Imperfect Labor Mobility, Urban Unemployment and Agricultural Trade Reform in Chile

David Holland
Washington State University

Eugenio Figueroa
Universidad de Chile and University of Alberta

Roberto Álvarez
Universidad de Chile

John Gilbert
Utah State University

A component of agricultural policy in Chile is the use of price bands to stabilize domestic price movements in selected agricultural crops and processed agricultural commodities. In the 1990s, the use of price bands for wheat, fats and oils, and sugar resulted in the equivalent of roughly a 22 percent tariff on these commodities. Depending on the result of pending discussions with the WTO following a complaint by Argentina and of ongoing discussions regarding Chile's participation in the North American Free Trade Agreement, constraints could be imposed on Chile's use of price bands to protect its agricultural economy.

The prospect of agricultural trade policy reform in Chile raises a number of related policy concerns. One of these is rural-urban income divergence, which remains at high levels. Rural wages are roughly one-third of the average wage in Chile's large cities (1996 Casen Survey). Carter (1997) notes the implications for political stability. Another

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consequence of income divergence is rural-urban migration (Harris and Todaro, 1970). Urban populations grew faster than rural populations throughout the 1990s. A closely related issue that became increasingly prominent in the recent economic slowdown is the emergence of high levels of urban unemployment.

A question of considerable interest, then, involves the effect that these developments might have on the economic analysis of the outcome of trade liberalization. Several recent applied general equilibrium studies undertake the quantitative modeling of the likely effect of Chilean trade liberalization (Harrison, Rutherford, and Tarr, 1997; Benjamin and Pogany, 1998). The existing literature, however, uses aggregated models of a strongly neoclassical flavor. As the preceding discussion indicates, the Chilean economy exhibits certain features closely associated with the development literature—namely, rural-urban migration, urban unemployment, and imperfect labor mobility. Since these economic features can have important consequences for the analysis of the effect of a number of different policies including trade reform, it seems appropriate to consider Chilean agricultural reform in the context of a model that incorporates them. That is task addressed in this paper.

The paper is organized as follows. In section 1 we briefly discuss the policy background. Section 2 uses a formal general equilibrium model to illustrate some important agricultural trade policy consequences of urban unemployment and imperfect labor mobility. This formal model also highlights the underlying structure of a large (fifty-sector) numerical general equilibrium model, which we describe in section 3. In section 4, we present the results of simulations designed to quantify the effects of removing the price bands in Chile under the assumption of dual labor markets with imperfect labor mobility, and we discuss policy implications. Accounting for the second-best implications of urban unemployment and limited labor mobility is shown to affect outcomes of agricultural reform. A key result is that removing price bands results in modest net welfare gains, but the welfare gains turn negative with a more comprehensive removal of all agricultural and food tariffs. This is a consequence of predicted increases in urban unemployment and declines in rural wages. Section 5 contains our concluding comments.

1. Policy Background

Overall economic growth in Chile has been very uneven, and the division between rural and urban economies remains significant. Many analysts note Chile's inability to integrate the poor rural regions with the rapidly growing industrial economy. Other researchers focus on the phenomenon of rural-urban migration in response to rural-urban income differentials. These differentials persist in the face of high rates of unemployment in Chile's major urban centers.

There is considerable debate over the importance of different factors as determinants of migration responses. The general economic framework postulates that migrants make rational economic choices, in which they consider the real income adjusted for the probability of obtaining employment at the destination and the costs of migration. Costs may include transportation, job search (expenses and opportunity cost), lodgings, and the like. They may include so-called upskilling costs, such as education and training necessary to obtain urban employment. They may also include less immediately obvious, but nonetheless real, opportunity costs such as giving up locational preferences and attachments to existing arrangements. These costs may be offset by chain effects—the availability of information through networks of previous migrants.

While labor migration may lead to a more efficient allocation of resources in a first-best framework, in a second-best framework, migration may worsen problems of urban congestion and unemployment, significant levels of which developed in urban Chile in the early 2000s. In Santiago, the rate of unemployment in 2001 was more than 10 percent.

Chile thus displays a number of important economic developments: high rates of urban unemployment; continuing flows of migrants from rural to urban areas in search of better income opportunities; and the attendant mix of urban congestion and poverty. Into this heady mix of domestic economic issues comes Chile's bid to join the North American Free Trade Agreement, which will clearly entail further reform of its external (trade) policy. The remainder of the paper explores the consequences of agricultural trade reform in Chile given the domestic problems of urban unemployment and rural-urban migration.

