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A Note on Terms of Trade Shocks and the Wage Gap

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A Note on Terms of Trade Shocks and the Wage Gap

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Abstract

Using Chilean data, we document that for resource-rich small open economies the effects of terms of trade shocks on the wage gap (between skilled and unskilled workers) depend on factor intensities in the non-tradable sector, following the model in Galiani, Heymann, and Magud (2010). For a skilled-intensive non-tradable sector we show that improvements in the terms of trade benefit skilled workers. We also show that this relation holds at the industry level: the wage gap widens in skilled-intensive sectors while it shrinks in unskilled-intensive ones, the more so as terms of trade volatility decreases.

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I. Introduction

Despite strong growth and trade liberalization in the last two decades, Chile's income inequality remains mostly unaltered. During this period, average real GDP growth has been 5 percent, while average per capita real GDP increased 3.6 percent. Yet, income inequality has improved only marginally: measured by the Gini coefficient, it decreased from 55.9 in 1990 to 55.0 in 2009.[1]

Globalization tends to worsen income inequality in resource-rich countries; see, e.g., Leamer and others (1999) and Spilimbergo, Londoño, and Szekely (1999). A relatively small skilled labor force diminishes the capacity of developing countries to fully absorb the transmission of technology embedded in international trade, and it is reflected in a high skill-premium.[2] However, this literature has paid little attention to the impact of external shocks to the functional distribution of income in resource-rich economies.

This note is a step toward bridging these facts, focusing on the effects of one (mainly exogenous) variable: the terms of trade. Using Chilean data, we document the effects of shocks to the terms of trade on income distribution—measured by the wage gap between skilled and unskilled workers.[3] Specifically, we document how improvements in the terms of trade favor skilled workers over unskilled workers given that non-tradable goods are skilled-intensive, following the model in Galiani, Heymann, and Magud (2010). We also show that this relation holds at the industry level: as the terms of trade improve, the wage gap widens in skilled-intensive sectors while it shrinks in unskilled-intensive ones. Lower volatility increases (decreases) the wage gap in skilled (unskilled) intensive sectors.[4]

The paths of terms of trade and relative wages (skilled vs. unskilled) in Chile for the period 1996–2009, suggest the existence of a co-movement between them (Figure 1 and Figure 2).[5] These variables had been relatively stable until 2003, and then increased until the global financial crisis erupted in mid-2008.

[1] See CASEN 2010 for details.

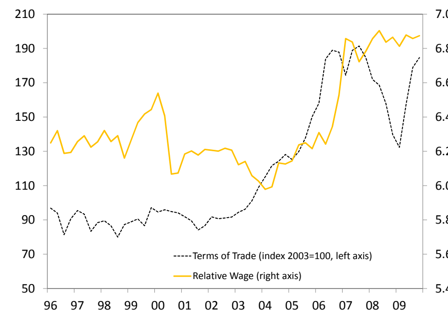
[2] See Brambilla and others (2010), Klein, Moser, and Urban (2010), Reshef (2007), Acemoglu (2002), and Feenstra to look at the relation between skill premia and exports.

[3] Even though other variables could certainly impact on the country's income distribution, the fact that Chile is natural-resource rich and very open to internatioanl trade makes shocks to the terms of trade relevant.

[4] The reduction in volatility could be due to the greater ability of skilled workers to access financial markets to absorb shocks.

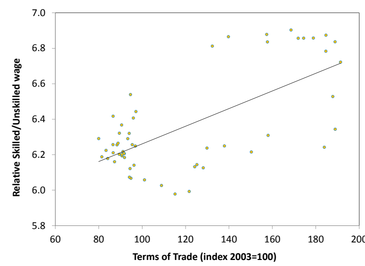
[5] Following INE, relative wages are measured as the ratio of managers and unskilled workers.

Figure 1. Terms of Trade vs. Relative Wages



Source: Authors' calculations using data from Central Bank of Chile and Chile's National Bureau of Statistics

Figure 2. Terms of Trade vs. Relative Wages



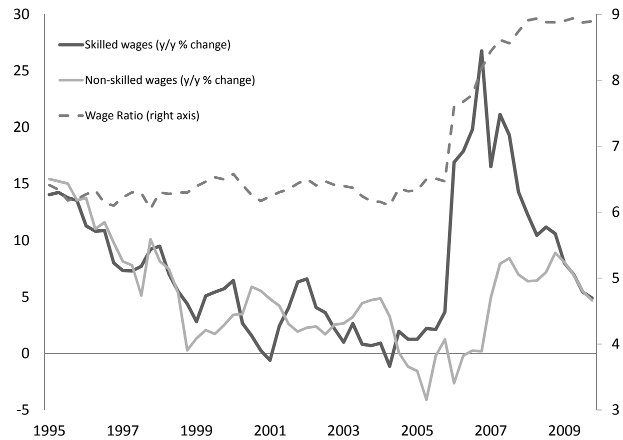
Source: Authors' calculations using data from Central Bank of Chile and Chile's National Bureau of Statistics

Furthermore, Figure 3 shows how most of the increase in the wage gap results from larger wage increases to skilled workers. Changes in skilled and unskilled workers' wages were relatively similar prior to the sharp increase in the terms of trade that started around 2005–2006. After that, however, skilled workers' wages increased proportionally more.[6]

The effects of shocks to the terms of trade on income distribution, in turn, depend on factor intensities. Stolper–Samuelson's seminal contribution, focuses on factor income redistributions due to relative factor intensities between tradable goods. However, non-tradable goods can represent a high share of a country's production. Theoretically, Galiani, Heymann, and Magud (2010) show how distributional effects of terms of trade shocks in the presence of non-tradable goods are conditional on factor intensities. They show that in response to a positive terms of trade shock the owner of the natural resource benefits–as in the standard Stolper-Samuelson model. More interestingly, they show that skilled workers benefit at the expense of unskilled workers if non-tradable goods are skilled-intensive–thus redistributing income within "urban" labor (see below for the mechanics of the income redistribution).

