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Maize and the Free Trade Agreement
between Mexico and the United States

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Setting the price of maize in rural Mexico above the world price is inefficient and likely to have negative distributional effects because many subsistence producers, and all landless workers, are net buyers; in fact it screens out the relatively poor rather than the relatively rich. The policy objective, therefore, should be to move toward free trade. This would yield large gains in efficiency.

The Free Trade Agreement provides an ideal opportunity to pursue this objective. It will provide freer entrance into the United States for other agricultural products as well as a broad range of manufactured products. Insuring secure and sustained access for labor-intensive agricultural and manufactured products can help ease the impact on the labor market of a transition away from subsistence maize cultivation.

Maize is perhaps the single most important commodity in Mexico. In rural areas it is the main food consumed by farmers; in urban areas it is the main input into tortillas, a key component of urban workers' diets. Maize cultivation occupies between one-third and one-half of the country's arable land and employs one out of three rural workers. It is grown by a large number of small-scale producers on rain-fed land and by relatively fewer large-scale farmers on irrigated land. But because many small-scale producers, or subsistence farmers, have plots of very poor quality, maize is directly associated with rural poverty. In addition poverty in Mexico is to a large extent a rural phenomenon (Levy 1991).

Governments in Mexico have announced maize self-sufficiency as a national goal. Governments also have expressed their commitment to poor maize producers by subsidizing production. The process of land reform in Mexico gave farmers some land, but, as the extensive margin was exhausted, the quality of the land distributed diminished. Of the 43 million hectares distributed between 1958 and 1976, 91 percent were hillside, mountainous terrains; 8.4 percent were rain-fed land; and only 0.4 percent were irrigated land (Salinas 1990).

Raising the producer price of maize was one way to increase the value of the

asset distributed. Governments have also expressed their commitment to the poor by subsidizing maize consumption, although the system of support to consumers operates mostly in urban areas. Rural consumers obtain most of their maize at the producer price. Attempts are made to subsidize rural consumers through a network of Conasupo (the government's food marketing and distribution agency) stores, where maize is sold at a discount. But these subsidies are small and do not systematically reach rural consumers. Therefore, rather than referring to the consumer and producer prices of maize, we instead refer to the urban and rural prices of maize.

To accomplish its goals of maize self-sufficiency and support for poor maize producers, the government controls imports, and intervenes directly in marketing and distribution through Conasupo. These policies thus raise distributional issues between urban and rural areas, and within rural areas, because not all rural producers grow maize and only a subset of maize producers are net sellers. But because significant land and labor resources are allocated to this crop, maize policies also have important effects on efficiency.

The soon-to-be-negotiated Free Trade Agreement (FTA) between Mexico and the United States has placed maize at the forefront of policy debates in Mexico. Policymakers face a dilemma: continue present policies, or include maize in the FTA. This article analyzes maize pricing policies in Mexico and explicitly calculates the costs of keeping maize outside the FTA. We argue that efficiency and distributional gains can be made by liberalizing maize. For a general analysis of agricultural pricing in developing countries, see Sah and Stiglitz (1987); for analysis of individual countries, see, for example, Braverman, Hammer, and Gron (1987) for Cyprus and Newbery (1987) for the Republic of Korea.

I. A Framework for Analysis

We opt for a partial equilibrium approach mostly because of the forbidding data requirements for a full-fledged general equilibrium model. This is in the spirit of much recent work on taxation in developing countries (Newbery and Stern 1987; Newbery 1987). We show that the tools used in this approach are in fact quite flexible and easily adaptable to reflect much country-specific detail. Sah and Stiglitz (1987) use similar tools, but go quite far toward a general equilibrium analysis. Their focus on the consequences of rural-urban interaction on growth is different from ours, however.

Four groups are associated with maize in Mexico. First, small-scale producers consist of farmers with three hectares or less of rain-fed land, who derive their income partly from producing maize and partly from participating in the labor market; they consume a significant share of their own production. Second, landless rural workers derive their income from wages and at times compete with subsistence producers on the supply side of the rural labor market. Third, large-scale producers mostly own irrigated land, are net buyers of labor, and

derive their income from producing a wide variety of crops. Fourth, urban consumers comprise many groups with different income levels and expenditure patterns.
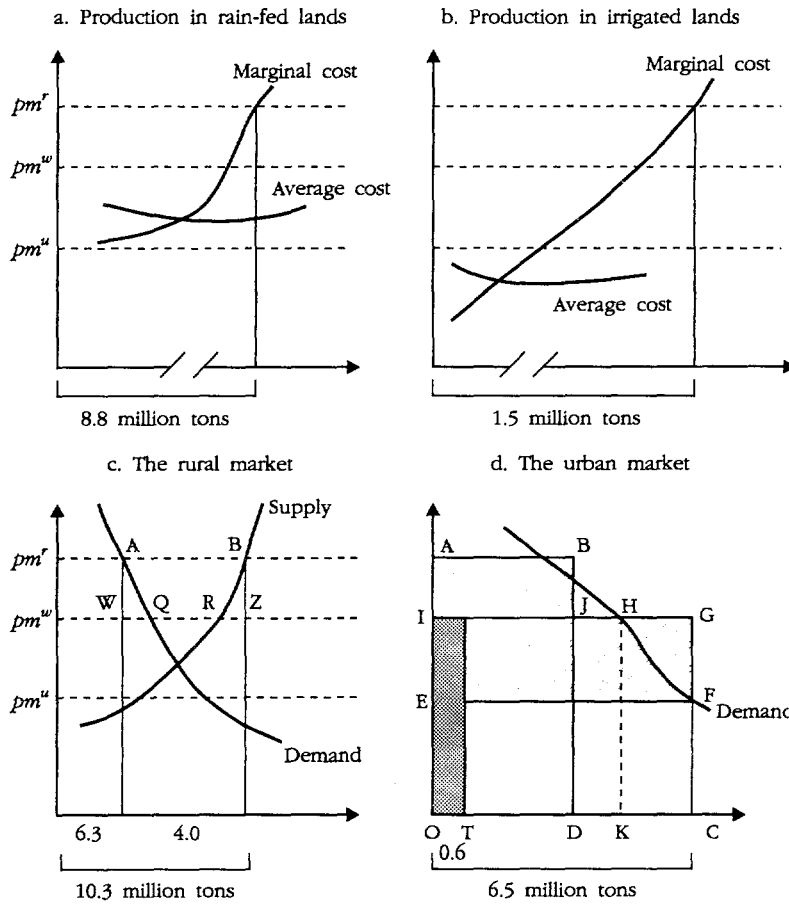
To evaluate maize policies, we distinguish between income changes incurred by individual groups and aggregate welfare. Calculations of aggregate welfare tell policymakers whether a particular policy needs to be changed; calculations of real income loss or gain per group indicate which groups might need assistance.