2. Theoretical Framework

To reinforce the structure of the numerical model we describe in section 3, we present a formal derivation of some key results concerning agricultural liberalization in a model with rural-urban migration, and we demonstrate how these may be altered by imperfect labor mobility. Consider a developing economy with distinct rural and urban regions. An industrial good, *X*, is produced in the urban region and exported. An agricultural good, *Y*, is produced in the rural region. Full employment of labor prevails in the rural region, but a rigid wage in the urban region creates unemployment. Following Harris and Todaro (1970), migration occurs between the two regions until the expected urban wage is equal to the actual rural wage. Capital is fully mobile. To keep things simple, world prices and factor endowments are exogenous. A compact algebraic description of the model is

$$c_X\left(\bar{w},r\right)=1\ , \tag{1}$$

$$c_Y\left(w,r\right)=p_Y\ , \tag{2}$$

$$w=\pi\bar{w}\ , \tag{3}$$

$$a_{XL}X+\pi a_{YL}Y=\pi\bar{L}\ , \tag{4}$$

$$a_{XK}X+a_{YK}Y=\bar{K}\ \text{, and} \tag{5}$$

$$G\left(p_Y,\bar{K},L_X,L_Y\right)+\left(p_Y-p_Y^*\right)M_Y=E\left(p_Y,u\right)\ . \tag{6}$$

Equations (1) and (2) are zero profit conditions (we chose p_x as numéraire), which can be solved for the factor prices. Once these are known, Shepherd's lemma enables us to derive the optimal input-output coefficients (a_{ij}). Equation (3), the Harris-Todaro labor market equilibrium condition, can be solved for the equilibrium rate of employment, π. Equations (4) and (5) are the factor market constraints, which can then be solved for output levels. Finally, equation (6) is the budget constraint expressed in terms of the gross national product (GNP) and expenditure functions, which can be solved for the welfare level. All the usual assumptions apply; production functions are homogeneous of degree one, continuous, and strictly concave; and the utility function is continuous, quasi-concave, and increasing in consumption of both goods. To guarantee stability, we assume that *X* is capital intensive (the Neary condition). Now, totally differentiating the budget constraint yields

$$dW=\left(p_Y-p_Y^*\right)dM_Y+\bar{w}dL_X+\pi\bar{w}dL_Y\ , \tag{7}$$

where $dW \equiv E_u du$, and an asterisk designates a world price. Following Corden and Findlay (1975), we define the total urban labor force as L_U, and then $dL_X = \pi dL_U + L_U d\pi$. Substituting into equation (7) we have

$$dW = \left(p_Y - p_Y^*\right) dM_Y + \bar{w} L_U d\pi \;, \tag{8}$$

where we have simplified by making use of the fact that $dL_U + dL_Y = 0$. The incremental change in welfare is thus the sum of a Harberger effect and the effect of changes in the probability of employment. As is well known, free trade is suboptimal, since $dW \neq 0$ when $p_Y = p_Y^*$ (only the first term drops out).

Let t be a tariff imposed on Y, such that $p_Y^*\left(1+t\right) = p_Y$. Using this and dividing both sides of equation (8) by dt, we have

$$\frac{dW}{dt} = tp_Y\left(\frac{dM_Y}{dt}\right) + \bar{w}L_U\left(\frac{d\pi}{dp_Y}\right)\left(\frac{dp_Y}{dt}\right), \tag{9}$$

which is the basic decomposition of the welfare effect of an agricultural import tariff. The first term reflects the deadweight loss, and it is negative. However, $dp_Y/dt = p_Y^* > 0$, and a sufficiently small tariff will thus raise social welfare if it raises the probability of employment.

By construction, factor prices are determined entirely by goods prices, and so logarithmically differentiating equations (1) and (2) and solving yields

$$\hat{w} = \frac{\hat{p}_Y \theta_{KX}}{\theta_{LY}\theta_{KX}} \;, \tag{10}$$

where a circumflex denotes a proportional change, θ_{ji} is the cost share of factor j in industry i, and

$$\hat{p}_Y = \left(\frac{p_Y^*}{p_Y}\right) dt > 0 \;.$$

It is clear from equation (1) that the return to capital is fixed. Now from equation (3), we know that $\hat{\pi} = \hat{w} - \hat{\bar{w}}$, and hence the probability of finding urban employment improves with a small tariff on Y. Reversing the arguments indicates that liberalizing agricultural trade may lower welfare.