[6] As extension, we are currently putting together the data from the Greater Santiago employment survey collected by University of Chile in order to replicate the exercise below for a different time series. Preliminary evidence shows a high correlation between both series.

Figure 3. Relative Wages



Source: Authors' calculations using data from Central Bank of Chile and Chile's National Bureau of Statistics.

Table 1. Labor Intensities by sector

	Non-Tradable	Tradable	Total
Ratio Unskilled/Skilled workers	2.2	5.6	2.8
Share of workers by sector (as percent of total labor force)	72.01	27.99	100.00

Source: Authors' calculations using CASEN Survey (2006).

In Chile, non-tradable goods are relatively skilled-intensive (see Table 1). Using information from the *National Socioeconomic Survey* (CASEN by its Spanish acronym), we observe that compared to the production of tradable goods, the non-tradable sector favors the use of skilled workers. The ratio of unskilled to skilled workers is over 2.5 times (5.6/2.2) larger in the tradable sector than in the non-tradable sector (Table 1).

Based on the above, we collect Chilean data on wages conditional on the years of schooling and terms of trade for 1993–2009. Regressing the wage gap of skilled vs. unskilled workers on terms of trade we find that the wage gap worsens as the terms of trade improve. This would be consistent with an economy in which the non-tradable sector is skilled-intensive, as documented by CASEN (Table 1). Using information of the wage gap disaggregated by production sector (mining, financial services, manufactures, etc.), we find that the wage gap worsens in skilled-intensive sectors and improves in unskilled intensive ones, again, in line with theory.

We perform several robustness checks such as controlling for real GDP per capita growth and GDP per capita to capture the idea that richer countries tend to have more equal income distribution, lagged wage gap control for persistence, and the volatility of the terms of trade to control for the impact of volatility on income distribution, among others. The results remain robust to all the different specifications that we tried.

Thus, since as a country grows the share of non-tradable goods in the economy increases and non-tradable goods become skilled-intensive, the higher the share of skilled workers in the economy, the higher the share of the population that benefit from positive external shocks. (This could imply a potentially lower cost per individual in case some redistributional subsidy were to be implemented.) Given the above, increasing an economy's human capital through education will be necessary to increase the share of skilled workers such that a larger share of the population could reap the benefits of positive external shocks.

The paper is structured as follows. Section II briefly lays out the theoretical model tested in this paper. Section III describes the data and the empirical strategy, and Section IV documents the main results and provides some robustness checks. Section V discusses some policy implications, and Section VI concludes.

II. THEORY

The following description follows Galiani, Heymann, and Magud (2010). The appendix describes the model with more detail.[7] Suppose a country produces three types of goods: tradable primary goods drawing on an abundance of natural resources (e.g. agricultural, mining, etc.), tradable manufactures, and a non-tradable good. Assume that the primary good uses land and unskilled labor as factors of production. The two "urban" goods (manufactures and non-tradables) use skilled and unskilled labor as their inputs. Assume further that non-tradable goods are skilled-intensive while manufactures are, thus, unskilled-intensive.

In this set up, if the economy receives a positive terms of trade shock, income distribution changes. The owner of the factor specific to the natural resource (land) will be better-off-in line with the Stolper–Samuelson theorem.The shock also generates redistributive frictions within urban factors of production, as skilled workers will be (*relatively*) better off. On the one hand, a positive terms of trade shock makes the economy as a whole wealthier. On the other hand, the price of tradable goods is exogenous to a small open economy—which applies to the price of primary goods and manufactures—while by definition, the price

[7]The interest reader is referred to the paper for complete details and proofs.

of non-tradable goods results from the market clearing conditions in the domestic market. Hence, a positive shock to the terms of trade raises income and spending on non-tradable goods, increasing the relative price of non-tradable goods. The zero-profit condition for firms implies that the factor used intensively in non-tradable goods would benefit over the other factor—sort of Stolper–Samuelson for non-tradable goods.[8]

The shock thus reduces demand for unskilled labor in the manufacturing sector, while it increases it in the agricultural and non-tradable sectors. Given factor intensity in the production of non-tradable and agricultural goods, the mass of unskilled workers that agricultural and non-tradable goods need to absorb is relative large given its demand for labor. Thus, for the unskilled labor market to clear its real wage needs to be reduced. Overall, income is redistributed from unskilled workers to skilled workers.

Formally, this can be represented as

$$\frac{h}{w} = F\left(\text{ToT}\right) \tag{1}$$

with $F'(\cdot) > 0$ if NT is skilled-intensive and $F'(\cdot) < 0$ if NT is unskilled-intensive, where h stands for skilled labor's wage, w for unskilled labor's earnings, ToT refers to the terms of trade, and NT stands for non-tradable goods.

The empirical application below tests for the latter relationship between terms of trade and the wage gap.

Although not tested in this note, Galiani, Heymann, and Magud (2010) extend the analysis to show the effects of alternative re-distributional fiscal policies. They show conditions under which export taxes could either ameliorate the income distribution effects of terms of trade shocks. They also show however, that under reasonable conditions the income distribution effects of terms of trade shocks could be exacerbated instead of ameliorated. Thus, it would not always be the case that export taxes would be able to undo the effects of shocks to the terms of trade to the functional income distribution of a country. The interested reader is referred to the mentioned paper for details.

[8] Galiani, Heymann, and Magud (2010) shows the results for the case in which manufactures are skilled intensive and extends the results is several directions, such as analyzing net importers, introducing physical capital, using imports as an additional input in production, alternative consumption preferences, and capital account dynamics, among many other things. It also extends the results to export taxes aimed at redistributing the effects of terms of trade shocks.

