Online Appendix for

Productivity and Misallocation During a Crisis:

Evidence from the Chilean Crisis of 1982*

Ezra Oberfield

Federal Reserve Bank of Chicago

ezraoberfield@gmail.com

October 6, 2012

Appendix

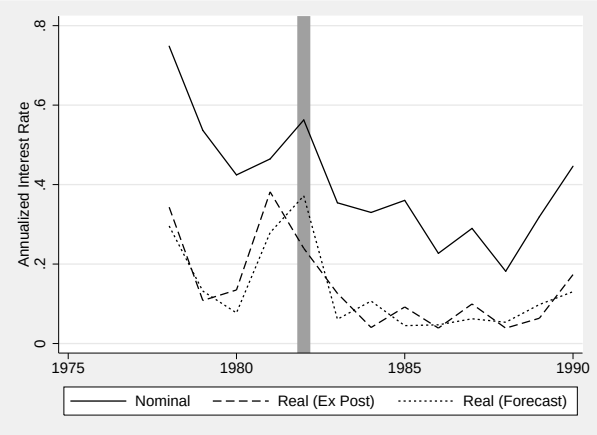
A Factor Prices During the Crisis

This section provides more background information regarding Chile's experience in the years surrounding the crisis. Inflation, in the triple digits during much the 1970s, began to decline in the late 1970s and early 1980s. As can be seen in Figure 12a, real interest rates spiked in 1981 and remained high in 1982. While there is no direct measure of the real interest rate, one can net out an estimate of expected inflation from the reported nominal rate. I compute two estimates of expected inflation: (i) actual ex post inflation during the period and (ii) a simple forecast using lagged inflation.

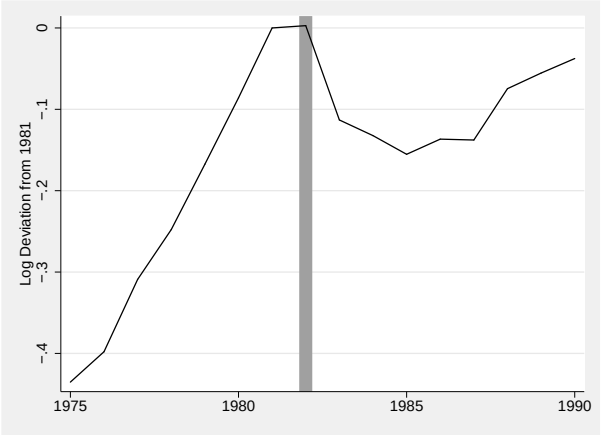
*The views expressed herein are those of the author and not necessarily those of the Federal Reserve Bank of Chicago or the Federal Reserve System. All mistakes are my own.

Figure 12: Factor Prices

(a) Real Interest Rates



(b) Real Wages



Note: The nominal interest rate is the average of the lending rate ("the bank rate that usually meets the short and medium term financing needs of the private sector") and the deposit rate, as reported by the IMF. For each month, the ex-post real interest rate is $(1 + R)/(1 + \pi) - 1$, where R is the nominal interest rate and π is (annualized) expected inflation over the next six months. Ex-post uses the actual inflation over the next six months, while the forecast uses actual inflation over the previous six months. The annual values of real interest rates are the average of these monthly real interest rates. Source of real interest rates: IMF and author's calculations. Source of real wages: Cortazar (1997).

Real wages also spiked during the recession. Because wages were indexed to previous inflation, declining inflation led to an increasing real wage rate even when labor productivity was stagnant. Figure 12b shows the large rise in real wages, which was especially pronounced in the manufacturing sector.

B Industry Details

Table 5 provides summary statistics for each industry. The number of plants varies widely across industries, as does the degree of competition. For example, Petroleum Refineries (353) is organized as a monopoly.

To check whether this matters for the results, the analysis is redone excluding industries with fewer than 20 plants. For each specification of production parameters, the decline in the Solow residual and the contribution from between-industry misallocation are very similar to the baseline. However, for each, excluding these industries raises the within-industry contribution to growth by 3-4 percentage points, implying a larger role for pure technology.

