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Steven John Torok
Iowa State University

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Torok, Steven John

INTERNATIONAL TRADE IN COMMODITIES AND LABOR: THE CASE OF THE IMPORTATION OF MEXICAN AGRICULTURAL LABOR AND FRESH MARKET WINTER TOMATOES INTO THE UNITED STATES, 1964-1979

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International trade in commodities and labor: The case of the importation of Mexican agricultural labor and fresh market winter tomatoes into the U.S., 1964-1979

by

Steven John Torok

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CHAPTER I. MEXICAN IMMIGRATION AS AN ECONOMIC DECISION

Currently, the United States is experiencing one of its most rapid periods of immigration in recent history, even though the Immigration Act of 1965 has established a quota of allowing approximately 120,000 legal Western hemisphere immigrants each year. The seeming paradox of rapid immigration in times of strict immigration legislation is due to the large numbers of Mexicans that are immigrating illegally to the United States and entering the labor force each year.

The estimated number of new illegal Mexican aliens, Mexicans who immigrate illegally to the U.S., is ten times greater than the total number of all legal immigrants entering the U.S. annually (Briggs, 1975a). The large flow of illegal Mexican aliens suggests a need for investigating why these individuals are entering the U.S. in such large numbers. It is important to discover what economic factors motivate such a large group of individuals to leave their families, travel a great distance, and violate immigration laws by entering the U.S. illegally. The results obtained from analyzing illegal Mexican immigration may be useful to U.S. and Mexican policymakers. A scholarly study can help these policymakers understand the economics of illegal immigration and establish better policy.

Historical Aspects of Mexican Immigration

The U.S. has historically experienced large population changes caused by immigration. The pattern of immigration to the U.S. has been cyclical (see Table 1.1). Economic historians have debated the causation of U.S. immigration and it is unclear whether the pull of economic opportunity in the U.S. is greater than the push of economic and social difficulty in the origin countries.

Table 1.1. Immigration to the U.S. as reported by the Immigration and Naturalization Service, 1821-1978[a]

Years	Immigrants
1821-1830	143,439
1831-1840	599,125
1841-1850	1,713,251
1851-1860	2,598,214
1861-1870	2,314,824
1871-1880	2,812,191
1881-1890	5,246,613
1891-1900	3,687,564
1901-1910	8,795,386
1911-1920	5,735,811
1921-1930	4,107,209
1931-1940	528,431
1941-1950	1,035,039
1951-1960	2,515,479
1961-1970	3,321,677
1971-1980	3,505,327

[a]Source: U.S. Department of Justice. Annual Report: Immigration Naturalization Service, 1978.

The immigration of Mexican labor into the U.S. labor market has historically been related to the performance of the U.S. economy and to U.S. immigration policies. Before 1900, Mexican labor immigrated into the U.S. via the newly created railroad system to fill jobs which were created by the mining boom of the 1800s and the development of irrigated southwest agricultural land (Corwin, 1978). The advent of WWI created another labor shortage in the U.S. that resulted in the first major wave of primarily legal Mexican immigrants that lasted until the Great Depression (see Table 1.2). During the era of the depression, the number of legal immigrants fell to a trickle, but the number of illegals apparently more than doubled (see Table 1.3)(Briggs, 1975a). As the U.S. economy recovered, the number of legal Mexican immigrants increased slowly until the early 1940s. The passage of the Mexican Labour Programme (Bracero Program) in 1942 led to a large surge of legal and illegal Mexican immigration. WWII created another labor shortage that helped create more job vacancies for the Mexican immigrants.

In 1951, the Bracero Program was revived under Public Law 78 due to labor shortages created by the Korean War. The largest wave to date of legal and illegal Mexican immigration followed. The Bracero Program was terminated in 1964 and an immigration quota was established by an ammendment to the Immigration and Naturality Act. These changes led to a decline in the number of legal Mexican immigrants, but the number of illegal Mexican immigrants increased dramatically. Currently, estimates of the flow of Mexicans immigrating illegally range up to 4 million a

Table 1.2. Legal Mexican immigration to the U.S., 1869-1978[a]

Year	Immigrants	Year	Immigrants	Year	Immigrants
1869	320	1906	1,197	1943	3,985
1870	463	1907	1,406	1944	6,399
1871	402	1908	6,067	1945	6,455
1872	469	1909	16,251	1946	6,805
1873	606	1910	17,760	1947	7,775
1874	386	1911	18,784	1948	8,730
1875	610	1912	22,001	1949	7,977
1876	631	1913	10,954	1950	6,841
1877	445	1914	13,089	1951	6,372
1878	465	1915	10,993	1952	9,600
1879	556	1916	17,198	1953	18,454
1880	492	1917	16,438	1954	37,456
1881	325	1918	17,602	1955	50,772
1882	366	1919	28,844	1956	65,047
1883	469	1920	51,042	1957	49,154
1884	430	1921	29,603	1958	26,712
1885	323	1922	18,246	1959	23,061
1886	.	1923	62,709	1960	32,684
1887	.	1924	87,648	1961	41,632
1888	.	1925	32,378	1962	55,291
1889	.	1926	42,638	1963	55,253
1890	.	1927	66,766	1964	32,967
1891	.	1928	57,765	1965	37,969
1892	.	1929	38,980	1966	45,163
1893	.	1930	11,915	1967	42,371
1894	109	1931	2,627	1968	43,563
1895	116	1932	1,674	1969	44,623
1896	150	1933	1,514	1970	44,469
1897	91	1934	1,470	1971	50,103
1898	107	1935	1,232	1972	64,040
1899	163	1936	1,308	1973	70,141
1900	237	1937	1,918	1974	71,863
1901	347	1938	2,014	1975	62,552
1902	709	1939	2,265	1976	58,354
1903	528	1940	1,914	1977	44,646
1904	1,009	1941	2,068	1978	92,367
1905	2,637	1942	2,182		

[a]Sources: Vernon M. Briggs. "Mexican Workers in the United States Labour Market:. A Contemporary Dilemma." No. 12, International Labor Review, (1975a); U.S. Department of Justice. Annual Report: Immigration and Naturalization Service (1978).

Table 1.3. Illegal Mexican immigrants apprehended and/or deported by the I.N.S., 1924-1978[a]

Year	Immigrants	Year	Immigrants
1924	4,614	1954	1,035,282
1925	2,961	1955	165,186
1926	4,047	1956	58,792
1927	4,495	1957	45,640
1928	5,529	1958	45,164
1929	8,538	1959	42,732
1930	18,319	1960	39,750
1931	8,409	1961	39,860
1932	7,116	1962	41,200
1933	15,875	1963	51,230
1934	8,910	1964	41,948
1935	9,139	1965	48,984
1936	9,534	1966	89,683
1937	9,535	1967	107,695
1938	8,684	1968	142,520
1939	9,376	1969	189,572
1940	8,051	1970	265,539
1941	6,082	1971	348,178
1942	10,603	1972	430,213
1943	16,154	1973	576,823
1944	39,449	1974	709,949
1945	80,760	1975	680,392
1946	116,320	1976	781,474
1947	214,543	1977	954,778
1948	193,852	1978	976,667
1949	289,400		
1950	469,581		
1951	510,355		
1952	531,719		
1953	839,149		

[a]Sources: Vernon M. Briggs. "Mexican Workers in the United States Labour Market: A Contemporary Dilemma." No. 12, International Labor Review, (1975a); U.S. Department of Justice. Annual Report: Immigration and Naturalization Service (1978).

year, compared to approximately 50,000 legal immigrants (Briggs, 1975b).

Economic conditions in Mexico and Mexican trade policy have also played an important role in Mexican immigration. The levels of Mexican per capita real incomes and real wage rates have been low relative to the magnitude in the United States (see Table 1.4). Mexico has experienced tremendous economic growth in the last twenty years (over 7% growth per year in Gross Domestic Product) with much of the growth focused in the "heavy" capital-intensive industry sector. The structure of the Mexican economy has changed with the growth of the Mexican economy; the traditional labor-intensive sectors such as agriculture, forestry, and fisheries have given way to capital-intensive manufacturing. Some modern manufacturing such as the steel, iron and rubber industries have shown a cost of over $30,000 for each job created (Reubens, 1979). The recent petroleum boom in Mexico will further lead to the development of capital-intensive industry within Mexico.

Mexican trade policies have focused on economic development and self-sufficiency. The trade policies instituted to establish domestic industry, such as "import substitution", have led to the development of highly capital-intensive industry and to the decline in the traditional labor-intensive sector (Evans and James, 1979). Likewise, Mexican exports have become capital-intensive. The fastest growing export industries in Mexico are the least labor-intensive (Watanabe, 1974).

Mexico has adopted a "Twin Plant" program to develop industry in the Northern border towns and to absorb some of the surplus labor within

Table 1.4. Comparison of wage rates in the U.S. and Mexico, 1968-1974[a]

Year	Real agriculture wage rates per day of male laborers in Mexico ($)	Real agricultural wage rates per day in the U.S. ($)	Real manufacturing wage rates per month in Mexico ($)	Real manufacturing per month in the U.S. ($)
1968	1.59	11.05	134	594
1969	1.54	11.55	136	594
1970	1.70	11.70	136	576
1971	1.61	11.70	140	594
1972	1.80	12.26	141	624
1973	1.77	12.67	142	624
1974	1.97	12.68	146	602

[a]Sources: International Labour Organization, 1967-1980; U.S. Department of Agriculture. Farm Labor, 1967-1977.

the country. U.S. firms have entered Mexico as a result and have established plants for the production of intermediate products that are labor-intensive. The minimum wage rates in Mexico have been increasing and higher than expected wage rates have made the goods noncompetitive in the world market, given the technology (Watanabe, 1974).

The interactions of the economic and trade policies of Mexico and the U.S. have influenced the flow of Mexican's illegally immigrating to the United States. Consequently, it is important to consider the simultaneous interaction of factors in both the U.S. and Mexico that affect the illegal immigration of Mexican aliens.

Characteristics of Mexican Immigrants

A summary of characteristics of both the legal and illegal Mexican immigrant may be helpful for understanding the immigrant's decision-making process. Unfortunately, observations on the characteristics of illegal Mexican immigrants are difficult to obtain and somewhat biased because the collected data are for apprehended illegal aliens rather than on the total population of illegal Mexican aliens. Observations on the characteristics of legal Mexican immigrants are available from the Immigration and Naturalization Service (INS) which surveys all legal Mexican immigrants and provides a comprehensive list of characteristics.

The available data on illegal and legal Mexican immigrants suggest that the socio-economic characteristics of both the legal and illegal immigrant have changed over time. The abolishment of the Bracero program

(1964) and the establishment of the immigration quota on Western Hemisphere immigrants (1965) have led to changes in the distribution and characteristics of Mexican immigrants.

Early Mexican immigrants, before 1965, were characterized by: having little education (4.9 years), speaking little English, being predominantly male (90.8% of the immigrants), having dependents (80%), and being involved in highly seasonal migrations (North and Houston, 1976; Reichert and Massey, 1979, and Rochin, 1978). Most of the early Mexican immigrants considered the U.S. labor market as the only viable source of employment and sought employment in agriculture (Reichert and Massey, 1979; Briggs, 1976, and Jenkins, 1977).

Current Mexican immigrants have adopted a "new" style that closely resembles the socio-economic characteristics of Chicanos in the United States (Corwin, 1978). The current legal Mexican immigrants are characterized by: preferring the urban Southwestern U.S., seeking employment in blue-collar nonagricultural jobs, with a majority as females, having an average labor-force participation rate and average marital status similar to the total U.S. population, and returning frequently to Mexico (Briggs, 1975a). Similarly, current illegal Mexican immigrants are characterized by: being predominantly males with females increasing in number, possessing some job skills and formal education, having greater facility with the English language than earlier illegal Mexican immigrants, preferring cities, and adapting readily to the Chicano sub-culture (Dagodag, 1975 and Corwin, 1978).

The distribution of immigrating Mexican aliens has changed since the

1965 immigration quota on immigrants from the Western Hemisphere. As a result of the immigration quota, Mexican aliens can immigrate legally to the U.S. only if the U.S. Department of Labor certifies a need for the immigrants employment classification or if the immigrant satisfies certain limited institutional requirements. Hence, the easiest way to enter the U.S. is by immigrating illegally.

The "new" illegal Mexican immigrant usually follows a "homogenization" process that involves finding temporary employment or some less preferred employment and then finding better jobs (U.S. Department of Labor, 1974). Although some of the "new" illegal Mexican aliens prefer to be employed in industry and unionized jobs, they appear to enter the "secondary" labor force as suggested by M. Piore (Piore, 1979). Consequently, not all of the illegal Mexican aliens seek agricultural employment.

Survey of Literature on International Labor Mobility

The international immigration of labor can be viewed as a response of labor to differential economic opportunities. The conditions of the destination and origin labor markets will influence the rate of immigration via differentials in wage rates and employment opportunities. Likewise, the conditions in the commodity markets of both the destination and origin countries will influence both labor markets because the demand for labor is a derived demand. Furthermore, domestic economic policies, trade policies, and immigration policies of trading countries affect their commodity and labor markets and the economic returns to immigration.

These complex causal relationships cannot be captured in a simple labor market framework between the destination and origin countries but must be integrated to include the commodity markets and policies of the destination and origin countries.

Hechsher-Ohlin trade model

Classical economic theory suggests that under the conditions of perfect competition and profit maximization factors are paid the value of their marginal products. A wage difference that exists between sectors encourages immigration which may reflect differences in the marginal productivity of labor between the sectors. Hechscher-Ohlin international trade theory states that differences in wage rates are brought about by differences in the marginal productivity of labor between sectors (Caves and Jones, 1973).

The Hechscher-Ohlin trade model suggests that under certain restrictive assumptions a sector that has a relatively large stock of labor and a relatively small stock of capital will, ceterus paribus, have a lower marginal product of labor and lower wage and will be a sector that will export labor; likewise, a sector that has a relatively large stock of capital and a relatively small stock of labor will, ceterus paribus, have a higher marginal product of labor and higher wage and will be a sector that imports labor (Young, 1970). Hence, under the Hechscher-Ohlin international trade framework, relative factor endowments determine relative factor prices.[1] Any differences in relative factor endowments will account for factor mobility.

[1]Jones (1957) has suggested that under certain conditions factor endowments have no independent influence on factor prices.

The Hechscher-Ohlin trade model has been adapted to explain factor-price equalization, commodity-price equalization, and the interaction of trade and factor mobility impediments on factor and commodity trade. Free mobility of factors implies factor-price equalization and, even when factors are immobile, there is a tendency toward factor-price equalization (Mundell, 1957). Impediments to commodity trade, such as quotas, tariffs and duties, may prohibit free commodity trade and encourage the international probability of factors in order to equalize commodity and factor prices. Likewise, impediments to factor trade, such as quotas and taxes, will stimulate commodity trade (Young, 1970 and Mundell, 1957).

The empirical investigations of factor mobility have been focused primarily on the migration of capital in a somewhat partial equilibrium framework and have provided generally poor statistical results (Amano, 1975, and Leamer and Stern, 1970). Ramaswami and Webb have analyzed policy alternatives in a general equilibrium framework that maximizes welfare via capital and labor migrations (Ramaswami, 1968 and Webb, 1970). Their results are theoretical in nature, and they have not considered trade impediments. Other studies that have investigated labor migration include demographic models, "push-pull" models, human capital models, and the dual labor market thesis.

Demographic models

The demographical models of migration have been basically "gravity-type" migration models. The "gravity-type" migration model suggests that migration is directly related to the size of the origin and destination populations and inversely related to the distance between the origin and destination regions.

The Zipf migration model was one of the first "gravity-type" migration models and is certainly one of the most well known. Zipf's model is in the form of: 1.1a) $M_{12} = \frac{P_1 P_2}{D_{12}}$ where M_{12} is the gross migration between the origin region (#1) and destination region (#2), P_1 is the origin population, P_2 is the destination population, and D_{12} is the distance between origin and destination regions (Zipf, 1946). Many demographers have tested Zipf's model and models similar to Zipf's, which included other behavioral variables, and they have found satisfactory results. One variant of the Zipf model was introduced by S. Stouffer to explain the direction of flow of migration. Stouffer's model is as follows: 1.1b) $M_{1-2} = \frac{\bar{M}_1 \bar{M}_2}{\bar{M}_{12}}$ where M_{1-2} is the total flow of migration from the origin region (#1) to the destination region (#2), $\bar{M}_1$ is the total out-migration from the origin to all other places, $\bar{M}_2$ is the total in-migration to destination from all other places, and $\bar{M}_{12}$ is the total in-migration to places located between the origin and destination regions (Stouffer, 1940). Stouffer's model introduced the "intervening opportunities hypothesis" which suggests that migration is directly related to the number of opportunities at the origin and destination regions and indirectly related to the number of "intervening opportunities," where intervening opportunities are captured by the numbers of in migrants to areas between the origin and destruction regions.

Both the Zipf and Stouffer models used "migration" variables such as population distance, and total in-and-out migration to explain gross and directional migration. Somemeijer has added to the basic Zipf model an "indice of attractiveness" which includes such variables as unemployment per capita income, degree of urbanization, recreational resources, and quality of dwellings. Somermeijer's model is as follows:

$$1.1c)\quad M_{12} = [\frac{1}{2}k + c(F_2 - F_1)]\frac{P_1P_2}{(D_{12})^a}$$

$$1.2c)\quad M_{21} = [\frac{1}{2}k - c(F_2 - F_1)]\frac{P_1P_2}{(D_{12})^a}$$

where M_{12} is the flow of migration from the origin to the destination region, M_{21} is the flow of migration from the destination to the origin region, k, c and a are constants, F_1 and F_2 are the indices of attractiveness, P_1 and P_2 are the populations of the origin and destination regions, respectively, and D_{12} is the distance between the origin and destination regions (Stouffer, 1940). The Somermeijer model suggests that the greater is the relative attractiveness of the destination region then the greater will be migration. The summation of Equations 1 and 2 yields gross migration:

$$1.3c)\quad M_{12} = k\frac{P_1P_2}{(D_{12})^a}$$

which is the basic Zipf formula.

Lowry has adopted the Somermeijer model and performed an empirical test for 90 SMSA's for 1955-60. Her model expands the "indice of attractiveness" variables to include wage rates, employment, and unemployment in both the origin and destination regions. The Lowry model is as follows:

$$(1.1d)\quad M_{12} = k[\frac{U_1}{U_2}, \frac{W_2}{W_1}, \frac{L_1L_2}{D_{12}}]$$

where M_{12} is the number of migrants from the origin to the destination region, k is a constant, U_1 and U_2 are unemployment as a percentage of the civilian nonagricultural labor force at the origin and destination regions, respectively, W_1 and W_2 are the hourly manufacturing wages in dollars for the origin and destination regions, respectively, L_1 and L_2 are the number of persons in the nonagricultural labor force at the origin and destination region; and D_{12} is the airline distance from the origin to the destination region in miles (Lowry, 1966). The Lowry model can be transformed into log form which can then be estimated by a multiple linear regression:

1.2d) $$\log M_{12} = \log k + \log U_1 - \log U_2 - \log W_1 + \log W_2 + \log L_1 + \log L_2 - \log D_{12}$$

Intuitively, the Lowry model suggests that people migrate from low wage areas to high wage areas, from areas with an excess supply of labor to areas with an excess demand for labor. As the number of migrants increases in the destination region and the population decreases in the origin region, the relative attractiveness of potential destination regions declines. Also, when the distance between the origin and destination is large, the attractiveness of the destination region is reduced. Lowry performed empirical tests for gross migration between the origin and destination regions and for the directional flow of migration from the origin to the destination region. Lowry's empirical estimates were satisfactory, but the explanatory power was rather low suggesting more variables were needed to explain migration. Lowry added origin and destination population size and an Armed Forces variables in subsequent regressions and improved the explanatory power of her model.

The basic Lowry model does not attempt to explain the existence of interregional differences in wages and unemployment or factors causing an excess supply of labor in the origin region and an excess demand for labor at the destination region. This lack of causality may account for the poor explanatory power of Lowry's model when applied to large geographical interstate migration. A better model might include factors affecting the excess supply of labor in the origin region and factors affecting the excess demand for labor in the destination region. A revised model might better explain interstate migration and possibly global immigration.

Rogers has adapted the Lowry model to explain interregional migration in California. His empirical results have much greater explanatory power, which may be a result of using a smaller geographical region for his data (Rogers, 1967).

"Push-pull" migration models

"Push-pull" migration models differ from the "gravity-type" migration models in the sense that "push-pull" migration models do not directly emphasize population sizes, distances, and "migration" variables but concentrate on other "economic" variables for explaining migration. The Lowry migration model which first expressed migration as a function of wage rates, unemployment, employment, and distance similar to the standard "push-pull" migration models.

The basic "push-pull" migration model suggests that competing economic factors are responsible for "pushing" migrants out of the origin region and "pulling" migrants into the destination region. The primary "push" factors for the origin region include: rapid population growth, land scarcity, high unemployment declining wage rates, falling product prices, declining labor productivity, and the substitution of capital for labor. The primary "pull" factors for the destination region include: high wage rates, lucrative employment opportunities, increases in labor productivity, low unemployment, and high final product prices.

The empirical models using the "push-pull" hypothesis have been applied to explain the immigration of illegal Mexican aliens into the United States. Regression analyses performed by Frisbe and Jenkins found that the "push" factors are stronger than the "pull" factors in explaining illegal Mexican immigration (Frisbe, 1975 and Jenkins, 1977). That is to say, Mexican laborers are being "pushed" out of Mexico due to the large gap in the U.S.-Mexican wage differential and the poor Mexican agricultural situation. Both studies focused on agricultural variables as being the best arguments in explaining the illegal immigration of Mexican aliens.

Human capital model

The human capital approach to immigration suggests that an individual will decide to immigrate if the discounted present value of the gains received from immigrating outweigh the present discounted present value of the costs of immigrating. For decision-making, the individual is assumed to have knowledge of or to form expectations about all pecuniary and nonpecuniary costs and benefits associated with immigrating.

In general, an individual residing in origin region (i) will migrate to destination region (j) if the present discounted value of investment in migration from (i) to (j) is greater than zero. This decision to migrate can be expressed algebraically as:

1.1e) $$\sum_{t=1}^{n} (B_{jt}-B_{it})/(1+r)^t - \sum_{t=1}^{n} (C_{jt}-C_{it})/(1+r)^t > 0$$

where:

$\sum_{t=1}^{n}(B_{jt}-B_{it})/(1+r)^t$ is the discounted present value of the net benefits received from migrating to region (j) from region (i)

$\sum_{t=1}^{n} (C_{jt}-C_{it})/(1+r)^t$ is the discounted present value of the net costs from migrating to region (j) from region (i)

r is the discount rate

n is the expected length of stay in region (j)

The net benefits include:

<u>pecuniary benefits</u>:

Higher earning capacity adjusted for the probability of employment.

Acquisition of human capital in the form of increased training and improvement in language skills.

<u>nonpecuniary benefits</u>:

Improvement in environment (better climate, less crime, less pollution, more amenities, better social atmosphere).