Table 2. Descriptive statistics

	Terms of Trade (index, 2003=100)	Relative Wage	GDP per capita growth rate (q-o-q percent change)
Mean	119.80	6.9	2.2
Median	96.53	6.4	2.3
Maximum	191.43	8.9	10.2
Minimum	79.97	6.0	−5.8
Std. Dev.	37.29	1.0	2.9
Observations	56	67	66

Source: Authors' calculations based on Chilean central bank and Chilean national bureau of statistics.

III. Data and Econometric Methodology

The data we use is from Chilean authorities. Terms of trade data is provided by the central bank of Chile (BCCh). It is computed as the ratio of export price index over the import price index (2003=100 for both of them). We have quarterly frequency between 1996:1 to 2009:4.

To measure the wage gap we used data produced by the National Statistical Institute (INE). Following standard procedures, the wage series for skilled workers were proxied by the average income perceived by managers. The wage of unskilled workers were given by the category unskilled—some robustness checks were performed using alternative classification for skilled workers, conditional on the average level of human capital. The results were mostly unaltered. This data had monthly frequency for the period 1993:4–2009:12 for the aggregate economy. As will be explained below, similar exercises were conducted at industry level, for which the monthly sample spanned 1993:4–2005:12. In each case, monthly incomes were averaged over each quarter so as to make it consistent with the terms of trade data.

Among the controls, real GDP per capita growth (from BCCh) spanned the entire sample period. Volatility measures were constructed by computing 3-quarter moving average of standard deviations of the series. Table 2 shows the basic descriptive statistics.

Following equation (1) above, we would expect the relative wage of skilled vs. unskilled workers to increase as the terms of trade improve, conditional on non-tradable goods being (relative) skilled intensive. The latter would represent a worsening of the wage gap. Given that Chile is a small open economy our analysis assumes that the terms of trade, measured by the export to imports prices ratios can be taken as exogenous. Thus, we can simply run

OLS regressions to test for the validity of the theoretical model. In order to focus on percentage changes we take logs of the variables (wage ratio and terms of trade) before running the regression—thus the coefficients will represent elasticities.

IV. Results

For the aggregate economy's results, we find that the wage gap worsens the as terms of trade improve (Table 3). The coefficient is statistically significant at the 1 percent level (see column (1)). It is also economically significant, as it implies that a 1 percent increase in the terms of trade increases the wage gap in close to half a percentage point. The R^2 is also quite solid.

We tested for unit roots using 7 different tests (see the Appendix). Most of them came out suggesting the possibility of having unit roots. However, Chumacero (2000) elaborates on the low power of these tests and their tendency to show false positives of the presence of unit roots. Yet, this could be a concern unless the series are co-integrated. Thus, we performed Johansen's co-integration tests. They support the existence of a long-term co-integration relationship for this specification—with a constant but no trend. This implies that regardless of the unit root tests, there exist a long-term relation such that the long-run residuals are stationary, validating the level specification that we are using.

In order to obtain more robust results we controlled for the growth rate of real GDP per capita (column (2)) and the volatility of the terms of trade (column (3)). Volatility is proxied by the standard deviation of the terms of trade. As an alternative measure of the wage gap we defined broader definitions of skilled and unskilled workers. Even though this might mask the true impact of terms of trade shocks on the wage gap—due to resulting from aggregating different types of wage-skill combinations jointly—the main message of the paper holds. Results remained robust for all the alternative specifications.

To delve into the details we take advantage of some data disaggregation obtained from the National Statistical Institute (INE). For most of the sample period the same data is disaggregated by industry into (i) financial services, (ii) manufacturing, (iii) construction, (iv) commerce, (v) transportation and telecommunications, (vi) electricity, gas, and water (EGW), (vii) mining, and (viii) personal services. Table 4 reports the share of some these sector in Chile's GDP. For each of these eight industries we performed similar exercises. Most of the results came out quite robust.

Table 3. Regression Output for the Aggregate Economy

	(1)	(2)	(3)
Aggregate Economy			
Constant	−0.09	−0.12	−0.02
Terms of Trade (−1)	0.43***	0.44***	0.41***
Growth of GDP per capita (−1)		−1.13**	−1.11**
Std. Dev. of ToT (−1)			0.02
R^2	0.75	0.79	0.79
Number of Observations	55	55	54

Note: *,** and *** denote statistical significance at the 90, 95, and 99 percent confidence levels.

Table 4. Relative Importance of the Sectors in the Overall Economy

	Sectors' shares in GDP) (in percent)
Manufacturing Industry	18.2
Financial Sector	17.2
Personal Services	12.1
Commerce	11.4
Transportation and Telecommunications	10.5
Mining	8.2
Construction	7.7
Rest	14.7

Source: Central Bank of Chile.

Regarding skill-intensity, it is worth mentioning that recent data from INE (2010) (*La Estructura de los Puestos de Trabajo en Chile*, March 2010, p. 7) support our results. They report that the financial services and EGW sectors are (relatively) skilled-intensive, whereas the manufactures, mining, commerce, and construction sectors are unskilled-intensive.

Financial services, with 17.2 percent of GDP, is mainly a skilled-intensive non-tradable service. It has a positive coefficient which is both statistically and economically significant. This implies that in this industry the wage gap worsens as terms of trade improve. When using terms of trade as the sole explanatory variable (Table 5, Panel A, column (1)), we see that for each 1 percent increase in the terms of trade the wage gap increases more than half a percentage point. Controlling for real GDP per capita growth the worsening of the wage gap increases more (close to 2/3 of a percentage point) in response to a 1 percent increase in the terms of trade (Table 5, Panel A, column (2)). The results remain robust in terms of magnitude and significance when the volatility measure is added. The main coefficient in terms of our exploration, the terms of trade, increases. Furthermore, the volatility coefficient is not only very significant but negative. We interpret this as consistent with the theory. Lower volatility enables skilled workers to take advantage of shocks to the terms of trade in a more favorable way—alternatively, the marginal effect of more volatility reduces the benefit of a higher human capital response to the terms of trade shock. The latter is based on the assumption that, relatively speaking, skilled workers are more financially sophisticated and thus posses a larger ability to somehow “hedge" against these types of shocks.