The Market for Maize

Maize pricing policies in 1989 fixed the rural price, p_m^r, above the world price, p_m^W, but set the urban price, p_m^u, below the world price. In this respect Mexico's policies differ from those of many other developing countries, where both the urban and rural prices of the key staple are below the world price, or those of middle-income countries like Korea, where the rural price of rice exceeds the urban price, but both exceed the world price (Newbery 1987). Figure 1 illustrates the 1989 interventions in the market for maize in Mexico. Panel a shows average and marginal cost curves for maize production on rain-fed land; panel b does the same for irrigated land. Average costs on rain-fed land are higher than on irrigated land. In addition, the supply curve of maize on irrigated land is more elastic, which reflects the fact that irrigated land gives greater crop choice to producers, thus resulting in higher cross-price elasticities of supply between maize and other crops. The rural maize market is depicted in panel c. The supply curve is obtained from the horizontal addition of the marginal cost curves of the two types of producers; the demand curve reflects own-consumption and other rural uses of maize (animal feed and seeds). At p_m^r the rural sector is a net exporter, in the amount AB. Increasing p_m^r above p_m^W gives rents to subsistence producers but gives larger inframarginal rents to large-scale producers on irrigated land. Panel d shows that at p_m^u urban demand for maize is OC. This is met by imports from rural areas in the amount AB (purchased by Conasupo at the price p_m^r), together with imports from abroad in the amount DC (purchased by Conasupo at the price p_m^W). Since urban consumers pay p_m^u for the full amount OC, this pricing-cum-import control scheme requires a subsidy given by the shaded areas of panel d, or the sum of rectangles AIJB and EFGI. Clearly, maize producers are subsidized, rural maize consumers are taxed, and urban maize consumers are subsidized. Rectangle EFGI is the subsidy received by urban consumers; rectangle AIJB is the subsidy received by rural producers.

The effects on imports and the fiscal balance of equating the rural and urban prices of maize to the world price are as follows. At p_m^W production by both types of producers declines, together with land rents. Rural consumption increases, which reduces net maize exports to the urban sector from AB to QR. But at p_m^W urban consumption falls from OC to OK. This partly reduces the increase in imports associated with lower domestic supply. In fact, it is conceivable that

Figure 1. *The Market for Maize in Mexico*

a. Production in rain-fed lands

b. Production in irrigated lands

c. The rural market

d. The urban market

imports could fall (if, say, rural maize demand is inelastic and urban consumption represents a large amount of total consumption). Eliminating subsidies generates fiscal savings measured by the shaded area of panel d.

Real Income Effects: Direct Price Effects

Consider a simple set-up where there are only three tradable products: maize, vegetables (a proxy for all other agricultural products), and manufactures (denoted by subscripts m, v, and q, respectively). Increasing the number of goods leaves the argument intact as long as their prices are not affected by changes in the price of maize, as is the case for tradable goods. Introducing nontradables complicates the argument because we need to incorporate the effect of changing maize prices on the price of the nontradable. But in Mexico maize accounts for less than 1 percent of gross national product, so even large changes in maize prices are unlikely to have an important effect on the price of nontradables.

To sharpen the argument, we also assume that rain-fed lands can produce only maize, while irrigated lands can also produce vegetables, and that all rain-fed lands are owned by subsistence producers and all irrigated lands are owned by large-scale producers. Let p_v and p_q be the prices of vegetables and manufactures, respectively, and let manufactures be the numeraire, so that $p_q = 1$. Prices of vegetables and manufactures are assumed to be the same in urban and rural areas. Abstracting from transport costs, this is a fair representation of Mexico, because there is no agency like Conasupo that explicitly intervenes to set a wedge between the two. Finally, let w^r be the rural wage rate. Consider now the income effects on each of the four groups mentioned above of removing production and consumption subsidies to maize.

Subsistence producers. Subsistence producers must allocate their total labor, $\bar{L}_p$ (where an overbar denotes an exogenous variable), between cultivating maize on their rain-fed land, L_m^{rf}, and participating in the labor market $(\bar{L}_p - L_m^{rf})$. Writing Q_m^{rf} for the quantity of maize produced by subsistence producers on rain-fed lands, and $E(\cdot)$ for the expenditure function, the budget constraint for subsistence producers is

$$(1) \qquad E(p_m^r, p_v, 1, U) = p_m^r \cdot Q_m^{rf}(L_m^{rf}) + w^r \cdot (\bar{L}_p - L_m^{rf})$$

where U is utility level. We ignore leisure, given the valuation difficulties in rural environments; see Braverman, Hammer, and Ahn (1987) for further discussion. Differentiating equation 1 with respect to the rural maize price, p_m^r, yields

$$(2) \quad E_{p_m^r} \cdot dp_m^r + E_U \cdot dU = p_m^r \cdot (dQ_m^{rf}/dp_m^r)dp_m^r + Q_m^{rf} \cdot dp_m^r +$$
$$(\bar{L}_p \cdot dw^r/dp_m^r - w^r \cdot dL_m^{rf}/dp_m^r - L_m^{rf} \cdot dw^r/dp_m^r)dp_m^r$$

where we use the fact that $dp_v/dp_m^r = 0$. Noting that $E_{p_m^r}$ is the compensated demand for maize, C_m, that at an optimal labor allocation $p_m^r \cdot \partial Q_m^{rf}/\partial L_m^{rf} = w^r$, and that $dQ_m^{rf}/dp_m^r = (\partial Q_m^{rf}/\partial L_m^{rf}) \cdot dL_m^{rf}/dp_m^r$, we can rearrange equation 2 to yield

$$(3) \qquad E_U \cdot dU = (Q_m^{rf} - C_m) \cdot dp_m^r + (\bar{L}_p - L_m^{rf})(dw^r/dp_m^r)dp_m^r.$$

E_U is the inverse of the marginal utility of income, so the left side of equation 3 provides a "money" measure of the change in real income associated with a small change in the rural maize price. Hence, equation 3 shows that changes in the rural maize price affect subsistence producers through two channels, which we label the direct price effect and the indirect wage rate effect (the first and second terms on the right side of equation 3, respectively). The direct price effect shows that without changes in the rural wage rate, the real income effect on subsistence producers of changes in the rural maize price depends only on their net maize position: subsistence producers who are net sellers (buyers) lose (gain) with a fall in the rural maize price. The indirect wage rate effect, however, shows that subsistence farmers gain (lose) on the amount of their marketed labor as the rural wage rate increases (decreases).