Table 5: Industry Summary

Industry (3 Digit)	Industry Name	Number of Firms	Share of Value Added	Share of Employment
311	Food products	1257	14.2%	23.5%
312	Animal feeds, etc	63	2.8%	1.5%
313	Beverages	136	5.4%	3.6%
314	Tobacco	3	4.0%	0.4%
321	Textiles	376	4.5%	8.9%
322	Wearing apparel, except footwear	336	2.7%	6.1%
323	Leather products	62	0.7%	1.0%
324	Footwear, except rubber or plastic	135	1.6%	2.4%
331	Wood products, except furniture	349	3.0%	6.5%
332	Manufacture of furniture and fixtures, except primarily of metal	165	1.0%	2.0%
341	Paper and products	55	4.5%	3.0%
342	Printing and publishing	201	5.1%	4.6%
351	Industrial chemicals	47	0.9%	1.0%
352	Other chemicals	158	7.8%	4.5%
353	Petroleum refineries	4	6.0%	0.8%
354	Misc. petroleum and coal products	11	0.9%	0.2%
355	Rubber products	53	1.0%	1.2%
356	Plastic products	144	1.5%	2.4%
361	Manufacture of pottery, china and earthenware	8	0.1%	0.2%
362	Glass and products	25	0.7%	0.8%
369	Other non-metallic mineral products	115	4.0%	2.7%
371	Iron and steel	33	2.7%	3.4%
372	Non-ferrous metals	24	13.3%	3.9%
381	Fabricated metal products	378	4.7%	6.8%
382	Machinery, except electrical	134	2.0%	3.6%
383	Machinery electric	60	1.6%	1.9%
384	Transport equipment	104	2.7%	2.1%
385	Professional and scientific equipment	16	0.1%	0.2%
390	Other manufactured products	65	0.3%	0.7%

C The Efficient Allocation

This appendix derives expressions for frictionless output, Y^{**}, and the corresponding capital share, α^{**}, given by equations (1) and (2) (the expressions for Y^* and α_s^* are just special cases with $\theta_s = 1$). Throughout this appendix, the superscript ** is dropped for readability. Total output is

$$Y^{**} \equiv \max_{\{K_i, L_i\}_{i \in I_s, s \in S}} \prod_{s \in S} \left[\sum_{i \in I_s} \left(A_i K_i^{\alpha_i} L_i^{1-\alpha_i} \right)^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}\theta_s}$$

subject to $\sum_{s \in S} \sum_{i \in I_s} K_i \leq K$ and $\sum_{s \in S} \sum_{i \in I_s} L_i \leq L$. Let ρ and ω be the multipliers on the capital and labor resource constraints, respectively. The first-order conditions with respect to K_i and L_i are

$$\begin{aligned} K_i &: \frac{\theta_s Y}{Y_s} \left(\frac{Y_i}{Y_s} \right)^{-\frac{1}{\sigma}} Y_i \alpha_i = \rho K_i \\ L_i &: \frac{\theta_s Y}{Y_s} \left(\frac{Y_i}{Y_s} \right)^{-\frac{1}{\sigma}} Y_i (1 - \alpha_i) = \omega L_i \end{aligned}$$

Summing the FOCs across all plants and across captial and labor gives $Y = \rho K + \omega L$. Defining $\alpha \equiv \frac{\rho K}{Y}$ so that $1 - \alpha \equiv \frac{\omega L}{Y}$, the FOCs can be written as

$$\begin{aligned} K_i &: \frac{\theta_s}{Y_s} \left(\frac{Y_i}{Y_s} \right)^{-\frac{1}{\sigma}} Y_i \frac{\alpha_i}{\alpha} K = K_i \\ L_i &: \frac{\theta_s}{Y_s} \left(\frac{Y_i}{Y_s} \right)^{-\frac{1}{\sigma}} Y_i \frac{1 - \alpha_i}{1 - \alpha} L = L_i \end{aligned}$$

Combining these and using $Y_i = A_i K_i^{\alpha_i} L_i^{1-\alpha_i}$ gives

$$A_i \left(\frac{\alpha_i}{\alpha}\theta_s K\right)^{\alpha_i} \left(\frac{1-\alpha_i}{1-\alpha}\theta_s L\right)^{1-\alpha_i} = Y_s \left(\frac{Y_i}{Y_s}\right)^{\frac{1}{\sigma}} \tag{10}$$