Proximity to relatives, friends, and social clan who reside in region (j).

The net costs include:

<u>pecuniary costs</u>:

Increase in living expenses.

Transportation cost.

Costs of training.

Job search cost.

<u>nonpecuniary costs</u>:

Foregone earnings while migrating.

Psychic costs of leaving friends and family who reside in region (i).

Psychological costs involved in risk of apprehension.

The present discounted value approach to explain immigration suffers from several data problems. Data exist for most current pecuniary costs and pecuniary benefits but not for future pecuniary costs and benefits. It may be assumed that current pecuniary costs and pecuniary benefits are a proxy for future pecuniary costs and pecuniary benefits. Data for non-pecuniary costs and nonpecuniary benefits remain a problem because the nonpecuniary costs and nonpecuniary benefits must be imputed. Schwartz has pointed out that psychic costs are related to travel expenses and distance (Schwartz, 1973). L. Sjaastad argues that nonpecuniary costs and nonpecuniary benefits should be ignored in the present discounted value analysis because "psychic costs of migration . . . involves no resource cost and nonmoney returns arising from locational preferences . . . represent consumption which has a zero cost of production" (Sjaastad, 1962). Sjaastad views psychic costs as a loss of consumer surplus by the migrant which involves no economic resource loss and views the pure rents arising from changes in location as not being differences in productivity but arising from locational preferences (Sjaastad, 1962). Even if Sjaastad's and Schwartz's views of nonpecuniary costs and nonpecuniary benefits are adopted in the present discounted value approach, the microeconomic decision process relies heavily on lifetime wage rates and income differentials between sectors as the main motivating force for explaining immigration (Cebula and Vedder, 1973, and Yezer and Thurston, 1976).

Dual labor market thesis

The underlying principle behind the dual labor market thesis suggests that jobs can be divided into "good" and "bad" (primary and secondary) jobs rather than the common practice of separating jobs into skilled and unskilled jobs (Rochin, 1978). The "good" jobs are characterized by higher wages, pleasant working conditions, and excellent promotion opportunities, and are usually filled first. The "bad" jobs are characterized by low wages, poor working conditions, and few promotion opportunities. The domestic labor supply does not adequately fill all the vacant secondary job positions because competing transfer payments such as welfare and unemployment compensation lure the domestic labor supply away from employment (Rochin, 1978). Migrants who consider their employment as being temporary, such as seasonal farm laborers, are willing to accept the secondary jobs. Likewise, individuals who leave their country in search of better employment opportunities and enter the U.S. illegally may also accept unfilled secondary jobs (especially in agriculture), believing that their illegal existence will not be recognized. Employers also play an important role in the dual labor market. If they recognize an ample supply of labor for their secondary job vacancies, wage rates may be kept low and working conditions kept poor.

Piore has adapted the dual labor market concept to explain the great influx of IMAs entering the U.S. secondary labor market (Piore, 1975). Illegal Mexican aliens are willing to accept the low wages and poor working conditions because they feel their stay is temporary and they will be going back to their families in Mexico in the future. As time passes, the illegal Mexican aliens do in fact stay and integrate into the Chicano-Mexican social strata. They may provide a reliable source of labor for secondary jobs. Piore suggests that the current social legislation and the reluctance of domestic labor to fill secondary jobs are reasons why secondary job vacancies are available for migrants (Piore, 1975). He argues for an improvement in the enforcement of existing legislation dealing with minimum wage rates, working conditions, and coverage by social security as a means to make secondary jobs more attractive to the domestic labor supply and hence to curb illegal immigration. An empirical model has not been adopted to test his dual labor market theory or to consider Piore's policy recommendations.

In general, previous studies on immigration have suggested that employment opportunities and wage differentials are the primary motivating factors behind international immigration. Unfortunately, previous studies have not investigated the causation behind differentials in wages and employment opportunities that leads to immigration. A more complete model is needed that treats the economic decision to immigrate in a complete economic framework.

Research Objectives

The objectives of this study are:

1) To develop a 2-country, 1-commodity, 1-factor extended partial equilibrium trade model that will explain immigration and commodity trade by interactions of the commodity and labor markets of the origin and destination countries.

2) To fit an empirical specification of this model to the U.S.-Mexican markets for traded winter tomatoes and for low-skilled harvest farm labor.

3) To draw policy implications for illegal Mexican immigration into the United States.

The model will consider labor immigration and commodity trade in an extended partial equilibrium framework that includes the U.S. and Mexican labor and commodity markets and incorporates domestic policies, immigration policies, and trade policies. The interaction of the commodity market, domestic policies, immigration policies, and trade policies by the two nations will have an effect on the Mexican and U.S. labor markets and hence, labor migration. The extended partial equilibrium model with two countries, one commodity, and one factor is a simplification over a large general equilibrium trade model, but it provides sufficient complexity to be able to perform a more general analysis of Mexican immigration to the U.S. than earlier studies by other researchers. Thus, the extended partial equilibrium model of trade is a promising framework for policy analysis.

CHAPTER II. THEORETICAL MODEL OF TRADE IN LABOR AND COMMODITIES

The previous chapter discussed the international immigration of labor as a response to economic opportunities. Economic conditions and policies that affect the commodity and labor markets of both the destination and origin countries will influence the flow of labor.

This chapter proposes an extended partial equilibrium trade model with two countries, one commodity, and one factor to explain international immigration. The partial equilibrium trade framework is a simplified model of a larger general equilibrium trade model, but it provides a useful framework for economic analysis.

An Extended Partial Equilibrium Model of Trade in One Output and One Factor

An algebraic and graphical representation of an extended partial equilibrium trade model will be demonstrated that provides for comparative static analysis of domestic economic, trade, and immigration policies that affects labor immigration. A two-country, one-commodity, one-factor trading world is assumed which suggests that the prices and quantities of the one output and one factor are simultaneously determined in only two nations without interactions with other output and factor markets or other nations. A homogeneous traded commodity (Q) is both produced and consumed in the origin country (Country 1) and in the destination country (Country 2). Labor services (L) are assumed to be the only variable factor of production and is homogeneous in Country 1 and Country 2. Country 1 is assumed to be a net exporter of both Q and L to Country 2. All import curves are assumed to be downward sloping, not perfectly elastic or inelastic, and all export curves are assumed to be upward sloping, not perfectly elastic or inelastic. This suggests, that Country 1 and Country 2 are relatively large enough that by changing the quantity they export and import of Q and L they may alter the equilibrium exchange commodity price and wage rate. All markets are assumed to be competitive.

The extended partial equilibrium trade model can be represented by the following system of sixteen structural equations:

Commodity Market	Labor Market
2.1a) $S_1^Q = S_1^Q[P_1^{(+)}, a_1^{(+)}, w_1^{(-)}]$	2.9a) $S_1^L = S_1^L[w_1^{(+)}, s_1^{(+)}]$
2.2a) $D_1^Q = D_1^Q[P_1^{(-)}, b_1^{(+)}]$	2.10a) $D_1^L = D_1^L[w_1^{(-)}, u_1^{(+)}, P_1^{(+)}]$
2.3a) $S_2^Q = S_2^Q[P_2^{(+)}, a_2^{(+)}, w_2^{(-)}]$	2.11a) $S_2^L = S_2^L[w_2^{(+)}, s_2^{(+)}]$
2.4a) $D_2^Q = D_2^Q[P_2^{(-)}, b_2^{(+)}]$	2.12a) $D_2^L = D_2^L[w_2^{(-)}, u_2^{(+)}, P_2^{(+)}]$
2.5a) $X_1^Q = S_1^Q - D_1^Q$	2.13a) $X_1^L = S_1^L - D_1^L$
2.6a) $M_2^Q = D_2^Q - S_2^Q$	2.14a) $M_2^L = D_2^L - S_2^L$
2.7a) $X_1^Q = M_2^Q$	2.15a) $X_1^L = M_2^L$
2.8a) $P_2 = P_1 + Z$	2.16a) $w_2 = w_1 + Y$

Where:

S_i^Q is the quantity of output Q supplied by the i-th nation;

i = 1,2 (Country 1 is a net exporter of Q and L and Country 2 is a net importer of Q and L);

D_i^Q is the quantity of output Q demanded by the i-th nation;

X_1^Q is the quantity of output Q exported by Country 1;

M_2^Q is the quantity of output Q imported by Country 2;

P_i is the price of output Q in the i-th nation expressed in a common currency;

a_i is a vector of exogenous output supply shift parameters for the i-th nation that includes weather (a_{i1}), and technology (a_{i2});

w_i is the real wage rate in the i-th nation expressed in a common currency;

b_i is a vector of exogenous output demand shift parameters for the i-th nation that includes income (b_{i1}), and population (b_{i2});

S_i^L is the quantity of labor services supplied by the i-th nation;

D_i^L is the quantity of labor services demanded by the i-th nation;

S_1^L is the quantity of labor services exported by Country 1;

M_2^L is the quantity of labor services imported by Country 2;

s_i is a vector of exogenous labor supply shift parameters for the i-th nation that includes nonfarm employment opportunities (s_{i1}), and population (s_{i2});

u_i is a vector of exogenous labor demand shift parameters for the i-th nation that includes weather (u_{i1}), and technology (u_{i2});

Z is a vector of exogenous shift parameters in the price equalization equation that includes transfer costs such as transportation costs (Z_{01}), import tariffs (Z_{02}) and export tariffs (Z_{03});

Y is a vector of exogenous shift parameters in the wage rate equalization equation that includes transfer costs such as transportation costs (Y_{01}), factor import taxes (Y_{02}) and factor export taxes (Y_{03}).

For Equations (2.1a)-(2.16b), the hypothesized signs of the first derivatives of the equation with respect to a variable are indicated in parenthesis above the variable [for a discussion of the hypothesized signs see: J. M. Henderson and R. E. Quandt (1971) and R. L. Thompson (1977)].

Equations (2.1a)-(2.4a) and Equations (2.9a)-(2.12a) represent the structure of the output and labor markets for Country 1 and Country 2. The output supply and demand for labor services in each country are determined by the domestic output price, domestic wage rate and a vector of exogenous shift parameters. Similarly, the output demand for each country is determined by the domestic output price and a vector of exogenous shift parameters, and the labor supply of each country is determined by the domestic wage rate and a vector of exogenous shift parameters.

Equations (2.5a)-(2.7a) and Equations (2.13a)-(2.15a) represent the trade structure of the output and labor markets, respectively, for both countries. The exportable quantities of output and labor services for Country 1 are equal to the excess supplies of output and labor services, respectively, in Country 1. Likewise, the importable quantities of output and labor services for Country 2 are equal to the excess demands for output and labor services, respectively, in Country 2. In equilibrium, the quantities exported of output and labor services from Country 1, must respectively, equal the quantities imported of output and labor services in Country 2.

Equations (2.8a) and (2.16a) are price and wage rate equalization equations. In equilibrium, the output price (expressed in a common currency) in Country 2 and Country 1 will be equal if transportation costs of the exported output are zero and there are no export or import tariffs or other trade barriers. Likewise, the wage rate in Country 2 and Country 1 will be equal if transportation costs of the exported labor services are zero and if there are no import or export taxes or subsidies or other barriers to labor mobility on labor services.

The vectors of exogenous shift parameters (a_1, a_2, b_1, b_2, s_1, s_2, u_1, u_2) are useful for determining how the domestic supply and domestic demand for output and for labor services change as an exogenous shock is introduced into the system. The vectors of exogenous shift parameters (Z, Y) are useful for determining the affect on output price and wage rates given a change in transportation costs, tariffs, or factor taxes. Comparative static analysis of specific exogenous shocks will be demonstrated later.

The sixteen structural equations can be represented by the following six graphs (Figures 2.1a–2.1f, p. 29).

Country 1's net export of output curve (X_1^Q) is derived as the horizontal distance at each price between its domestic quantity supplied and quantity demanded. Country 2's net import of output curve (M_2^Q) is derived as the horizontal distance at each price between its domestic quantity demanded and quantity supplied. The net export and import of labor services curves for Country 1 (X_1^L) and Country 2 (M_2^L) are derived similarly as the net export and net import of output curves.

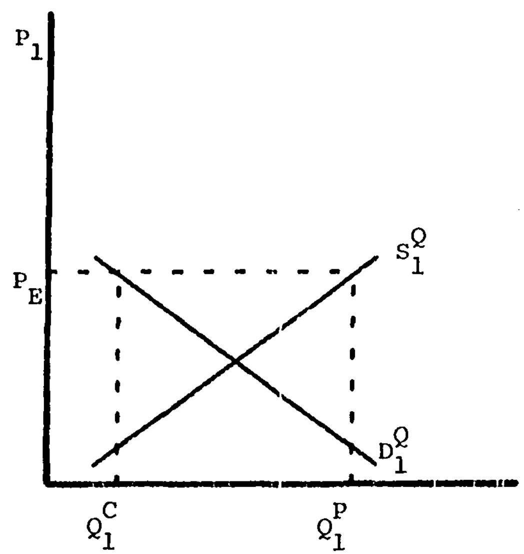

Figure 2.1a. Country 1's domestic output market

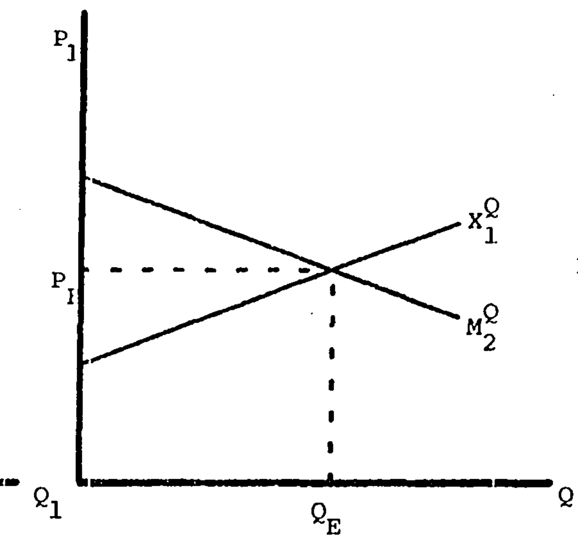

Figure 2.1b. Output exchange market

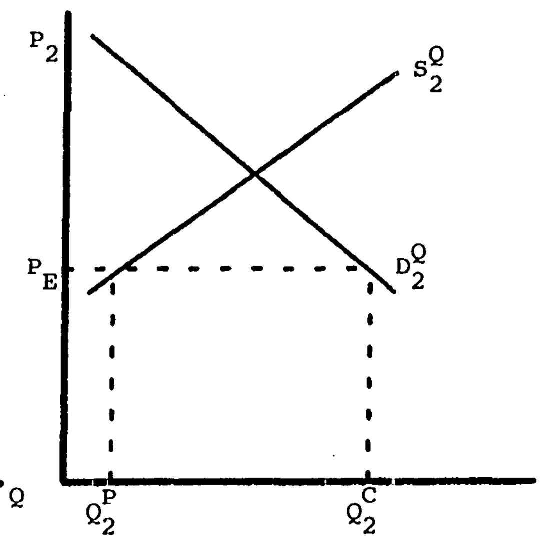

Figure 2.1c. Country 2's domestic output market

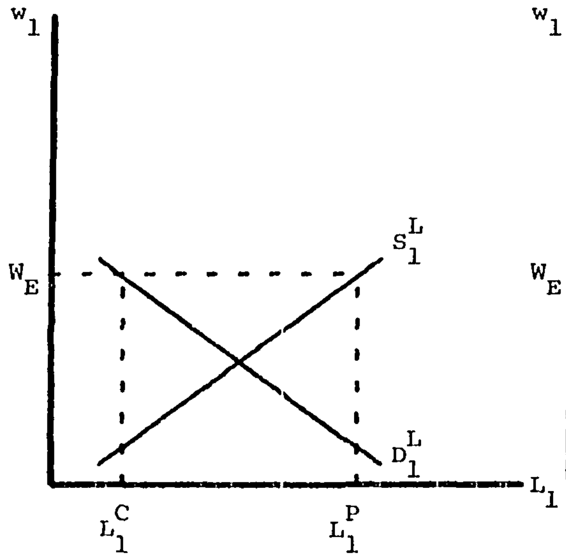

Figure 2.1d. Country 1's domestic labor market

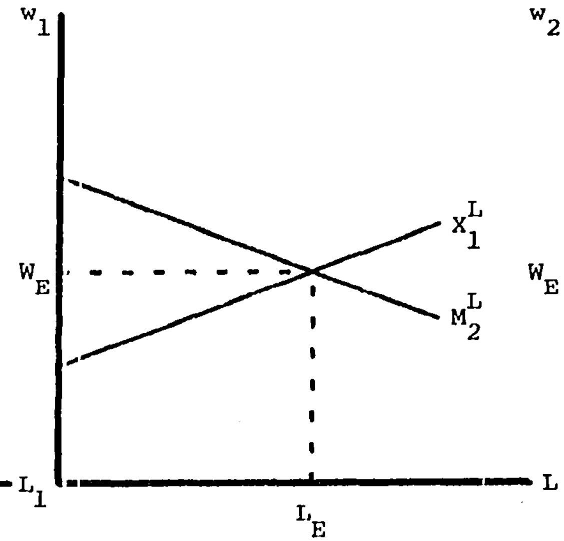

Figure 2.1e. Exchange market

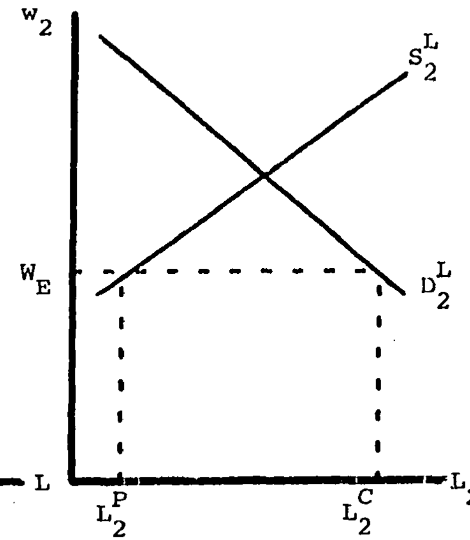

Figure 2.1f. Country 2's domestic labor market

The equilibrium quantities and prices of output and labor services are determined simultaneously in the output exchange and labor exchange markets. The intersection of Country 1's output export curve (X_1^Q) and Country 2's output import curve (M_2^Q) determines the equilibrium trade price (P_E) and equilibrium quantity traded (Q_E). Given P_E, Country 1's domestic production is the quantity Q_1^P and Country 1's domestic consumption is the quantity Q_1^C and the difference ($Q_1^P-Q_1^C$) is Country 1's export of output to Country 2. Country 2's domestic consumption is the quantity Q_2^C and Country 2's domestic production is the quantity Q_2^P and the difference ($Q_2^C-Q_2^P$) is Country 2's quantity of imports of output from Country 1. Likewise, the intersection of Country 1's labor service export curve (X_1^L) and Country 2's labor service import curve (M_2^L) determines the equilibrium trade wage rate (w_E) and equilibrium quantity of labor services traded (L_E). Given w_E, Country 1's domestic quantity (gross) supplied of labor services is L_1^P and Country 1's domestic quantity (gross) demanded is L_1^C and the difference ($L_1^P-L_1^C$) is the quantity of labor services exported or immigrating to Country 2. Country 2's domestic quantity (gross) demanded for labor services is L_2^C and Country 2's domestic quantity (gross) supplied of labor services is L_2^P and the difference ($L_2^C-L_2^P$) is the quantity of labor services traded or immigrating to Country 2 from Country 1. Note, if Country 2 administers a quota on the number of immigrants which is less than the quantity L_E, then there will exist some incentive for illegal immigration from Country 1. The number of illegal immigrants entering Country 2 will depend on the size of L_E and the quota; the smaller the quota, the larger will be the number of illegal immigrants entering Country 2.

The elasticities of the import and export of output and labor service curves, in turn, depend on the elasticities of the domestic supply and demand curves for the output and labor services. If the domestic supply and demand curves for output and labor services are flatter or more elastic, then the import and export of output and labor services curves will be flatter or more elastic.

Given that the domestic demand and supply equations for output and labor services can be represented as excess supply and excess demand equations, the system of sixteen structural equations can be reduced to a system of eight excess supply and excess demand equations in eight unknowns:

<u>Excess Supply & Demand Equations:</u>

2.1b) $X_1^Q = X_1^Q[P_1, a_1, w_1, b_1]$

2.2b) $M_2^Q = M_2^Q[P_2, a_2, w_2, b_2]$

2.3b) $X_1^Q = M_2^Q$

2.4b) $X_1^L = X_1^L[w_1, s_1, u_1, P_1]$

2.5b) $M_2^L = M_2^L[w_2, s_2, u_2, P_2]$

2.6b) $X_1^L = M_2^L$

2.7b) $P_2 = P_1 + Z$

2.8b) $w_2 = w_1 + Y$

<u>Unknowns:</u>

$\{P_1, P_2, w_1, w_2, X_1^Q, M_2^Q, X_1^L$ and $M_2^L\}$

Equations (2.1b)-(2.6b) represent the output and labor markets of Country 1 and Country 2 that includes domestic (gross) supplies, domestic (gross) demands, and trade of output and labor services. The excess supply and excess demand equations are specified as a function of all arguments in the corresponding domestic supply and domestic demand functions for Country 1 and Country 2. Equations (2.7b)-(2.8b) are price and wage rate equalization equations which specifies that the output price in both countries as well as the wage rate (expressed in a common currency) in both countries will be equalized given that transportation costs are zero and that there are no tariffs or factor taxes (i.e., transfer costs of output and labor services are zero).