Panel B of Table 5 reports the results for manufacturing, which represents 18.2 percent of GDP. This is an unskilled-intensive tradable good and, as expected, it depicts the opposite result. The wage gap improves in the terms of trade. Again it is not only significant (at the 1 percent level), but also economically significant: A 1 percent increase in the terms of trade results in a 1/3 percent decrease in the wage gap—see column (1). This holds when controlling for the growth rate of real GDP per capita the volatility of the terms of trade.

Panels C and D of Table 5 show that similar results obtain for the construction and commerce sectors, which are also unskilled-intensive sectors. Consistent with the results reported in Panel B of Table 5, the estimated coefficient on the lagged terms of trade coefficient are negative.

Results for other sectors are not always statistically significant. Yet, the signs of the coefficients on the terms of trade term estimated for the Electricity, Gas, and Water, Mining, and Personal Services sectors—see Table 6—point in right direction since the second and third of these sectors are unskilled-intensive (thus the negative coefficient) whereas the first is skilled-intensive (i.e., should show a positive coefficient).[9]

V. Discussion and Policy Implications

The analysis above shows the benefits to skilled workers of shocks to the terms of trade for a resource-rich open economy. Production of non-tradable goods and relative skill-intensity play a key role. We now focus on the policy implications.

One of the most salient messages of the paper is the importance of investing in human capital. The higher the share of skilled workers in the labor force, the greater the number of work-

[9]This is also consistent with the March 2010 data of INE (2010).

Table 5. Regression Output for the Financial Services, Manufacturing, Construction, and Commerce Sectors

	(1)	(2)	(3)
A. Financial Services Sector			
Constant	−0.43	−0.9	−1.33
Terms of Trade (−1)	0.53*	0.64**	0.76**
Growth of GDP per capita (−1)		−1.88**	−2.44**
Std. Dev. of ToT (−1)			−0.12***
R^2	0.12	0.17	0.32
Number of Observations	39	39	38
B. Manufacturing Sector			
Constant	3.26***	3.28***	3.3***
Terms of Trade (−1)	−0.31***	−0.31***	−0.32***
Growth of GDP per capita (−1)		0.09	0.05
Std. Dev. of ToT (-1)			0.01**
R^2	0.59	0.59	0.64
Number of Observations	39	39	38
C. Construction Sector			
Constant	4.25***	4.47***	4.62***
Terms of Trade (−1)	−0.51**	−0.57**	−0.61**
Growth of GDP per capita (−1)		0.88	1.00
Std. Dev. of ToT (−1)			0.05
R^2	0.18	0.19	0.23
Number of Observations	39	39	38
D. Commerce Sector			
Constant	3.2***	3.18***	3.12***
Terms of Trade (−1)	−0.27***	−0.27***	−0.25***
Growth of GDP per capita (−1)		−0.06	−0.21
Std. Dev. of ToT (−1)			−0.01
R^2	0.64	0.64	0.68
Number of Observations	39	39	38

Note: *,** and *** denote statistical significance at the 90, 95, and 99 percent confidence levels.

Table 6. Regression Output for the EGW, Mining, and Personal Services Sectors

	(1)	(2)	(3)
Electricity, Gas, and Water (EGW) Sector			
Constant	1.73**	1.54**	1.42**
Terms of Trade (−1)	0.17	0.22	0.26*
Growth of GDP per capita (−1)		−0.75	−0.64
Std. Dev. of ToT (−1)			−0.06***
R^2	0.04	0.06	0.21
Number of Observations	39	39	38
Mining Sector			
Constant	2.9***	2.66**	2.58**
Terms of Trade (−1)	−0.21	−0.16	−0.14
Growth of GDP per capita (−1)		−0.95	−1.17
Std. Dev. of ToT (−1)			−0.01
R^2	0.08	0.12	0.14
Number of Observations	39	39	38
Personal Services Sector			
Constant	1.57***	1.68***	1.65***
Terms of Trade (−1)	−0.05	−0.04	
Growth of GDP per capita (−1)		0.43**	0.33*
Std. Dev. of ToT (−1)			0
R^2	0.01	0.15	0.12
Number of Observations	39	39	38

Note: *,** and *** denote statistical significance at the 90, 95, and 99 percent confidence levels.

ers that can benefit from terms of trade shocks—which is relevant given the magnitude of the non-tradable sector. Moreover, a higher share of skilled workers imply that, in case a redistributive mechanism to smooth shocks to the terms of trade were to be implemented, there are more taxable individuals—implying, all else equal, a lower cost for each individual. If as a consequence of such a shock a government were to tax skilled workers to redistribute to unskilled workers, the larger the share of skilled workers, the lower the tax would be for each individual. Taxing skilled workers during "good times" can also be used as a source to build a "rainy day" fund for when external shocks turn negative.

Also, the paper supports implementing a strategy to improve overall and especially manufacture's competitiveness—yet not through protectionism. Innovation to this sector can result in these tradable goods turning into actually traded goods—i.e. exported. In this case, manufactures will benefit when its relative price increases. (In other words, at least some part of the economy will always be better off, regardless of the terms of trade.) The higher the share of skilled workers in manufactures, the higher the share of workers that benefit. Thus, having more competitive manufactures helps enlarging the set of shock absorber mechanisms.[10]