Raising each side to the $(\sigma - 1)$ power and summing plants gives

$$\sum_{i \in I_s} \left[A_i \left(\frac{\alpha_i}{\alpha}\theta_s K\right)^{\alpha_i} \left(\frac{1-\alpha_i}{1-\alpha}\theta_s L\right)^{1-\alpha_i}\right]^{\sigma-1} = Y_s^{\sigma-1} \tag{11}$$

while raising each side to the $\frac{\theta_s}{\sigma-1}$ power and multiplying across industries gives equation (1).

Next, we start with the definition of α and sum over first order conditions for plants' capital

$$K = \sum_{s \in S} \sum_{i \in I_s} K_i = \sum_{s \in S} \theta_s \sum_{i \in I_s} \left(\frac{Y_i}{Y_s}\right)^{\frac{\sigma-1}{\sigma}} \frac{\alpha_i K}{\alpha}$$

Equation (2) then comes from multiplying through by $\frac{\alpha}{K}$ and the fact that

$$\left(\frac{Y_i}{Y_s}\right)^{\frac{\sigma-1}{\sigma}} = \frac{\left[A_i \left(\frac{\alpha_i}{\alpha}\theta_s K\right)^{\alpha_i} \left(\frac{1-\alpha_i}{1-\alpha}\theta_s L\right)^{1-\alpha_i}\right]^{\sigma-1}}{\sum_{j \in I_s} \left[A_j \left(\frac{\alpha_j}{\alpha}\theta_s K\right)^{\alpha_j} \left(\frac{1-\alpha_j}{1-\alpha}\theta_s L\right)^{1-\alpha_j}\right]^{\sigma-1}}$$

D The Level of Misallocation

Table 6 lists the values of output relative to the efficient allocation for each industry. These correspond to figure (6).

Table 6: Allocational Efficiency

	Plant Specific Shares			U.S. Industry Shares		
	Within	Between	Both	Within	Between	Both
1979	0.517	0.885	0.458	0.430	0.844	0.363
1980	0.524	0.826	0.433	0.420	0.788	0.331
1981	0.582	0.877	0.510	0.472	0.830	0.391
1982	0.586	0.836	0.490	0.497	0.792	0.394
1983	0.586	0.813	0.477	0.485	0.769	0.373
1984	0.603	0.820	0.494	0.499	0.777	0.388
1985	0.598	0.782	0.467	0.511	0.743	0.380
1986	0.595	0.846	0.503	0.520	0.792	0.412
1987	0.604	0.857	0.518	0.518	0.794	0.411
1988	0.587	0.830	0.487	0.523	0.774	0.405
1989	0.599	0.826	0.495	0.512	0.772	0.395
1990	0.576	0.840	0.484	0.489	0.791	0.387
1991	0.578	0.837	0.483	0.502	0.790	0.396
1992	0.558	0.837	0.467	0.483	0.783	0.378
1993	0.602	0.844	0.508	0.524	0.789	0.414
1994	0.593	0.868	0.515	0.533	0.806	0.429
1995	0.597	0.901	0.538	0.558	0.816	0.456
1996	0.590	0.872	0.515	0.532	0.811	0.431

Note: This table shows allocational efficiency for each specification. The column labeled "Within" and "Between" show M_W and M_B respectively, while "Both" is their product.

