SOUTH AMERICAN FREE TRADE

AND INCOME REDISTRIBUTION IN BOLIVIA

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October 1999

The pending merger between the Andean Market and Mercosur will move South America farther toward becoming a free trade area. Each member country will have to adjust to liberalization, and the various sectors of each economy will be affected differently. The present paper uses a specific factor model of production to examine the income redistribution and output changes that will occur in Bolivia with projected price changes in a South American free trade area.

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An underlying lesson of factor proportions trade theory is that some factors of production will gain but others will lose with the price changes that occur due to free trade. Bolivia is a small economy that will face international prices with the move to free trade in South America. Outputs will adjust along Bolivia's production frontier, and income will be redistributed toward factors abundant and cheap relative to trading partners.

The present paper examines this income redistribution and output adjustment in a specific factor model of Bolivia. Thompson (199) develops a similar specific factor model of the Japanese economy, and Thompson (199) examines the effects of NAFTA in a specific factor model of Alabama.

Free trade will eliminate Bolivia's tariffs on agricultural imports from Brazil and Argentina, the low cost agricultural producers in South America. On the other hand, Bolivia's exports of minerals and natural gas are projected to rise with regional free trade, and increased exports are projected in light manufacturing and apparel. The Bolivian government started

privatization of state enterprises in 1996, selling half ownership and transferring control. Prices of telecommunication and banking services have fallen, and increasing efficiency should continue in the free trade regime.

The model in the present paper uses Cobb-Douglas and constant elasticity production to build a specific factor model based on factor shares and industry shares. There are five sectors in the model: agriculture, minerals, natural gas, manufacturing, and services. Skilled and unskilled labor are shared inputs in the five sectors, and capital is specific to each sector. The effects of free trade and projected price changes on factor prices and outputs are examined.

1. Factor Shares and Industry Shares

Table 1 reports the total payment matrix in domestic currency for each of the seven factors of production: skilled labor S, unskilled labor U, and capital K_j in agriculture A, mining M, natural gas G, manufacturing F, and services V. The capital payment is derived as the residual after payment to labor.

Factor shares in Table 2 represent the share of each factor in the revenue of each sector. Summing down a column in Table 1 gives total

revenue of the sector. For instance, the total revenue of agriculture in Bolivia is 3,052 million bolivianos, and the share of skilled labor is 96/3,052 = 0.031 = 3.1%. Agricultural land is implicitly in the capital residual. Note there is a zero share of each type of capital in every other sector, but Table 2 is compressed to a single row of capital shares.

Summing across a row in Table 1 gives the total income of that factor. Assuming perfect labor mobility between sectors, the factor price would be the same across sectors. The industry share of each factor represents its portion employed in each sector. For instance, the total income of skilled labor is 4,257 million bolivianos, and 96/4,257 = 0.022 = 2.2% of this total income is earned in agriculture. Assuming equal skilled wages across sectors, 2.2% of the skilled workers in Bolivia would be in agriculture. Industry shares for labor are presented in Table 3. The share of each type of capital in its sector is 1, and in all other sectors 0.

Factor intensities are presented in Table 4. Agriculture uses skilled labor the least intensively, by far, relative to both unskilled labor and capital. Each sector uses its own specific capital in the model, and capital intensity refers to that specific capital. The service sector uses skilled labor the most intensively relative to both other inputs. For unskilled labor, the reverse is

true. Agriculture uses unskilled labor most intensively, while services use unskilled labor the least intensively.

Mining, natural gas, and manufacturing are similar in their factor intensities. Among these three, mining has the lowest intensity of skilled labor relative to unskilled labor. Manufacturing uses skilled labor slightly more intensively than mining and natural gas. Natural gas is slightly more capital intensive than the other two.