Complementary to both of the above policy implications—increasing the share of skilled workers in the economy jointly with making manufactures more competitive—relative factor intensity does matter. On the margin, it is better for factor intensity not to be that skewed toward one sector due to the following. One of the main channels behind the income redistribution generated by the shock to the terms of trade is the mechanism by which the labor market clears. The increase in the price of the resource-based good is accommodated by an increase in the relative price of non-tradable goods jointly with a lower relative price of manufactures. The shock thus reduces demand for unskilled labor in the manufacturing sector, while it increases it in the agricultural and non-tradable sectors. Given factor intensity in the production of non-tradable and agricultural goods, the mass of unskilled workers that agricultural and non-tradable goods need to absorb is relative large given its demand for labor. Thus, for the unskilled labor market to clear its real wage needs to be reduced. *Relative* factor intensity will almost always exist. The degree of relative skill-intensity however, matters for the adjustment in unskilled workers' factor return. The more balanced relative factor intensity is, the smaller the required adjustment. All else equal, the higher the share of skilled work technologically required to produce non-tradable goods, the lower the return to unskilled workers should be in order for them to be hired by non-tradable producing firms. Thus, given relative factor intensity, if the relative demand for factors across sectors does not differ substantially, the unskilled labor market would clear at a lower cost in terms of real wages reductions—consequently lessening the distributional effects.[11]

The increase in skilled labor could be accompanied by a higher degree of flexibility in the labor market as well. Flexibility will ease skilled (and to a lesser extent, unskilled too) workers moving from non-tradable to tradable sectors. This will enable the labor force to accommodate to medium-term changes in terms of trade by being able to benefit from these shocks regardless of whether they are driven by increases in the price of manufactures or of agricultural goods. This flexibility is relevant for Chilean. The existence of large numbers of so called “temporary" contracts—which impact mostly unskilled and young workers—reflects

[10] Section II mentions this; Galiani, Heymann, and Magud (2010) elaborate on different redistributional fiscal policies and their effects on income distributions triggered by terms of trade shocks.

[11] For example, we can think that for a 0.55 ratio of skilled to unskilled labor in the non-tradable sector the unskilled workers wage drop would be smaller than if that ratio would be 0.95.

the lack of sufficient labor market flexibility, as well as it asymmetry. Improving such flexibility will help to reduce the prominence of such types of contracts, therefore diminishing the income distributional effects of terms of trade shocks.

VI. Conclusions

The results reported verify that for countries in which non-tradable goods are (relatively) skilled-intensive positive terms of trade shocks benefit skilled workers. We have shown that these results hold in the Chilean economy as a whole. We have also shown that, in response to the terms of trade shock, the wage gap between skilled and unskilled workers widens in skilled-intensive sectors (the more so the lower the volatility of the terms of trade) and narrows in unskilled intensive sectors. These results are consistent with theory, as in Galiani, Heymann, and Magud (2010), and robust to several specifications. We have shown not only the statistical significance of our estimations, but also its economic significance.

Therefore, a small open economy mainly exposed to terms of trade shocks would benefit from increasing the share of skilled workers in the labor force, underscoring the relevance of investing in human capital. Furthermore, since the non-tradable sector tends to increase and become more skilled-intensive as the economy grows, a larger share of the population will benefit from positive external shocks.

Additionally, innovation is also needed. Long-term competitiveness, reflected through higher TFP growth boosts every sector in the economy. This might be particularly important for import-competing tradable goods to turn into exportable goods. Additionally, to the extent relative factor intensity is not too skewed, factor reallocation can be attained at a lower cost in terms of real wages.

Finally, for a small open economy mainly exposed to real shocks—as is the case with Chile—a higher share of skilled workers will be better served by a more flexible labor market. The more flexible the labor market is, the easier it is for skilled workers to absorb external shocks. Workers can reallocate within sectors conditional on the external shock—the more so as skilled workers' share increase and factor intensity is somewhat more "balanced" within sectors—which also highlights the need to improve the country's competitiveness.

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APPENDIX A. THE GALIANI–HEYMANN–MAGUD MODEL

The details of the model can be found in Galiani, Heymann, and Magud (2010). Here we present a brief sketch of the structure of the model and some of its results, drawing heavily on that paper. The interest reader is referred to the original manuscript for further details.

Production

We consider a small open economy that produces three goods: agricultural (A), manufactures (M), and non-traded (N) goods. The quantities produced are labeled y_A, y_M and y_N, respectively. The world price of the agricultural good, p_A, is exogenously given, as is the price of the non-produced imported good M, p_M, which serves as the numeraire. The production functions are as follows:

$$y_A = f(T,L) \tag{A.1}$$

$$y_N = g(H,L) \tag{A.2}$$

$$y_M = s(H,L) \tag{A.3}$$

where T denotes agricultural land, L stands for raw labor, and H denotes skilled labor.[12] Notice that the third manufactures competes with foreign products in the market for the imported good. Factor L is assumed to be mobile between the three sectors, while H can shift between "manufactures" and the non-traded sector.

The price-cost equality derived from the assumption of perfect competition in all markets can be expressed in terms of proportional changes as:

$$\hat{p}_A = \theta_{TA}\hat{t} + \theta_{LA}\hat{w} \tag{A.4}$$

$$\hat{p}_N = \theta_{HN}\hat{h} + \theta_{LN}\hat{w} \tag{A.5}$$

$$\hat{p}_M = 0 = \theta_{HM}\hat{h} + \theta_{LM}\hat{w} \tag{A.6}$$

where a hat above a variable denotes a proportional change, p_N is the price of the non-traded good, t is the return to factor T, w is the wage rate, and h is the rate of return to factor H, while θ_{ij} stands for the share of factor i in the unit cost of producing good j. (Alternatively,

[12] All the results carry through if we add another mobile factor: capital. Alternatively, we can think of skilled workers as capital.

the parameters θ_{ij} are the corresponding output elasticities or factor shares, such that $\sum_i \theta_{ij} = 1 \forall j$.)