Labor allocated by subsistence producers to on-farm maize production is obtained by solving the equation $p_m^r \cdot \partial Q_m^{rf} / \partial L_m^{rf} - w^r = 0$. Let the solution be $L_m^{rf}(w^r, p_m^r)$, and note that $\partial L_m^{rf} / \partial p_m^r > 0$. Hence, reducing the rural maize price increases subsistence farmers' participation in the labor market. This increase in the rural labor supply causes a change in the rural wage rate, which in turn affects subsistence farmers by changing the income they receive on their marketed labor.

The term dw^r / dp_m^r captures this indirect effect. The direction of change in the wage rate, however, also depends on what happens to the demand for rural labor as the rural maize price falls. If $dw^r / dp_m^r > 0$ there are two effects. First, subsistence producers who are net sellers lose both because their marketed maize is worth less and because their marketed labor is worth less. Second, subsistence producers who are net buyers gain from lower maize prices because of the maize they buy, but lose from lower wages for their labor, so the impact on their real income is ambiguous. Conversely, if $dw^r / dp_m^r < 0$, subsistence producers who are net sellers face an ambiguous real income change (losing on their maize sold but gaining on their labor sold), and subsistence producers who are net buyers unambiguously gain (paying less for the maize they buy and getting more for the labor they sell).

Landless rural workers. By definition landless rural workers own no land; market all their labor, $\bar{L}_r$; and purchase all the maize they consume. The change in their real income is given by

$$(4) \qquad E_U \cdot dU = - C_m \cdot dp_m^r + \bar{L}_r \cdot (dw^r / dp_m^r) \cdot dp_m^r.$$

Clearly, the direct effect of lower maize prices is beneficial to landless rural workers. However, the indirect effect may hurt them if the rural wage rate falls as a result of the increased labor market participation by subsistence producers and if such a fall is large enough to eliminate the gains associated with a lower price for the maize they consume. When p_m^r falls the wage rate measured in terms of maize increases, but if $dw^r / dp_m^r > 0$ the wage rate in terms of manufactures decreases.

Large-scale farmers. We assume that large-scale farmers derive all their income from the (irrigated) land they own. Their problems are to allocate their total land, T, between maize and vegetables (T_m^i and T_v, respectively,) and to determine how much labor to employ in each crop (L_m^i and L_v). Hence, their budget constraint is

$$(5) \quad E(p_m^r, p_v, 1, U) = p_m^r \cdot Q_m^i(T_m^i, L_m^i) + p_v \cdot Q_v(T_v, L_v) - w^r \cdot (L_m^i + L_v)$$

where Q_m^i is maize output on irrigated land, and Q_v is vegetable output. Efficient allocation of land requires $dT_v / dp_m^r = - dT_m^i / dp_m^r$, given the land constraint $T = T_v + T_m^i$. Differentiating equation 5 and using this condition yields

$$(6) \qquad E_U \cdot dU = (Q_m^i - C_m) \cdot dp_m^r - (L_v + L_m^i) \cdot (dw^r / dp_m^r) \cdot dp_m^r.$$

Large-scale farmers certainly consume less maize than they produce. Hence, the direct price effect lowers their real income. The indirect wage rate effect again depends on the sign of dw^r/dp_m^r. If it is positive, large-scale producers gain because their total wage bill is less. If the wage fall is large enough, these gains can offset the loses on their marketed maize, thus implying that large-scale farmers may actually benefit from lower maize prices.

Urban consumers. The impact on the real income of urban workers is given by an expression similar to equation 4, except that the urban wage rate, w^u, and the urban price of maize are the relevant variables in this case. Since $p_m^u < p_m^W$, a full liberalization of the maize market would lower urban workers' real income. And urban workers could be affected through the indirect wage rate effect if rural employment contracts as a result of a large fall in the rural maize price and this, through migration, lowers the urban wage. Urban employers will also see their real income lowered when the urban maize price is increased through the direct price effect, although its significance is probably minimal because maize is relatively unimportant in their diets. However, to the extent that the indirect wage rate effect puts downward pressure on the urban wage rate through migration, the product wage in manufacturing falls, thus leading to an increase in employment and quasi-rents on the capital stock employed in manufacturing.

Real Income Effects: Indirect Wage Rate Effects

Lowering the rural price of maize increases participation by subsistence farmers in the rural labor market. But the resulting change in the rural wage rate also depends on the change in the demand for rural labor as the rural maize price falls and on the change in the size of the rural labor force resulting from migration to urban areas. In the appendix we discuss the relationship between urban and rural labor markets. Here we consider the isolated rural labor market described by the equilibrium condition in equation 7,

$$(7) \qquad (\bar{L}_p - L_m^{rf}) + \bar{L}_r = L_v + L_m^i + L_g.$$

The bracketed term on the left side of equation 7 is marketed labor by subsistence farmers, and $\bar{L}_r$ is marketed labor by landless rural workers. The right side is the demand for rural labor, made up of employment in vegetable and maize production on irrigated land and a term (L_g) that represents an exogenous component of rural labor demand (associated, say, with government infrastructure projects).

When the rural maize price falls, marketed labor supply of subsistence farmers increases, labor demand in irrigated maize falls, and labor demand in vegetables increases. Thus, the pressures on the rural wage rate hinge on:

$$(8) \qquad \left| \frac{\partial L_m^{rf}}{\partial p_m^r} + \frac{\partial L_m^i}{\partial p_m^r} \right| \underset{>}{<} \frac{\partial L_v}{\partial p_m^r}$$

that is, on whether the additional employment created in vegetable production

can absorb the employment displaced from maize cultivation. The appendix derives conditions that determine the direction of the inequality. Here we discuss the case where there is a net release of labor (the left side of expression 8 exceeds the right side); if this is not the case, the analysis needs to be modified accordingly.

Equilibrium in the rural labor market can be restored through different mechanisms. First, ignoring migration, the rural wage rate would fall, with employment increasing in both maize and vegetable production until excess labor disappears. Second, still ignoring migration, released labor could be absorbed through direct interventions like public work programs (increase L_g). Third, equilibrium can be restored through migration. If the only policy change is a decrease in the rural maize price, the labor released from maize would reduce the rural wage rate and widen the rural-urban wage differential. This would induce rural workers to migrate to urban areas, which would mitigate the decline in the rural wage rate but would lower the urban wage rate. A lower urban wage rate, in turn, increases employment and the marginal product of capital in manufacturing. A fourth possibility arises if the decrease in the rural maize price is accompanied by an increase in the urban maize price (as urban subsidies are eliminated). In this situation migration incentives are reduced because there are offsetting changes. The outcome in terms of migration and wage rate changes depends on the magnitude of the different effects. Clearly, however, policymakers can influence migration flows (and hence the changes in the rural and urban wage rates) through both direct interventions, which hire labor for rural public work programs, and the size of programs like the *tortibonos* in Mexico, which is targeted on the urban poor and operates through coupons.