The preceding analysis has cast the neoclassical Harris-Todaro model of the developing economy in a slightly different light, since the model is generally used to illustrate the negative welfare consequences of restricting imports of capital-intensive goods. Less frequently emphasized is the positive welfare effect of agricultural export subsidies, and the clearly implied (second-best) role for agricultural protection.

Three recent papers attempt to incorporate imperfect labor mobility into the Harris-Todaro framework (Parai and Beladi, 1997; Gilbert and Mikic, 1998; Gilbert and Wahl, 2001). The latter two introduce the concept of the elasticity of labor migration. Consider a situation in which there is a differential between the rural wage and the expected urban wage, ρ; hence equation (3) becomes $w = \pi\bar{w} - \rho$. The variable ρ is positive and may represent locational preferences, attachments to existing arrangements, a high cost of relocation, and the effect of a restrictive government policy, as discussed in section 1. The elasticity of labor migration can then be defined in a natural way as

$$\varepsilon = \frac{\hat{L}_U}{\hat{\rho}},$$

which is the proportional change in the total urban population induced per proportional change in the expected wage differential ($0 < \varepsilon < \infty$). All other equations remain unchanged, as does the fundamental welfare derivation for a tariff on Y, given equation (9). The proportional change in the probability of employment, however, is now

$$\hat{\pi} = \frac{\varepsilon w \hat{w} + \rho\left(\hat{a}_{XL} + \hat{X}\right)}{\varepsilon\pi\bar{w} + \rho}, \tag{11}$$

which is of ambiguous sign, in general.

A full analytical description of the properties of this model, while interesting, is beyond the scope of this paper. However,

$$\lim_{\varepsilon\to 0} \hat{\pi} = \hat{a}_{XL} + \hat{X},$$

which in the case of a tariff on Y (discussed above) can be shown to have negative welfare effects. Hence, the less labor movement is allowed, the greater is the potential for gains from agricultural liberalization. Moreover,

$$\lim_{\varepsilon \to \infty} \hat{\pi} = \left(\frac{w}{\pi \bar{w}} \right) \hat{w} \ ,$$

such that this model converges to the standard Harris-Todaro case. There is clearly also a critical value of ε (such that $\hat{\pi} = 0$) beyond which the model will behave in the same manner (qualitatively) as the standard Harris-Todaro model.

The intuition behind the result is quite straightforward. An agricultural tariff in the standard Harris-Todaro model draws labor and capital out of the urban region, but because agriculture is labor intensive, more labor is drawn than capital. The end result is an improvement in urban employment. In the limiting case of no labor migration, the rural wage rises as before and agricultural output expands, but now labor cannot move to fill the needs of agriculture. A reduction in production of *X* then leads to higher urban unemployment, and welfare subsequently declines. Hence, the degree of labor mobility, in addition to the prevalence of urban unemployment, become important variables when evaluating the consequences of agricultural trade liberalization in a developing economy.

3. An Applied General Equilibrium Model

The simplified framework described above, while helpful in formalizing the issues involved, makes a number of major abstractions in the interest of tractability. The most obvious include the dimensions of the model and the effect of other policy distortions on the equilibrium system, which can have important second-best implications. While it is difficult if not impossible to take all of these factors into account within the constraints of an abstract formal model, an applied general equilibrium (AGE, also known as computable general equilibrium, or CGE) model is well suited to the task. Such models take data from an actual economy or set of economies and combine them with a structural description of the behavior of agents within the system and the constraints that they face. The system can then be solved numerically, and the effect of policy interventions can be quantitatively examined within a consistent framework that accounts for important market interrelationships.

In this section we describe an applied counterpart to the formal model analyzed above. Our notation uses the Greek alphabet to denote free and calibrated parameters, lower case letters to denote policy variables, and bars to denote those variables fixed by the closure assumptions. The sets used are as follows: g represents agents; sectors are defined as $i(j) \subset g$; urban sectors are $u \subset i$; endowment commodities are f, and underemployed endowments are $m \subset f$. Full definitions are presented in the appendix. The basic structure is the well-established single-country Armington trade model.[1]

The production block consists of a set of constant elasticity of substitution (CES) production functions, with intermediates used in fixed proportions:

$$Q_i = \frac{\alpha_i^Q}{1-\sum_j a_{ji}} \left(\sum_f \theta_{fi}^Q FD_{fi}^{-\rho_i^Q} \right)^{-1/\rho_i^Q} . \tag{12}$$

