%	26.5%	25.8%	25.2%	11.6%
1996	40.4%	26.6%	26.5%	0.0%	8.9%	32.3%	12.7%	35.5%	24.6%	28.3%	47.8%	42.4%	-8.0%	18.3%	0.3%	-77.1%	35.2%	14.4%	30.4%	26.9%	36.3%	34.1%	43.4%	22.4%	23.2%	22.8%	39.6%	12.1%
1997	42.6%	21.8%	32.8%	0.0%	10.8%	33.6%	12.2%	37.7%	21.2%	32.6%	47.2%	48.1%	-19.5%	17.1%	0.0%	-43.4%	47.1%	9.0%	30.1%	42.6%	38.4%	21.7%	40.9%	22.3%	26.3%	26.3%	39.6%	12.0%
1998	43.4%	19.2%	-22.2%	15.8%	13.5%	29.4%	21.0%	38.4%	14.6%	34.5%	46.8%	45.0%	-16.7%	17.5%	50.5%	-7.8%	54.9%	14.7%	17.6%	45.7%	30.7%	44.2%	40.6%	24.0%	25.1%	29.0%	33.3%	7.1%
1999	38.0%	18.3%	-22.6%	0.0%	8.9%	33.6%	14.6%	38.6%	22.7%	37.8%	49.9%	43.8%	22.0%	19.3%	30.4%	-82.8%	44.1%	14.9%	18.6%	60.1%	24.5%	19.0%	42.2%	27.4%	21.8%	13.4%	32.5%	13.1%
2000	38.6%	-17.9%	-41.6%	18.7%	5.0%	22.3%	22.1%	33.1%	26.4%	37.6%	51.9%	41.6%	7.9%	7.1%	39.8%	-46.6%	47.3%	8.3%	30.6%	54.0%	-6.4%	-29.4%	-28.9%	28.9%	31.3%	23.1%	20.8%	20.1%
2001	39.0%	23.5%	-30.2%	0.0%	3.6%	22.5%	11.3%	24.8%	24.9%	26.2%	40.5%	33.7%	16.2%	6.0%	25.0%	-28.9%	41.5%	22.2%	38.8%	49.2%	24.9%	34.2%	21.8%	38.1%	20.7%	30.0%	34.8%	-1.3%
2002	34.8%	9.6%	-35.8%	0.0%	4.1%	23.0%	12.9%	23.3%	24.1%	27.1%	44.2%	42.2%	5.1%	6.0%	26.5%	-58.9%	48.2%	28.4%	35.6%	58.7%	29.1%	34.1%	33.6%	16.9%	32.0%	24.3%	39.7%	10.6%
2003	32.3%	10.3%	-7.8%	0.0%	0.3%	16.2%	4.7%	23.7%	9.3%	4.6%	47.8%	16.4%	7.2%	0.0%	33.4%	-82.4%	41.9%	17.4%	44.2%	59.6%	23.1%	34.4%	29.1%	21.1%	19.4%	16.3%	27.9%	15.0%
2004	29.4%	11.3%	6.1%	43.3%	1.4%	15.0%	12.1%	45.4%	23.3%	15.2%	50.4%	19.3%	21.4%	13.1%	45.9%	-33.3%	37.1%	20.7%	46.7%	61.0%	20.5%	53.7%	34.1%	12.2%	21.3%	13.4%	48.1%	11.0%
2005	28.1%	1.4%	10.5%	43.5%	-4.3%	23.8%	-3.0%	31.7%	11.8%	12.0%	46.8%	14.4%	56.1%	15.3%		-42.1%	20.2%	19.7%	34.1%	49.1%	8.0%	-35.3%	30.8%	6.6%	24.3%	19.9%	40.6%	5.0%
2006	32.1%	37.8%	-25.7%		-6.4%	24.0%	15.4%	32.6%	22.5%	5.4%	47.9%	16.1%	30.5%	20.0%	-2.6%	-45.7%	24.7%	17.2%	40.2%	51.3%	5.1%	-9.6%	37.9%	18.1%	21.2%	15.7%	30.0%	-9.1%
2007	26.7%	16.8%	-7.3%		-28.9%	21.8%	12.3%	35.6%	17.1%	7.9%	51.1%	13.4%	30.9%	13.7%		-42.9%	20.7%	18.8%	38.9%	37.2%	12.8%	42.6%	19.4%	26.7%	25.2%	15.8%	5.8%	2.5%