The system of excess supply and excess demand equations can be simplified by equating the excess supply of output in Country 1 with the excess demand for output in Country 2 and by equating the excess supply of labor services in Country 1 with the excess demand for labor services in Country 1. By substituting the price and wage equalization equations for P_2 and w_2 the extended partial equilibrium model can be represented by two equations and two unknowns, P_1 and w_1:

$$2.1c) \quad X_1^Q(P_1,w_1,a_1,b_1) - M_2^Q(P_1 + Z,w_1 + Y,a_2,b_2) = 0$$

$$2.2c) \quad X_1^L(w_1,P_1,u_1,s_1) - M_2^L(w_1 + Y,P_1 + Z,u_2,s_2) = 0$$

In order to evaluate the directional responses of the dependent variables (X_1^Q, M_2^Q, X_1^L, M_2^L) in Equations (2.1c-2.2c) to changes in the explanatory variables (P_1,w_1, and the vectors of exogenous shift parameters) partially differentiate each of the dependent variables with respect to each of the explanatory variables. The output responses are:

2.1d) $$\frac{\partial X_1^Q}{\partial P_1} = \overset{(+)}{\frac{\partial X_1^Q}{\partial S_1^Q}} \overset{(+)}{\frac{\partial S_1^Q}{\partial P_1}} + \overset{(-)}{\frac{\partial X_1^Q}{\partial D_1^Q}} \overset{(-)}{\frac{\partial D_1^Q}{\partial P_1}} > 0$$

2.2d) $$\frac{\partial X_1^Q}{\partial w_1} = \overset{(+)}{\frac{\partial X_1^Q}{\partial S_1^Q}} \overset{(-)}{\frac{\partial S_1^Q}{\partial w_1}} < 0$$

2.3d) $$\frac{\partial X_1^Q}{\partial a_1} = \overset{(+)}{\frac{\partial X_1^Q}{\partial S_1^Q}} \overset{(+)}{\frac{\partial S_1^Q}{\partial a_1}} > 0$$

2.4d) $$\frac{\partial X_1^Q}{b_1} = \overset{(-)}{\frac{\partial X_1^Q}{\partial D_1^Q}} \overset{(+)}{\frac{\partial D_1^Q}{\partial b_1}} < 0$$

2.5d) $$\frac{\partial M_2}{\partial P_1} = \overset{(+)}{\frac{\partial M_2^Q}{\partial D_2^Q}} \overset{(-)}{\frac{\partial D_2^Q}{\partial P_2}} \overset{(+)}{\frac{\partial P_2}{\partial P_1}} + \overset{(-)}{\frac{\partial M_2^Q}{\partial S_2^Q}} \overset{(+)}{\frac{\partial S_2^Q}{\partial P_2}} \overset{(+)}{\frac{\partial P_2}{\partial P_1}} < 0$$

2.6d) $$\frac{\partial M_2^Q}{\partial Z} = \overset{(+)}{\frac{\partial M_2^Q}{\partial D_2^Q}} \overset{(-)}{\frac{\partial D_2^Q}{\partial P_2}} \overset{(+)}{\frac{\partial P_2}{\partial Z}} + \overset{(-)}{\frac{\partial M_2^Q}{\partial X_2^Q}} \overset{(+)}{\frac{\partial S_2^Q}{\partial P_2}} \overset{(+)}{\frac{\partial P_2}{\partial Z}} < 0$$

2.7d) $$\frac{\partial M_2^Q}{\partial w_1} = \overset{(-)}{\frac{\partial M_2^Q}{\partial S_2^Q}} \overset{(-)}{\frac{\partial S_2^Q}{\partial w_2}} \overset{(+)}{\frac{\partial w_2}{\partial w_1}} > 0$$

2.8d) $$\frac{\partial M_2^Q}{\partial Y} = \overset{(-)}{\frac{\partial M_2^Q}{\partial S_2^Q}} \overset{(-)}{\frac{\partial S_2^Q}{\partial w_2}} \overset{(+)}{\frac{\partial w_2}{\partial Y}} > 0$$

$$2.9d)\quad \frac{\partial M_2^Q}{\partial a_2} = \overset{(-)}{\frac{\partial M_2^Q}{\partial S_2^Q}}\,\overset{(+)}{\frac{\partial S_2^Q}{\partial a_2}} < 0$$

$$2.10d)\quad \frac{\partial M_2^Q}{\partial b_2} = \overset{(+)}{\frac{\partial M_2^Q}{\partial D_2^Q}}\,\overset{(+)}{\frac{\partial D_2^Q}{\partial b_2}} > 0$$

The input responses are:

$$2.11d)\quad \frac{\partial X_1^L}{\partial w_1} = \overset{(+)}{\frac{\partial X_1^L}{\partial S_1^L}}\,\overset{(+)}{\frac{\partial S_1^L}{\partial w_1}} + \overset{(-)}{\frac{\partial X_1^L}{\partial D_1^L}}\,\overset{(-)}{\frac{\partial D_1^L}{\partial w_1}} > 0$$

$$2.12d)\quad \frac{\partial X_1^L}{\partial P_1} = \overset{(-)}{\frac{\partial X_1^L}{\partial D_1^L}}\,\overset{(+)}{\frac{\partial D_1^L}{\partial P_1}} < 0$$

$$2.13d)\quad \frac{\partial X_1^L}{\partial u_1} = \overset{(-)}{\frac{\partial X_1^L}{\partial D_1^L}}\,\overset{(+)}{\frac{\partial D_1^L}{\partial u_1}} < 0$$

$$2.14d)\quad \frac{\partial X_1^L}{\partial s_1} = \overset{(+)}{\frac{\partial X_1^L}{\partial S_1^L}}\,\overset{(+)}{\frac{\partial S_1^L}{\partial s_1}} > 0$$

2.15d) $$\frac{\partial M_2^L}{\partial w_1} = \overset{(+)}{\frac{\partial M_2^L}{\partial D_2^L}}\,\overset{(-)}{\frac{\partial D_2^L}{\partial w_2}}\,\overset{(+)}{\frac{\partial w_2}{\partial w_1}} + \overset{(-)}{\frac{\partial M_2^L}{\partial S_2^L}}\,\overset{(+)}{\frac{\partial S_2^L}{\partial w_2}}\,\overset{(+)}{\frac{\partial w_2}{\partial w_1}} < 0$$

2.16d) $$\frac{\partial M_2^L}{\partial Y} = \overset{(+)}{\frac{\partial M_2^L}{\partial D_2^L}}\,\overset{(-)}{\frac{\partial D_2^L}{\partial w_2}}\,\overset{(+)}{\frac{\partial w_2}{\partial Y}} + \overset{(-)}{\frac{\partial M_2^L}{\partial S_2^L}}\,\overset{(+)}{\frac{\partial S_2^L}{\partial w_2}}\,\overset{(+)}{\frac{\partial w_2}{\partial Y}} < 0$$

2.17d) $$\frac{\partial M_2^L}{\partial P_1} = \overset{(+)}{\frac{\partial M_2^L}{\partial D_2^L}}\,\overset{(+)}{\frac{\partial D_2^L}{\partial P_2}}\,\overset{(+)}{\frac{\partial P_2}{\partial P_1}} > 0$$

2.18d) $$\frac{\partial M_2^L}{\partial Z} = \overset{(+)}{\frac{\partial M_2^L}{\partial D_2^L}}\,\overset{(+)}{\frac{\partial D_2^L}{\partial P_2}}\,\overset{(+)}{\frac{\partial P_2}{\partial Z}} > 0$$

2.19d) $$\frac{\partial M_2^L}{\partial u_2} = \overset{(+)}{\frac{\partial M_2^L}{\partial D_2^L}}\,\overset{(+)}{\frac{\partial D_2^L}{\partial u_2}} > 0$$

2.20d) $$\frac{\partial M_2^L}{\partial s_2} = \overset{(-)}{\frac{\partial M_2^L}{\partial S_2^L}}\,\overset{(+)}{\frac{\partial S_2^L}{\partial s_2}} < 0$$

The signs of the partial derivatives of Equations (2.1d)-(2.20d) are consistent with the previous hypothesized signs assumed in Equations (2.1a)-(2.16a).

Equations (2.1d), (2.5d), (2.11d), and (2.15d) identify the slope of the export and import of output and labor services curves, respectively. The remaining equations identify the directional shift in the export and import curves, given a change in an explanatory variable and holding all other variables constant.

The following table (Table 2.1) summarizes the initial shift in the import and export curves (excess demand and excess supply curves) for output and labor services given a change in an explanatory variable.

Table 2.1 has illustrated the <u>initial</u> (or first-round) effects on the import and export of commodity and labor services given a change in an explanatory variable. The extended partial equilibrium trade, however, permits adjustments in the commodity and factor markets and interactions between them. Hence, the total effect on the imports and exports of output and labor services given a change in an explanatory variable, depends on the interactions of the output and labor markets.

In order to see the interactions of the commodity and factor markets, it will be necessary to isolate the labor market independently of the commodity market, and trace out the effect of a change in an exogenous parameter. In Figure 2.2a, the effect on labor given a change in an exogenous parameter is illustrated. For example, consider a rise in s_{21}, which is a decrease in nonfarm employment opportunities in Country 2. Initially, the exchange wage rate is w_E and the amount of trade is L_E. After (s_{21}) rises, Country2's import of labor curve

Table 2.1. Initial effect on import and export of output and labor services curves given a change in an exogenous parameter

Specific change in an exogenous parameter	Initial effect of import and export of output and labor curves
a_{11} - increase in favorable weather conditions in Country 1 a_{12} - increase in technology of production in Country 1	X_1^Q shifts outward to the right (increase in the excess supply of output in Country 1)
a_{21} - increase in favorable weather conditions in Country 2 a_{22} - increase in technology of production in Country 2	M_2^Q shifts inward to the left (decrease in the excess demand for output in Country 2
b_{11} - increase in income in Country 1 b_{12} - increase in population in Country 1	X_1^Q shifts inward to the left (decrease in the excess supply of output in Country 1)
b_{21} - increase in income in Country 2 b_{22} - increase in population in Country 2	M_2^Q shifts outward to the right (increase in the excess demand for output in Country 2)
w_1 - increase in the wage rate	M_2^Q shifts outward to the right, and X_1^Q shifts inward to the left
P_1 - increase in output price	M_2^L shifts outward to the right, and X_1^L shifts inward to the left
u_{11} - increase in technology of production in Country 1 u_{12} - increase in favorable weather conditions in Country 1	X_1^L shifts inward to the left (decrease in the excess supply of labor services in Country 1)

Table 2.1 (Continued)

Specific change in an exogenous parameter	Initial effect of import and export of output and labor curves
u_{21} - increase in technology of production in Country 2 u_{22} - increase in favorable weather conditions in Country 2	M_2^L shifts outward to the right (increase in the excess demand for labor services in Country 2)
s_{11} - decrease in nonfarm employment opportunities in Country 1 s_{12} - increase in population in Country 1	X_1^L shifts outward to the right (increase in the excess supply of labor services' in Country 1)
s_{21} - decrease in nonfarm employment opportunities in Country 2 s_{22} - increase in population in Country 2	M_2^L shifts inward to the left (decrease in the excess demand for labor services in Country 2)
Z_{01} - increase in transportation costs of output Z_{02} - increase in import tariffs in Country 2 Z_{03} - increase in export tariffs in Country 1	M_2^Q shifts inward to the left (decrease in the excess demand for output in Country 2), and M_2^L shifts outward to the right (increase in the excess demand for labor services in Country 2)
Y_{01} - increase in transportation costs of labor services Y_{02} - increase in factor import taxes in Country 2 Y_{03} - increase in factor export taxes in Country 1	M_2^Q shifts outward to the right (increase in the excess demand for output in Country 2), and M_2^L shifts inward to the left (decrease in the excess demand for labor services in Country 2)

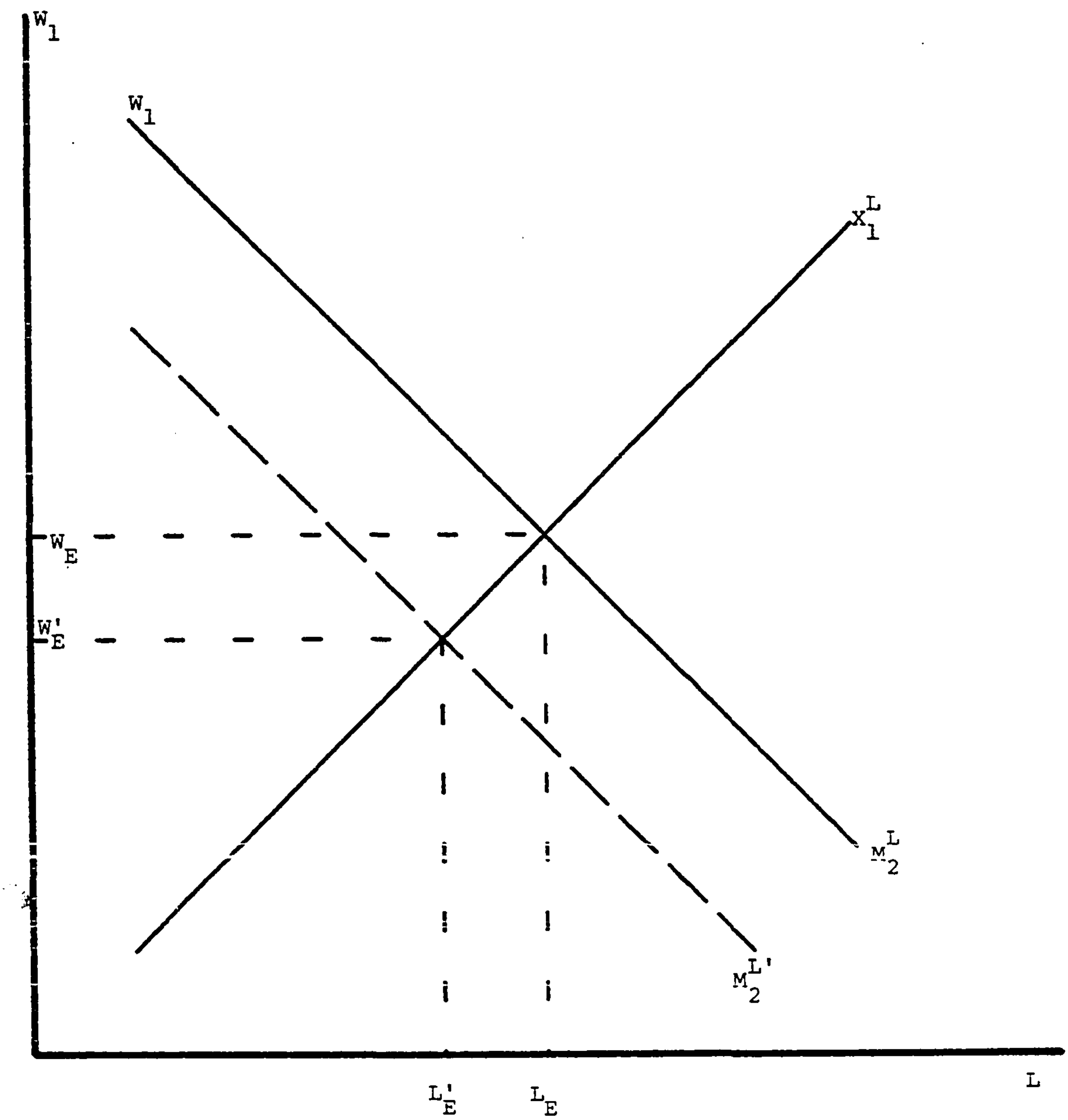

Figure 2.2a. Labor exchange market

shifts inward to $M_2^{L'}$, which results in a lower exchange wage rate of w_E' and a smaller quantity of labor traded L_E'.

The addition of the output markets results in additional opportunities for adjustment and leads to changes in output prices given a change in an exogenous parameter. Figures 2.3a-2.3b illustrate the total effect of a rise in (s_{21}) on both the output and labor markets of Country 1 and Country 2.

Initially, there exists equilibrium in all markets with Q_E quantity of output traded at the price of P_E and the quantity L_E of labor services traded at the wage rate w_E. A rise in (s_{21}) will have a first-round effect of shifting Country 2's import of labor services curve inward to $M_2^{L'}$ (shift #1) which results in a decrease in labor services traded and a decline in the wage rate to w_E'. The second-round effect will shift Country 1's export of output curve outward to $X_1^{Q'}$ (shift #2) and to shift Country 2's import of output curve inward to $M_2^{Q'}$ (shift #2), because the reduction in the wage rate reduces the domestic costs of production in Country 1 and Country 2. The exchange output price will decline to P_E' given the shifts in both countries export and import of output curves. The third-round effect consists of shifting Country 1's export of labor services curve outward to $X_1^{L'}$ (shift #3) and to shift Country 2's import of labor services curve inward to $M_2^{L''}$ (shift #3), because the decline in the output price decreases the domestic demand for labor services in each country. The exchange wage rate will decline further to w_E''. The net effect on quantity of labor services traded is an unambiguous decrease.

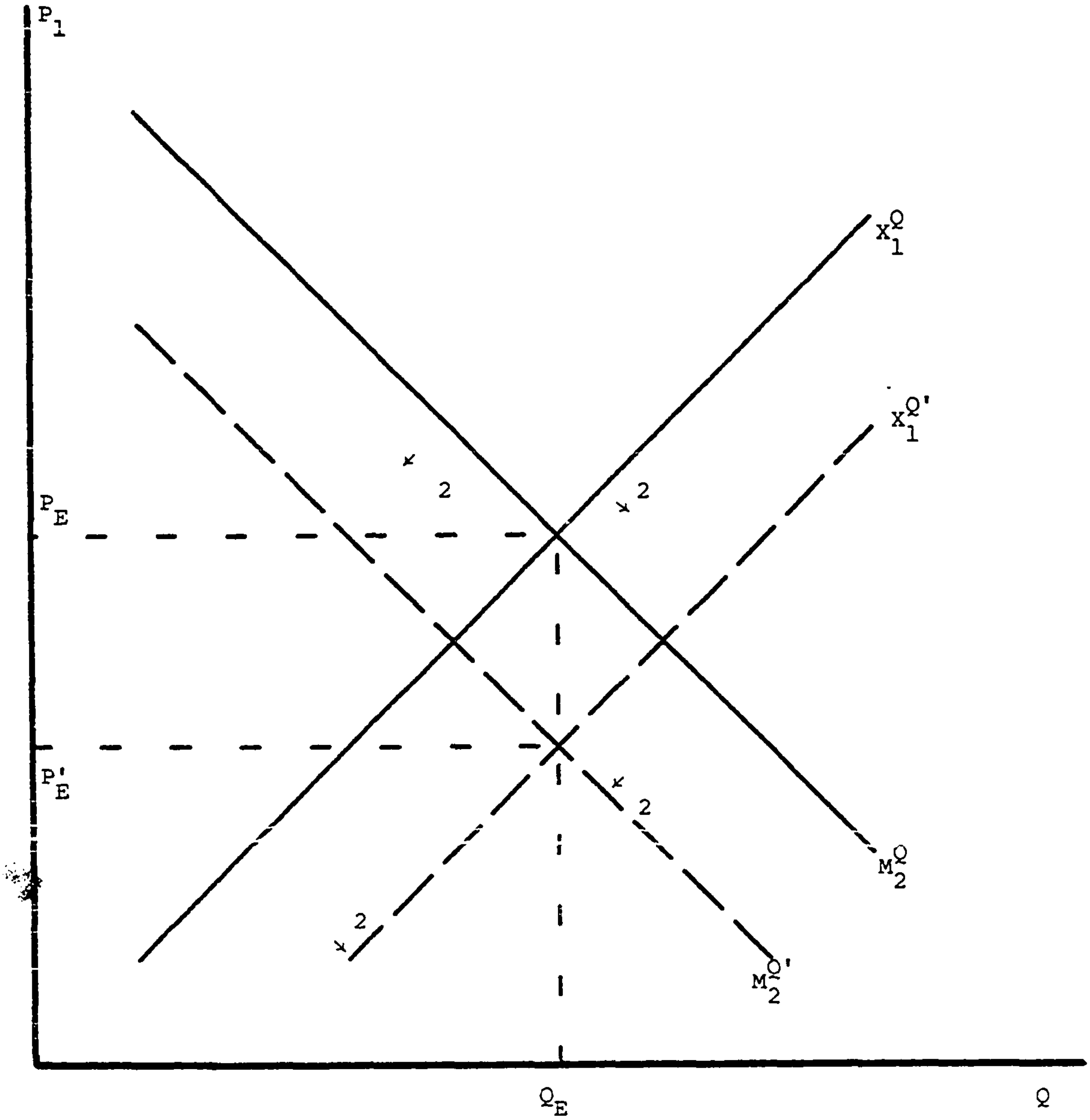

Figure 2.3a. Output exchange market

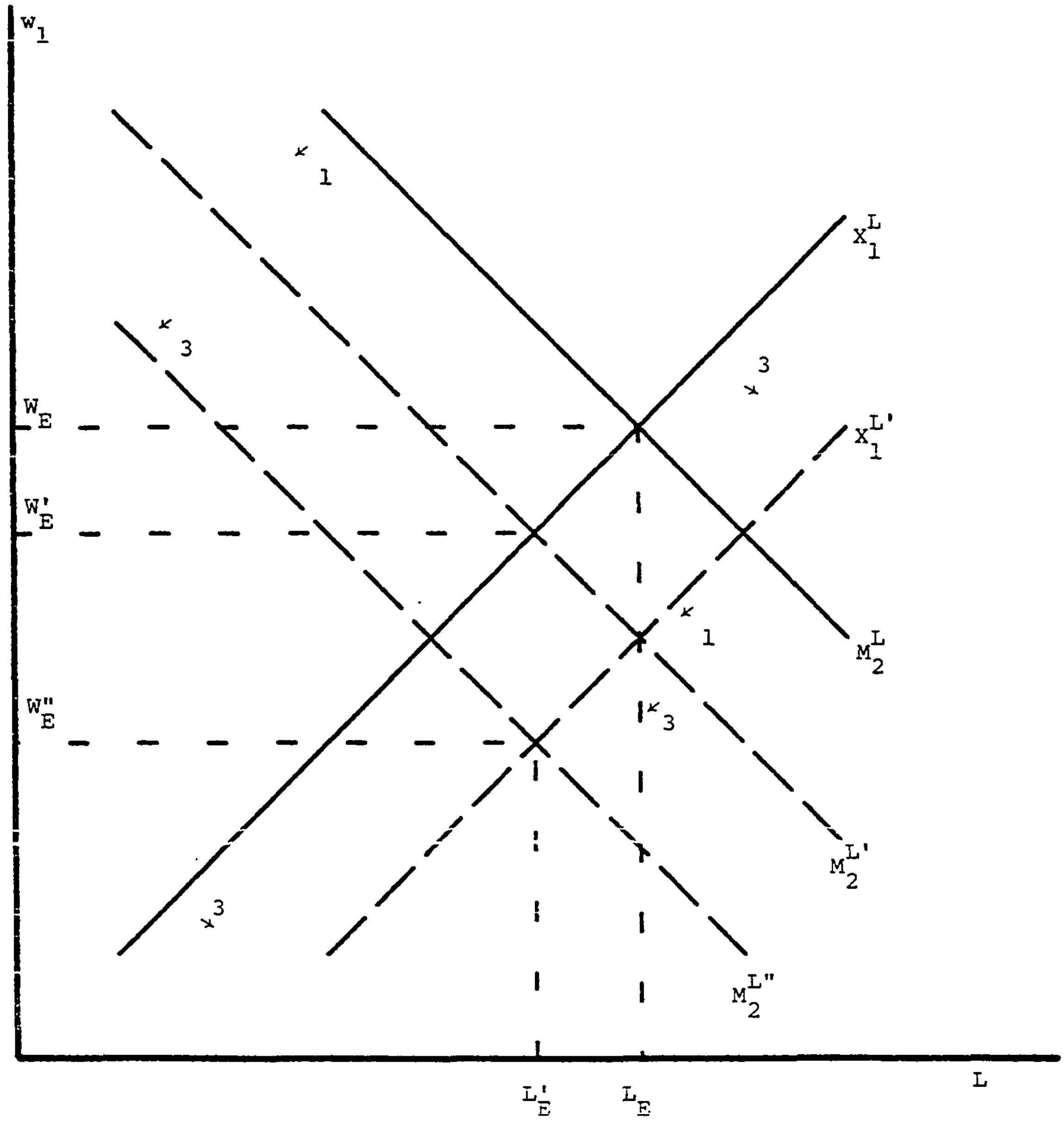

Figure 2.3b. Labor exchange market

The net effect on quantity of output traded is a priori ambiguous, depending on the relative elasticities of Country l's export of output curve and Country 2's import of output curve.