2. A Specific Factor Model of Production and Trade

Substitution elasticities for the general equilibrium model describe the change in the cost minimizing input of one factor given a change in the price of another, as developed by Jones (1965) and Takayama (1982). Following Allen (1938), the cross price elasticity between the input of factor *i* and the payment to factor *k* in sector *j* is written

$$E_{ij}^{k} = \hat{a}_{ij} / \hat{w}_k = \theta_{kj} S_{ij}^{k}, \qquad (1)$$

where ^ represents percentage change in a variable, and S_{ij}^{k} is the Allen partial elasticity of substitution. Cobb-Douglas production functions imply $S_{ij}^{k} = 1$. With constant elasticity of substitution (CES) production, the Allen

partial elasticity can have any positive value. Assuming linear homogeneity, $\Sigma_k E_{ij}^k = 0$, and the own price elasticity E_{ij}^i is derived as the negative of the sum of cross price elasticities.

Substitution elasticities are the weighted average of cross price elasticities for each sector,

$$\sigma_{ik} \equiv \hat{a}_i / \hat{w}_k = \Sigma_j \lambda_{ij} E_{ij}^k = \Sigma_j \lambda_{ij} \theta_{kj} S_{ij}^k . \quad (2)$$

Factor shares and industry shares are used to derive the elasticities of substitution in Table 5. The subscripts *A, M, G, F,* and *V* refer to sector specific capital. The largest own substitution elasticity occurs for unskilled labor, and the smallest for agricultural capital. The own labor substitution elasticities are larger than the own capital elasticities. Skilled and unskilled labor are about equal substitutes. The most inelastic input is skilled labor, except in services. Each industry is relatively insensitive to the price of capital, with higher wages inducing more of a shift toward capital input than vice versa.

With constant elasticity of substitution (CES) production, the elasticities in Table 5 would be scaled accordingly. With CES of 0.5, the elasticities are all half as large. With CES of 2, they are twice as large.

Competitive pricing and full employment can be stated

$$\Sigma j\, akj\, x\, j = V\, k\,, \tag{3}$$

$$\Sigma_i\ a_{im}\ w_i\ =\ p_m\,, \tag{4}$$

where a_{ij} is the cost minimizing input of factor i in sector j, x_j is the output of good j, v_k is the endowment of factor k, w_i is the price of factor i, and p_m is the price of good m. Fully differentiate (3) and (4) to find

$$\begin{bmatrix} \sigma & \lambda \\ \theta' & 0 \end{bmatrix} \begin{bmatrix} \hat{w} \\ \hat{x} \end{bmatrix} = \begin{bmatrix} \hat{v} \\ \hat{p} \end{bmatrix} \tag{5}$$

where σ is the 7x7 matrix of substitution elasticities, λ is the 7x5 matrix of industry shares, and θ is the 5x7 matrix of factor shares. The inverse of the 12x12 matrix in (5) is to relates exogenous price changes to endogenous factor prices and output. Comparative static elasticities w/p and x/p are found by inverting (5).

Outputs and factor prices adjust to maintain full employment and competitive pricing in the comparative statics of the model. Endowments are held constant throughout the exercise. The effects of a predicted vector of price changes are also derived.

3. Comparative Static Elasticities in the Model

Table 6 shows elasticities of factor prices with respect to prices of goods in the general equilibrium comparative statics. The largest elastic effects occur for capital, and the smallest effects for skilled labor. Natural gas prices have very small effects on factor markets other than capital in the gas sector. Service prices have the largest impacts on factor markets.

As an example, a 10% decrease in agricultural prices would raise the wage of skilled labor by 0.7%, but unskilled labor would suffer a 3.7% wage decrease. Payment to capital in agriculture would fall by 15.7%, a significant impact for capital (and land) owners. The lower price of agricultural goods would release unskilled labor from the sector. Movement of labor to the other sectors causes those capital returns to rise. The increase in skilled wages can be explained by a relative increase in the demand for skilled labor as agricultural output declines. Agriculture uses skilled labor the least intensively.

Every 1% increase in the price of minerals would increase the wage of skilled labor by 0.08% and the wage of unskilled labor by 0.17%, while mineral capital benefits with a 2.02% increase in return. Both skilled and

unskilled labor benefit with a higher price of minerals, which is true in every sector except agriculture. For natural gas, results are very similar to mining.