Aggregate Social Welfare

In the rural sector we treat the difference between the rural and the world price of maize as an ad valorem tariff, denoted by t_T^r, so that $p_m^r = p_m^W(1 + t_T^r)$. It is convenient to take 1989 as the base year and calculate any deviations from the base year as a tariff, t^r, that is additional to the tariff ruling in 1989 (denoted by t_0^r). Thus, the wedge between the rural and world maize price is given by $(1 + t_T^r) = (1 + t^r)(1 + t_0^r)$, with the convention that in the base year $t^r = 0$. We linearize the expressions for welfare change around the values observed in 1989, rather than around the free trade values (as is customary) because the free trade values are not known and we would not be able to calculate the linearization constants without a potentially large approximation error. This approach allows us to compute the welfare effects of any tariff, including as special cases a tariff that would produce self-sufficiency (denoted by t_{SS}) and the tariff-equivalent that would produce free trade (denoted by t_{FT}).

We assume tariff revenues are plowed back into the rural sector. (See Newbery 1987 for a discussion of how distributional weights could be incorporated.) This leads to the following aggregate rural budget constraint:

$$(9) \qquad R^r[p_m^W(1 + t_T^r) \ldots] + p_m^W(E_m^r - R_m^r)t_T^r = E^r[p_m^W(1 + t_T^r) \ldots, U^r]$$

where R^r and E^r are the rural revenue and expenditure functions, respectively. Hence, R^r_m is the quantity of maize supplied and E^r_m the compensated demand for maize, so that the second term in parenthesis in the left side of equation 9 is net rural maize exports. Differentiation of equation 9 yields:

$$(10) \qquad E^r_U \, dU = [(R^r_m - E^r_m)p^r_{m,0} + p^W_m(1 + t^r_0)(E^r_m - R^r_m)] \, dt^r$$

$$+ p^W_m(E^u_{mm} - R^r_{mm}) \, t^r_T \, p^r_{m,0} \, dt^r + \frac{t^r_0}{(1 + t^r_0)} v_{mr} E^r_U \, dU$$

$$= \left[\frac{p^r_{m,0} \, (E^r_{m0} \, \epsilon^D - R^r_{m0} \, \epsilon^S)}{(1 - \dfrac{t^r_0}{1 + t^r_0} v_{mr})} \right] \frac{t^r_T}{1 + t^r_0} \, dt^r$$

where v_{mr} is the marginal value share of maize in total rural expenditure; ϵ^D and ϵ^S are the price elasticities of demand and supply of maize, respectively; and the subscript 0 refers to base year (1989) values. If we linearize around the base situation, the term in parentheses on the right side of equation 10 becomes a constant, to be evaluated at base year prices and quantities. Integration of equation 10 yields the change in welfare due to a change in the tariff from its value in the base year to any specific target tariff.

$$(11) \quad E^r_U \, [U^r(t^r_T) - U^r(t^r_0)] = \frac{p^r_{m,0} \, (E^r_{m0} \, \epsilon^D - R^r_{m0} \, \epsilon^S)}{(1 - \dfrac{t^r_0}{1 + t^r_0} v_{mr})} \left[\frac{t^r_0}{1 + t^r_0} t^r + \frac{(t^r)^2}{2} \right]$$

$$\equiv - \zeta^r_0 \left[\frac{t^r_0}{1 + t^r_0} t^r + \frac{(t^r)^2}{2} \right].$$

A formula similar to equation 11 can be derived for urban areas by setting R^r_m (and hence ϵ^S) equal to zero and replacing t^r by t^u:

$$(12) \qquad E^u_U[U^u(t^u_T) - U^u(t^u_0)] = - \zeta^u_0 \left[\frac{t^u_0}{1 + t^u_0} t^u + \frac{(t^u)^2}{2} \right].$$

Expressions 11 and 12 measure the "dead-weight loss" in the rural and urban sectors associated with any tariff and are equivalent to the sum of triangles AWQ and BRZ in panel c and to triangle HGF in panel d of figure 1, respectively. As long as price elasticities are not zero, maize protection has positive welfare costs. These costs increase with the square of the tariff, so increasing protection becomes progressively more costly.

II. Fiscal Costs, Redistributive Impact, and Aggregate Welfare

We now apply the model to an assessment of the fiscal costs and distributive consequences of Mexico's policies on maize pricing and of the welfare gains of moving to free trade.

Table 1. *Estimated Supply and Demand for Maize, 1989*

Category	Quantity (millions of tons)
Supply	
Domestic production in rain-fed lands	8.8
Domestic production in irrigated lands	1.5
Imports	2.5
Total	12.8
Demand	
Rural own consumption	3.6
Intermediate use[a]	2.7
Urban consumption	6.5
Total	12.8

a. This includes animal feeds and seeds.
Source: Rivera (1990).

Fiscal Costs

Table 1 gives the 1989 quantities of maize associated with each of the panels in figure 1.[1] The domestic production of 10.3 million tons exceeds rural consumption, so that the rural sector is a net exporter (4 million tons). Because rural exports exceed production on irrigated land, it follows that the subsistence sector as a whole is a net maize exporter. And urban consumption of 6.5 million tons is met by importing 4 million tons from the rural sector and 2.5 million tons from abroad.

The ratio $(p_m^r - p_m^W)/p_m^W$ was 54 percent in 1989; this gives a subsidy of US\$72.8 per ton. In 1989 the rural maize price was US\$208.5 per ton, and the world maize price (using the yellow maize Gulf price as a proxy) was US\$135.5 per ton. Thus for domestic production of 10.3 million tons, the gross producer subsidy is US\$749.8 million. But not all of this subsidy is paid by the government, since part of domestic output is consumed within the rural areas at the rural price. The net producer subsidy is only US\$291.2 million, which is obtained by multiplying rural exports of 4 million tons by the US\$72.8 per ton subsidy; this is area AIJB in panel d of figure 1. The US\$458.6 million difference between the US\$749.8 million and US\$291.2 million gross and net subsidy is the tax paid by rural maize consumers. This is made up as follows: a tax of US\$196.5 million paid by intermediate users (2.7 million tons times US\$72.8) and a tax of US\$262.1 million (3.6 million tons times US\$72.8) paid by final consumers in the rural areas (landless rural workers and subsistence producers who are net buyers).

Large-scale producers sell 1.5 million tons; therefore they appropriate 109.2 million (or 38 percent) of the US\$291.2 million net production subsidy. The remaining US\$182 million (or 62 percent) goes to producers on rain-fed land who are net sellers. But the ratio $(p_m^u - p_m^W)/p_m^W$ was −37.1 percent in 1989,

1. The following is based on data presented in Rivera (1990).

because the average urban price of maize was US$85.2 per ton (the weighted average of the different urban prices; see Rivera 1990 for more details). The subsidy per ton is US$50.37, which when multiplied by the 6.5 million tons of urban consumption gives a subsidy of US$327.40 million (area EFGI in panel d of figure 1).