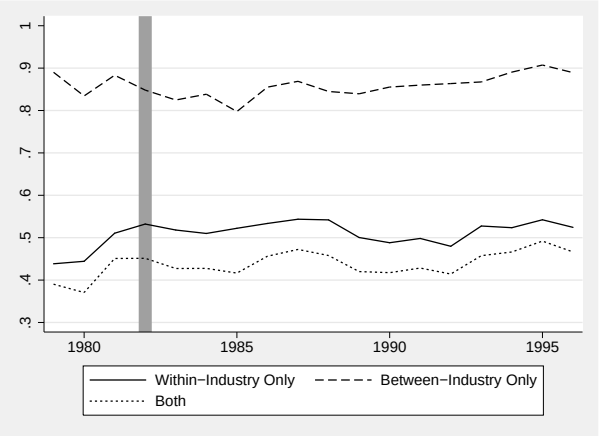
E Alternative Specifications

E.1 Chilean Industry Shares

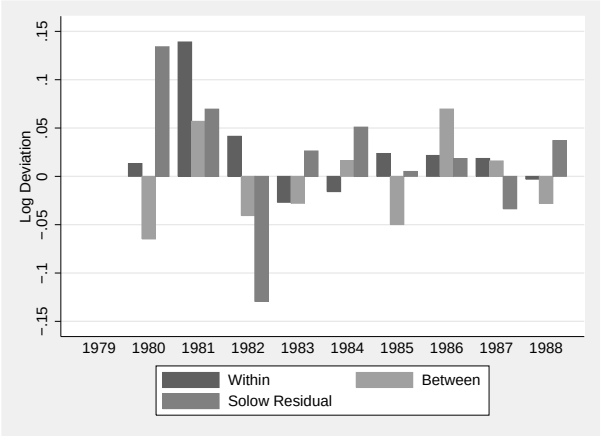
It is possible that industries in Chile are qualitatively different from the corresponding industries in the U.S. In that case, the cost shares of U.S. industries provide a poor benchmark for production parameters of the Chilean plants. This appendix proceeds under the assumption that each Chilean industry is, on average, undistorted. For each industry, I compute the log of the ratio of expenditure on capital to expenditure on labor in each year, and back out the factor intensities assuming that the median best reflects the true production parameters.

Figure 13: Allocational Efficiency using Chile Industry Shares

(a) Output Relative to Efficient Allocation



(b) Contributions to TFP



Note: This figure shows changes in allocational efficiency. Each year, the figure shows the log deviation of within-industry allocational efficiency, M_W, the log deviation of between-industry allocational efficiency, M_B, and the log deviation of the appropriate Solow residual.

As with the specification using U.S. industry shares, within-industry allocational efficiency makes a positive contribution to growth in 1982 that is broadly offset by the between-industry contribution.

Between the two baseline specifications, there are two differences: (i) the interpretation of within-industry differences in capital intensity and (ii) differences between the U.S. and Chile in the levels of capital intensity. That the results here match the specification that uses U.S. industry shares suggests that the former is the more important distinction between the two baseline specifications.

E.2 Restricting the Sample to a Balanced Panel

Bergoeing et al. (2010) find that reallocation through net entry accounts for a substantial part of aggregate efficiency gains in Chile during the crisis. Hence it would be informative to see whether entry and exit (from the sample) is driving the results presented in Section 4. A reason to think that net entry is not the driving factor is that aggregate productivity and measured misallocation are dominated by large plants, while most entering and exiting plants are small.

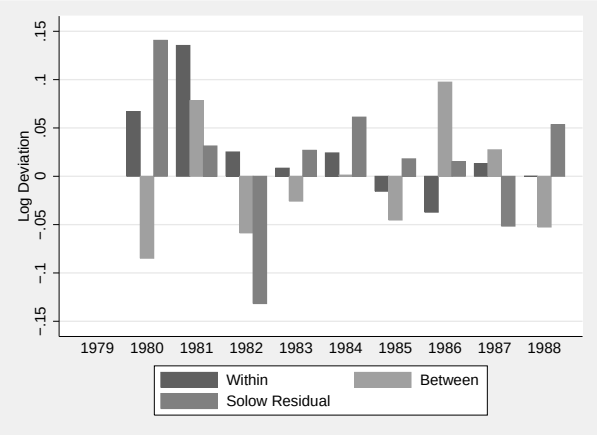
One way to check whether net entry is driving the results is to restrict the analysis to plants that were in the sample every year from 1979 to 1988. Figure 14 confirms that, among plants in this balanced panel, the decline in the Solow residual is large and the changes in allocational efficiency during the crisis are very similar to those found in the baseline. Any explanation of the crisis would have to account for these changes among incumbent plants.