Equation (13) represents the corresponding demand functions for primary factors. A subset of factors have prices fixed exogenously in a subset of sectors, corresponding to the rigid urban wages of the Harris-Todaro specification:[2]

$$PF_{fi} = PN_i \left(\frac{\alpha_i^Q}{1-\sum_j a_{ij}} \right) \left(\sum_f \theta_{fi}^Q FD_{fi}^{-\rho_i^Q} \right)^{-1/\rho_i^Q - 1} \theta_{fi}^Q FD_{fi}^{-\rho_i^Q - 1} , \tag{13}$$

where $PF_{mu} = \overline{\mathrm{PF}}_{mu}$ and $PF_{fi} = PF_f$, with $f \not\in m$. This implies unemployment of that subset of factors, with the rate of employment defined by equation (14)

$$ER_m = \frac{\sum_i FD_{mi}}{\sum_i FD_{mi} + UN_m} . \tag{14}$$

1. We present only brief details of the Armington trade model. For a full description, see, for example, Devarajan and Lewis (1990).

2. There is no government-imposed wage floor in Chile, so our characterization of unemployment as arising from downward inflexible wages is a simplification. Other explanations (such as search costs) are plausible. Furthermore, labor classified as unemployed in this model does not contribute to net social welfare, whereas in reality these workers are likely to be involved in the informal sector (although their marginal productivity may well be very low). For both of these reasons, our model probably presents what can be interpreted as worst-case scenarios for unemployment.

Equation (15) specifies our modified Harris-Todaro factor market equilibrium conditions:

$$PF_{mi} = ER_m \overline{PF}_{mu} - COST_m \ , \tag{15}$$

where $i \notin u$. Equation (16) introduces an inelastic migration response, as in our simplified model above:[3]

$$\sum_u FD_{mu} + UN_m = \alpha_m^M COST_m^{\varepsilon_M} \ . \tag{16}$$

Finally, equation (17) defines the factor market constraints:

$$\sum_i FD_{fi} = \overline{END}_f - UN_f \ . \tag{17}$$

The demand block consists of two levels. At the first level, households maximize a Stone-Geary linear expenditure system (LES), the objective function of which is equation (19), subject to their income as defined in equation (18). At the second level, the household optimizes domestic and imported goods (see equation 24).

$$\begin{aligned} NDI = {} & \sum_i Q_i PN_i + \sum_i tm_i \overline{PWM}_i \sum_g M_{ig} \overline{XR} + \sum_i tx_i PD_i X_i \\ & - \sum_i ty_i PD_i Q_i - \sum_{ig} C_{ig} P_{ig} - \overline{CA} \cdot \overline{XR} \ , \end{aligned} \tag{18}$$

where g represents the government or investors as appropriate, and

$$U = \alpha \prod_i \left(C_{ig} - \lambda_i \right)^{\theta_i^C} \ , \tag{19}$$

where g represents households. Equation (20) defines the corresponding household demand functions:

$$C_{ig} = \lambda_i + \left(\frac{\theta_i^C}{P_{ig}} \right) \left(NDI - \sum_j \lambda_j P_{jg} \right) , \tag{20}$$

where g represents households.

3. The Harris-Todaro specification of labor market equilibrium is often interpreted as implying a competitive auction in each period, with each worker having an equal chance of obtaining employment. As in all models, this is a stylized description—we interpret equation (16) only as meaning that once the dust has settled, any new equilibrium will have the familiar Harris-Todaro characteristics.

Firms demand final goods in fixed proportions to their output:

$$C_{ij} = \sum_j a_{ij} Q_j \ . \tag{21}$$

Final demands for government consumption and investment are fixed in quantity terms by equations (22) and (23):

$$C_{ig} = \bar{G}_i \ , \tag{22}$$

where g represents the government, and

$$C_{ig} = \bar{I}_i \ , \tag{23}$$

where g represents investors.