Redistributive Impact

The redistributive impact works directly through prices and indirectly through the impact of maize prices on labor markets.

Direct price effects. Figure 2 serves as departure point to estimate the direct price effects of lower maize prices on the net income of various groups. The vertical axis measures maize output and consumption by all producers. The horizontal axis lists all maize producers: K large-scale producers and N subsistence producers. Next to N we append a total of M other maize consumers in the rural areas (mainly landless rural workers but also other non-maize producers). Maize producers are listed in order of decreasing output. The underlying assumption is that all large-scale producers on irrigated land have larger maize output than any subsistence producer on rain-fed land.

Let $f(Q_m)$ be the distribution of production, so that the total area under $f(Q_m)$, the sum of A + B + C, is total maize output. The distribution of maize consumption is denoted by $g(C_m)$; area B + C + D is total own-consumption by maize producers. If maize is a normal good and if all producers have the same tastes, $g(\cdot)$ should be a decreasing function, although probably much flatter than $f(\cdot)$. In addition, the area under $g(\cdot)$ may also include some consumption by other rural workers as well as some animal consumption. Masera (1990, table 4.5,

Figure 2. *Maize Consumption and Production*
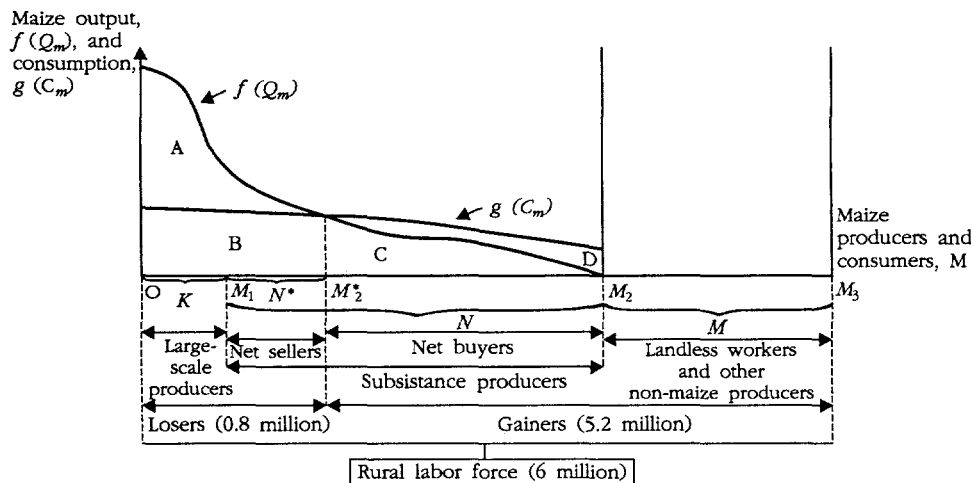
p. 126) presents interesting data for this phenomenon from two communities in the state of Michoacan. A similar phenomenon is noted by Andrade (1988, pp. 16–18). All K large-scale producers and N^* subsistence producers are net sellers, while $N - N^*$ subsistence producers are net buyers. Because the subsistence sector as a whole is a net seller, it holds that:

$$(13) \qquad \Sigma_{j=1}^{N^*} (Q_m^j - C_m^j) > \Sigma_{j=N^*+1}^{N} (C_m^j - Q_m^j).$$

Figure 2, however, makes clear that N^* depends critically on the shapes of $f(\cdot)$ and $g(\cdot)$. Hence a condition like inequality 13, by itself, provides insufficient information for policy. In particular, if we take $K + N + M$ to be the total rural population, it follows that there are $K + N^*$ losers and $N - N^* + M$ gainers from the direct price effect of lowering the price of maize. If $f(\cdot)$ is relatively steep, then $K + N^*$ will be a relatively small number, and, while all large-scale producers and subsistence producers as a whole lose, most of the rural population may directly benefit from lower maize prices.

The available data are insufficient to completely trace $f(Q_m)$ and $g(C_m)$ or to determine the exact numbers for K, N, and M. Nevertheless, piecing together estimates in the literature, we find information in two areas. First, the rural population is estimated to be 21.8 million people (or 27 percent of the total); out of this about 6 million are estimated to be the economically active population. In turn, out of the 6 million rural workers, about 2.5 million to 3 million are estimated to be landless, with the remaining 3 million to 3.5 million small producers (Salinas 1990, p. 817; Montanez 1988, p. 684). Montanez and Warman (1985) mention that there are about 2 million subsistence maize producers; the same figure is quoted by Masera (1990, p.39). INEGI (1988, p. 20) also states that there are more than 2 million such producers. However, Masera (1990, table 1.6, p. 40) cites a total of 2.2 million maize producers (of all types). Although some of these figures relate to different years, it seems reasonable to make an estimate of 2.25 million maize producers (out of which 2 million are subsistence and 0.25 million are large scale), about 3 million landless rural workers, and about 0.75 million other rural producers dedicated to non-maize activities. In terms of figure 2 this suggests $K = 0.25$, $N = 2.0$, and $M = 3.75$ million.

Second, data to trace the production and consumption distributions of maize are also scarce. Montanez (1988, p. 679, our translation) states that: "Of all maize producers in the spring-summer cycle, 55 percent do not cultivate more than 2.5 hectares, which yield, on average, 1.35 tons per hectare. Individually, 58 percent obtain, at most, 2.5 tons. It is estimated that 66 percent keep all of its output and that, of the total amount produced, only 50 percent enters the market." Andrade (1988, pp. 11–15) points out that only 5.8 percent of producers obtained more than 10 tons, with average yields of 2.2 tons per hectare; he also shows that 66 percent of all producers harvested between 0 and 2.5 hectares, 32.3 percent between 2.5 and 10 hectares, and only 1.73 percent more than 10 hectares.

These figures imply that out of the 2.25 million maize producers assumed above, only 787,000 (34 percent) are net sellers and that about 135,000 of these (or 6 percent of all producers) account for the bulk of the sales. Thus, the distribution of maize production falls rather steeply at first and then flattens out. With own-consumption requirements falling as well with lower production (less *maize required to pay for hired labor and for animal feed*), this implies that area D in figure 2 is relatively small. An immediate observation is that the 66 percent of producers who are net buyers probably buy a small share of their total maize consumed, so the benefit they receive from lower maize prices is positive, but probably small. Conversely, there is a group of producers who are net sellers, but whose sales are also relatively small, so their loses from lower maize prices would also not be significant.