Effects of changing prices for manufacturing and services are similarly analyzed. A higher price, *ceteris paribus*, increases the return to capital in that sector but lowers the capital return in other sectors. While some factors benefit and others lose with any price change, the benefits are uneven. Price changes affect the payment to sector specific capital more than shared labor.

The comparative elasticities in Table 6 extend to all CES production functions, regardless of the degree of substitution. Thompson and Toledo (1999) prove the effects of prices on factor prices are the same for all CES production functions. The degree of substitution, as long as it is constant along the isoquants, does not affect *w/p* elasticities in these competitive general equilibrium models of production.

Table 7 shows the *x/p* output elasticities along the production frontier. A higher price raises output in a sector, drawing labor away from other sectors and lowering all other outputs. The largest own output effect occurs in mining, where every 1% increase in price raises output 1.03%. All other effects are inelastic, and the smallest effect occurs for services. The price of

services has the largest effects on other outputs, and natural gas prices have the smallest.

4. Projected Price Changes and Adjustment

Predicted changes with free trade in Bolivia include higher prices for minerals, natural gas, and manufacturing due to increased export demand. On the other hand, the agricultural and service sectors are expected to lose from free trade due to increased imports. Projected price changes from the Department of Analysis of Economic Policy (yr) and the Chamber of Agricultural Commerce (yr) are used in the present study. Agricultural prices are projected to fall by as much as 12%, and service prices are projected to fall 20%. Mineral prices are expected to increase 4%, natural gas prices 8%, and the price of manufactures 30%.

$$[N_{7x5}]\begin{bmatrix}\hat{p}_A\\ \hat{p}_M\\ \hat{p}_G\\ \hat{p}_F\\ \hat{p}_V\end{bmatrix}=\begin{bmatrix}\hat{w}_S\\ \hat{w}_U\\ \hat{w}_A\\ \hat{w}_M\\ \hat{w}_G\\ \hat{w}_F\\ \hat{w}_V\end{bmatrix}.$$

The vector of projected price changes is multiplied by the matrix of *w/p* elasticities in Table 6 to find the vector of predicted factor price changes,

Results are reported in Table 8. Skilled wages are projected to fall by 12.9% and unskilled wages by 4.7%, due mainly to the falling prices in services and agriculture. Other losers from free trade would be capital in services and agriculture, with declines of 29.8% and 17.7%. Free trade benefits capital in minerals, natural gas, and manufacturing by 18.3%, 24.5%, and 20.5% respectively.

The lower return to capital in agriculture suggests there will be secondary problems with the banking system in Bolivia. Agricultural loans represent about 10% of the loan portfolio of the banking industry. Lower revenue in agriculture increases the likelihood of loan defaults. With the large projected output changes, there will have to be sizeable adjustments in the banking sector. Low agricultural prices have forced many banks to reschedule loans with the agricultural sector, and the government is currently

negotiating with the IMF an additional $50 million to complete the rescheduling.

Effects of trade liberalization on output with Cobb-Douglas production are also in Table 8. The vector of changes is found by multiplying the x/p matrix by the p vector, similar to (6). Agricultural output is projected to fall by 5.7%, and service sector output by 9.8%. The output of minerals is expected to rise 14.3%, and natural gas 16.5%, both much larger than the projected price changes. Although the price of minerals is expected to rise only half as much as the price of natural gas, minerals output is projected to increase by almost the same percentage. Output in manufacturing is expected to increase by about the same percentage as natural gas and minerals.

These projected output adjustments are large. Revenue in agriculture will fall 17.7% due to lower prices and falling output. Agriculture is 40% of Bolivian exports. Projected changes in agriculture would lower the trade balance, but exports of natural gas and minerals are projected to rise. The share of manufactured goods in exports is small, and the effect of manufacturing output adjustment on the trade balance will be marginal.

Firms in the service sector might find it difficult to survive short of alliances with more multinational foreign firms.