Factor Markets

The economy is endowed with a fixed amount of factors of production. Given competitive factor markets, and the assumption of homogenous of degree one Cobb–Douglas production functions, equilibrium conditions can be characterized as:

$$\hat{T} = 0 = \hat{p}_A + \hat{y}_A - \hat{t} \tag{A.7}$$

$$\hat{L} = 0 = \lambda_{LA}(\hat{p}_A + \hat{y}_A) + \lambda_{LN}(\hat{p}_N + \hat{y}_N) + \lambda_{LM}\hat{y}_M - \hat{w} \tag{A.8}$$

$$\hat{H} = 0 = \lambda_{HN}(\hat{p}_N + \hat{y}_N) + \lambda_{HM}\hat{y}_M - \hat{h} \tag{A.9}$$

where λ_{ij} stands for the participation of sector j in the employment of factor i ($\lambda_{Li} = L_i/L$). Since the incomes of the specific factors T and H are determined by constant shares in the values of production of the goods A and N, respectively, their unit earnings vary in proportion to those values. In the case of the mobile factor, L, wages change according to a weighted average of the values of production, in relation to the importance of the sector in total employment.

Preferences and Consumption

For analytical tractability we assume homothetic preferences thus ignoring the effects of income distribution on the composition of demand. All individuals have identical Cobb–Douglas preferences over the consumption of the agricultural good, c_A, non-traded good, c_N, and manufactured good c_M:

$$u(c_A, c_M, c_N) = c_A^{\gamma_A} c_M^{\gamma_M} c_N^{\gamma_N} \tag{A.10}$$

The parameters γ represent the constant proportions of spending allocated to the different goods. Without loss of generality, we assume that $\gamma_A + \gamma_M = 1$, so that these two coefficients measure the shares of the value of each tradable good in the total value of expenditures on traded goods. The individual's budget constraint is given by:

$$I = p_A c_A + p_N c_N + p_M c_M \tag{A.11}$$

where I is the income earned by the individual, which depends on factor prices w, t and h, and the factor endowments of the agents. Optimal consumption is such that the value of spending on each of the three goods vary proportionally. Hence, in equilibrium:

$$\hat{p}_A + \hat{c}_A = \hat{c}_M = \hat{p}_N + \hat{c}_N = \hat{p}_N + \hat{y}_N \tag{A.12}$$

where the exogenous price of the manufacturing good has been assumed to remain unchanged (i.e. $\hat{p}_M = 0$).

The trade balance constraint, or equivalently, the equality between the value of production of traded goods and the value of consumption of those goods (in an economy without capital flows), is now given by the expression:

$$\chi_A(\hat{p}_A + \hat{y}_A) + \chi_M \hat{y}_M = \gamma_A(\hat{p}_A + \hat{c}_A) + \gamma_M \hat{c}_M \tag{A.13}$$

where χ_i denotes the share of traded good i in the total value of tradable production (i.e., $\chi_i = p_i y_i/(p_A y_A + p_M y_M)$. Since A is the exported good, it must be the case that $\chi_A > \gamma_A$: its share in production is larger than its share in consumption.

We define an equilibrium as a set of proportional changes in the produced quantities $\{\hat{y}_A, \hat{y}_N, \hat{y}_M\}$, volumes of consumption $\{\hat{c}_A, \hat{c}_N, \hat{c}_M\}$, factor earnings $\{\hat{t}, \hat{w}, \hat{h}\}$, and the price of the non-traded good, $\hat{p}_N$, which satisfies equations (A.4) to (A.9), (A.12), and (A.13) and **??** for given values of the changes in international prices, $\{\hat{p}_A, \hat{p}_M = 0\}$.

Results

Given the above setup the paper shows, among other things, the following.

Proposition 1 If the production of the non-traded good, N, is relatively intensive in human capital (factor H) in comparison with the manufactured good, M (or equivalently, if sector M is relatively labor intensive), then $\Delta > 0$. This implies that if an exogenous change (for instance, in international prices, as analyzed here) results in an increase in the price of good N relative to the imported good M, then the earnings of skilled workers H increase unambiguously in terms of both goods, N and M, while the wage of factor L falls, also in terms of both goods.

where

$$\hat{h} = \frac{\theta_{LM}}{\Delta}\hat{p}_N \tag{A.14}$$

$$\hat{w} = -\frac{\theta_{HM}}{\Delta}\hat{p}_N \tag{A.15}$$

where $\Delta = \theta_{HN} - \theta_{HM} = \theta_{LM} - \theta_{LN}$. Equations (A.14) and (A.15) clearly show that a Stolper–Samuelson type of distributive tension arises in this economy between factors H and L (with the important proviso that here the change in the relative price of both goods, $\hat{p}_N$, is determined endogenously).

Then it shows that:

Proposition 2 In the three-good, three-factor economy described above, an increase in the international relative price of the agricultural good A implies that:

- The return to factor T, specific to the production of good A, increases unambiguously, and that the proportional change of the return to factor T is greater than the proportional change in the price of the exported good: $\hat{t} > \hat{p}_A > 0$. Besides, the proportional change of the return to factor T is also greater than the proportional change of the non-traded good: $\hat{t} > \hat{p}_N$.
- Production factors are reallocated in such a way that agricultural output increases ($\hat{y}_A > 0$) and the output of the import-competing sector decreases, ($\hat{y}_M < 0$).
- The consumption of traded goods switches towards good M, $\hat{c}_M > 0$. The economy increases its volume (and value) of imports since c_M increases, while y_M falls.
- If, as assumed, factor H is used more intensively in sector N than in sector M, and conditional on the share of labor used in the production of the agricultural good being "small" (see the Appendix for the precise bound):
    1. The price of the non-traded good increases in terms of the manufactured good M.
    2. The price of the factor used intensively in the production of the non-traded good, skilled labor, increases relative to the prices of goods M and N.
    3. The return to the unskilled labor L, used intensively in the production of import-competing goods, M, decreases in terms of the three goods.
- Compared to an "aggregate" consumption price index ($\hat{p} = \gamma'_A\hat{p}_A + \gamma'_M\hat{p}_M + \gamma'_N\hat{p}_N$):

1. The purchasing power of the return to unskilled labor decreases (increases), $\hat{w} - \hat{p} < 0$ ($\hat{w} - \hat{p} > 0$), if non-traded goods are sufficiently skilled-labor intensive (not sufficiently skilled-labor intensive). The threshold is shown in the Appendix. The "wedge" in factor intensity increases, among other things in the share of exportable goods consumed and decreases in the share of exportable tradable goods production and the share of land used in the production of exportable goods.
2. The purchasing power of the return to skilled-labor increases (decreases), $\hat{h} - \hat{p} > 0$ ($\hat{h} - \hat{p} < 0$), if non-tradable goods are sufficiently skilled-labor intensive (not sufficiently skilled-labor intensive). The threshold is shown in the Appendix. The "wedge" in factor intensity increases, among other things in the share of exportable goods consumed and decreases in the share of exportable tradable goods production and the share of land used in the production of exportable goods.