E.3 Outliers

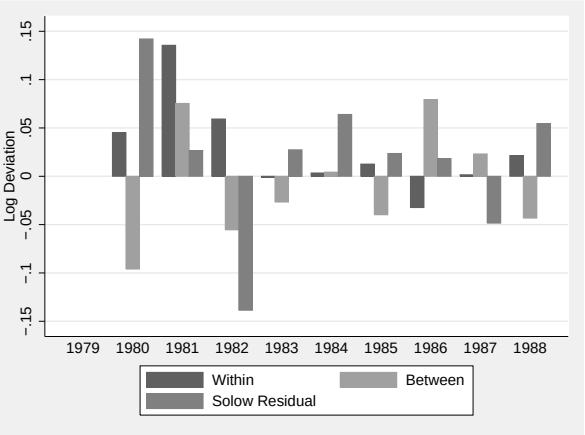
As discussed in the main text, measured misallocation is sensitive to outliers. In the baseline, the top and bottom 1% of the distributions of capital and labor deviations were Winsorized. Figure 15a and Figure 15b show the results of doing the exercise without Winsorizing for the two specifications of production functions, while Figure 15c and Figure 15d show the results when Winsorizing the

Figure 14: A Balanced Panel

(a) Plant-Specific Shares



(b) U.S. Industry Shares



Note: Contributions to changes in the Solow residual restricting the sample to plants that were in the sample every year from 1979 to 1988.

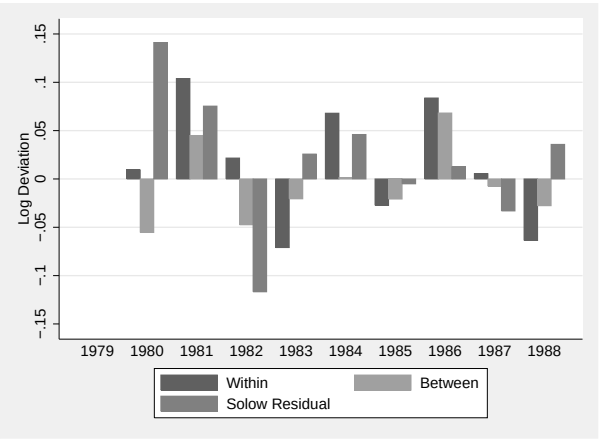
top and bottom 3%.

Omitting Winsorization has almost no effect on the between-industry contribution, but the within-industry contribution becomes much more volatile. This is to be expected, as outliers tend to dominate measured misallocation. In both specifications, the within-industry misallocation makes a positive contribution to growth in 1982, offsetting the contribution of between-industry misallocation.

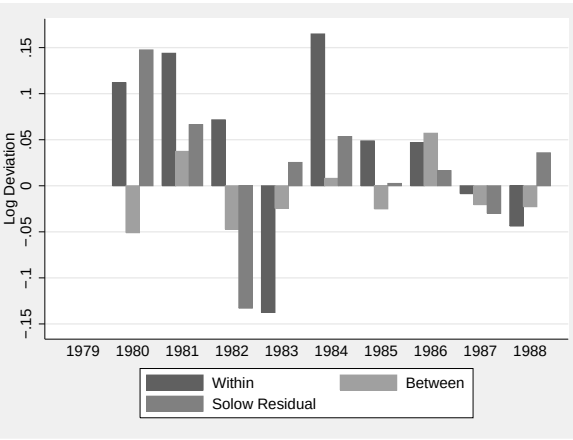
For each of the specifications, Winsorizing at 3% gives a similar time series as the baseline.