Having allocated their expenditure across the commodities, all agents then choose the optimal combination of imports and domestic production (the Armington composite). This is reflected in each agent's demands for domestic production (equation 24) and imports (equation 25).[4] The introduction of product differentiation via this mechanism is the major departure of the model from models of standard trade theory.

$$D_{ig} = \frac{\alpha_{ig}^{A\,-1}\left[PD_i \big/ \left(1-\theta_{ig}^A\right)\right]^{\sigma_i^A} C_{ig}}{\left[\theta_{ig}^A \left(PM_i \big/ \theta_{ig}^A\right)^{\sigma_i^A \cdot \rho_i^A} + \left(1-\theta_{ig}^A\right)\left[PD_i \big/ \left(1-\theta_{ig}^A\right)\right]^{\sigma_i^A \cdot \rho_i^A}\right]^{-1/\rho_i^A}} \tag{24}$$

and

$$M_{ig} = \left(\frac{\theta_{ig}^A}{1-\theta_{ig}^A}\right)^{\sigma_i^A} \left(\frac{PD_i}{PM_i}\right)^{\sigma_i^A} D_{ig} \ . \tag{25}$$

Equations (26) through (30) describe the price equations of the model, and they have straightforward interpretations. Equation (28) defines the price of a composite of imports and domestic production; it is derived from the assumption of CES Armington aggregation. Similarly, we use constant elasticity of demand (CED) functions to describe how world prices respond to changes in the trade volume (equation 30). Equation (29) defines net prices. The nominal exchange rate is the chosen numéraire for the system (all prices in the model are relative prices).

4. Allowing each agent to independently make import decisions along Armington lines is known as the SALTER specification.

$$PM_i = \overline{PWM}_i(1+tm_i)\overline{XR} \;, \tag{26}$$

$$PD_i = \frac{PWX_i \overline{XR}}{1+tx_i} \;, \tag{27}$$

$$P_{ig} = \alpha_{ig}^{A\;-1}\left[\theta_{ig}^{A\;\sigma_i^A} PM_i^{\left(1-\sigma_i^A\right)} + \left(1-\theta_{ig}^A\right)^{\sigma_i^A} PD_i^{\left(1-\sigma_i^A\right)}\right]^{1/\left(1-\sigma_i^A\right)} \;, \tag{28}$$

$$PN_i = PD_i\left(1+ty_i\right) - \sum\nolimits_{j=1}^{N} a_{ji} P_{ji} \;, \tag{29}$$

$$X_i = \alpha_i^X PWX_i^{\varepsilon_X} \;. \tag{30}$$

Lastly, we impose equilibrium conditions on the model. Equation (31) defines the familiar material balance conditions, and equation (32) the balance of trade. The current account balance is set exogenously. Since Walras Law implies the equilibrium conditions are not independent, any one of them can be dropped.

$$Q_i = X_i + \sum\nolimits_g D_{ig} \;, \tag{31}$$

$$\sum\nolimits_i \overline{PWM}_i \sum\nolimits_g M_{ig} + \overline{CA} = \sum\nolimits_i PWX_i X_i \;. \tag{32}$$

To summarize, the AGE model presented here incorporates the key features of our formal modeling: institutionally rigid urban wages and corresponding urban unemployment, rural-urban migration in response to expected wage differentials, and an imperfectly elastic migration response. It also makes a number of extensions. It can accommodate many endowment factors, each of which may be fully or partially employed, fully or partially mobile, or specific to a given economic activity. It can accommodate many sectors, each of which can be classified as rural or urban and traded or nontraded. The model incorporates product differentiation, thereby accommodating simultaneous export and import activities in the same sector and varying domestic versus import preferences among agents. Finally, the model incorporates a complete set of trade taxes and subsidies to ensure accounting for the second-best implications of policy interventions.

The GTAP4 database (McDougall, Elbehri, and Truong, 1998) is the primary source for the production, protection, and trade data used in the model, as well as for many of the free parameters.[5] The base year of the data is 1995. Although virtually all of the now-extensive applied general equilibrium literature based on the GTAP4 database employs the GTAP model described in Hertel (1997), or derivatives thereof, it is a straightforward procedure to extract the information necessary to construct a single-economy model such as that used here. Also, because we are using a single-country model, we are able to work at a much greater level of detail than most of the GTAP-based literature (we use fifty sectors, of which four are nontraded and forty-six are traded—the full GTAP4 disaggregation). Using the GTAP4 data ensures not only that our starting point is consistent with much of the existing research, but also that the data are widely available to other researchers who wish replicate our results.

We supplement the GTAP4 data with rural and urban labor force counts from the 1996 National Socioeconomic Survey (Casen) database, which we use to estimate rural and urban wages consistent with the GTAP4 payments data. Agricultural and resource-based industries (forestry, fishing, and mining), along with processing activities that are generally located close to a raw material source (food production, lumber production, and so forth) are assumed to be rural activities, while textiles, heavy manufactures, and services are classified as urban. In this model the urban region represents the cities of Santiago, Concepción, and Valparaíso. The rest of Chile is represented as rural. The initial (baseline) urban unemployment rate of 7.35 percent is from the Casen survey. The implied expected urban-rural wage differential in 1995 is nearly 200 percent (that is, the rural wage is just over one-third of the expected urban wage)—which reflects the substantial impediments to labor mobility that remain a feature of the Chilean economy. Since estimates of the elasticity of labor migration are not available, we use two limiting values: low (0.1) and high (10). The model is implemented in the General Algebraic Modeling System (GAMS) and solved in levels form. The following section presents the results of our policy simulations.