This analysis suggests that the indirect wage rate effect of lower maize prices is more important to subsistence producers who are on the margin of being net sellers or net buyers than is the direct price effect. It also indicates that the direct impact of lower maize prices would be strong only for producers in the initial segment of the distribution. A plausible estimate is that this group of significant sellers represents, at most, 15 percent (or 330,000) of all producers (250,000 large-scale producers on irrigated land and 80,000 subsistence producers on rain-fed land). Groups that are definitely net gainers would be those close and to the right of point M_2 in figure 2, or about 3.75 million other rural workers, made up mostly by landless workers. About 1.92 million subsistence producers would lose or gain little.

Indirect labor market effects. To provide an assessment of expression 10, the first step is to calculate the output reduction implied by free trade in maize. A recent survey of econometric estimates of supply elasticities in Mexico shows that the aggregate price elasticity of supply of maize, ϵ^S, is in the order of 1.1 (Nathan Associates 1989, table 4.1). (Since we analyze nonmarginal price changes, we assume that the supply curves of maize are isoelastic.) Unfortunately, these studies failed to distinguish between supply elasticities for irrigated and rain-fed lands, (ϵ^i and ϵ^{rf}, respectively). Since $\epsilon^S = \alpha\epsilon^i + (1 - \alpha)\epsilon^{rf}$, where α is the share of maize cultivated on irrigated land, it is necessary to exogenously assume one of the two individual elasticities (satisfying $\epsilon^i > \epsilon^{rf}$). Lacking additional information, we set ϵ^i equal to 1.5, such that ϵ^{rf} is 1.03 (since $\alpha = 0.15$; see table 1). A move toward free trade in maize would reduce the rural price of maize by, roughly speaking, 50 percent, thus implying a cut in maize output from irrigated land of 0.97 million tons (from 1.5 million to 0.53 million) and of 4.5 million tons from rain-fed land (from 8.8 million to 4.3 million tons).

The second step is to estimate the land and labor released from maize cultivation. Assuming average maize yields from irrigated and rain-fed lands of, respectively, 2 and 1.4 tons per hectare, the output contraction in maize releases 3.21 million hectares of rain-fed land and 0.32 million hectares of irrigated land. Table 2 then implies that 59.1 million worker-days are released from rain-fed

Table 2. *Ratios of Land to Labor, by Crop and Kind of Land*

Kind of land	Maize	Other grains	Fruits and vegetables	Other	Pasture
Irrigated	51.5	25	165	23	n.a.
Rain-fed	18.4	9	58	18	5

n.a. Not applicable.

Note: Number of worker-days employed per year per hectare of land.

Source: Norton and Solis (1983).

maize cultivation and 16.48 million worker-days from irrigated maize cultivation, so that $|\partial L_m^{rf}/\partial p_m^r + \partial L_m^i/\partial p_m^r| = 75.58$ million worker-days.

The third step is to calculate average labor requirements on non-maize irrigated land and estimate the increase in non-maize employment. Assume the released irrigated land is used to produce other grains, fruits, and vegetables as well as other crops in the same proportions found in table 3. This implies that 62.05 worker-days are required per hectare of non-maize irrigated land. As a result, when the 0.32 million hectares of irrigated land are turned over to other crops, we have that $\partial L_v/\partial p_m^r$ equals 19.85 million worker-days. Consider now what happens to the rain-fed land released from maize. According to agricultural experts, a plausible scenario is that half of the released rain-fed land is devoted to pasture, with the remaining half equally divided between other grains and other crops (and no fruits and vegetables). Table 2 indicates that this use of the released rain-fed land requires 29.6 million worker-days, implying a net release of labor of 26.13 million worker-days. Assuming the average rural worker works 180 days a year in agricultural activities, this translates into 145,000 workers.

Thus, under the assumptions made above and without any other government intervention, free trade in maize would put downward pressure on the rural wage rate. Of course, the wage reduction also depends on migration assumptions, as well as on the elasticities of labor demand in non-maize crops. However, the number of workers released by free trade in maize is small when compared with the total rural labor force (approximately 6 million workers).

Table 3. *Allocation of Land, 1989*
(thousands of harvested hectares)

Crop	Irrigated	Rain-fed	Total
Maize	915	5,553	6,468
Other grains[a]	1,554	1,620	3,174
Fruits and vegetables[b]	1,110	796	1,906
Other[c]	1,367	5,295	6,662
Total	4,946	13,264	18,210

a. Rice, sorghum, wheat, and barley.

b. Including perennial crops and sugar.

c. Cotton, tobbaco, beans, and others.

Source: Direccion General de Estadistica (unpublished data); Secretaria de Agricultura y Recursos Hidraulicos (1984).

Thus, very small migration responses and very small elasticities of labor demand would be required to generate a significant fall in the rural wage rate.

Social Welfare Costs

In this section we look at the aggregate welfare cost of maize policies in 1989 and estimate the welfare gains of free trade in maize. We also evaluate the long-standing Mexican policy objective of maize self-sufficiency. It is difficult to ascertain the economic merit of this objective because its appeal is political and therefore outside the scope of this article. However, we can estimate the economic costs of self-sufficiency.

We apply expressions 11 and 12 to measure the cost of current policies by adding the total welfare gain to both urban and rural groups in moving from the present tariff equivalent, t_0, to the free trade tariff equivalent, $t_{FT} = 1/(1 + t_0) - 1$. Beginning from the base situation, the free trade tariff equivalent would make all producers and consumers face the world price of maize.[2]

To measure the welfare costs of self-sufficiency requires an estimate of the tariff equivalent that would reduce maize imports to zero. This tariff equivalent can be derived from the import demand equation. By definition, at self-sufficiency total maize imports, M, equal zero. To estimate the tariff that yields this outcome, we must also make an assumption about which consumers face the increased maize price. In what follows we assume that self-sufficiency would be reached while maintaining constant the price of maize to urban consumers; this is consistent with the current situation where only rural consumers face the producer price of maize. Thus the self-sufficiency tariff needs to provide enough of a producer subsidy to generate net exports from the rural to the urban areas high enough to offset the effect of urban subsidies. The import demand function for maize is

$$(14) \qquad\qquad M = E_m^u + E_m^r - R_m^r.$$

The implicit rural self-sufficiency tariff t_{SS}^r needs to solve

$$(15) \quad - E_m^u = E_m^r [p_m^W (1 + t_0^r)(1 + t_{SS}^r), \ldots] - R_m^r [p_m^W (1 + t_0^r)(1 + t_{SS}^r), \ldots].$$

Differentiation while ignoring income effects then yields

$$(16) \qquad\qquad \Delta t^r = - (E_{m,0}^r \epsilon^D - R_{m,0}^r \epsilon^S)^{-1} M_0.$$

Table 4 provides the data to carry out the computations. The supply elasticity is much higher than the demand elasticity, something that will affect the relative cost of rural versus urban distortions.