Figure 15: Alternative Thresholds for Winsorization

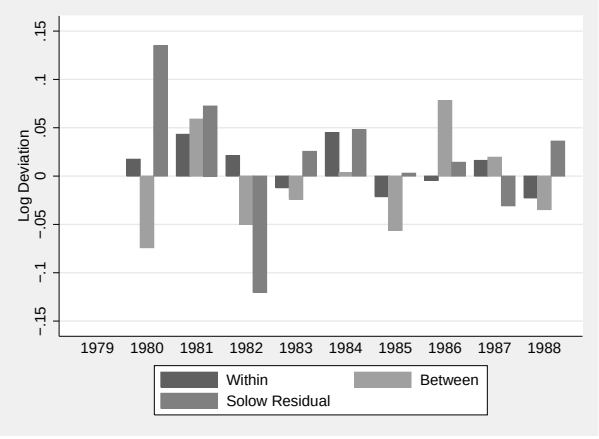
(a) Plant-Specific Shares, 0%



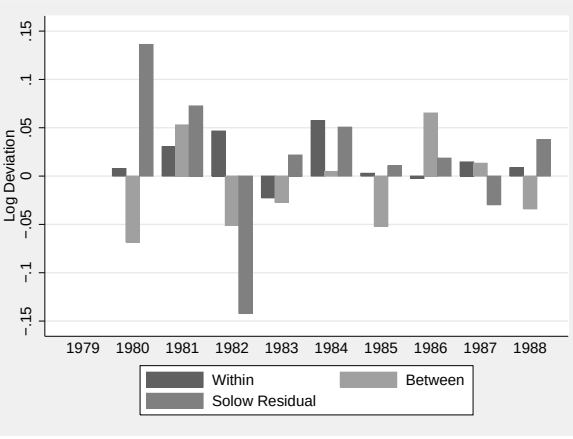
(b) U.S. Industry Shares, 0%



(c) Plant-Specific Shares, 3%



(d) U.S. Industry Shares, 3%



Note: This figure shows the contributions to changes in the Solow residual under alternative Winsorization thresholds. Panels (a) and (b) show the results when the threshold is 0% – the raw data is used. Panels (c) and (d) show the results when Winsorizing the top and bottom 3%.

F Within-Industry Allocational Efficiency

Table 7 shows regressions of within-industry allocational efficiency on various industry characteristics.

Table 7: Changes in Within-Industry Allocational Efficiency

(a) Chile Plant Shares

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Durable	0.100					0.049	0.056	0.001
	(0.110)					(0.062)	(0.071)	(0.063)
Export Share		0.653*				0.279	0.506	0.068
		(0.360)				(0.296)	(0.313)	(0.313)
Financial Dependence			-0.203		-0.745**	-0.617*	0.764	2.195
			(0.146)		(0.359)	(0.345)	(1.546)	(1.616)
Import Share				-0.558	-0.854**	-0.565*		-0.898*
				(0.336)	(0.344)	(0.323)		(0.457)
Fin Dep × Import					2.651*	2.135		3.644*
					(1.509)	(1.521)		(1.874)
Materials Share							0.261	0.662*
							(0.507)	(0.356)
Fin Dep × Materials							-1.356	-4.645
							(2.289)	(2.814)
Observations	29	29	27	29	27	27	27	27
R^2	0.089	0.258	0.083	0.160	0.392	0.443	0.365	0.551

(b) U.S. Industry Shares

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Durable	0.013					-0.048	-0.017	-0.058
	(0.103)					(0.075)	(0.078)	(0.077)
Export Share		0.657**				0.443	0.691	0.345
		(0.254)				(0.363)	(0.440)	(0.495)
Financial Dependence			-0.142		-0.718***	-0.556*	-1.109	-0.142
			(0.136)		(0.255)	(0.321)	(1.467)	(1.673)
Import Share				-0.476	-0.831**	-0.588		-0.681
				(0.339)	(0.313)	(0.457)		(0.553)
Fin Dep × Import					2.828**	2.282		2.345
					(1.084)	(1.361)		(2.062)
Materials Share							-0.091	0.220
							(0.602)	(0.493)
Fin Dep × Materials							1.576	-0.608
							(2.167)	(3.007)
Observations	29	29	27	29	27	27	27	27
R^2	0.001	0.243	0.041	0.108	0.346	0.424	0.336	0.432

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Each column shows a regression of the log deviation of within-industry allocational efficiency from 1981 to 1982 on various industry characteristics. In each regression, industries are weighted by their average shares of value added in 1981 and 1982. Constant not shown.

References

Bergoeing, Raphael, Andres Hernando, and Andrea Repetto, "Market Reforms and Efficiency Gains in Chile," *Estudios de Economia*, December 2010, *37* (2 Year 20), 217–242.

Cortazar, Rene, "Chile: The Evolution and Reform of the Labor Market," in Sebastian Edwards and Nora Claudia Lustig, eds., *Labor Markets in Latin America*, Brookings Institute Press, 1997, pp. 235–260.