To gain some insight into the sensitivity of the model, the results of a vector of more conservative price changes is reported in Table 9. Price changes in agriculture, manufacturing, and services are half the size of Table 8, and a smaller increase in the price of gas is also included. The resulting decline in skilled wages is about one quarter as large as with the larger price changes. Unskilled wages rise slightly. The effects on capital returns are similar but smaller than in Table 8. Output declines are larger in agriculture and services than in Table 8, and the output increase in manufacturing is larger. Mining and natural gas have much smaller output increases.

Table 10 shows the factor price and output adjustments with CES production. The factor price adjustments are large, and the output adjustments very large with CES = 2. These impacts on the Bolivian economy will require sizeable adjustments.

5. Conclusion

Neoclassical international trade theory emphasizes the gains in welfare due to free trade. Factor proportions trade theory breaks these gains

into the underlying income redistribution across factors. The present paper uses the specific factor model to examine the magnitude of income redistribution for skilled labor, unskilled labor, and capital in various sectors of the Bolivian economy due to free trade.

Bolivian agriculture and services are projected to suffer falling prices under the free trade agreement in South America. Minerals, natural gas, and manufacturing sectors in Bolivia are expected to enjoy higher prices. Projected output changes are quite large, ranging from an average decrease of perhaps 10% in services to increases of about 15% in minerals, natural gas, and manufacturing.

Projected factor price adjustments in Bolivia are also large. Wages would fall with free trade, and skilled wages would be the most exposed. The share of skilled labor in the economy is small except in services, which is projected to lose with free trade and import competition. The return to capital in manufacturing is projected to increase. Returns to capital in mining and natural gas should also increase considerably as those prices in those sectors rise. The return to capital in services will fall. In agriculture, the return to capital, including land, will fall.

This comparative static analysis holds endowments constant. If investment increases in an opening and increasingly competitive Bolivian economy, all factors could end up with higher productivity and higher factor prices. The general benefits of free trade have been documented in numerous economies around the world, and the present model is hardly an argument for trade restrictions. Nevertheless, it should be recognized that various sectors and factors of production stand to lose with the move to free trade. The projected effects in Bolivia are large. Recognizing this potential redistribution should help Bolivia in the political struggle toward free trade in South America.

References

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Table 1
Factor Payment Matrix, 1997
(In millions of bolivianos)

	A	M	G	F	V
S	96	413	160	844	2,744
U	1,321	622	225	1,025	1,181
Kj	1,635	865	374	1,618	3,806

Source: National Institute of Statistics, 1998

Table 2
Factor Shares, θ_{ij}

	A	M	G	F	V
S	0.031	0.217	0.210	0.242	0.355
U	0.433	0.327	0.296	0.294	0.153
Kj	0.536	0.456	0.494	0.464	0.492

Table 3
Industry Shares, λ_{ij}

	A	M	G	F	V
S	0.022	0.097	0.037	0.198	0.644
U	0.302	0.142	0.051	0.234	0.27

Table 4
Factor Intensities

	S/K_j	U/K_j	S/U
Agriculture	0.06	0.81	0.07
Mining	0.48	0.72	0.6
Natural Gas	0.43	0.60	0.71
Manufacturing	0.52	0.63	0.82
Services	0.72	0.31	2.32

Table 5
Cobb-Douglas Substitution Elasticities, σ_{ik}

	$\hat{w}_S$	$\hat{w}_U$	$\hat{w}_A$	$\hat{w}_M$	$\hat{w}_G$	$\hat{w}_F$	$\hat{w}_V$
$\hat{a}_S$	-0.69	0.21	0.01	0.04	0.02	0.09	0.32
$\hat{a}_U$	0.20	-0.70	0.16	0.06	0.03	0.11	0.13
$\hat{a}_A$	0.03	0.43	-0.46	0	0	0	0
$\hat{a}_M$	0.22	0.33	0	-0.54	0	0	0
$\hat{a}_G$	0.21	0.30	0	0	-0.51	0	0
$\hat{a}_F$	0.24	0.29	0	0	0	-0.54	0
$\hat{a}_V$	0.36	0.15	0	0	0	0	-0.51