Moving to free trade. Table 5 shows that moving to free trade from the 1989 base year configuration yields welfare benefits of US$154 million per year, most of which is due to a reduction in rural distortions. To put this number in

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2. By definition of t, t_{FT} has to satisfy $(1 + t_{FT})(1 + t_0) = 1$.

Table 4. *Basic Maize Statistics, 1989*

	Urban	Rural	Rest of the world
Basic data			
Consumption, C_m (millions of tons)	6.5	3.6	n.a.
Output, Q_m (millions of tons)	0.0	7.6[a]	n.a.
Net imports M_m (millions of tons)	6.5	−4.0	−2.5[b]
Price (US$ per ton)	85.23	208.50	135.60
Implicit tariff in 1989 (percent)	−37	54	n.a.
Implicit tariff to produce self-sufficiency (percent)	−37	94	n.a.
Basic parameters			
ς_0 (US$ billion)[c]	0.185	1.99	n.a.
Price elasticity of demand of maize, ϵ^{D} [d]	0.334	0.334	n.a.
Price elasticity of supply of maize, ϵ^{S} [d]	n.a.	1.1	n.a.
Marginal income share of maize v_m (assumed)	0.01	0.01	n.a.

n.a. Not applicable.
a. Output, Q_m, equals gross output *minus* intermediate use (see table 1).
b. World imports of maize minus Mexico's total maize imports.
c. Derived from basic data, above.
d. Nathan Associates (1989).
Source: Authors' calculations.

perspective, assume the 1989 intervention structure is maintained forever. In that case, the costs of the subsidy will rise at the growth rate of gross domestic product (GDP), say 5 percent on average over the medium term. However, future distortionary costs need to be discounted; the relevant discount rate is the marginal real cost of borrowing in foreign markets. Taking recent, post-debt-deal market flotations as a guide, this marginal real cost is estimated at 7.6 percent in real terms, when using a long-term inflation estimate of 5 percent. This makes for a growth-adjusted discount rate of 2.5 percent ([1.076]/1.05 = 1.025). Applying this discount rate yields the results summarized in table 6: the total,

Table 5. *Annual Recurrent Welfare Costs of Maize Price Interventions*
(millions of U.S. dollars)

	Areas of welfare costs		
Intervention	Rural	Urban	Total
Move from free trade to 1989 price structure	122	32	154
Move from 1989 price structure to self-sufficiency	251	n.a.	251
Move from free trade to self-sufficiency	374	32	406

n.a. Not applicable.
Note: Totals may not add because of rounding.
Source: Authors' calculations.

Table 6. *Permanent Growth-Adjusted Welfare Costs of Maize Price Intervention*
(net present value, billions of U.S. dollars)

Intervention	Areas of welfare costs		
	Rural	Urban	Total
Move from free trade to 1989 price structure	4.9	1.3	6.2
Move from 1989 price structure to self-sufficiency	10.0	n.a.	10.0
Move from free trade to self-sufficiency	14.9	1.3	16.2

n.a. Not applicable.
Note: Totals may not add because of rounding.
Source: Authors' calculations.

permanent, but discounted, welfare costs of current maize policies equals about US$6.2 billion, or 3 percent of 1989 Mexican GDP.

Moving to self-sufficiency. Combining data from table 4 with expression 16 yields the self-sufficiency tariff t_{SS} of 0.26. This means that to reach self-sufficiency in maize while maintaining urban consumer subsidies, the rural price needs to be raised by 26 percent above the 1989 level of 54 percent over world prices. Thus the total self-sufficiency tariff would be 94 percent.

The second and third rows of table 5 indicate that the associated welfare costs are substantial. To move from the 1989 configuration to a price configuration that achieves self-sufficiency increases the welfare costs by US$251 million a year. The permanent costs of this policy, using the same growth adjusted discount rate of 2.5 percent, are US$10 billion, or around 5 percent of 1989 GDP. But the real costs are higher, because the relevant comparison should not be the 1989 base year, but free trade; this almost doubles the yearly cost estimate of self-sufficiency to US$406 million. If maintained forever, the total discounted welfare costs in 1989 dollars of self-sufficiency are equal to US$16.2 billion, or 8 percent of 1989 GDP!

Fiscal subsidies and aggregate welfare costs. The analysis shows that in 1989 the government spent US$618.6 million in maize subsidies divided between a net subsidy to the rural areas of US$291.2 million and an urban subsidy of US$327.4 million. Netting out redistributions, we find that the aggregate welfare cost of this policy is US$154 million, divided between US$122 million in the rural areas and US$32 million in the urban areas. For the country as a whole every dollar of subsidy generated only US$0.75 of welfare gain. Thus, the country as a whole loses 25 cents per dollar spent on maize price intervention. For the rural areas every dollar of subsidy generated only US$0.58 of welfare gain, making for a net loss of 42 cents per dollar, while for the urban areas the corresponding amount is 0.90 (a net loss of 10 cents per dollar spent). The difference between rural and urban losses is explained by the fact that in the rural areas subsidies induce a production and a consumption distortion, while in the urban areas the production distortion is absent.

These welfare costs of course depend on the values of the elasticities of supply and demand of maize, parameters that are very difficult to estimate with precision. Nevertheless, it is worth pointing out that the values used are probably on the low side (particularly so with respect to the elasticity of supply of maize),[3] so that these estimates would appear to be a lower bound on the welfare costs of current policies. This observation is reinforced by noting that in the analysis we also have ignored the welfare costs of raising the fiscal revenues required to cover the maize subsidies, a potentially important additional cost (Browning 1987). Unfortunately, there are no studies of the welfare cost of raising fiscal revenues in Mexico. To the extent that this cost is substantial, our estimates of welfare loses would have to be increased accordingly.

III. WHY MAIZE POLICIES NEED TO BE CHANGED

A recent study of poverty found that 67 percent of the extremely poor population in Mexico lives in rural areas (Levy 1991). The importance of urban poverty is reduced further if account is made of the fact that not all the extremely poor are equally poor and that the distribution of poverty is not the same across regions. When poverty measures that are sensitive to the depth and distribution of poverty are used, the proportion of people in extreme poverty accounted for by the rural areas in Mexico increases to 76 percent. It is thus very difficult to justify, on poverty alleviation grounds, a subsidy to maize consumption in the urban areas.