Figures 2.4a-2.4b illustrate the effect of a rise in the exogenous parameter (s_{21}) on the quantity of output traded for different relative elasticities of the import and export of output curves.

In Figures 2.4a-2.4b, given the same proportionate increase in the exogenous parameter (s_{21}), the country with the more elastic export or import of output curve will dictate the direction of the change in quantity of output traded. As shown (Figure 2.4b) if Country l's export of output curve is relatively more elastic than Country 2's import of output curve, then a rise in the exogenous parameter (s_{21}) will lead to a decrease in the quantity of output traded.

To determine the total effect of a change in any of the exogenous parameters on the quantities traded of output and labor services, a procedure similar to the one outlined above can be employed to trace the interactions of the commodity and factor markets. The following table summarizes the total effects on the imports and exports of output and labor services given a change in any of the exogenous parameters (see Appendix A for a graphical analysis of a change in any of the exogenous parameters).

Table 2.2 has provided a comprehensive list of the effects of a change in any of the exogenous parameters on the quantities of output and labor services traded. For an opposite change in any of the exogenous

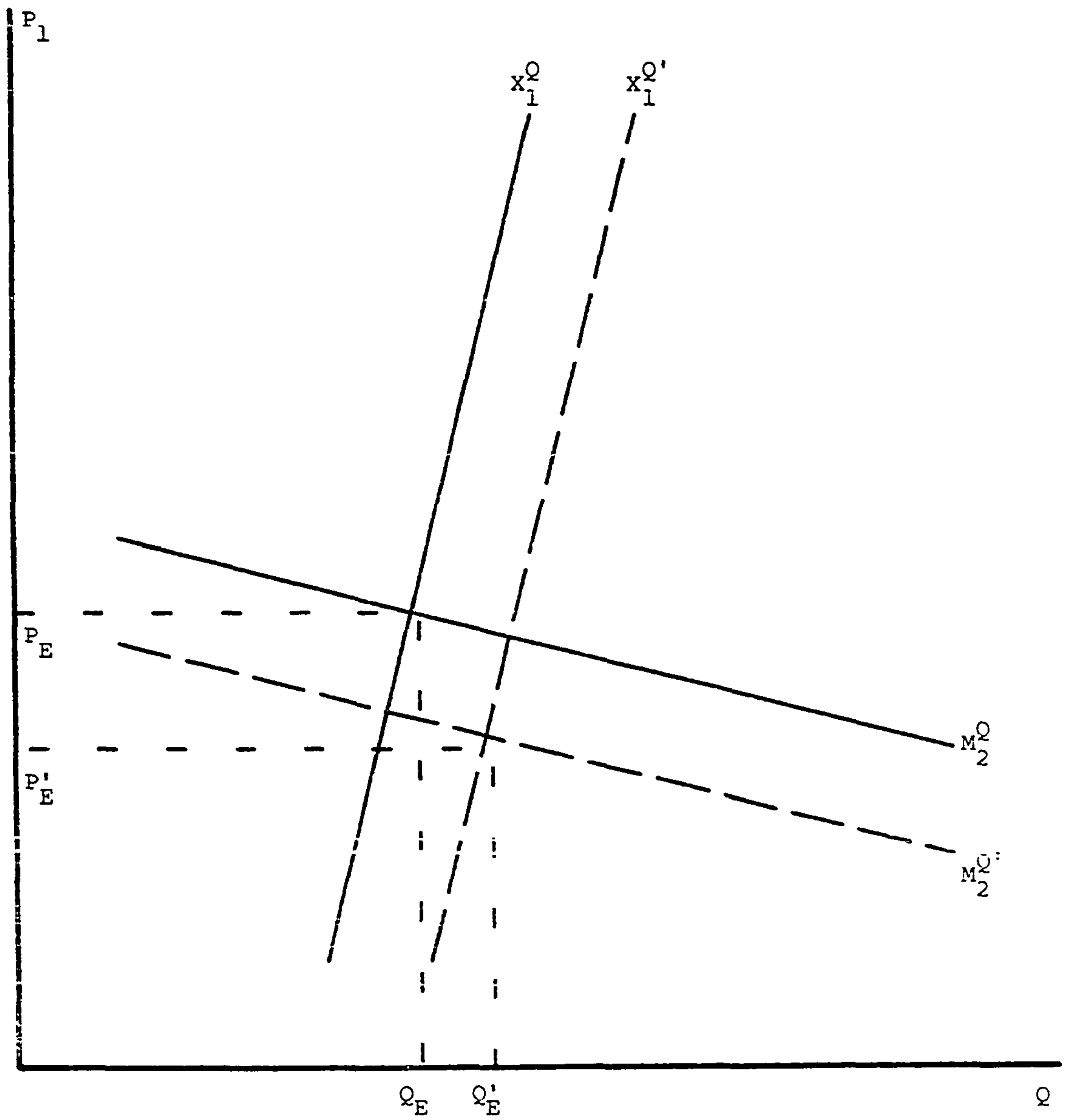

Figure 2.4a. Country 2's import of output curve relatively more elastic

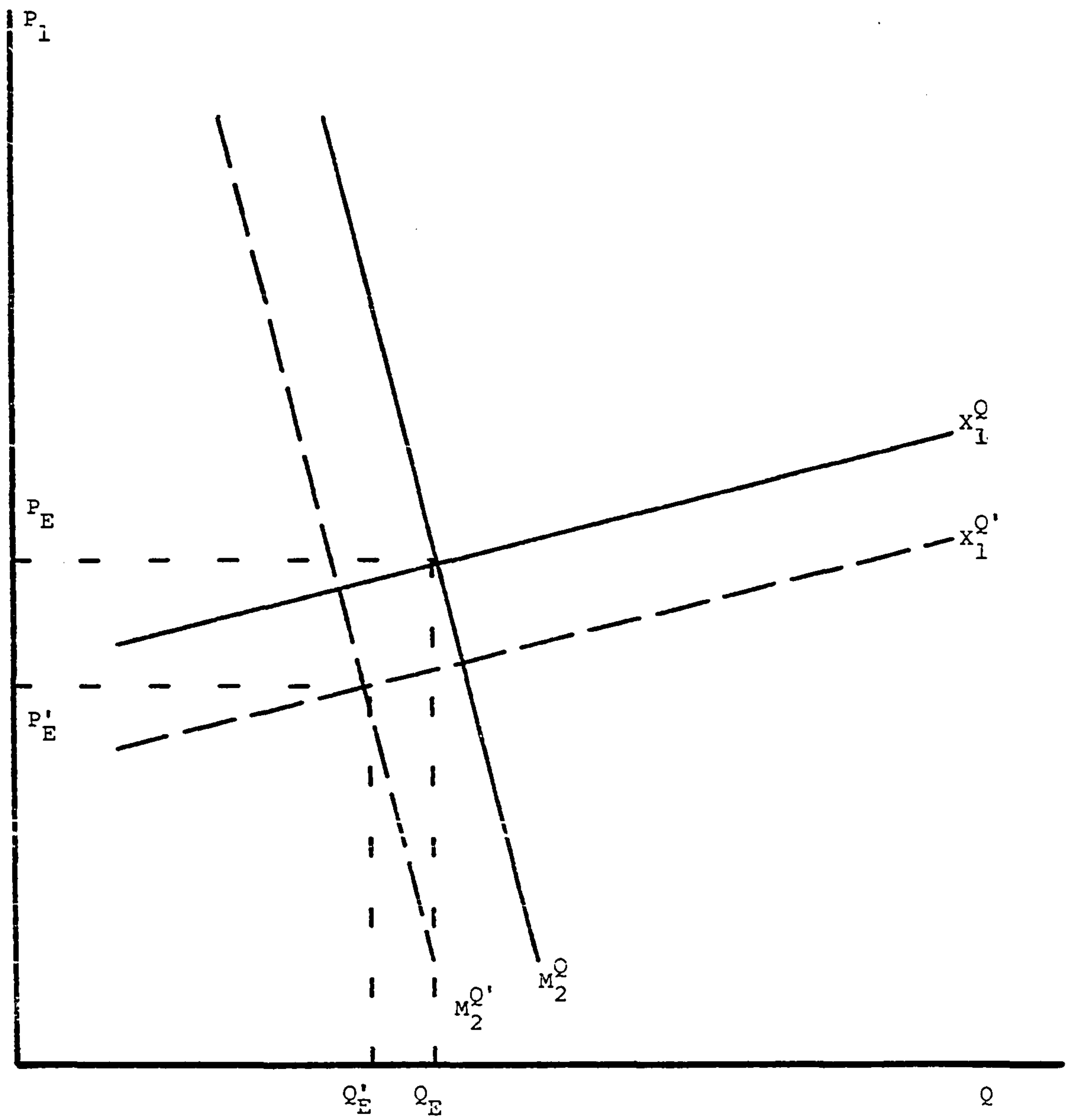

Figure 2.4b. Country 1's export of output curve relatively more elastic

Table 2.2. Effect on quantity of output and labor services traded, given a change in an exogenous parameter

Specific change in an exogenous parameter	Effect on quantity of output and labor services traded
u_{11}, a_{11} - increase in favorable weather conditions in Country 1 u_{12}, a_{12} - increase in technology of production in Country 1	Quantity of output traded increases Quantity of labor immigrating to Country 2 decreases
u_{21}, a_{21} - increase in favorable weather conditions in Country 2 u_{22}, a_{22} - increase in technology of production in Country 2	Quantity of output traded decreases Quantity of labor immigrating to Country 2 increases
b_{11} - increase in income in Country 1	Quantity of output traded declines Quantity change of labor services traded is ambiguous. If Country 1's export of labor services curve is more elastic than Country 2's import of labor services curve then the quantity of labor services traded will increase. Likewise, if Country 2's import of labor services curve is more elastic than Country 1's export of labor services curve then the quantity of labor services traded will decrease
s_{12}, b_{12} - increase in population in Country 1	Quantity of output traded decreases Quantity of labor immigration to Country 2 increases
b_{21} - increase in income in Country 2	Quantity of output traded increases Quantity change of labor services traded is ambiguous. If Country 1's export of labor services curve is more elastic than Country's 2's import of labor services curve then the quantity of labor services traded will

Table 2.2 (Continued)

Specific change in an exogenous parameter	Effect on quantity of output and labor services traded
	(Continued) increase. Likewise, if Country 2's import of labor services curve is more elastic than Country 1's export of labor services curve then the quantity of labor services traded will decrease
s_{22}, b_{22} - increase in population in Country 2	Quantity of output traded increases Quantity of labor immigrating to Country 2 decreases
s_{11} - decrease in nonfarm employment opportunities in Country 1	Quantity change of output traded is ambiguous if Country 1's export of output curve is more elastic than Country 2's import of output curve then the quantity of output traded will decrease. Likewise, if Country 2's import of output curve is more elastic than Country 1's export of output curve then the quantity of output traded will increase Quantity of labor immigrating to Country 2 will increase
s_{21} - decrease in nonfarm employment opportunities in Country 2	Quantity change of output traded is ambiguous. If Country 1's export of output curve is more elastic than Country 2's import of output curve then the quantity of output traded will decrease. Likewise, if Country 2's import of output curve is more elastic than Country 1's export of output curve then the quantity of output traded will increase Quantity of labor immigrating in Country 2 will decrease

Table 2.2 (Continued)

Specific change in an exogenous parameter	Effect on quantity of output and labor services traded
Z_{01} - increase in transportation cost of output Z_{02} - increase in import tariffs in Country 2 Z_{03} - increase in export tariffs in Country 1	Quantity of output traded decreases Quantity of labor immigrating to Country 2 increases
Y_{01} - increase in transportation costs of labor services Y_{02} - increase in factor import taxes in Country 2 Y_{03} - increase in factor export taxes in Country 1	Quantity of output traded increases Quantity of labor immigrating to Country 2 decreases

parameters, the effects on quantities traded of output and labor services will be in the opposite direction to the effects reported in Table 2.2.

The role of the elasticities of the import and export of output and labor services curves is also important in determining the effect on the quantities traded of output and labor services. The more elastic are the import and export of output and labor service curves, then the greater will be the adjustment of the quantities of output and labor services to a change in an exogenous parameter.

The exogenous parameters can be influenced by domestic economic, trade, and immigration policies. The adoption of a rigorous national birth control program may reduce population growth or government funded research may increase technology of production. Hence, policies that affect the exogenous parameters must be identified in order to explain or control commodity trade and factor immigration. The following table lists some possible policies that can change the exogenous parameters of the model (Table 2.3).

In order to determine the impact on commodity and factor trade, given a change in a policy variable, it will be necessary to combine the information in Tables 2.1 and 2.2. Table 2.4 summarizes the effect of a change in a policy variable on the quantity of output and labor services traded.

An extended partial equilibrium trade model has been developed in this chapter to explain trade in one commodity and one factor service for two trading nations. The generalized treatment of trade for two nations can be applied to the case of trade in agricultural labor and fresh market winter tomatoes between the United States and Mexico. The following chapter investigates the relationship between fresh market winter tomatoes and agricultural labor in Mexico and the United States and postulates the excess supply and excess demand functions for fresh market winter tomatoes and agricultural labor in Mexico and the United States.

Table 2.3. Policy variables that influence exogenous parameters

Specific exogenous parameters	Policy variables that influence exogenous parameters
a_{i2}, u_{i2} - domestic technology of production	Government funded research programs; extension programs
b_{i2} and s_{i2} - domestic population	Birth control programs
Z_{01} - transportation costs of output	Energy pricing policies; licenses and inspection fees on imports
Z_{02} - import tariffs	Importing nation's trade policy
Z_{03} - export tariffs	Exporting nation's trade policy
Y_{01} - transportation costs of labor services	Immigration policies and apprehension effort; energy pricing policies
Y_{02} - factor import taxes	Importing nations trade policy
Y_{03} - factor export taxes	Exporting nations trade policy

Table 2.4. Comparison of changes in the trade of output and labor services given a change in policy variable

Change in the quantity traded of output and labor services	Change in a domestic economic, trade or immigration policy variable
Reduces the quantity of labor immigrating to Country 2	A reduction in import tariffs levied by Country 2
Increases the quantity of output imported to Country 2	A reduction in export tariffs levied by Country 1
	An improvement in transportation services, which reduces transportation costs of shipping exports from Country 1
Decreases the quantity of labor immigrating to Country 2	Stricter enforcement of immigration policies, which increases transportation costs of labor services
Increases the quantity of output imported to Country 2	Increase in factor import taxes levied by Country 2
	Increase in factor export taxes levied by Country 1
Decreases the quantity of labor immigrating to Country 2	Adoption of a rigorous birth control program in Country 1
Increases the quantity of output imported to Country 2	Subsidization of labor-intensive industries in Country 1
	Increase in government funded research and extension programs in Country 1 which leads to an increase in technology

CHAPTER III. APPLICATION OF THE EXTENDED PARTIAL EQUILIBRIUM MODEL TO THE TRADE OF FRESH MARKET WINTER TOMATOES AND AGRICULTURAL LABOR IN MEXICO AND THE UNITED STATES

The illegal immigration of Mexican aliens into the U.S. can be analyzed by considering the agricultural commodity and agricultural labor markets of Mexico and the United States. Historically, most of the legal and illegal Mexican immigrants who entered the U.S. were from a rural background and entered directly into the U.S. agricultural labor market (Corwin and Fogel, 1978; Dagodag, 1975; U.S. Department of Labor, 1974; Rochin, 1978; Jenkins, 1977; and North, 1970). Over time, however, there has been a change in the occupational distribution of illegal Mexican immigrants. Many now seek employment outside of agriculture. Others continue to enter the borderlands agricultural labor force and the migratory agricultural labor force. Some illegal Mexican aliens who prefer ultimately to obtain nonagricultural employment may initially enter the agricultural labor force and then secure nonagricultural employment after they have become socialized into the Mexican-American culture. Consequently, I will restrict most of the analysis in this study to trade policy, domestic policy, immigration policy, and other factors that affect the agricultural commodity and agricultural labor markets of both the U.S. and Mexico.

Mexico and U.S. Agricultural Trade

The supply of most of the fresh market vegetables for the U.S. during the winter season, December through June, is produced by Mexico and Florida. The climates of southern Florida and Northwest Mexico are such that freezes are rare during the winter-spring months, making these areas important producers of fresh market winter vegetables. The major winter vegetable crop produced by both Mexico and Florida is tomatoes.

The termination of trade between the U.S. and Cuba in 1962 has led to a tremendous increase in the importation of fresh market tomatoes from Mexico, making Mexico the only major foreign supplier of fresh market tomatoes. Tomatoes have become Mexico's most important agricultural commodity in acreage, value and amount of labor employed.

In Florida, winter tomatoes are the largest vegetable crop in value and rank second to citrus in total revenue of all Florida agricultural commodities. Florida provides virtually all of the domestic supply of winter tomatoes in the United States (see Figure 3.1).

Tomato production in both Mexico and Florida requires a relatively large labor input. Zepp and Simmons reported in their study, "Producing Fresh Winter Vegetables in Florida and Mexico: Costs and Competition" that labor costs are the largest shares of input costs in tomato production and that tomato production is a relatively labor-intensive operation in both Florida and Mexico (Zepp and Simmons, 1979). Furthermore, Froman has found that the harvesting of tomatoes in Florida is performed by migrant Mexican-American crews (Froman, 1980b). Unfortunately, Froman did not

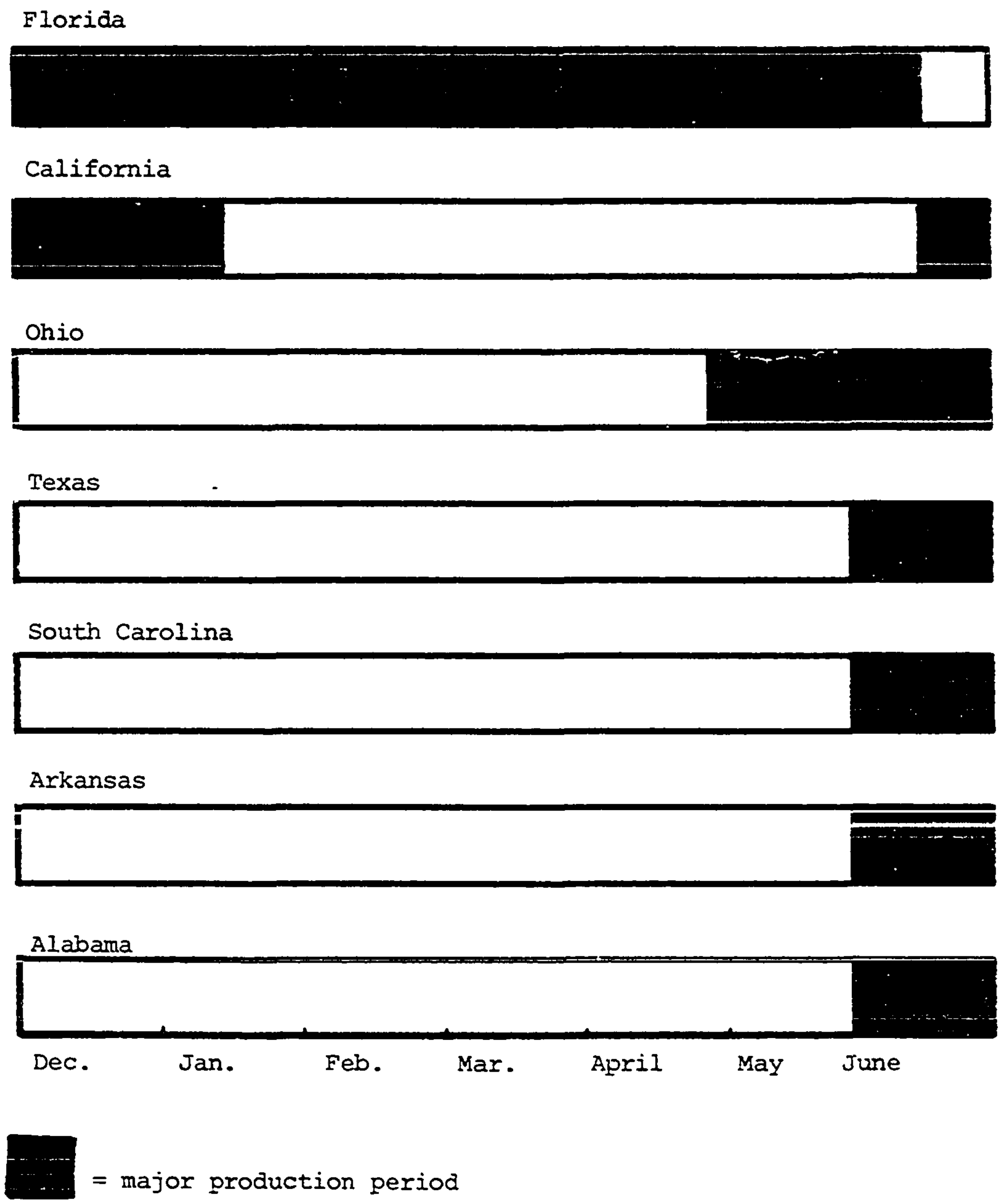

Figure 3.1. Fresh market winter tomato supplies (December-June): Major production states (U.S. Department of Agriculture, <u>Fresh Fruit and Vegetable Unloads</u> (1963-1969)

report how many illegal Mexican aliens were involved in the migrant harvesting crews, so the influence of Florida tomato production on the extent of illegal Mexican immigration is unknown.

An extended partial equilibrium model can be applied to model the interactions of the Florida and Mexico winter tomato markets and the flow of the winter-spring immigration of illegal Mexican aliens. The use of the extended partial equilibrium model is applicable to the comparative static analysis of international trade in commodities and factor inputs when there are two nations, one commodity, and one factor input.

The winter-spring (December-June) months provide a unique time period when Florida and Sinaloa, Mexico are the only producers of fresh market winter tomatoes for the U.S. market. The importance of winter tomatoes in Florida and Mexico as a labor-intensive commodity and as the only major winter vegetable crop makes tomatoes a viable commodity to analyze in the determination of illegal Mexican immigration. Factors that affect the tomato industry in Florida and Mexico will affect the amount of labor employed in tomato production and ultimately the degree of illegal Mexican immigration.

Production and Marketing of Fresh Market Winter Tomatoes in Florida and Mexico

Tomato market in Mexico

Winter tomato production in Mexico is concentrated in the Northwest. The state of Sinaloa on the Northwestern coast of Mexico accounts for 90% of the fresh market winter tomatoes exported from Mexico. The climate in the river valleys of Sinaloa is such that frosts are quite rare and over one-third of the cultivated land is rain-fed. The expansion of tomato production in Sinaloa, Mexico has primarily come about due to three factors: the diffusion of U.S. capital into Mexico following the termination of the Bracero Program; the increase in irrigation in Sinaloa, Mexico; and the improvements in the transportation network in Mexico (Froman, 1980a).