Based on the above general result, the paper also analyzes some specific cases such as the following ones–al shown in the appendix of the paper.

Remark 1 (Imports as production inputs)
The use of good M as a production input, and not only as a consumption good, does not alter the income-distribution of the terms-of-trade shift.

Remark 2 (Non-unitary demand elasticities)
The result of changes in factor earnings would change if consumption demands were not characterized by unitary elasticities. If, for instance, the demand for the non-traded good were highly income elastic, the spending share in that good would rise with higher export prices, which would tend to increase the earnings of the specific factor H. In such an economy, it would then be possible that, after a positive shock on the price of the agricultural good A, an "urban" factor could receive larger benefits in terms of income.

Remark 3 (Transitory non-neutralities)
In a multi-period setup, the dynamics of spending may cause differences between the "short" and "medium-run" impacts of a positive terms of trade shock on the economy. If, for instance, after an increase in the international price of good A there is a delay in the rise of domestic expenditures (in this context, if the higher export prices initially induce larger savings of agricultural producers, resulting in a trade surplus, until eventually the additional income gets reflected in domestic spending), the first effect on "urban" groups would take the form of a loss of purchasing power, as the agricultural consumption good becomes more expensive while incomes would not react. Thus, the result of neutrality of factor prices changes

would not hold in this case and, hence, it is more realistic to think about it as the equilibrium response to permanent than transitory changes in the terms of trade.

Remark 4 (Distributive effects with different factor intensities in the urban sectors) It is conceivable that in some primary-goods exporting economies, relative factor intensities in the "urban activities" are different from the configuration that we have considered before, and that services are more unskilled-labor intensive than manufacturing. In this case, it is factor H which faces a decline in its earnings in terms of the three goods, while the wage of L rise relative to the urban goods; those shifts in factor prices are associated with an increase in the relative price of N relative to M.

Remark 5 (Effects of terms of trade in an economy with manufacturing exports) Consider the case of an economy with different factor endowments (for example, with lower land-labor ratio) which, given factor intensities as before, exports good M and imports A. It is straightforward to show that if the economy experiences a positive terms of trade shock (in this case $\hat{p}_M > 0$, $\hat{p}_A = 0$), then skilled-labor (or physical capital) increases its income unambiguously, land decreases its income unambiguously, and unskilled-labor increases its relative income provided that agricultural goods represent a sufficiently high share in its consumption basket relative to manufactures; decreases otherwise Clearly, the results are reversed if the terms of trade shock is negative (i.e. $\hat{p}_M = 0$, $\hat{p}_A > 0$, as in the previous cases).

For a simplified, two-good economy (agricultural and non-tradable goods only), it shows:

Remark 6 (Effects of heterogeneous consumption baskets with homothetic preferences) The analysis above assumed the existence of a representative agent with preferences over goods that can be characterized using a homothetic utility function. Heterogeneity in the consumption baskets among individuals, maintaining the assumption of homotheticity, does not affect the important result of neutrality of factor prices changes -i.e., factor prices still would change in proportion to the positive terms of trade shock. However, it does affect the welfare implications of the shift in international prices. For example, assuming that individual agents own a single factor of production, and that they have Cobb–Douglas preferences which are identical within groups but differ across them (so that utility parameters and spending shares are γ_j^i, $j = A,N,M$, $i = t,w,h$), the change in the value of consumption of the various goods will be determined by the aggregate expenditure functions:

$$\hat{p}_j + \hat{c}_j = \gamma_j^t \hat{t} + \gamma_j^w \hat{w} + \gamma_j^h \hat{h}, \quad j = A,N,M \tag{A.16}$$

It can readily be seen that the equal proportional changes in all factor earnings also applies in this instance: $\hat{t} = \hat{w} = \hat{h} = \hat{p}_A = \hat{p}_N$. Consequently, the welfare of all agents would still increase with an improvement of the international terms of trade. Nevertheless, the existence of differentiated consumption baskets means that agents with consumption preferences biased towards good M (i.e. higher γ_M^I for $I = w, h, t$) would benefit relatively more.

Remark 7 (Terms-of-trade improvement: real appreciation, but no “Dutch disease")
An increase in the international price of good A implies an unambiguous rise in the price of the non-traded good relative to an index of the consumer prices of traded goods:

$$\hat{e} = \gamma_A \hat{p}_A + \gamma_M \hat{p}_M - \hat{p}_N = -(1-\gamma_A)\hat{p}_A < 0 \tag{A.17}$$

Thus, the improvement of the terms of trade brings about an appreciation of the real exchange rate (e). However, in this economy there is no import competing sector that may be affected by a “Dutch disease". Given the structure of economy, all groups benefit or loose together according to the evolution of international relative prices.