4. Results and Policy Implications

The results of the simulations are presented in tables 1 through 4. Table 1 summarizes the recent history of commodity price bands in

5. The calculation of model parameters is specified in GAMS code for the Chile model. The code and the model are available from the authors on request.

Chile in terms of tariff equivalents. Table 2 presents some important economywide summary statistics for the estimated effects of removing the agricultural price bands followed by estimated effects of removing all tariffs on agricultural and food commodities. The first column gives the estimated change in welfare, measured as the equivalent variation in millions of 1995 dollars. The second column is the estimated rate of urban employment (one minus the rate of urban employment gives the rate of urban unemployment). Finally, the third column gives the rural labor wage as a percentage of the urban labor wage. Table 3 presents estimated percent changes in baseline agricultural production, while table 4 presents the estimated percent changes in baseline agricultural imports. Changes in trade and quantity supplied occur in all other sectors, as well; we do not report those results in this paper, but they are available from the authors.

Table 1. Chile: Equivalent Total Tariffs for Products with Price Bands, 1990–1999
Percent

Year	*Wheat*	*Refined sugar*	*Coarse soja oil*
1990	53.7	6.1	25.4
1991	42.1	12.3	24.3
1992	19.7	21.5	29.0
1993	18.1	28.8	23.3
1994	15.3	12.3	6.0
1995	7.0	2.6	1.4
1996	5.3	16.5	15.2
1997	15.1	28.1	17.1
1998	47.1	49.0	6.1
1999	49.9	77.4	33.5

Source: Ministry of Agriculture, Office of Agrarian Policies and Studies (Odepa).

Table 2. Summary Statistics

Simulation	*Welfare change (millions of dollars)*	*Employment rate (percent)*	*Rural wage (percent of urban wage)*
Low Mobility			
Initial equilibrium	–	92.57	32.5995
Price band removal	6.28	92.63	32.5935
No agricultural tariff	–7.10	92.62	32.4339
High Mobility			
Initial equilibrium	–	92.66	32.5668
Price band removal	3.03	92.67	32.5777
No agricultural tariff	–17.73	92.56	32.4590

Source: Authors' calculations.

Table 3. Estimated Effects on Production of Key Agricultural/ Food Commodities

Commodity	Initial output value (millions of dollars)	Percent change in volume: Low mobility, No band	Low mobility, No tariff	High mobility, No band	High mobility, No tariff
Paddy rice	46	–3.33	–3.37	–3.34	–3.39
Wheat	971	–2.11	–2.44	–2.12	–2.48
Other grains	367	0.40	0.66	0.38	0.61
Vegetables and fruit	3,424	0.08	0.14	0.07	0.08
Oil seeds	37	–3.15	–3.17	–3.16	–3.22
Sugar cane and beets	344	–3.64	–3.73	–3.65	–3.77
Plant-based fibers	10	0.02	–2.08	–0.01	–2.13
Other crops	302	–0.01	–0.05	–0.02	–0.11
Cattle	712	0.07	–0.80	0.06	–0.84
Other agriculture	995	0.11	–0.29	0.10	–0.33
Raw milk	352	0.26	–2.09	0.26	–2.11
Meat from cattle	1,086	0.09	–0.98	0.07	–1.03
Other meat products	1,298	0.06	0.01	0.05	0.01
Vegetable oils	69	–19.06	–16.29	–19.07	–16.34
Dairy products	943	0.35	–2.95	0.35	–2.27
Processed rice	53	–7.76	–7.54	–7.77	–7.57
Sugar	436	–4.90	–5.07	–4.91	–5.11
Other food products	7,072	2.05	1.38	2.03	1.33
Beverages and tobacco	2,072	0.26	–1.85	0.24	–1.91

Source: Authors' calculations.