Tomatoes that are produced in Sinaloa are grown primarily for export to Nogales, Arizona. The exported tomatoes are of grade U.S. No. 1 (65% or more U.S. No. 1 quality) and are approximately 60% of the total tomato production (Froman, 1980b). The remaining tomatoes that are harvested are sold domestically and are usually of lesser quality than the exported tomatoes.

Most of the tomatoes exported to the U.S. from Sinaloa are staked tomatoes. Staked tomatoes are different from ground tomatoes in that they are more labor-intensive because of staking and tying vines, but they produce a larger quantity of fruit and allow for more pickings per season than ground tomatoes. Over 90% of the exported staked tomatoes are picked vine-ripe. Vine-ripe tomatoes are usually picked with a tinge of yellow or pink at the blossom end. Generally, the tomatoes that are exported are the larger and firmer tomatoes that can withstand extensive handling and shipping (USDA, 1980).

The production and marketing of tomatoes grown in Sinaloa involves the following steps: Planting (usually from greenhouse transplants);

irrigating (15-25 waterings per season); cultivating (10 times per season to kill weeds); fertilizing (before planting with diammonium phosphate (18-46-0)); spraying (usually by hand); harvesting (vine ripes are picked every 1 or 2 days during the harvest season); packing (sorting and loading for export at local packing houses); transportation (usually by truck to Nogales which is 600 miles north of Sinaloa); and distributing (Sinaloa growers transfer the tomatoes to Nogales distributors and then brokers arranged sales to the final customers) (USDA, 1980).

Planting of tomatoes in Sinaloa takes place from September to January with harvesting occurring from December to June. Both men and women are employed in tomato production with men generally involved in the heavy fieldwork and women employed in jobs involving dexterity such as packing and picking. Typically, one hectare of tomatoes requires over 300-400 labor-days per season with the majority of laborers hired during harvest. The hired farm laborers receive the minimum wage which usually increases every two years.

Grower associations play an important role in affecting the production and marketing of tomatoes in Sinaloa. The Union Nacional de Productores de Hortalizes (UNPH) and the Confederacion de Associaciones Agricoles del Estado de Sinaloa (CAADES) are the principal associations that govern tomato production in Sinaloa. The UNPH and CAADES establish regulations governing types of containers used in shipping, recommended maximum planting acreage, export permits based on acreage allotments, and varying quality standards for exports that adjust to U.S. prices. The regulations established by the UNPH and CAADES are administered to avoid overproduction and a resulting decline in export prices (Froman, 1980b). The effect on tomato exports resulting from the regulations set by the UNPH and CAADES is to improve the quality of tomatoes (often standards are raised above 75% U.S. No. 1) and to reduce the quantity of tomatoes during periods of low prices.

Tomato market in Florida

Florida's fresh market winter tomatoes are grown in the southwest, southeast, west central and southern parts of the state. Production starts in the central regions and moves southward as the weather becomes cooler during the winter months. As spring arrives, production moves back to the central areas.

Florida growers employ both staked and ground cultural methods in tomato production. There has been a trend by Florida growers in the past decade to adopt the labor-intensive stake culture in order to increase yields. Currently, over two-thirds of the Florida growers are now employing the stake cultural method (Froman, 1980a).

The majority of fresh market tomatoes produced in Florida are picked and marketed mature green although some vine ripes are marketed. Mature green tomatoes are picked green but will turn red naturally on or off the vine. Some growers use ethylene gas to quicken ripening after the mature greens are packed. The advantage of mature greens over vine ripes is that mature green tomatoes have a prolonged shelf life and stay firm longer.

Total production and yields have been increasing for Florida tomato growers even though tomato acreage has been decreasing. The adoption of stake tomato culture and the adoption of full-bed plastic mulch are two of the major factors responsible for increased yields. Plastic mulch has been used by Florida growers for over five years and has resulted in promoting plant growth, controlling weeds and reducing fertilizer leaching. The pre-harvest costs attributed to the adoption of plastic mulch and stake tomato culture are more than offset by the increase in yields (Zepp and Simmons, 1979).

The techniques of production and input usages differ across each tomato producing area in Florida. For any given tomato producing area there will exist different labor requirements, planting procedures, fertilizer usage, cultural operations, pesticide usage, and irrigation techniques. A characteristic common to all Florida tomato growers is that labor is the single largest share of variable production costs.

Florida's winter tomatoes are marketed through packinghouses. The packinghouses are usually owned by the growers themselves. The harvested tomatoes are brought to a packinghouse to be washed, waxed, graded, and artificially ripened,if necessary. Packinghouses sell the tomatoes through a broker or hired salesman.

Florida tomato growers are regulated by Federal Marketing Orders and the Florida Tomato Committee (Froman, 1980a). The Federal Marketing Order on Florida tomatoes governs the size, grade, container, and inspection requirements. Each year, before the growing season, the marketing order is set given the recommendations by the Florida Tomato Committee. The marketing order may be revised or changed during any given year. All tomato imports are subject to the same grade and size requirements under the federal marketing order.

Mexico's and Florida's share of the winter tomato market

Florida and Mexico have roughly split the share of the U.S. tomato market since the early 1970s. Annual fluctuations in market shares are usually attributed to weather conditions in Florida. Generally, supplies from Mexico are the largest in January through April and Florida's supplies are largest in the early and later part of the season (Zepp and Simmons, 1979).

The distribution of supplies of tomatoes to various markets in the U.S. by Mexico and Florida is not uniform. Although Mexico and Florida supply tomatoes to all regions in the United States, the geographic locations are such, that Florida supplies the Eastern United States and Mexico supplies the West. The supplies to the Mid-West fluctuate according to the season. The seasonal variations associated with market distributions are highly influenced by domestic weather and crop conditions in Mexico and Florida. When Florida experiences a killing frost, as it has in the 1970s, Mexico supplies more eastern markets.

Mexico and U.S. Trade of Labor

Mexican labor has historically immigrated to the U.S. in search of employment opportunities and economic security. The micro-economic decisions to immigrate illegally to the U.S. by Mexican laborers can be viewed in a constrained utility maximization framework and the decision to hire illegal Mexican immigrants by U.S. farmers can be viewed in a profit maximization framework. The supply of labor to the U.S. by illegal Mexican immigrants can be expressed as a function of the wage rates in Mexico and the U.S., unemployment rates in the U.S. and Mexico, the price of consumption goods in the U.S. and Mexico, unearned income in Mexico, and the Border Patrol apprehension effort (see Appendix B). Likewise, the demand for illegal Mexican immigrant labor by U.S. farmers can be expressed as a function of the domestic agricultural wage rate, prices of other inputs in production, and the price of agricultural output in the United States (see Appendix B).

The out migration of Mexican labor has occurred in the core areas of the west and north center of Mexico (Mines, 1981). Mines and Nuckton have found that the immigration process by Mexicans has frequently followed a kin network system where "at its earliest stages, a village migratory network links its numbers to agricultural, rural, and unskilled work and the immigrants are most often undocumented. As the network matures, jobs tend to become nonagricultural, urban, and semi-skilled and its migrants legalized" (Mines and Nuckton, 1982). This kin network has provided a large number of illegal Mexican immigrant laborers entering U.S. agricultural labor markets. Although the current illegal Mexican alien does not consider agriculture as the primary source of employment, many IMAs enter the U.S. agricultural labor market depending on the season, availability of alternative "secondary" employment opportunities, and the IMAs attitude toward temporary residence in the United States (Mines and Nuckton, 1982).

The U.S. labor market has also facilitated the illegal Mexican immigration process. Agriculture in the U.S. has become more capital-intensive in some of the historically labor-intensive sectors, such as in processed fruits and processes vegetable crops, but there still exists a demand for significant quantities of labor in the labor-intensive fresh fruit and fresh vegetable sectors in the United States. Similarly, many employment opportunities in low skilled industry are available. The supply of labor to low-skilled jobs has been affected by economic and demographic factors in the United States. Transfer payments such as U.S. welfare payments and the shift to a more human capital-intensive labor force in the U.S. have in effect reduced the domestic supply of labor to low-skilled jobs (Rochin, 1978).

Factors present in both the U.S. and Mexican labor markets and economics have influenced the illegal immigration of Mexican labor. In Chapter I, several factors influencing the illegal immigration of Mexican labor to the U.S. were discussed:

1) development of irrigated southwestern agricultural land;

2) the occurrence of WWI, WWII and the Korean War;

3) the establishment of the Bracero Program in the U.S.;

4) the development of capital-intensive industry in Mexico; and,

5) the establishment of Mexican trade policies, such as "import substitution" and the "Twin Plants Program".

No single factor appears to be responsible for the illegal immigration of Mexican labor to the United States. Mines in his study of a Mexican sending community has adequately summarized the causal relationships between factors influencing Mexican migration to the United States. The maintenance of a high demand for low-wage labor in the U.S. and the shift to an older, better-educated domestic labor force have opened up the highly uneven and region-specific development patterns in Mexico. Mexico has not produced adequate employment for its burgeoning population and has compelled hundreds of thousands of Mexicans to follow their networks across the international frontier to fill low-wage job slots (Mines, 1981).

Modeling the Agricultural Labor and Tomato Markets in Florida and Mexico

In Chapter II, a theoretical model of immigration was developed by examining the excess supply and excess demand equations for one commodity and one factor service in an extended partial equilibrium framework. Equations 2.1b-2.8b in Chapter II represent the full structural model in the determination of trade in one commodity and one factor service. Similarly, the winter fresh tomato and agricultural labor markets of

Florida and Mexico can be modeled in an extended partial-equilibrium framework. The Mexican winter tomato and agricultural labor markets can be represented by a system of excess supply equations given that Mexico is a net exporter to the U.S. of winter tomatoes and labor. Likewise, Florida's winter tomato and agricultural labor markets can be represented by a system of excess demand equations.

U.S. excess demand for fresh market winter tomatoes

The U.S. excess demand for fresh market winter tomatoes is the difference between the aggregate quantity demanded in the United States during December-June and the quantity of fresh market winter tomatoes produced in Florida (nearly all of the domestic winter fresh market tomatoes are produced in Florida). The following equations represent the structural model of the U.S. market for fresh winter tomatoes:

U.S. domestic demand for tomatoes:

3.1a) $$D_2^T = D_2^T(\overset{(-)}{P_2}, \overset{(+)}{IN_2}, \overset{(+)}{POP_2})$$

U.S. domestic supply of tomatoes:

3.2a) $$S_2^T = S_2^T(\overset{(+)}{P_2}, \overset{(-)}{W_2}, \overset{(-)}{LPG_2}, \overset{(-)}{TP_2}, \overset{(+)}{PR_2}, \overset{(-)}{IR_2}, \overset{(+)}{P_2^*})$$

U.S. excess demand for tomatoes:

3.3a) $$M_2^T = D_2^T - S_2^T = M_2^T(\overset{(-)}{P_2}, \overset{(+)}{W_2}, \overset{(+)}{IN_2}, \overset{(+)}{POP_2}, \overset{(-)}{PR_2}, \overset{(+)}{LPG_2}, \overset{(+)}{IR_2}, \overset{(-)}{P_2^*}, \overset{(+)}{TP_2})$$

where:

M_2^T = is the quantity of fresh market winter tomatoes imported into the U.S. from Mexico

P_2 = is the real average Florida growers' price for fresh market winter tomatoes (dollars per cwt)

W_2 = is the real farm wage per day in Florida for hired laborers

LPG_2 = is the one year lag of real average Florida growers' price for fresh market green peppers (dollars per cwt)

IN_2 = is the real U.S. personal income in billions of dollars, seasonally adjusted

POP_2 = is the population of the U.S.

PR_2 = is the index of farm output for vegetables in southeastern U.S.

P_2^* = is the expected real average Florida growers' price for fresh market tomatoes (dollars per cwt)

TP_2 = is the square root of the average number of freeze days per month in Daytona, Florida and Tampa, Florida

IR_2 = is the real U.S. agricultural interest rate

The hypothesized signs of the first derivative of each dependent variable with respect to the independent variable is given in the parenthesis above each variable. All price, wage, and income variables are expressed in real terms to account for changes in the aggregate price level.

U.S. domestic demand function for fresh market winter tomatoes

The U.S. demand function for tomatoes specifies the quantity of fresh market winter tomatoes during December-June as an inverse function of the price of tomatoes and as a positive function of income and population. The inclusion of personal income and population accounts for changes in the demand for tomatoes due to growth in population and changes in income (Firch and Young, 1968). An increase in real personal income, <u>ceturus paribus</u>, will lead to an increase in the demand for tomatoes (assuming tomatoes are a normal good in consumption in the United States). Increases in population will increase the aggregate demand for tomatoes.

<u>U.S. domestic supply function of fresh market winter tomatoes</u> The U.S. supply function for fresh winter market tomatoes specifies the quantity produced by Florida tomato producers during December-June as a positive function of the actual and expected price of tomatoes and agricultural productivity in the southeastern U.S. and as an inverse function of the price of a substitute crop (lagged green pepper prices), weather and input costs (farm wage rates and the agricultural interest rate). The price of a substitute crop will influence Florida tomato growers' decision to plant tomatoes. As the price of substitute crops increases, the quantity supplied of tomatoes is expected to decline. Low temperatures will affect the setting of fruit or may kill the plant and cause a reduction in quantity of tomatoes supplied. The farm wage rate is a price for an important input. The agricultural interest rate accounts for the opportunity cost of capital by Florida tomato growers (Shonkwiler and Emerson, 1981).

The supply response by Florida tomato growers is composed of both an acreage response and a yield response. The modeling of the supply response by growers with respect to tomato prices must take into account that producers initially decide on acreage for planting (acreage response) and then decide on the intensity or number of times the crop can be picked (yield response). The number of times farmers pick their tomatoes affects the tomato yield (staked tomatoes can be picked up to five times and ground tomatoes twice). Zepp and Simmons have reported that crop conditions and the actual market price are the primary factors governing tomato farmers harvesting decision (Zepp and Simmons, 1979). Hence, current tomato prices will affect the supply response via affects on yields.

The acreage response by tomato farmers is a decision that takes place at the time of planting, but the price that farmers will receive for them is generally unknown (unless they are contracted). Farmers form expectations about these harvest prices of tomatoes. Because expectations are not directly observable, the choice of a particular model of tomato growers formulation of expectations of future tomato prices can not *a priori* be determined. The available expectation models include a simple naive expectation model, Nerlove's adaptative expection model, and the rational expectations model.

Naive price expectations model If tomato growers formulate their tomato price expectations based on the previous year's price, then a simple naive expectations model may be represented as:

3.1b) $E(P_t/P_{t-1}) = f(P_{t-1})$.

This naive model of expectations suggests that the harvest price of tomatoes in previous years can be used as a prediction of the current tomato harvest price (Chern and Just, 1978). The simple naive model can be expanded to include prices for several previous years:

$$3.2b)\quad E(P_t/P_{t-1}, P_{t-2},\ldots) = \sum_{i=1}^{n} a_i P_{t-1} \qquad n = 2,3,4,\ldots$$

where a_i's are some specified weights and

$$\sum_{i=1}^{n} a_i = 1$$

In terms of empirical analysis, this simple naive expectational model can be adopted to provide for predictions of future tomato harvest prices.

Nerlove's adaptative expectation model The adaptative expectation model was developed by Marc Nerlove on the premise that "farmers react, and this expected price depends only to a limited extent on what last year's price was" (Nerlove, 1956). On the basis of this premise, Nerlove hypothesized that "each year farmers revise the price they expect to prevail in the coming year in proportion to the error they made in predicting price this period" (Nerlove, 1956). This hypothesis is expressed mathematically as:

$$3.1c)\quad P^*_t - P^*_{t-1} = B(P_{t-1} - P^*_{t-1}) \qquad 0<B\leq 1$$

where:

P^*_t is the price expected this year

P^*_{t-1} is the price expected last year

P_{t-1} is the actual price last year,

B is a constant representing the proportion of error by which farmers revise their expectations

This expression can be restated as:

3.2c) $P_t^* = BP_{t-1} + (1-B)BP_{t-2} + (1-B)^2BP_{t-3} + \ldots$, or

3.3c) $P_t^* = B\sum_{i=1}^{n}(1-B)^{i-1}P_{t-i}$

Expression 3.3c suggests that expected price can be represented as a geometrically declining lag formulation in which the weights of past prices decline over time. The value of B (the coefficient of adjustment) is determined by the data. The value of n will be influenced by the value of B. The closer is B to one (i.e., the more important is the previous expectation), then the smaller will be the size of n or the fewer will be the number of years of previous prices that must be considered.

Nerlove incorporated the adaptative expectation model into an acreage response function in order to obtain estimates of the elasticities of supply of selected agricultural commodities. He specified acreage response as a function of expected price. His equation relating acreage to expected price is:

3.1d) $X_t = c_0 + c_1P_{t-1} + c_2X_{t-1} + v_t$

where:

X_t is the number of acres actually planted

X_{t-1} is last years acres planted

P_{t-1} is last years actual price

v_t is a random disturbance term

The empirical results Nerlove obtained with the above equation suggested an improvement over the simple naive expectational model. The estimates of the elasticity of acreage to price and the percentage of the variance of acreage explained appeared to be improved (Nerlove, 1956).

In terms of empirical analysis, Nerlove's adaptative expectation model can be easily applied to the case of one explanatory variable. When there are several explanatory variables, the estimation procedure becomes difficult because the reduced-form equation becomes complex, and the number of degrees of freedom is reduced (Nerlove and Addison, 1958; and Chern and Just, 1978).

Rational expectations hypothesis Under the rational expectations hypothesis, farmers formulate price expectations based on the structure of the economic system which suggests that farmers form price expectations by considering all information available in the supply and demand model (Muth, 1961). The information available in the supply and demand model is incorporated into predictions of the exogenous variables in the structural model and these predictions of the exogenous variables will depend on past values of the exogenous variables (Wallis, 1980).

In estimating the acreage response by farmers using the rational expectations hypothesis, the reduced form equation for the expected price must be expressed as a function of all of the predicted exogenous variables. The exogenous variables are forecasted as a linear function of the values of the exogenous variables in previous years. The forecasted values of the exogenous variables are then substituted into the reduced form equation for the expected price. Finally, the reduced form equation is substituted into the acreage response function, making acreage response a function of all of the forecasted exogenous variables.

Shonkwiler and Emerson incorporated the rational expectations hypothesis in a model of tomato grower's response to prices (Shonkwiler and Emerson, 1981). Their empirical procedure compared price expectations based on the rational expectations hypothesis and the adaptative expectations model in a full structural model. The estimating method they employed was full information maximum likelihood. The results obtained showed an improvement in the acreage response equation which is consistent with the theory that farmers make acreage decisions based on expectations of prices.

The empirical estimation procedure involved in incorporating the rational expectations hypothesis has been demonstrated to be quite complex for estimating supply response function for one country. When supply response functions for two nations are estimated simultaneously, the estimated procedure and reduced form equations become even more complex.

None of the price expectation models that have been presented can be accepted or rejected on *a priori* grounds. There exists a tradeoff between the use of the simple naive expectation model which can be easily implemented versus the use of more sophisticated models that suffer from complex empirical specifications. Given these circumstances, the formulation of price expectations used in this study will be based on the simple naive price expectations that assume growers formulate price expectations based on the previous year's price.

U.S. excess demand for agricultural labor

The U.S. excess demand for labor is assumed to be the difference between the winter (December-June) demand for hired agricultural labor in Florida and the winter supply of agricultural labor in Florida. The assumption that the winter U.S. excess demand for labor is essentially the winter excess demand for labor in Florida, allows for the simplification that the Florida tomato price and the Florida agricultural wage rate are the only commodity price and wage variables that need to be included in the U.S. excess demand for agricultural labor function. This study did not include alternative output prices such as the price of citrus in Texas, Florida or California or other winter U.S. vegetable prices. Likewise, alternative regional agricultural wage rates for California and Texas were not included. The following equations represent the structural model of the U.S. agricultural labor market:

U.S. domestic demand for agricultural labor:

$$3.1e)\quad D_2^L = D_2^L(\overset{(-)}{w_2},\ \overset{(+)}{P_2},\ \overset{(+)}{PR_2},\ \overset{(-)}{IR_2},\ \overset{(-)}{TP_2},\ \overset{(+)}{P_2{*}}),$$

U.S. domestic supply of agricultural labor:

$$3.2e)\quad S_2^L = S_2^L(\overset{(+)}{w_2},\ \overset{(+)}{POP_2},\ \overset{(+)}{UNE_2}),$$

U.S. excess demand for agricultural labor:

$$3.3e)\quad M_2^L = D_2^L - S_2^L = M_2^L(\overset{(-)}{w_2},\ \overset{(+)}{P_2},\ \overset{(-)}{POP_2},\ \overset{(+)}{P_2^*}.\ \overset{(+)}{PR_2},\ \overset{(-)}{TP_2},\ \overset{(-)}{IR_2},\ \overset{(-)}{UNE_2}).$$

where:

M_2^L = the quantity of agricultural labor immigrating from Mexico to the United States[1]

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[1]The number of deportable Mexican adult males found in the U.S., by month is used as a measure of the excess demand for labor in the United States. It is hypothesized that the proportion of the number of deportable Mexican aliens found in the U.S. that enter Florida's labor market depends on economic variables and that this relationship is stable over time. The following equations model this relationship:

1. $XD_L^{AGU} = a_0(X_0)XD_L^{TOTU} \qquad XD_L^{TOTU} = a_0^{-1}(X_0)XD_L^{AGU}$
2. $XD_L^{TOTU} = a_1(X_1)A \qquad A = a_1^{-1}(X_1)SD_L^{TOTU}$
3. $XD_L^{AGF} = a_2(X_2)XD_L^{AGU} \qquad XD_L^{AGU} = a_2^{-1}(X_2)XD_L^{AGF}$

where:

XD_L^{AGU} = the excess demand for low-skilled agricultural labor in the U.S.

XD_L^{TOTU} = the excess demand for all low-skilled labor in the U.S.

XD_L^{AGF} = the excess demand for low-skilled agricultural labor in Florida

A = the number of deportable Mexican aliens found in the U.S.