Remark 8 (Economy with sector-specific factors)
The intuition of the mechanisms in operation can be shown sharply by considering an economy where there is a one-to-one correspondence between sectors and production factors. In this case we assume that each of the three sectors uses a different specific factor. In particular, we assume that agriculture, manufactures and services use only land, unskilled labor and skilled labor, respectively. Thus, in this simplified economy $\theta_{LA} = \theta_{HM} = \theta_{LN} = 0$, and cost-price equalities reduce to:

$$\hat{p}_A = \hat{t} \quad , \quad \hat{p}_M = 0 = \hat{w} \quad , \quad \hat{p}_N = \hat{h} \tag{A.18}$$

Since, by construction, there is no factor substitutability:

$$\hat{y}_A = \hat{y}_M = \hat{y}_N = 0 \tag{A.19}$$

The balance of payments and the demand conditions simplify to:

$$\gamma_A(\hat{p}_A + \hat{c}_A) + \gamma_M \hat{c}_M = \chi_A \hat{p}_A = \hat{p}_N + \hat{c}_N = \hat{p}_N \tag{A.20}$$

Aggregate consumption of traded goods varies according to:

$$\gamma_A \hat{c}_A + \gamma_M \hat{c}_M = (\chi_A - \gamma_A)\hat{p}_A$$

Thus, the outcomes can be summarized as follows:

- A higher price of good A raises the consumption of the imported good while the consumption of A declines. The aggregate volume of consumption moves together with the terms-of-trade effect. An improvement in the terms of trade (i.e. an increase in p_A if A is the exported good, so that $\chi_A - \gamma_A > 0$) increases the volume of goods consumed.

- For a given production structure, the magnitude of the change in the consumption index (an indicator of welfare) would be larger the smaller is the weight of the exported good in the consumption basket. If, in particular, the economy exports a good that is not consumed domestically, as could be the case of some countries specializing in minerals ($\gamma_A \to 0$), higher international prices of that commodity would raise domestic incomes without the counterpart of a direct impact in consumer prices.

- In any case, the factor of production used in the production of manufactures, unskilled labor, reduces its purchasing power in terms of the two other goods, A and N.

- The agricultural factor of production maintains its earnings in terms of good A, and gains purchasing power relative to the other goods.

- The income of the factor of production used in the non-traded sector, H, increases relative to M but decreases in terms of A. The net change on the "real" purchasing power of that income is, in principle, ambiguous, and turns out to depend on the terms-of-trade effect. The consumption-weighted price index, p, is given by:

$$\hat{p} = \gamma_A' \hat{p}_A + \gamma_N' \hat{p}_N = (\gamma_A' + \gamma_N' \chi_A) \hat{p}_A \tag{A.21}$$

  where $\gamma_i' = \gamma_i/(1+\gamma_N)$ stands for the expenditure share of good i, being γ the coefficients of the utility function as defined before. Thus, the purchasing power of factor H increases when p_A rises if and only if the agricultural good is exported ($\chi_A - \gamma_A > 0$). This also implies that the relative price of the non-traded good increases (a measure of "real appreciation").

$$\hat{h} - \hat{p} = \hat{p}_N - \hat{p} = (1 - \gamma_N')(\chi_A - \gamma_A) \hat{p}_A \tag{A.22}$$

Clearly, a higher price of good A benefits the specific factor used in its production, and reduces the real income of the producers of good M, whose international relative price has decreased. The non-traded sector is, naturally, in an intermediate situation. The demand for its output increases due to the higher income of the producers in sector A, but the factors used in sector M contract their volume of spending (as their expenditures remain constant in terms of M when other prices have increased). In the two-sectors case, this offsetting effect of the lower real incomes of the producers in sector M is absent; therefore, the earnings generated in the non-traded sector rise in proportion to the price of good A. Here, the increase is less than proportional. If the terms-of-trade effect is positive, that is, if good A has more weight in production than as a consumption good (or, alternatively, if sector A is quantitatively more important in generating income than in absorbing expenditures), the real earnings in sector N improve with the shift in international prices.

The case with specific factors can be seen as a representation of the consequences of the terms-of-trade shift after the transmission to the activities producing for the domestic market of the effects on spending of the income changes in traded sectors, but before factor and output reallocations have taken place. These reallocations establish the difference between this case and the case with factor mobility analyzed before. Assuming mobility, sector A attracts more resources (labor), which increases output and productivity of the specific factor in that sector. This amplifies the effect of earnings of factor T, which improve also in terms of the higher-priced good A. Factor L perceives an additional demand in the expanding sector A which, by itself, tends to raise its income in terms of the other traded good, M. However, at the same time, sector M faces competition for productive resources from the non-traded activities. The consequences on factor earnings depend on the factor intensities in the "urban" industries M and N. If, as assumed above, sector N uses intensively skilled labor (H), it would demand comparatively more of that factor, while the contraction of sector M would predominantly liberate labor L. Therefore, if the demand for L from the agricultural sector is not strong, the wages of labor will decline while, at the same time, the factors used intensively in the production of non-traded goods would gain from the reallocation. The pull of resources by the non-traded sector away from the import-competing activity, which hurts the factors used intensively in this industry, can be interpreted as a symptom of "Dutch disease." In any case, it seems clear that international shocks that on average would increase the real income of agents in an economy, may also induce redistributive effects such that significant segments of the population see their welfare reduced. Policy interventions with redistributive aims can of course take very different forms; however, distributive considerations seem to have played an important role in some countries' trade policies. In the following section we briefly address some aspects of this matter.

Remark 9 (Distributive effects of international transfers)
Given the relative price of traded goods, a relaxation of the "external constraint," by itself,

would tend to redistribute income towards the factor used intensively in the non-traded sector. In this particular context, consider a "transfer problem" à la Ohlin–Keynes (see the 1936 discussion), where the economy receives, as a lump-sum, a certain amount of tradable resources. It can then be shown that in the two-good economy

$$\hat{h} > \hat{p}_N > \hat{w} > 0 > \hat{t}. \tag{A.23}$$

Thus, the transfer would reduce the real income of the factor specific to the export-oriented activity. However, in the three-good economy the factor with intensive use in the import-competing sector (rather than factor T, specific to the export sector) which experiences the strongest distributive loss.

Figure A.1. Regression Results