Consider first the effect of removing the price bands on wheat, fats and oils, and sugar. When labor movement is relatively inelastic, welfare is estimated to rise by just over $6.28 million. When a high level of labor mobility is assumed, the gains drop by over $3 million but are still positive. This result confirms the importance of the migration elasticity parameter. As our simple abstract model indicated would be the case, when labor is relatively immobile, the removal of price bands improves the urban unemployment problem. When labor is more mobile, however, price band removal leads to expanded migration to urban areas and thus to expanded urban unemployment relative to the low-mobility scenario. This has a detrimental effect on the net welfare gains from liberalization.

When labor is relatively immobile, price band removal improves urban unemployment because more capital than labor shifts to the

Table 4. Estimated Effects on Imports of Key Agricultural/Food Commodities

		Percent change in volume			
	Initial output value	*Low mobility*		*High mobility*	
Commodity	*(millions of dollars)*	*No band*	*No tariff*	*No band*	*No tariff*
Wheat	25	80.97	75.37	80.98	75.42
Other grains	93	2.07	–1.38	2.07	–1.38
Vegetables and fruit	50	1.17	9.23	1.17	9.25
Oil seeds	4	–21.69	7.08	–21.69	7.05
Sugar cane and beets	20	–17.45	–18.87	–17.44	–18.83
Plant-based fibers	62	–0.27	0.62	–0.27	0.59
Other crops	137	0.02	10.19	0.01	10.17
Cattle	9	–0.63	58.21	–0.60	58.38
Other agriculture	16	–0.31	36.77	–0.29	36.87
Meat from cattle	152	–0.08	13.92	–0.07	13.96
Other meat products	16	–0.38	27.31	–0.35	27.43
Vegetable oils	119	13.77	12.87	13.77	12.84
Dairy products	71	–1.49	53.40	–1.48	53.46
Processed rice	12	24.69	22.47	24.69	22.49
Sugar	38	69.26	66.26	69.28	66.33
Other food products	255	–1.89	38.43	–1.89	38.44
Beverages and tobacco	98	–0.64	61.96	–0.62	62.07

Source: Authors' calculations.

urban economy, and the increased capital allows more urban labor to be employed at the fixed wage. In the case of high mobility, the urban employment rate still goes up, and the rural wage goes up relative to the base line. This is because more of the rural labor force has moved to the urban labor force, allowing the rural wage to be bid up for the remaining labor. The welfare gain is lower in the case of high mobility, however, because of the increase in urban unemployment.

The estimated effect of the reform scenarios on Chile's pattern of food and agricultural production, as well as imports, is presented in tables 3 and 4.[6] Two main patterns emerge. First, removal of the price

6. The GTAP4 data (1995) on vegetable oils no longer represent the current situation in Chile. The data indicate a small domestic oil industry with small imports, but the domestic crushing industry has since disappeared, as has production of edible oil seeds, which have been replaced by imports of edible oil.

bands leads to substantial expansion of imports of the directly affected commodities, as we might expect. Second, the next-most-substantial changes in import volumes (which are negative) are for commodities that are inputs into the production of the directly affected commodities, such as sugar beets in the case of sugar. For example, the removal of the price band on sugar leads to an increase in sugar imports of 69 percent (table 4.) and a fall in sugar production of nearly 5 percent (table 3).[7] With reduced sugar production, the inputs into domestic sugar production—such as sugar beets—are likewise reduced (table 3).

In the case of a full removal of agricultural tariffs, the policy leads to a loss in welfare that increases as the elasticity of labor migration increases. The reduction in agricultural supply is more pronounced the more labor mobility is allowed (table 2). With high labor mobility, the urban employment rate falls relative to the baseline. The rural wage declines as capital and labor are drawn out of rural areas, reflecting the relative reduction in capital in the rural region resulting from increased international competition. The result is a falling employment rate in the urban area, increased unemployment in the urban area, and reduced wages in the rural area. While total returns to capital do increase, the harm inflicted on rural workers and the worsening of urban unemployment offset the efficiency gains from cheaper imports and result in a net welfare loss. In the case of low mobility, the loss in welfare stems mainly from the reduction in the rural wage relative to the urban wage. In this scenario, the urban employment rate manages to increase relative to the baseline, but urban unemployment increases and the overall change in welfare is negative.