$a_0(X_0)$ = the proportion of the total excess demand for all low skilled labor in the U.S. to the excess demand for low-skilled agricultural labor in the U.S. (X_0 - includes the U.S. manufacturing wage rates, U.S. unemployment rate, U.S. agricultural wage rates, technology, U.S. manufacturing output prices, and U.S. agricultural output prices)

$a_1(X_1)$ = the proportion of the number of deportable Mexican aliens found in the U.S. to the total excess demand for all low-skilled labor in the U.S. (X_1 - depends on the Border Patrol apprehension effort)

$a_2(X_2)$ = the proportion of the excess demand for low-skilled agricultural labor in the U.S. to the excess demand for low-skilled agricultural labor in Florida (X_2 - includes Florida's agricultural wage rate, the U.S. agricultural wage rate, Florida's agricultural output prices and the U.S. agricultural output price)

Equations 1-3 can be solved for (A):

4. $A = a_1^{-1}(X_1)a_0^{-1}(X_0)a_2^{-1}(XD_L^{AGF})$

Equation 4 states that there is a link or a relationship between the number of deportable Mexican aliens found in the U.S. and the excess demand for low-skilled agricultural labor in Florida. It is assumed that this relationship, which depends on economic variables, is stable over time.

w_2 = the real farm wage per day in Florida for hired laborers

P_2 = the real average Florida growers price for fresh market winter tomatoes (dollars per cwt)

PR_2 = the index of farm productivity for vegetable farms in southeastern United States (1967=100)

IR_2 = the real U.S. agricultural interest rate

TP_2 = the square root of the average number of freeze days in Daytona, Florida and Tampa, Florida

P_2^* = the expected real average Florida growers price of fresh market tomatoes (dollars per cwt)

UNE_2 = the U.S. unemployment rate; proxy for nonfarm employment opportunities and expected wage rate in the United States

POP_2 = the population of the United States

All price and wage variables are expressed in real terms to account for changes in the aggregate price level. The hypothesized sign of the first derivative of each independent variable with respect to the dependent variable is given above each independent variable.

U.S. domestic demand function for agricultural labor

The U.S. demand for agricultural labor is the quantity of agricultural labor demanded in Florida during December-June and is a positive function of the price of tomatoes, the expected price of tomatoes, and technology (agricultural productivity) and is an inverse function of freezing weather and input costs (wage rate and agricultural interest rate). The actual price of tomatoes and the level of technology are included in the demand function to account for shifts in demand due to changes in the final product price and changes in technology (Walker, 1975). Increases in the expected price of tomatoes will lead to increases in tomato production and the demand for agricultural labor. Freezing weather will reduce tomato output and decrease the amount of labor required for harvest. Increases in the agricultural interest rate will lead to higher input costs on land and purchased inputs, reducing tomato production and the amount of labor demanded.

U.S. supply function of agricultural labor

The U.S. supply of agricultural labor specifies the quantity of agricultural labor supplied to the U.S. during December-June as a positive function of the Florida farm wage rate, U.S. population, and U.S. nonfarm employment opportunities (U.S. unemployment rate). Changes in the U.S. civilian unemployment rate reflect changes in nonfarm employment opportunities which will influence the supply of labor to agriculture (Morgan, 1980). For example, a decline in the U.S. civilian unemployment rate increases the probability of securing nonfarm employment which will reduce the supply of agricultural labor. The size of the United States population will influence the size of the labor force and the supply of labor to agriculture (Tyrchniewicz and Schuh, 1969).

Mexico's excess supply of fresh market winter tomatoes

Mexico's excess supply of fresh market winter tomatoes is the difference between the December-June aggregate quantity of tomatoes supplied in Mexico and the aggregate quantity demanded in Mexico. The following equations represent the structure of Mexico's market for fresh winter tomatoes:

Mexico's domestic supply of tomatoes:

3.1f) $S_1^T = S_1^T(\overset{(+)}{P_1}, \overset{(-)}{w_1}, \overset{(-)}{LPF_1}, \overset{(+)}{TP_1}),$

Mexico's domestic demand for tomatoes:

3.2f) $D_1^T = D_1^T(\overset{(-)}{P_1}, \overset{(+)}{IN_1}, \overset{(+)}{POP_1}),$

Mexico's excess supply of tomatoes:

3.3f) $X_1^T = S_1^T - D_1^T = X_1^T(\overset{(+)}{P_1}, \overset{(-)}{w_1}, \overset{(-)}{LPF_1}, \overset{(+)}{TP_1}, \overset{(-)}{IN_1}, \overset{(-)}{POP_1}).$

where:

X_1^T = the quantity of fresh market winter tomatoes exported from Mexico to the United States

P_1 = the real price per cwt for extra large size breakers and ripers tomatoes F.O.B. Nogales, Arizona, duty and crossing charges paid, in pesos

w_1 = the real daily minimum wage for laborers in Sinaloa, Mexico, in pesos

LPF_1 = the real lagged price for diammonium phosphate (18-46-0) fertilizer in pesos

TP_1 = the average temperature in Culican, Sinaloa, Mexico

IN_1 = the real national income in Mexico in pesos

POP_1 = the population in Mexico

All price, wage and income variables are expressed in real terms to account for changes in the aggregate price level. The hypothesized sign of each independent variable with respect to the dependent variable is given in the parentheses above each independent variable.

Mexico's domestic supply function of fresh market winter tomatoes

Mexico's supply function of tomatoes specifies the quantity of tomatoes produced in Mexico during December-June as a positive function of the price of tomatoes and weather (average temperatures in Mexico's tomato producing area) and as an inverse function of input costs (labor and fertilizer). Moderate to high temperatures in the tomato producing regions in Mexico will increase the yield of tomatoes in Mexico during the winter months. The lagged price for diammonium phosphate (18-46-0) fertilizer is used to account for changes in fertilizer input costs. The lagged fertilizer price reflects the farmer's decision to apply pre-plant fertilizer.

The supply response by Mexican tomato growers to tomato prices is different from the supply response by Florida tomato growers. Growers' unions such as CAADES and UNPH play an active and important role in a Mexican tomato grower's decision regarding acreage planted and intensity of harvest (Zepp and Simmons, 1979). Hence, it is argued that the current Mexican tomato price best explains output response, because acreage response is heavily influenced by growers' unions in Mexico.

Mexico's domestic demand function for fresh market winter tomatoes Mexico's demand for tomatoes is the quantity of fresh market winter tomatoes consumed domestically during December-June in Mexico and is an inverse function of the price of tomatoes and a positive function of income and population. Population and income are included in the demand function to account for changes in demand due to growth in these variables. Increases in real national income and population will lead to increases in the aggregate demand for tomatoes (assuming tomatoes are a normal good in consumption in Mexico).

Mexico's excess supply of agricultural labor

Mexico's excess supply of labor is the difference between the quantity of agricultural labor domestically supplied during December-June and the quantity of agricultural labor demanded for this period. The following equations represent the structure of Mexico's agricultural labor market:

Mexico's domestic supply of agricultural labor:

$$3.1g)\quad S_1^L = S_1^L(\overset{(+)}{w_1}, \overset{(-)}{MW_1}, \overset{(+)}{POP_1}, \overset{(+)}{UNE_1}),$$

Mexico's domestic demand for agricultural labor:

$$3.2g)\quad D_1^L = D_1^L(\overset{(-)}{W_1}, \overset{(+)}{P_1})$$

Mexico's excess supply of agricultural labor:

$$3.3g)\quad X_1^L = S_1^L - D_1^L = X_1^L(\overset{(+)}{w_1}, \overset{(-)}{P_1}, \overset{(-)}{MW_1}, \overset{(+)}{POP_1}, \overset{(+)}{UNE_1})$$

where:

X_1^L = the quantity of agricultural labor immigrating from Mexico to the United States

w_1 = the real minimum wage rate per day for laborers in Sinaloa, Mexico

P_1 = the real price per cwt for extra large size breakers and ripers tomatoes F.O.B. Nogales, Arizona, duty and crossing charges paid, in pesos

MW_1 = the real monthly earnings in manufacturing in pesos

POP_1 = the population of Mexico

UNE_1 = the predicted amount of unemployment in Mexico

All price and wage variables are expressed in real terms to account for changes in the aggregate price level. The hypothesized sign of the first derivative of each independent variable with respect to each dependent variable is given in the parentheses above each independent variable.

Mexico's domestic supply function of agricultural labor Mexico's domestic supply of agricultural labor is the quantity of agricultural labor supplied in Mexico from December-June. Mexico's domestic supply of agricultural labor is a positive function of the wage rate, population, and amount of unemployment and is an inverse function of the manufacturing wage rate. The manufacturing wage rate and the amount of predicted unemployment represent alternative employment opportunities to agricultural employment. The greater are the alternative employment opportunities the less will be the supply of labor in agriculture (Morgan, 1980). The size of the population in Mexico is a proxy for the size of the labor force in Mexico.

Mexico's domestic demand function for agricultural labor Mexico's domestic demand for agricultural labor specifies the quantity of agricultural labor demanded in Mexico during December-June as an inverse function of the wage rate and as a positive function of the price of tomatoes. The price of tomatoes is included to account for shifts in the demand for labor given changes in the price of the final product (Walker, 1975).

Tomato price and wage rate equalization equations

The following equations represent the tomato price and wage rate equalizing equations, respectively:

3.1h) $P_2^T = P_1^T \cdot ER + Z(\overset{(+)}{IT_2}, \overset{(-)}{ER})$,

3.2h) $w_2 = w_1 \cdot ER + Y(\overset{(+)}{BP})$.

where:

Z = factors that inhibit tomato price equalization (includes transfer costs such as the U.S. import tariff on tomatoes and the exchange rate)

ER = the market exchange rate of pesos to dollars

IT_2 = the import tariff levied by the U.S. on fresh market winter tomatoes imported from Mexico

Y = factors that inhibit wage rate equalization (includes transfer costs such as transportation costs which are influenced by the apprehension effort of the U.S. Border Patrol)

BP = the Border Patrol apprehension effort by the U.S. Immigration and Naturalization Service

The hypothesized sign of the first derivative of each independent variable with respect to the dependent variable is given in the parentheses above each independent variable.

The tomato price equalization equation specifies the Florida tomato price to be equal to Mexico's tomato price multiplied by the exchange rate plus transfer costs (U.S. import tariff and the exchange rate). The wage rate equalization equation specifies Florida's wage rate to be equal to Mexico's wage rate multiplied by the exchange rate plus transfer costs (Border Patrol apprehension effort, which influences the transportation costs of illegal Mexican immigration).

The tomato price and wage rate equalizing equations are expressed in dollars. The inclusion of transfer costs in both the tomato price and wage rate equalizing equations accounts for differentials in tomato prices and wage rates due to trade and immigration policies. An increase in the import tariff on tomatoes imported to the U.S. will increase the price of tomatoes in Florida (Thompson, 1977). Likewise, a devaluation of Mexican currency will decrease the price of tomatoes in Florida (Thompson, 1977 and Chambers and Just, 1979). An increase in the Border Patrol apprehension effort can be viewed as an increase in the cost of transportation of illegal Mexican alien immigrants because illegal immigration becomes more risky and mobility within the U.S. becomes more difficult. An increase in transportation costs of immigrating has an effect of driving a wedge between the U.S. and Mexican wage rates, resulting in an increase in the U.S. wage rate and a decrease in Mexico's wage rate.

The Extended Partial Equilibrium Trade Model Applied to Trade with Mexico and the United States

Equations (3.3a, 3.3e, 3.3f, and 3.3g) of the previous section represent the excess supply and excess demand functions for agricultural labor and fresh market winter tomatoes in Mexico and the United States. Equations (3.1h and 3.2h) represent the tomato price and wage rate-equilizing equations. The complete extended partial equilibrium trade model includes these excess supply and demand equations and the tomato price and wage rate equalizing equations, plus the trade equalization equations. The following system of equations complete the full extended partial equilibrium trade model:

<u>Mexico's excess supply of tomatoes equation:</u>

3.1i) $X_1^T = X_1^T(\overset{(+)}{P_1}, \overset{(-)}{w_1}, \overset{(-)}{LPF_1}, \overset{(+)}{TP_1}, \overset{(-)}{IN_1}, \overset{(-)}{POP_1}),$

<u>U.S. excess demand for tomatoes equation:</u>

3.2i) $M_2^T = M_2^T(\overset{(-)}{P_2}, \overset{(+)}{w_2}, \overset{(+)}{IN_2}, \overset{(+)}{POP_2}, \overset{(+)}{TP_2}, \overset{(+)}{LPG_2}, \overset{(-)}{PR_2}, \overset{(+)}{IR_2}, \overset{(-)}{P_2^*}),$

<u>Tomato trade equalization equation:</u>

3.3i) $X_1^T = M_2^T,$

<u>Mexico's excess supply of agricultural labor equation:</u>

3.4i) $X_1^L = X_1^L(\overset{(+)}{w_1}, \overset{(-)}{P_1}, \overset{(-)}{MW_1}, \overset{(+)}{POP_1}, \overset{(+)}{UNE_1}),$

U.S. excess demand for agricultural labor equation:

$$3.5i)\quad M_2^L = M_2^L(\overset{(-)}{w_2}, \overset{(+)}{P_2}, \overset{(-)}{POP_2}, \overset{(-)}{UNE_2}, \overset{(+)}{PR_2}, \overset{(-)}{TP_2}, \overset{(+)}{P_2^*}, \overset{(-)}{IR_2}),$$

Agricultural labor trade equalization equation:

$$3.6i)\quad X_1^L = M_2^L,$$

Tomato price equalization equation:

$$3.7i)\quad P_2 = (P_1) \cdot \underline{(ER)} + Z(\overset{(+)}{IT_2}\ \overset{(-)}{\underline{ER}}),$$

Wage rate equalization equation:

$$3.8i)\quad w_2 = (w_1) \cdot \underline{(ER)} + Y(\overset{(+)}{BP}).$$

The hypothesized sign of each independent variable with respect to the dependent variable is given in the parentheses above each independent variable.

The structure and trade of tomatoes is reflected in Equations (3.1i-3.3i). The excess supply of tomatoes in Mexico is represented by Equation (3.1i) and the excess demand for tomatoes in the U.S. is represented by Equation (3.2i). Equation (3.3i) is the tomato trade equalization equation which equalizes the tomato exports from Mexico with the tomato imports to the United States. Similarly, the structure and trade of agricultural labor is reflected in Equations (3.4i-3.6i). The excess supply of agricultural labor in Mexico is represented in Equation (3.4i) and the excess demand for agricultural labor in the U.S. is represented by Equation (3.5i). Equation (3.6i) is the agricultural-labor trade-equalizing equation, the quantity of agricultural labor immigrating from Mexico equals the quantity migrating to the United States. Equations (3.7i and 3.8i) are the tomato price and wage rate equalizing equations which includes factors inhibiting tomato price and wage rate equalization.

The comparative static analysis of the effect of a change in any of the exogenous parameters in the extended partial equilibrium trade model on quantities traded of tomatoes and agricultural labor between Mexico and the United States will be similar to the comparative static analysis performed in Chapter II. The following table (Table 3.1) summarizes the hypothesized effects on the quantities of tomatoes and agricultural labor traded given a change in any of the exogenous parameters (see Appendix A for a graphical interpretation of the comparative static analysis.

Table 3.1 summarizes the effects on the quantities traded of agricultural labor and tomatoes for a given change in an exogenous parameter. Domestic economic policies, trade policies, and immigration policies will influence the quantities of labor immigrating and the quantities of tomatoes imported to the United States (see Table 3.2).

The theoretical modeling of the extended partial equilibrium trade model of trade in tomatoes and agricultural labor has been presented in this chapter. The effects of domestic economic policies, trade policies, and immigration policies have been investigated to show their expected impact on the quantity of labor immigrating to the U.S. and the quantity of tomatoes imported by the United States. The empirical model, estimation

Table 3.1. Effects on trade of tomatoes and agricultural labor between the U.S. and Mexico given a change in an exogenous parameter

Change in an exogenous parameter	Effects on quantities traded of tomatoes and agricultural labor
PF_1 (real lagged price of fertilizer in Mexico) - assume an increase	Quantity of tomatoes imported by the U.S. decreases
UNE_2 (unemployment rate in the U.S.) - assume an increase	Quantity of labor immigrating to the U.S. decreases
IN_1 (real national income in Mexico) - assume an increase	Quantity of tomatoes imported by the U.S. decreases
TP_1 (average temperature in Mexico) - assume an increase	Quantity of tomatoes imported by the U.S. increases
TP_2 (freezing temperatures in Florida) - assume an increase	Quantity of tomatoes imported by the U.S. increases
IR_2 (U.S. real agricultural interest rate) - assume an increase	Quantity of labor immigrating to the U.S. decreases
LPG_2 (real lagged green pepper price in the U.S.) - assume an increase	Quantity of tomatoes imported by the U.S. increases
PR_2 (farm productivity in the U.S.) - assume an increase	Quantity of tomatoes imported by the U.S. decreases Quantity of labor immigrating to the U.S. increases
P_2^* (expected real tomato price in the U.S.) - assume an increase	Quantity of tomatoes imported by the U.S. decreases Quantity of labor immigrating to the U.S. increases
IN_2 (real personal income in the U.S.) - assume an increase	Quantity of tomatoes imported by the U.S. increases
POP_1 (population in Mexico) - assume an increase	Quantity of tomatoes imported to the U.S. decreases Quantity of labor immigrating to the U.S. increases

Table 3.1 (Continued)

Change in an exogenous parameter	Effects on quantities traded of tomatoes and agricultural labor
MW_1 (manufacturing wage rate) - assume an increase UNE_1 (predicted level of employment) - assume a decrease	Quantity of labor immigrating to the U.S. decreases
POP_2 (population in the U.S.) - assume an increase	Quantity of tomatoes imported by the U.S. increases Quantity of labor immigrating to the U.S. decreases
BP (Border Patrol apprehension effort; proxy for transportation costs of immigrating labor) - assume an increase	Quantity of tomatoes imported by the U.S. increases Quantity of labor immigrating to the U.S. decreases
ER (exchange rate) - assume a devaluation by Mexico	Quantity of tomatoes imported by the U.S. increases Quantity of labor immigrating to the U.S. decreases
IT_2 (import tariff on tomatoes levied by the U.S.) - assume an increase	Quantity traded of tomatoes decrease Quantity of labor immigrating to the U.S. increases

Table 3.2. Effects on labor immigration and tomatoes traded given a change in a policy variable

Change in a policy variable	Effect of quantities of labor immigration and tomatoes traded
Decrease in the U.S. import tariff on tomato imports	Quantity of labor immigrating to the U.S. decreases Quantity of tomatoes imported by the U.S. increases
Development of a rigorous birth control program in Mexico	Quantity of labor immigrating to the U.S. decreases Quantity of tomatoes imported by the U.S. increases
Devaluation of Mexican currency	Quantity of labor immigrating to the U.S. decreases Quantity of tomatoes imported by the U.S. increases
U.S. funded research in agronomy, crop improvement and agricultural extension	Quantity of labor immigrating to the U.S. increases Quantity of tomatoes imported by the U.S. decreases
Increase in Border Patrol apprehension effort by the Immigration and Naturalization Service	Quantity of labor immigrating to the U.S. decreases Quantity of tomatoes imported by the U.S. increases

technique, and data needed for empirical estimation of the extended partial equilibrium model of trade in agricultural labor and tomatoes between Mexico and the U.S. will be presented in the following chapter.

CHAPTER IV. THE EMPIRICAL MODEL: ESTIMATION TECHNIQUE AND THE DATA SET

An extended partial equilibrium trade model was developed in Chapter III to explain the trade of agricultural labor and fresh market winter tomatoes between the U.S. and Mexico during the months of December through June. Chapter IV presents a discussion of the empirical model, including the estimation technique and the data set.

The Empirical Model and Estimation Technique

A system of equations was developed in Chapter III (Equations 3.1i-3.8i) that modeled the immigration of agricultural labor and the importation of fresh market winter tomatoes to the U.S. from Mexico. These equations included U.S. and Mexico import and export equations for fresh market winter tomatoes and agricultural labor, trade equalization equations, a wage rate equalizing equation, and a tomato price equalizing equation. This simultaneous system of equations can be estimated by a limited-information estimation method such as two-stage least squares (2SLS). An Ordinary Least Squares (OLSQ) estimation procedure will yield biased and inconsistent estimates, because tomato prices and wage rates in the U.S. and Mexico (P_1, P_2, w_1 and w_2) are not truly exogenous variables (Intriligator, 1978).

The 2SLS method proceeds by estimating the first-stage or reduced form equations where each tomato price and wage rate (P_1, P_2, w_1, w_2) is made a function of all of the exogenous variables in the system. The predicted values of the tomato prices and wage rates ($\hat{P}_1$, $\hat{P}_2$, $\hat{w}_1$ and $\hat{w}_2$ obtained in this first stage are then employed in the second stage to obtain estimates of the structural parameters. Robert L. Thompson suggests that "very few international agricultural commodity market models in the literature have followed this procedure" (Thompson, 1977). The resulting structural parameter estimates will be consistent, because the endogenous variables ($\hat{P}_1$, $\hat{P}_2$, $\hat{w}_1$ and $\hat{w}_2$) are uncorrelated with the residuals in the probability limit.

All variables in the model are expressed in natural logarithms except the temperature, trend and dummy variables. Temperature variables are not $\log_e$ transformed because it is desired to know the percentage change in quantity of labor immigration and tomato imports given a small change in temperature. The $\log_e$ specification provides estimated parameters that are interpreted directly as the elasticity of the explanatory variable with respect to the dependent variable.

The Data Set

The variables included in this trade model for agricultural labor and fresh market winter tomatoes between the U.S. and Mexico were defined in Chapter III. The collection and identification of the appropriate variables was not without problems. Data for some variables such as the actual number of immigrating harvest workers and the average growers' price for tomatoes in Mexico are not available. Consequently, proxy variables are used in cases where data for the actual theoretical variables are not available. Similarly, there exist problems in locating a complete December-June time series for the years 1964-1979 for all of the variables. A list of the variables and procedures for deriving them follows.

Quantity of tomatoes imported to the U.S. (X_1^T, M_2^T)

The quantity of fresh market winter tomatoes imported to the U.S. is measured by the total recorded movement of mature green breakers and ripers tomatoes in 30 pound cartons from Mexico to the United States. Only fresh market winter tomatoes are considered. Thus, processed and cherry tomatoes are excluded. The data are taken from the Florida Tomato Committee, Annual Report (1972-1980).

Tomato price in the U.S. (P_2)

The real average Florida growers price for fresh market winter tomatoes is constructed from monthly observations of Florida's average growers price for fresh market tomatoes deflated by the U.S. CPI. Tomato prices are for fresh market winter tomatoes produced in Florida. Tomato price data are from the U.S.D.A., Fresh Market Vegetable Prices (1973). The CPI data include all items, wage earners, and clerical workers (1967=100) and is from the U.S. Department of Commerce, Survey of Current Business (1963-1980).

Tomato price in Mexico (P_1)

Mexico's monthly average growers' price for tomatoes is not available. Consequently, the export price received by Mexican tomato growers FOB (Nogales, Arizona is used as a proxy. Mexico's tomato price are expressed as the price paid for generally good quality and condition of extra large breakers and ripers, FOB Nogales, Arizona. Duty and crossing charges are included in the tomato prices. The monthly tomato prices are deflated by Mexico's CPI/cost of living. Mexican tomato prices are expressed in pesos in the tomato and labor export equations and are expressed in dollars in the price equalization equation. Tomato price data are taken from Florida Tomato Committee, Annual Report (1972-1980). Mexico's CPI data are from the International Monetary Fund, Inter-Financial Statistics (1963-1980) except for April and May 1972 which is from the U.N. Department of International Economic and Social Affairs, Monthly Bulletin of Statistics (1963-1980).