Table 6
$\hat{w}/\hat{p}$ Elasticities

	$\hat{p}_A$	$\hat{p}_M$	$\hat{p}_G$	$\hat{p}_F$	$\hat{p}_V$
$\hat{w}_S$	-0.07	0.08	0.03	0.19	0.77
$\hat{w}_U$	0.37	0.17	0.06	0.26	0.14
$\hat{w}_A$	1.57	-0.14	-0.05	-0.22	-0.16
$\hat{w}_M$	-0.23	2.03	-0.05	-0.28	-0.46
$\hat{w}_G$	-0.19	-0.14	1.98	-0.24	-0.41
$\hat{w}_F$	-0.20	-0.15	-0.05	1.88	-0.49
$\hat{w}_V$	-0.06	-0.11	-0.04	-0.22	1.44

Table 7
$\hat{x}/\hat{p}$ Elasticities

	$\hat{p}_A$	$\hat{p}_M$	$\hat{p}_G$	$\hat{p}_F$	$\hat{p}_V$
$\hat{x}_A$	0.57	-0.14	-0.06	-0.22	-0.16
$\hat{x}_M$	-0.23	1.03	-0.05	-0.28	-0.46
$\hat{x}_G$	-0.19	-0.14	0.98	-0.24	-0.41
$\hat{x}_F$	-0.20	-0.15	-0.05	0.89	-0.49
$\hat{x}_V$	-0.06	-0.11	-0.04	-0.22	0.44

Table 8
Trade Liberalization, Cobb-Douglas

Prices		Factor Prices		Outputs	
$\hat{p}_A$	-12%	$\hat{w}_S$	-12.9%	$\hat{x}_A$	-5.7%
$\hat{p}_M$	4%	$\hat{w}_U$	-4.7%	$\hat{x}_M$	3.6%
$\hat{p}_G$	8%	$\hat{w}_A$	-17.7%	$\hat{x}_G$	5.3%
$\hat{p}_F$	30%	$\hat{w}_M$	18.3%	$\hat{x}_F$	18.8%
$\hat{p}_V$	-20%	$\hat{w}_G$	24.5%	$\hat{x}_V$	-7.6%
		$\hat{w}_F$	20.5%		
		$\hat{w}_V$	-29.8%		

Table 9
Trade Liberalization, Small Price Changes

Prices		Factor Prices		Outputs	
$\hat{p}_A$	-6%	$\hat{w}_S$	-3.9%	$\hat{x}_A$	-5.9%
$\hat{p}_M$	4%	$\hat{w}_U$	1.1%	$\hat{x}_M$	5.8%
$\hat{p}_G$	2%	$\hat{w}_A$	-11.8%	$\hat{x}_G$	3.0%
$\hat{p}_F$	15%	$\hat{w}_M$	9.8%	$\hat{x}_F$	18.7%
$\hat{p}_V$	-10%	$\hat{w}_G$	5.0%	$\hat{x}_V$	-7.8%
		$\hat{w}_F$	33.6%		
		$\hat{w}_V$	-17.8%		

Table 10
Trade Liberalization, CES

Prices		Factor Prices		CES= .05		CES= 2	
$\hat{p}_A$	-15%	$\hat{w}_S$	-5.8%	$\hat{x}_A$	-11.8%	$\hat{x}_A$	-5.7%
$\hat{p}_M$	5%	$\hat{w}_U$	-0.9%	$\hat{x}_M$	9.4%	$\hat{x}_M$	3.6%
$\hat{p}_G$	10%	$\hat{w}_A$	-26.8%	$\hat{x}_G$	13.8%	$\hat{x}_G$	5.3%
$\hat{p}_F$	20%	$\hat{w}_M$	14.4%	$\hat{x}_F$	26.7%	$\hat{x}_F$	18.8%
$\hat{p}_V$	-15%	$\hat{w}_G$	23.2%	$\hat{x}_V$	-11%	$\hat{x}_V$	-7.6%
		$\hat{w}_F$	46.7%				
		$\hat{w}_V$	-25.9%				