Moreover, the reduced urban maize price represents an across-the-board subsidy to all urban consumers. Hence, although poor urban inhabitants benefit, part of the benefit spills over into groups that clearly do not need the subsidy. Since the fiscal cost of this policy is substantial (US$327.4 million in 1989), a targeted program can be equally effective in transferring income to the urban poor while at the same time reducing the fiscal burden and the dead-weight loss. An infra-marginal targeted subsidy (using coupons) also breaks the link between income and the size of benefits received and liberates resources to help the rural poor. Targeted programs are not without problems, however. When benefits are made a function of income, a negative incentive to work is created: if participants realize that benefits fall when their incomes increase they effectively face very high marginal tax rates. From this perspective it is better not to make benefits conditional on income. As poverty programs in Mexico move away from generalized subsidies to means-tested programs, the tension between incentives to work and means-tested targeting will become sharper.

This article has shown that the policy of setting the rural price of maize above the world price is inefficient. The policy precludes workers from being employed in other areas where the value of their marginal product at world prices can

3. The econometric studies surveyed by Nathan Associates (1989) are all based on single equation estimates of maize supply elasticities. We know of no econometric study for Mexico where individual crop elasticities are derived from a profit function approach that incorporates cross-price effects.

eventually be higher, while it induces some of the scarce factor, high-quality land, to be used in activities for which the value of its marginal product at world prices is lower. The labor allocation is also distorted because, by keeping subsistence farmers employed on their own land, higher maize prices reduce the supply of labor and put upward pressure on the rural wage. This is a very indirect and inefficient mechanism for supporting the rural wage rate. The same amount of resources currently spent on maize subsidies could be used for rural infrastructure programs. These programs would provide rural employment and would create the necessary infrastructure that, over the medium term, is required to open more earnings possibilities for the rural poor.

We have shown that the distributional effects of the higher maize price are mixed. It directly benefits subsistence producers who are net sellers. But a substantial number of subsistence producers are net buyers; and even while the policy helps a subset of subsistence producers, larger rents are transferred to large-scale producers. And finally, landless rural workers are hurt because they must pay a higher price for the maize they consume.

But perhaps the fundamental problem with the policy of protecting maize production is that it focuses on the wrong objective. Rather than helping those who produce maize, the objective should be to help poor rural inhabitants, regardless of where they work. Of course reaching the poor directly is notoriously difficult, especially in rural areas. Indirect methods often need to be applied, which use an observable variable that one suspects is highly correlated with the degree of poverty as a "screening device." We have shown that, because of its differing effects on subsets of the rural poor, the rural price of maize is a very ineffective screening device. There is in fact a strong presumption that it screens out the relatively poor rather than the relatively rich. With distributional arguments discredited, the central policy objective for maize, therefore, should be to move toward eventual free trade in this commodity.

The FTA provides an ideal opportunity to pursue this objective. It is likely to provide freer entrance into the U. S. market for other agricultural products in which Mexico does have a comparative advantage (such as sugar and fruits and vegetables), as well as for the broadest possible range of manufactured products. Insuring secure and sustained access for labor-intensive agricultural and manufactured products can help ease the transition away from subsistence maize cultivation. If this opportunity is taken, Mexico, unlike many other countries, will avoid the need to increase protection to agriculture as real incomes increase in the rest of the economy and will be able to provide sustainable increases in living standards over the medium term to the currently rural poor.

APPENDIX. THE RELATION BETWEEN THE URBAN AND RURAL LABOR MARKETS

To analyze the wage rate effect of reducing the producer price of maize, we first consider the impact on the rural labor market, assuming there is no migration. We then integrate the urban and the rural labor markets.

The initial rural wage rate, $w^{r,0}$, is obtained by solving

(A-1) $L_m^{rf}(w^r, p_m^0; \overline{T}^{rf}) + L_m^i(w^r, p_m^0; T_m^i) + L_v[w^r, p_m^0; (\overline{T}^i - T_m^i)] - \overline{L}_r - \overline{L}_p = 0$

where the superscript 0 denotes the value of the variable before the producer price of maize is reduced, $\overline{T}^i$ is the total endowment of irrigated land, T_m^i is irrigated land allocated to maize, and $(\overline{T}^i - T_m^i = T_v)$ is irrigated land allocated to vegetables, and $\overline{T}^{rf}$ is the total endowment of rain-fed land.

Differentiating the total demand for rural labor, DL_R, and noting that $\partial T_m^i / \partial p_m = - \partial T_v / \partial p_m$, equation A-1 can be rearranged to yield

(A-2) $dDL_R / dp_m = \partial L_m^{rf} / \partial p_m + (\partial L_v / \partial T_v - \partial L_m^i / \partial T_m^i) \cdot \partial T_v / \partial p_m$.

The first term on the right side of equation A-2 is obviously positive. The second term, however, depends on the comparison between the marginal labor-land ratios in vegetable and maize cultivation on irrigated land. If at the margin vegetables are less labor intensive than maize, the second term will be positive since $\partial T_v / \partial p_m < 0$. Expression A-2 thus tells us that if vegetables are less labor intensive than maize on irrigated land, when p_m falls, the total demand for rural labor unambiguously falls. Conversely, if on irrigated land vegetables are more labor intensive than maize, the change in the demand for labor is ambiguous. Clearly, without migration the contraction in rural labor demand translates directly into lower rural wages. Rural employment stays constant, although its composition changes. Subsistence producers now devote less of their labor to grow maize in their own land, so labor is shed from subsistence maize cultivation. We can calculate the amount of labor that needs to be shed from the rural areas to keep wages constant. Thus, if L_g increased by this amount, the rural wage would remain the same. Differently put, we can calculate the size of a rural employment program that neutralizes the wage effect of reducing the price of maize.

The impact of migration on this outcome depends on the assumptions made about the determinants of rural-urban wage differentials. Before the change in the price of maize, equilibrium wage rates are $w^{r,0}$ and $w^{u,0}$, implying an urban-rural wage differential measured by $\beta^0 = w^{u,0} / w^{r,0} > 1$.

The fall in the price of maize shifts the rural labor demand downward. Without migration the rural wage falls. But this increases the differential between urban and rural wages, which in turn may induce rural migration. If migration occurs until the initial wage differential is reestablished, some rural workers migrate, thus reducing the labor supply in the rural areas and increasing it in the urban areas. Under a constant wage differential assumption part of the wage rate effect of reducing the price of maize is absorbed by lower wages and part by shifting labor from rural to urban areas. Of course, migration need not restore the initial wage differential. But as long as there is some (positive) migration, the fall in the rural wage is mitigated. The counterpart to this is some fall in the urban wage, which in turn increases manufacturing employment. Hence, under

the assumptions stated above and without rural employment programs ($\Delta L_g = 0$), free trade in maize would increase the marginal productivity of capital in manufacturing.[4]

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4. Of course, the free trade agreement also shifts the demand for urban labor. If such an agreement results in increased investment (foreign or domestic), demand for urban labor increases, thus increasing urban (and, through migration, rural) wages.

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