Farm wage rate in Florida (w_2)

Florida's farm wage rate is the wage rate per day without room or board deflated by the U.S. CPI. Wage rate data are reported quarterly in U.S.D.A., Farm Labor (1963-1980). The quarterly data were averaged in order to obtain monthly observations. After January 1975, the daily wage rate series was changed to an hourly wage rate series. In order to obtain daily wage rates from the hourly wage rate series, the hourly wage rate series was multiplied by the number of hours worked in a day in Florida

Mexico's farm wage rate (w_1)

Agricultural labor in Sinaloa, Mexico is paid a daily minimum wage. The daily minimum wage rate for field labor in the State of Sinaloa, Mexico deflated by Mexico's CPI is used. The Mexican wage rate is expressed in pesos in the tomato and labor export equations and is expressed in dollars in the wage equalization equations. The wage rate data are taken from Mr. Soliz, of the Union Nacional de Productores de Hortalizas (UNPH).

Real personal income in the U.S. (IN_2)

Real personal income in the U.S. is measured by the real U.S. personal income in billions of dollars, seasonally adjusted and deflated by the U.S. CPI. The income data are from the U.S. Department of Commerce, Survey of Current Business (1963-1980).

Real national income in Mexico (IN_1)

Personal income data are not available for Mexico. Consequently, Mexico's national income deflated by Mexico's CPI is used. Data are taken from the U.N. Department of International Economic and Social Affairs, Monthly Bulletin of Statistics (1963-1980).

U.S. population (POP_2)

The United States population is measured by the U.S. total population in millions. Data are from the U.S. Department of Commerce, Survey of Current Business (1963-1980).

Mexico's population (POP_1)

The population of Mexico is measured by Mexico's midyear population. In order to obtain monthly data, a constant growth rate per month was assumed. Data are taken from the U.N. Department of International Economic and Social Affairs, Monthly Bulletin of Statistics (1963-1980).

Freeze days in Florida (TP_2)

The square root of the average number of days below freezing per month in Daytona, Florida and Tampa, Florida is used. The effect of a one or two day hard freeze may have similar effects on tomato production as a longer duration freeze. Hence, the square root of the number of freeze days per month is used to give less weight to long duration freezes. Daytona and Tampa are located on the east and west coasts of Florida and were chosen to provide for a representation of climatic donditions in Florida's tomato producing areas. Data are from the U.S. Department of Commerce, Climatological Data National Survey (1963-1980).

Temperature in Mexico (TP_1)

The average monthly temperature in °C for Culican, Mexico is used. Culican, Mexico is located in the center of Mexico's winter tomato growing area. Data are from Mr. Michel, of the Confederaction de Asociaciones Agricolas del Estado de Sinaloa (CAADES).

<u>Quantity of agricultural labor immigrating from Mexico to the U.S. (X_1^L, X_2^L)</u>

The Immigration Act of 1965 established a quota on the number of immigrants from the Western Hemisphere. As a result of the quota, Mexican aliens who wish to immigrate to the U.S. can do so if the U.S. Department of Labor certifies a need for the immigrant's employment classification. Agricultural laborers in Mexico have discovered that it is virtually impossible to legally immigrate to the U.S. due to the implementation of the Immigration Act of 1965. Consequently, many Mexican agricultural laborers immigrate illegally to the U.S. to seek employment.

All illegal Mexican aliens entering the U.S. are not employed in the Florida's agricultural labor market. Many are employed in other parts of the country and at nonagricultural jobs. It may, however, be reasonable to assume that the proportion of IMAs entering Florida's agricultural labor market during the months of December-June depends on economic variables, e.g., wage rates for manufacturing and farm labor and the unemployment rate, and that this relationship is stable over time. However, the actual number of IMAs entering the U.S. each month is not available. What is available are data from the Immigration and Naturalization Service on the number of deportable Mexican aliens. The most relevant data are the number of deportable Mexican adult males found in the U.S., by month (U.S. Department of Justice, <u>Monthly Report: Immigration and Naturalization Service</u> (1963-1980). These data are subject to a number of problems such as: aliens may be arrested more than once, many IMAs are never detected, and the number of illegals apprehended is subject to the apprehension effort of the Border Patrol. The problems with using data on the number of IMA's deported are similar to the problems encountered by social scientists investigating crime rates (see S. J. Deutsch, 1977, and R. Smith, 1976.

Nonfarm employment opportunities in Mexico (MW_1)(UNE_1)

Employment rate figures for Mexico are not available. Hence, Mexico's predicted unemployment rate and monthly earnings in manufacturing (male and female) deflated by the CPI for Mexico are used as proxies for nonfarm employment opportunities in Mexico. A proxy for Mexico's unemployment rate was constructed as the difference between the predicted log of current national income and the log of current national income in Mexico. Deviations of actual from predicted national income in Mexico are assumed to be accounted for by the amount of unemployed resources in Mexico. Data are from the U.S. Department of Economic and Social Affairs, Monthly Bulletin of Statistics (1963-1980).

Agricultural productivity in Florida (PR_2)

The index of farm productivity for vegetable farms in southeastern United States (1969-100) is used as a proxy for technology. Changes in technology should be positively correlated by this productivity variable. Data are taken from U.S.D.A., Changes in Farm Production and Efficiency (1979).

Lagged price of green peppers in Florida (LPG_2)

The one year lagged monthly average Florida growers price for fresh market green peppers in dollars per cwt is used. The lagged price is deflated by a one year lag of the U.S. CPI. Data are from U.S.D.A., Fresh Market Vegetable Prices (1973) for the years 1964-1970. Data for the years 1971-1976 are from the U.S.D.A., Agricultural Prices (1963-1980). Data for the years 1977-1979 are from the U.S.D.A., Vegetable Annual Summary Acreage, Yield, Production, and Value (1977-1980). Average prices were used as an approximation of the actual price for missing observations.

Nonfarm employment opportunities in the U.S. (UNE_2)

The U.S. percentage of vcivilian labor force unemployed is used as a proxy for nonfarm employment opportunities in the United States. Changes in the U.S. unemployment rate will influence laborers' expectations of securing nonfarm employment and wage rate in the United States. Data are from the U.S. Department of Commerce, Survey of Current Business (1963-1980).

U.S. agricultural interest rate (IR_2)

The interest rate on U.S. Federal Intermediate Credit Bank Loans is deflated by the U.S. CPI. Data are from the U.S. Department of Commerce, Survey of Current Business (1963-1980).

Expected average growers price for tomatoes in Florida (P_2^*)

A simple naive expectations model is used to forecast logarithmic monthly real tomato prices in Florida. The logarithmic real tomato price was forecasted based on the one year lag of real tomato price. Data are from U.S.D.A., Fresh Market Vegetable Prices (1973).

Lagged fertilizer price in Mexico (LPF_1)

The lagged annual price for diammonium phosphate (18-46-0) fertilizer in Mexico is deflated by Mexico's CPI. A lagged fertilizer price is used to capture the practice of pre-plant fertilization by tomato growers in Mexico. The data are from Mr. Michel of CAADES. Missing observations were replaced with average prices.

Market exchange rate (ER)

The market rate (par exchange rate) is expressed as the ratio of pesos to dollars. The data are taken from the International Monetary Fund, International Financial Statistics (1963-1980).

Import tariff levied by the U.S. (IT_2)

The U.S. tariff on fresh market imported tomatoes is a variable tariff depending on the season. The tariff is always in effect, but during March 1-July 14 and September 1-November 4 the rate increases by .6¢ per pound. A dummy variable is specified to capture the variable import tariff, where $IT_2 = 1$ March through June, $IT_2 = 0$ otherwise.[1] Data were from U.S. Tariff Commission, Tariff Schedules of The United States (1963-1980).

[1]The import tariff was included as a continuous variable deflated by the U.S. CPI in earlier estimations. The specification of the import tariff as a dummy variable was found to be superior.

Border Patrol apprehension effort (BP)

The Border Patrol apprehension effort is measured by the predicted logarithmic dollar expenditure on the U.S. Border Patrol deflated by the U.S. CPI. Border Patrol expenditures are affected by economic conditions in the U.S. economy and labor market. The predicted value of the Border Patrol variable is employed rather than the actual value to get rid of simultaneous equation bias. The one year lag of the log of U.S. unemployment rate and the log of U.S. real personal income are used to predict the real logarithmic values of Border Patrol expenditures to account for changes in Border Patrol expenditures due to economic conditions in the United States. Data are from Mr. T. Perrelli, Budget Officer for the INS.

Summary of the variables

A definitional summary of all the variables used in the extended partial equilibrium trade model is presented in Table 4.1. The mean and standard deviation for each variable is presented in Table 4.2.

Table 4.1. Definitions of the variables in the extended partial equilibrium trade model

Symbol	Variable definition
(X_1^T, M_2^T)	Quantity (cwt) of fresh market winter tomatoes imported monthly to the U.S. from Mexico
(P_2)	Real monthly average Florida growers price (per cwt) for fresh market winter tomatoes in 1967 prices
(P_1)	Real monthly average Mexican growers price (per cwt) for fresh market winter tomatoes in 1975 prices
(w_2)	Real farm wage rate per day in Florida without room or board in 1967 prices
(w_2)	Real minimum wage rate per day for field labor in Sinaloa, Mexico in 1975 prices
(IN_2)	Real monthly personal income in the United States in 1967 prices
(IN_1)	Real monthly national income in Mexico in 1975 prices
(POP_2)	Monthly population of the United States
(POP_1)	Estimated monthly population of Mexico
(TP_2)	Square root of the average number of freeze days in Daytona and Tampa, Florida
(TP_1)	Average monthly temperature in Culican, Mexico
(X_1^L, M_2^L)	Quantity of agricultural labor immigrating from Mexico to the United States; the number of deportable Mexican adult males found in the United States is used as a proxy
$(MW_1)(UNE_1)$	Nonfarm employment opportunities in Mexico (the real monthly manufacturing wage rate in Mexico and the predicted monthly unemployment rate in Mexico)

Table 4.1 (Continued)

Symbol	Variable definition
(UNE_2)	Nonfarm employment opportunities in Florida (the monthly U.S. unemployment rate)
(IR_2)	Real monthly U.S. agricultural interest rate in 1967 prices
(PR_2)	Index of annual agricultural productivity in Florida (1969=100)
(LPG_2)	Real monthly lagged price (per cwt in 1967 prices) of green peppers in Florida
(P_2^*)	Expected average growers' price for tomatoes in Florida, based on one year lag of the monthly average growers' price for tomatoes in Florida per cwt in 1967 prices
(LPF_1)	Real annual lagged price per ton of diammonium phosphate (18-46-0) fertilizer in Mexico in 1975 prices
(BP)	Border Patrol apprehension effort (the predicted monthly real dollar expenditure on the U.S. Border Patrol in 1967 prices)
(ER)	Monthly market exchange rate of pesos to dollars
(IT_2)	Monthly U.S. tariff on fresh market imported tomatoes dummy variable

Table 4.2. Means and standard deviations[a]

Variable	Mean	Standard deviation
X_1^T, M_2^T	8631672.1	5401760.4
P_2	.115	.02
P_2^*	-2.175	.05
P_1 - in pesos	2.36	.79
P_1 - in dollars	.164	.04
w_2	.101	.01
w_1 - in pesos	.463	.07
w_1 - in dollars	.033	.01
IN_2	7.289	.98
IN_1	6.93	1.71
POP_2	207.57	7.91
POP_1	54.45	8.18
TP_2	.437	.672
TP_1	21.69	3.45
X_1^L, M_2^L	36315.02	26570.5
MW_1	31.40	4.14
UNE_1	1.91	.246
UNE_2	.054	.015
PR_2	91.69	5.28
IR_2	.054	.010
LPG_2	.137	.04
LPF_1	21.57	11.91
BP	5.38	.968
ER	14.52	4.07
IT_2	.60	.49

[a]The means and standard deviations are for the nonlogarithmic transformed variables, except for the predicted variables (P_2^*, BP), which are expressed as predicted logarithmic values.

CHAPTER V. ESTIMATES OF THE EXTENDED PARTIAL EQUILIBRIUM TRADE MODEL

This chapter presents estimates of the model applied to the trade of agricultural labor and fresh market winter tomatoes between the U.S. and Mexico. The partial equilibrium trade model is fitted to data for the months of December-June, 1964-1979. All equations are expressed in log linear functional form. The system of equations were estimated by the method of two-stage least squares.

General Discussion of the Empirical Results

Estimates of the model are presented in Table 5.1. Variables for linear annual trend (TR) and quadratic annual trend (TR^2) are included to detrend the original data. Monthly trend variables were also included to capture the influence of seasons on immigration in Mexico's excess supply of labor equation. The monthly trend (M) was included in the U.S. excess demand for tomato equation and Mexico's excess supply of tomato equation. It was constructed by assigning a value of one to January and each successive month the value increased by one. This monthly trend and the corresponding monthly quadratic trend (M^2) were included to account for the growing pattern of tomatoes (i.e., tomato production will be small at the beginning of the season, then reach a peak, and begin to diminish).

The Durbin-Watson statistics suggest the presence of serial correlation

Table 5.1. Estimates of the extended partial equilibrium trade model, December 1963-June 1979

Explanatory variables	Dependent variables						
	M_2^L	X_1^L	M_2^T	X_1^T	P_2	W_2	BP^a
Constant	595.4 (6.6)*[b]	-111.3 (-1.02)	-26.8 (-.08)	-200.5 (-.40)	-.986 (-2.4)*	-4.66 (-24.4)	1.31 (3.3)*
P_1 (pesos)		-.035 (-.28)		.255 (.72)			
P_1 (dollars)					.639 (3.0)*		
P_2	.31 (1.6)		-.81 (-1.4)				
w_1 (pesos)		1.38 (2.2)*		-.89 (-.61)			
w_1 (dollars)						.058 (1.56)	
w_2	-2.42 (-4.23)*		.92 (.61)				
UNE_1		1.02 (1.45)					
UNE_2	-.57 (-4.2)*						.48 (15.3)*
IR_2	-.09 (-.47)		.11 (.25)				
PR_2	.06 (.11)		-.08 (-.06)				
TP_1				.03 (.58)			
TP_2	-.05 (-1.4)		.038 (.42)				

[a]U.S. unemployment rate and U.S. personal income are lagged one year.

*Coefficients are significantly different from zero at the .05 level.

[b]t-ratios are given in parentheses.

Table 5.1 (Continued)

Explanatory variables	Dependent variables						
	M_2^L	X_1^L	M_2^T	X_1^T	P_2	W_2	BP^a
IN_1				-.44 (-.16)			
IN_2			5.0 (1.6)				1.9 (8.8)*
MW_1		-1.50 (-2.6)*					
POP_1		33.6 (1.2)		56.9 (.42)			
POP_2	-112.5 (-6.5)*		6.14 (.09)				
P_2^*	.432 (.97)		(-.273) (-.24)				
LPF_1				-.212 (-.33)			
LPG_2			.561 (2.6)*				
BP						.466 (16.9)*	
ER					-.112 (-1.2)		
IT_2					.039 (.36)		
TR	.263 (8.9)*	-.104 (-.74)	-.02 (-.20)	-.24 (-.37)	.003 (2.9)*		-.004 (-3.4)*
TR^2	-.007 (-9.3)*	-.003 (-8.1)*	-.00002 (-.10)	-.003 (-1.3)			
M			1.64 (9.6)*	1.91 (7.2)*			
M^2			-.20 (-10.1)*	-.226 (-8.0)*			

Table 5.1 (Continued)

Explanatory variables	Dependent variables M_2^L	X_1^L	M_2^T	X_1^T	P_2	W_2	BP^a
JA		-.002 (-.01)			.14 (2.2)*	(-.02) (-.74)	(.003) (.27)
FE		.06 (.33)			.29 (3.3)*	(-.03) (-1.3)	(.004) (.28)
MA		.58 (2.8)*			.24 (2.3)*	(-.05) (-1.9)	(.007) (.50)
AP		.63 (2.2)*			.19 (1.7)	(-.04) (-1.5)	(.006) (.46)
MAY		.78 (2.4)*			-.001 (-.01)	(-.04) (-1.6)	(.006) (.44)
JU		.70 (1.7)			-.11 (-.96)	(-.04) (-1.7)	(.02) (1.2)
R^2	.959	.987	.780	.755	.380	.764	.982
F-ratio	201.6	487.1	23.0	26.8	5.3	36.0	540.6
Durbin-Watson	1.141	1.133	2.281	2.118	1.612	.414	.555

in the disturbance terms in all but two of the estimated equations. Applications of multi-order autoregressive techniques and multi-period differencing of the system of equations yielded poor results. One explanation is not all of the equations in the full-structural model have serially correlated disturbance terms. Application of auto-regressive techniques may introduce serial correlation in those equations which previously did not have serially correlated disturbance terms. Thus, the reported equations are not corrected for serial correlations.

The following sections present the empirical results of the trade model. The U.S. excess demand for agricultural labor is represented by Equation 1 in Table 5.1, Mexico's excess supply of agricultural labor is represented by Equation 2, the U.S. excess demand for fresh market winter tomatoes is represented by Equation 3, Mexico's excess supply of fresh market winter tomatoes is represented by Equation 4, the tomato price equalization equation is represented by Equation 5, the wage rate equalization equation is represented by Equation 6 and the Border Patrol expenditure equation is represented by Equation 7. All signs of the estimated coefficients in the full structural model are consistent with the theoretical model developed in Chapter II.

U.S. Excess Demand for Agricultural Labor Equation

The own wage rate elasticity of the U.S. excess demand for agricultural labor is large (-2.4) and significantly different from zero at the 0.5% level. Thus, increasing Florida's agricultural wage rate causes a decrease in the quantity demanded of illegal Mexican labor.

Factors that influence the domestic supply of U.S. agricultural labor, such as U.S. population and the U.S. unemployment rate, have a significantly different from zero (0.5% level) effect on the demand for illegal laborers. These variables, as demonstrated in Chapter II, shift the U.S. excess demand for agricultural labor curve to the left (decrease).

Population in the U.S. has a large negative (-112.5) coefficient and elasticity of -112, suggesting that increasing U.S. population by 1 percent causes a 112 percent reduction of the demand for illegal Mexican labor. The U.S. unemployment rate has a small negative (-0.57) coefficient, suggesting that increases in the U.S. unemployment rate tends to cause a small decrease in the demand for IMA's.

Factors that influence the domestic demand for agricultural labor such as the actual and expected Florida tomato price, U.S. agricultural interest rate, southeastern U.S. agricultural productivity, and winter temperatures in Florida have small estimated coefficients and small t-ratios. The U.S. agricultural interest rate and number of low temperature readings in Florida have negative (-.09 and -.05, respectively) coefficients, suggesting that the excess demand for agricultural labor curve shifts to the left (decrease) as these variables increase. The actual and expected Florida tomato price and southeastern U.S. agricultural productivity have positive (0.31, 0.43 and 0.06) coefficients suggesting that the excess demand for labor curve shifts to the right (increase) as these variables increase. One possible reason for small coefficients associated with factors influencing the domestic demand for agricultural labor in the U.S. is that only one labor-intensive commodity (tomatoes) is considered in determining the number of IMAs entering the United States. A possible improvement would be to consider an aggregation of labor-intensive traded agricultural commodities or a combination of traded labor-intensive agricultural and nonagricultural commodities (see page 73).

Mexico's Excess Supply of Agricultural Labor Equation

Mexico's own-wage rate elasticity of excess-supply of agricultural labor is 1.4 and significantly different from zero at the 2.5% level. Hence, an increase in the agricultural wage rate increases Mexico's excess supply of labor or IMAs.

Factors affecting the domestic supply of agricultural labor such as the unemployment rate and manufacturing wage rate in Mexico and population have relatively large estimated coefficients. The estimated coefficient of Mexico's population is a positive 33.6, suggesting that increasing Mexico's population by 1% shifts Mexico's excess supply of agricultural labor curve to the right by 34 percent. Mexico's (predicted) unemployment rate also has a positive coefficient. The coefficient of the manufacturing wage rate is a negative (-1.5) and significantly different from zero at the 2.5% level. Hence, increasing Mexico's manufacturing wage rate by 1% reduces the number of illegal aliens supplied to the U.S. by 1.5%.

The Mexican average growers' tomato price has a small negative estimated coefficient (-0.4) and t-ratio (-0.28). Thus, the supply of IMAs immigrating to the U.S. is unaffected by the price of tomatoes received by Mexican growers. An aggregation of labor-intensive traded commodities may yield a larger price elasticity of Mexico's excess supply of labor.

U.S. Excess Demand for Fresh Market Winter Tomatoes

The own-price elasticity of the U.S. excess demand for fresh-market winter tomatoes is -0.81. Similarly, the coefficient of the expected tomato price is small (-0.27). Shonkwiler and Emerson also found the price elasticity of demand for Florida tomatoes to be inelastic (Shonkwiler and Emerson, 1981). Mittelhammer also found a small price elasticity for the U.S. demand for tomatoes (Mittelhammer, 1979).

Factors that influence the domestic demand for tomatoes such as U.S. personal income and population have large (5.0 and 6.1) estimated coefficients (large elasticities) but small t-ratios. Thus, increasing either of these factors shifts the excess demand for tomatoes curve rightward (increase) and increases the importation of tomatoes from Mexico. Shonkwiler and Emerson's estimate of the income elasticity of demand for Florida tomatoes was also large (Shonkwiler and Emerson, 1981).

Factors that influence the domestic supply of tomatoes such as southeastern U.S. agricultural productivity, Florida farm wage rate, U.S. agricultural interest rate, lagged price of green peppers in Florida and low temperatures in Florida have small effects on the U.S. demand for Mexican winter tomatoes. Increasing U.S. agricultural productivity has a small negative (-.08) effect on the demand for Mexican tomatoes. The small coefficient might reflect the quality of the productivity index. The agricultural productivity index is a general vegetable productivity index and does not directly measure technological advances specific to Florida tomato production such as the adoption of plastic mulch by Florida tomato growers in the 1970s. Input costs such as Florida's farm wage rate and U.S. agricultural interest rate have positive (0.92 and 0.11) estimated coefficients, suggesting that increasing these variables shifts the U.S. excess demand for tomatoes curve to the right. The coefficient of the lagged price of green peppers in Florida, which represents the price of substitute commodity for tomato producers is 0.56 and significant, suggesting that green peppers are a strong substitute crop for U.S. tomato growers. Frost in Florida, represented by the square root of the average number of freeze days in eastern and western Florida, has a positive but insignificant coefficient in the demand for Mexican tomato equation. The small size of the coefficient is a bit surprising.