The results of the model thus generate some valuable policy lessons. The most important point is that in a general equilibrium model that accounts for imperfect labor mobility and urban unemployment, the removal of the price bands on wheat, sugar, and fats and oils increases welfare, but the net effects of total agricultural tariff elimination are estimated to be negative. The elimination of all agricultural

7. The production functions used in the model assume quasi-concavity and continuity. The assumption of continuity becomes somewhat tenuous in a sector like sugar, which is characterized by only a few processing plants that require a minimum output level to remain viable. In this case, reduction of production below a given threshold would result in the collapse of the industry. From this point of view, our prediction of a 5 percent reduction in sugar production may be conservative and dependent on a continuity assumption that may not be true. Some observers of Chilean agriculture feel that the sugar industry would collapse completely without the protection of the price band.

and food tariffs generates sufficient urban unemployment so as to negate the positive welfare effect stemming from lower agricultural and food prices. Chile's labor policy needs to be closely coordinated with possible trade liberalization. If reform results in significant harm to the agricultural sectors increases in urban unemployment will mitigate the beneficial economic efficiency effects.

5. Concluding Comments

As in all economic models, the applied general equilibrium techniques used in this paper are based on a highly stylized structural framework, and this raises a number of issues. One problem with the approach used here is that it is difficult to separate rural and urban activities cleanly along sectoral lines. Another is that the single-country specification means we are unable to account for the effect of Chile gaining access to other markets or the effect of Chile's liberalization on other economies. With regard to the latter issue, several recent studies develop global general equilibrium models, so there is little need to add to that literature. Most of the gaps that remain to be filled involve Chile-specific issues, and more detailed single-country models are an appropriate analytical tool. With respect to the former, to paraphrase Whalley (1985), applied general equilibrium models increase the level of understanding of how institutions affect outcomes, tell a story that is consistent with a set of stylized facts, and provide a consistent framework for the policy debate. The results presented in this paper should be interpreted in this context.

Our findings also suggest that given the existence of urban unemployment and its second-best implications, policies harmful to agriculture and other rural-based industries should be approached with caution if they are likely to provoke worsening terms of trade for the rural sectors. The gains from lower natural resource prices are likely to be offset by worsening rural-urban income divergence and urban unemployment.

Finally, the analysis in this paper examines only the removal of agricultural and food product tariffs. More comprehensive trade liberalization would also remove existing export and output barriers, taxes, and subsidies—not only on agriculture, but also on other portions of the economy. It is quite possible that the net effect of complete liberalization would result in economywide adjustments that would substantially improve overall welfare, but that is another study.

APPENDIX
Notation Used in the Model

This appendix provides the full definition of all the variables and parameters used in the model presented in section 3 (equations (12) through 32). An asterisk at the end of the definition indicates parameters that are independent of the base year data (free) and are supplied independently; other parameters then follow by calibration.

Variables

PM_i	Importable price
PD_i	Domestic price
PWX_i	World price of exportables
P_{ig}	Domestic-import aggregate price
PN_i	Net prices
PF_f	Factor returns
Q_i	Gross output
FD_i	Factor demands
ER_f	Employment rate ($=1\ f \notin g$)
UN_f	Unemployment ($=0\ f \notin g$)
$COST_f$	Cost of migration ($=0\ f \notin g$)
U	Utility level
C_{ig}	Total agent consumption
NDI	Household income
M_{ig}	Imports
D_{ig}	Domestic demand
X_i	Exports

Parameters

a_{ij}	Input-output coefficients
$\overline{PWM}_i$	World price of importables
$\overline{END}_f$	Factor endowments
$\overline{PF}_g$	Institutionally rigid factor returns

$\overline{I}_i$	Investment
$\overline{G}_i$	Government expenditure
$\overline{CA}$	Current account balance
$\overline{XR}$	Exchange rate
tm_i	Import taxes/subsidies
tx_i	Export taxes/subsidies
ty_i	Output taxes/subsidies
α_i^Q	Production function shift
θ_{fi}^Q	Production function share
σ_i^Q	Production elasticity*
ρ_i^Q	$\left(1/\sigma_i^Q\right)-1$
α	Utility function shift
θ_i^C	Utility function share parameter
λ_i	Subsistence consumption level
α_{ig}^A	Armington shift parameter
θ_{ig}^A	Armington share
σ_i^A	Armington elasticity*
ρ_i^A	$(1/\sigma_i^A)-1$
α_i^X	Export demand shift
ε_i^X	Export demand elasticity*
α_g^M	Migration function shift
ε_f^M	Migration elasticity*

The following parameters do not appear in the model, but they are used in the calibration process of the Stone-Geary utility function (to determine the subsistence parameters). The Frisch parameter (minus the reciprocal of the marginal utility of income) scales the price elasticities.

η_i	Income elasticity of demand*
ϖ	Frisch parameter*

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