Mexico's Excess Supply of Fresh Market Winter Tomatoes

Mexico's own-price elasticity of excess-supply of tomatoes is inelastic 0.26. This result is consistent with Zepp's price inelastic estimate of Mexico's tomato exports and may be explained by the influence of CAADES on Mexican tomato exports (Zepp, 1979). CAADES effectively influences the Mexican acreage planted and the level of Mexican tomato exports. Hence, Mexico's excess supply of tomatoes might be approximately fixed in the short run and adjustments to price occur in the long run. Factors influencing the domestic supply of tomatoes in Mexico such as Mexico's agricultural wage rates, fertilizer price, and average temperature in

Culican (Mexico) have small estimated coefficients. Zepp has also found input costs to have a relatively small effect on Mexico's supply of tomatoes (Zepp, 1979). Average temperature has a small positive (.03) effect on Mexican tomato exports, which may be due to the general absence of freezing weather in Mexico's tomato producing areas.

The impact of Mexican income and population on Mexican tomato exports is mixed. An increase in Mexican real national income has a negative effect (elasticity of -0.44) on the quantity of tomato exports, implying that tomatoes are a normal good in Mexico. Increasing Mexican population, holding Mexican real national income constant, increases Mexican tomato exports. It appears that increasing population, holding real national income constant, has a two-fold effect. The aggregate demand for tomatoes is increased because the number of consumers in the market has increased, but per capita income decreases which reduces the demand for tomatoes. The sign and size of the estimated coefficient on population suggests that the latter effect dominates strongly.

Tomato Price Equalization Equation

As expected, the Florida and Mexican tomato prices are strongly linked together. A 10 percent increase in the Mexican price causes a 6.4 percent increase of the U.S. price. The coefficient is significantly different from zero at the 0.5 percent level.

Inclusion of the U.S. import tariff and the exchange rate in the price equalization equation is to account for changes in transfer costs of tomato trade. Increasing transfer costs (an increase in the U.S. import tariff) drives a larger wedge between the U.S. and Mexican tomato prices, resulting in an increase in the U.S. tomato price, holding the Mexican tomato price unchanged. Likewise, decreases in transfer costs (a devaluation of Mexico's currency) cause a decline in the U.S. tomato price. The estimated coefficients of the U.S. import tariff and exchange rate were found to be small (.04 and -.11), respectively. Zepp also found that the U.S. import tariff had little effect on tomato prices in the United States (Zepp, 1979). Devaluation of the Mexico's currency appears to reduce the U.S. tomato price, but the small size of the coefficient suggests that U.S. tomato prices do not immediately adjust to devaluations of Mexico's currency.

Agricultural Wage Rate Equalization Equation

The Mexican and Florida agricultural wage rates are also linked by trade. A 10 percent increase in the Mexican agricultural wage rate causes a 0.6 percent increase in the Florida agricultural wage. This effect may seem to be small, but it has the correct sign and is surfacing through extensive data deficiencies.

The U.S. Border Patrol variable accounts for labor transfer costs. The U.S. Border Patrol expenditures appear, however, to be a choice variable and to be determined by some of the same variables that determine other endogenous variables in the system. Thus, an instrumental variable replaces the actual value of the Border Patrol variable in the wage equalization equation. The instrument is obtained by regressing real U.S. Border Patrol expenditures on the one year lagged U.S. unemployment rate and U.S. real personal income. The estimated coefficient of the unemployment rate is 0.48 and of personal income is 1.9, and both are significantly different from zero at the 2.5 percent level.

The estimated coefficient of the predicted border patrol variable is positive in the wage equalizing equation, as expected. Increasing Border Patrol expenditures drives a larger wedge between U.S. and Mexican agricultural wage rates. The estimated coefficient implies that a 10 percent increase in U.S. Border Patrol expenditure increases the Florida agricultural wage rate by 4.7 percent, other things equal. Thus, Border Patrol expenditures appear to be a significant deterrent to illegal Mexican immigration.

The empirical results presented in this chapter show only one space is needed that a relatively simple model of international trade between two countries can explain trade in outputs and inputs. Furthermore, the model as applied to U.S.-Mexican trade in winter tomatoes and agricultural labor has important implications for trade and immigration policy.

CHAPTER VI. SUMMARY, CONCLUSIONS AND POLICY RECOMMENDATIONS

Chapter V provided estimates of a trade model applied to the trade of agricultural labor and fresh market winter tomatoes between the U.S. and Mexico. This chapter presents the summary and conclusions and provides recommendations for policies that influence trade of agricultural labor and fresh market winter tomatoes.

Summary and Conclusions

The development and application of an extended partial equilibrium trade model with one output, one factor input, and two trading nations is an aid in policy analysis. This simple trade model offers the advantage of allowing for commodity and labor market interactions in analyzing labor migration and commodity trade, but reduces the complexities involved with larger general equilibrium trade models. An aggregation of all traded labor-intensive commodities in Mexico and the U.S. might provide a more complete modeling of IMA immigration to the United States, but this study reduced the degree of traded labor-intensive commodity aggregation by investigating only the December-June immigration of IMAs to the United States. The December-June period provides a unique time period when Mexico and Florida are the only suppliers of fresh market winter tomatoes to the U.S. market. Thus, a simple partial equilibrium trade model may be applied to analyze this market situation.

This study verifies the importance of "push" variables in explaining

IMA immigration to the U.S. and, in addition, contributes to the study of IMA immigration through a more comprehensive economic modeling of IMA immigration.

Domestic Mexican supply of labor factors has the greatest effect on IMA immigration to the United States. Increases in Mexico's level of unemployment and population and decreases in Mexico's manufacturing wage rate all contribute to "push" Mexican labor to the United States. These "push" variables are consistent with findings by Frisbe and Jenkins (Frisbe, 1975 and Jenkins, 1977). One advantage of the extended partial equilibrium trade model over the "push-pull" models is that it allows for policy analysis via interactions of commodity and labor markets in Mexico and the United States.

Policy Recommendations

The fitted extended partial equilibrium trade model provides recommendations for trade, immigration, and domestic economic policy by Mexico and the United States. Table 6.1 summarizes the effects of policy changes on IMA immigration and tomato imports to the United States. Policy recommendations to reduce the flow of IMA immigration to the U.S. are presented in Table 6.2.

A major implication from this study of U.S.-Mexican trade of tomatoes and agricultural labor is that Mexico and the U.S. should have cooperative domestic economic, trade and immigration policies in order to curb the flow of illegal Mexican immigration to the United States. Mexican

Table 6.1. Effects of policy on IMA immigration and tomato imports to the U.S.[a]

Policy changes	Effect on IMA immigration	Effect on U.S. tomato imports
1. U.S. Trade Policy - (U.S. Import Tariff) A 1% increase in the U.S. import tariff on fresh market tomatoes will increase tomato prices by .04% and will indirectly affect IMA immigration and U.S. tomato imports via the increase in U.S. tomato prices	.01% increase	.03% decrease
2. Mexico's Trade Policy - (Devaluation of the peso) A 1% devaluation of the Mexican peso will decrease U.S. tomato prices by 11% and will indirectly effect IMA immigration and U.S. tomato imports via the decrease in U.S. tomato prices	.04% decrease	.09% increase
3. U.S. Immigration Policy - (Border Patrol Expenditures) A 1% increase in Border Patrol Expenditures will increase Florida's agricultural wage rate by .47% and will indirectly affect IMA immigration and U.S. tomato imports via the increase in Florida's agricultural wage rate	1.1% decrease	.43% increase
4. U.S. Domestic Economic Policy - (U.S. funded agricultural research that increases agricultural productivity) A 1% increase in southeastern U.S. agricultural productivity will increase IMA immigration directly by .06% and will decrease U.S. tomato imports by .08%	.06% increase	.08% decrease

[a]Some of these conclusions have large confidence intervals (see Chapter V for details).

Table 6.1 (Continued)

Policy changes	Effect on IMA immigration	Effect on U.S. tomato imports
5. <u>Mexico's Domestic Economic Policy - (promotion of labor-intensive commodity production and birth control program)</u>		
The promotion of labor-intensive commodity production (e.g. subsidies to agricultural and manufacturing labor-intensive industries, or increases in incentives in establishing "Twin-Plant" industry) and a rigorous birth control program will lead to an absorption of Mexico's population and a reduction in unemployment. A 1% reduction in unemployment in Mexico decreases IMA immigration by 1%. A 1% reduction in Mexico's population decreases IMA immigration by 34%	1% decrease (given a reduction in Mexico's unemployment) 34% decrease (given a reduction in Mexico's population)	

Table 6.2. Policy recommendations to reduce the flow of IMA immigration to the U.S.

1. U.S. Trade Policy
   The U.S. import tariff on fresh market tomatoes has little effect on IMA immigration. Thus, a reduction in U.S. import tariffs appears to be a weak policy tool and is not recommended for attempting to reduce the flow of IMA immigration.

2. Mexico's Trade Policy
   Devaluation of the Mexican peso has little effect on reducing IMA immigration. Export subsidies on labor-intensive commodities that make Mexican goods more competitive in the world market will increase labor-intensive commodity production in Mexico and will help to absorb the Mexican surplus of labor. The use of "import substitution" policies by Mexico should be reduced in order to further encourage increases in labor-intensive production in Mexico.

3. U.S. Immigration Policy
   Increases in Border Patrol expenditures will reduce IMA immigration. However, the apprehension effort is costly and "treats the symptoms, not the problem" of IMA immigration.

4. U.S. Domestic Economic Policy
   Changes in U.S. funded research and extension to enhance U.S. agricultural productivity have little effect on IMA immigration.

5. Mexico's Domestic Economic Policy
   Promotion of labor-intensive commodity production is recommended to ease Mexico's unemployment. Furthermore, rigorous birth control programs to reduce Mexico's population growth rate and thus the surplus labor force will greatly reduce IMA immigration

economic variables, e.g., unemployment rate, wage rate, population size, have strong effects on IMA immigration to the United States.

The U.S. should coordinate trade policies that encourage the importation of labor-intensive commodities from Mexico rather than labor itself. A reduction of U.S. tariffs on imports from Mexico is not a strong policy instrument for affecting immigration from Mexico. Instead, alternative trade policies such as the encouragement of American firms to develop "Twin Plants" in Mexico might be pursued.

The U.S. need not be the only nation that absorbs labor-intensive Mexican imports. Other capital-intensive trading nations may be viable importers of Mexican labor-intensive agricultural and manufacturing commodities. For example, Canada is currently an importer of agricultural commodities including fresh market winter tomatoes. The important point to consider is Mexico's competitiveness in world labor-intensive commodity trade.

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APPENDIX A

Graphical Analysis of the Effects of a Change in an Exogenous Parameter on Quantity of Output and Labor Services Traded

The effects of a change in an exogenous parameter on quantities of output and labor services traded can be determined by considering the simultaneous interaction of the output and labor markets in Country 1 and Country 2. The shifts of the import and export curves of output and labor services for Country 1 and Country 2, given a change in an exogenous parameter, will determine the change in the quantities of output and labor services traded between Country 1 and Country 2. The following graphical analysis illustrates the interactions of the output and labor markets for Country 1 and Country 2, given a change in any of the exogenous parameters (see following figures).

An increase in (a_{11} and u_{11}) or (a_{12} and u_{12}) will have a first-round effect of shifting X_1^Q to the right to $X_1^{Q'}$ (because S_1^Q increases) and shifting X_1^L to the left to $X_1^{L'}$ (because D_1^L increases). The second-round effect occurs as output price falls and the wage rate falls, which shifts M_2^L to the left to $M_2^{L'}$ (because D_2^L decreases) and shifts M_2^Q to the right to $M_2^{Q'}$ (because S_2^L increases). The quantity of labor immigrating to Country 2 declines and the quantity of output imported to Country 2 increases.

Case 1: (a_{11} and u_{11}) increase in favorable weather conditions in Country 1 or (a_{12} and u_{12}) increase in technology in Country 1

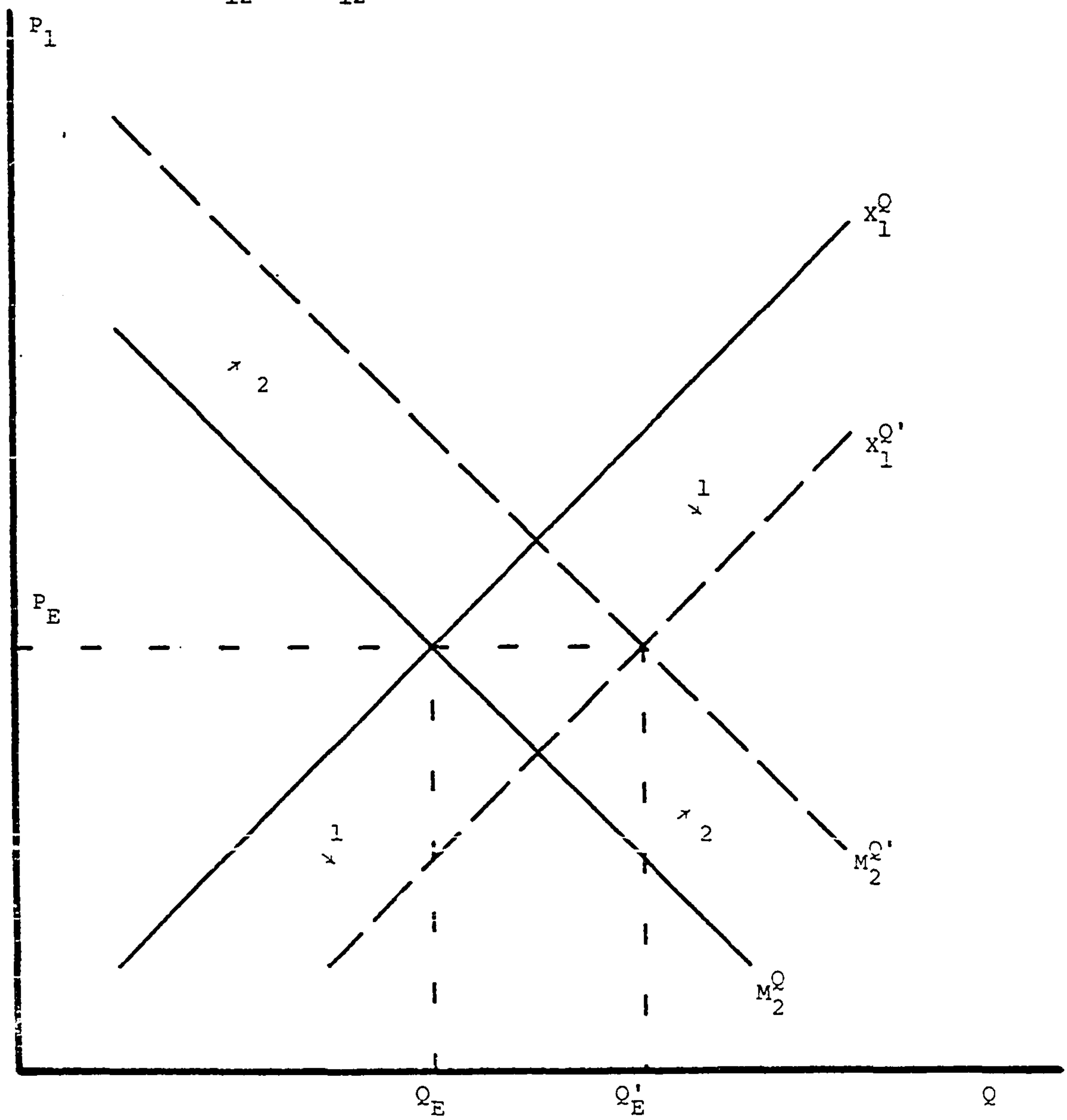

Figure A.1. Output exchange market

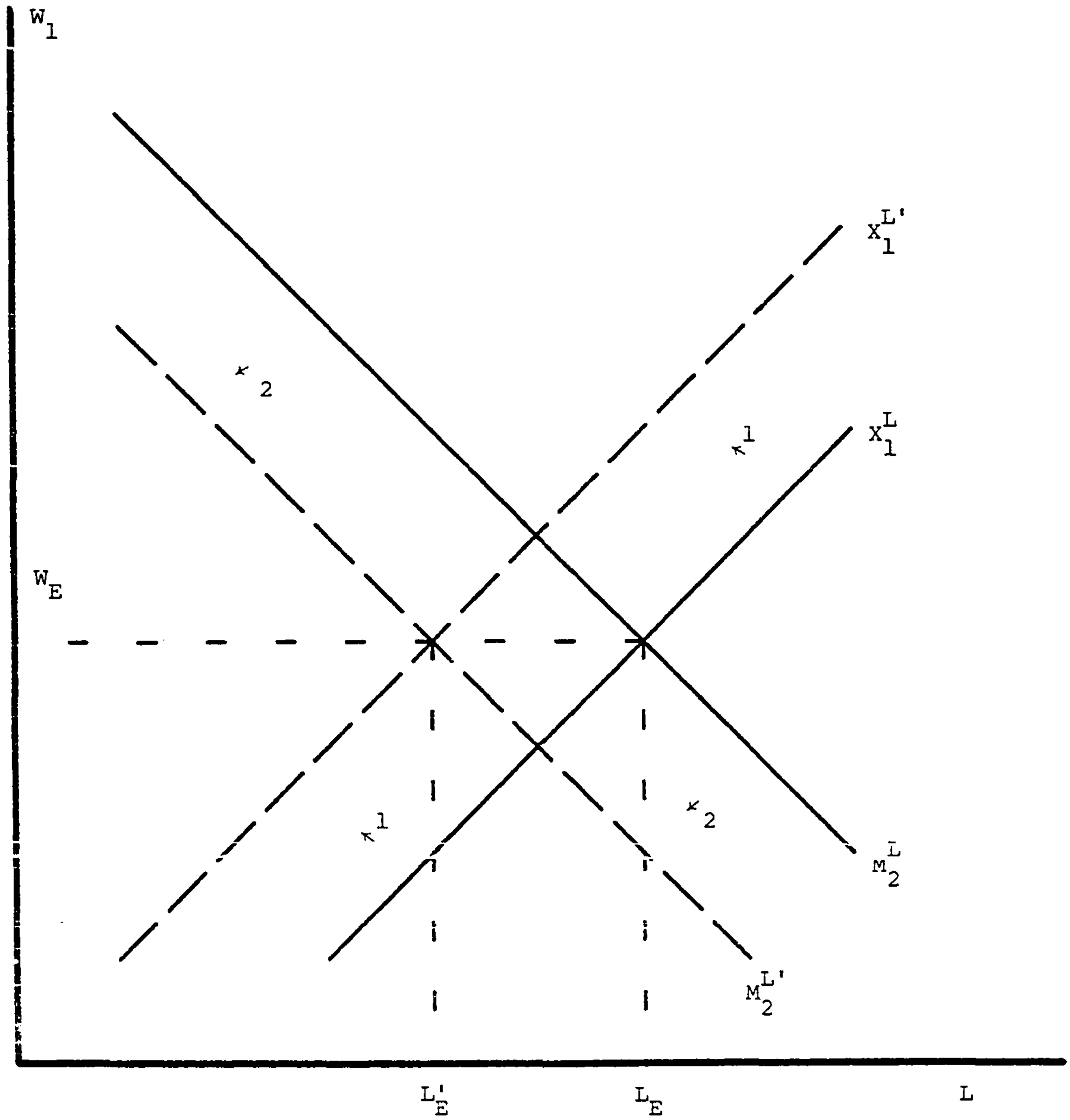

Figure A.2. Labor exchange market

<u>Case 2:</u> (b_{11}) increase in income in Country 1

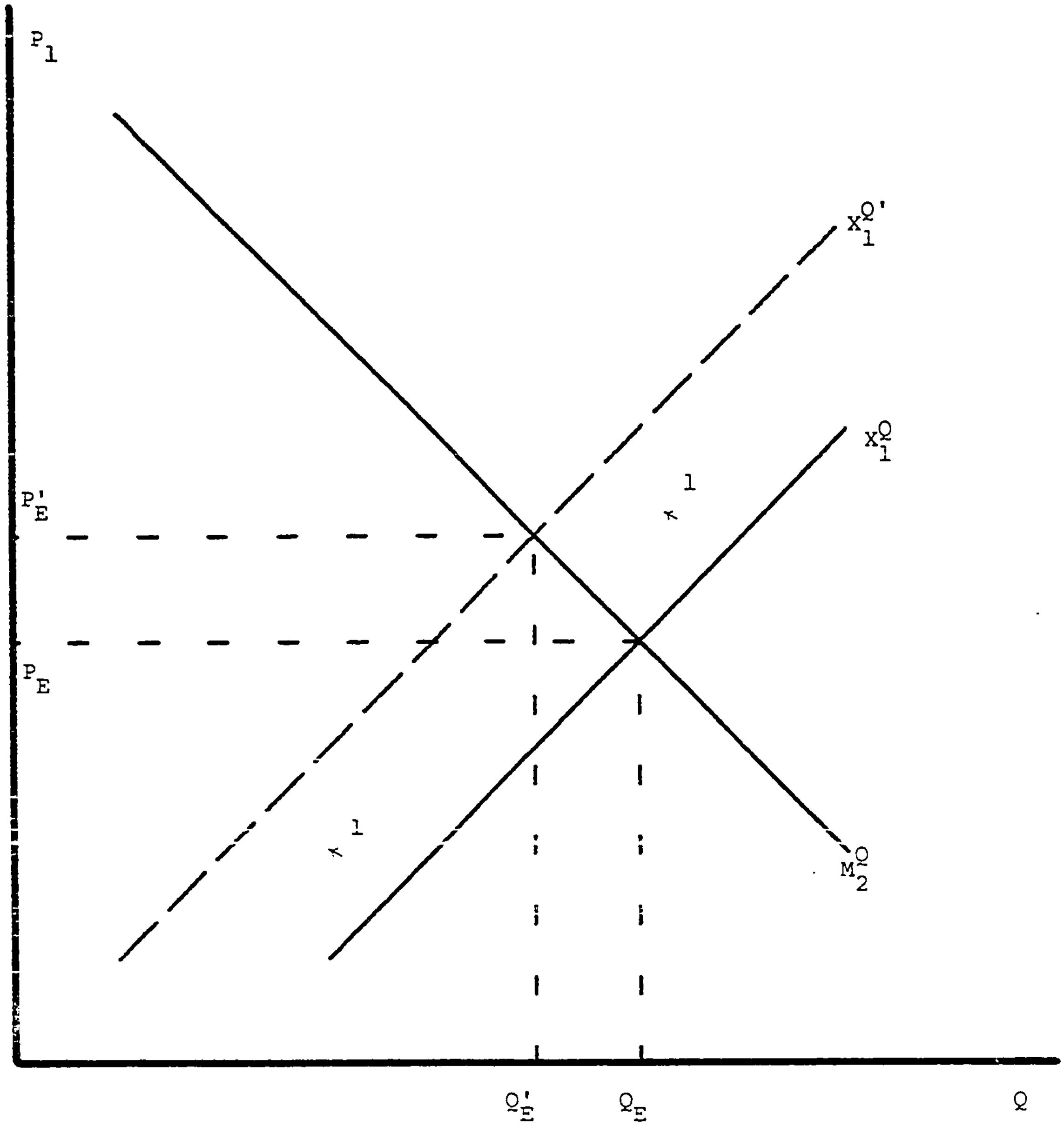

Figure A.3. Output exchange market

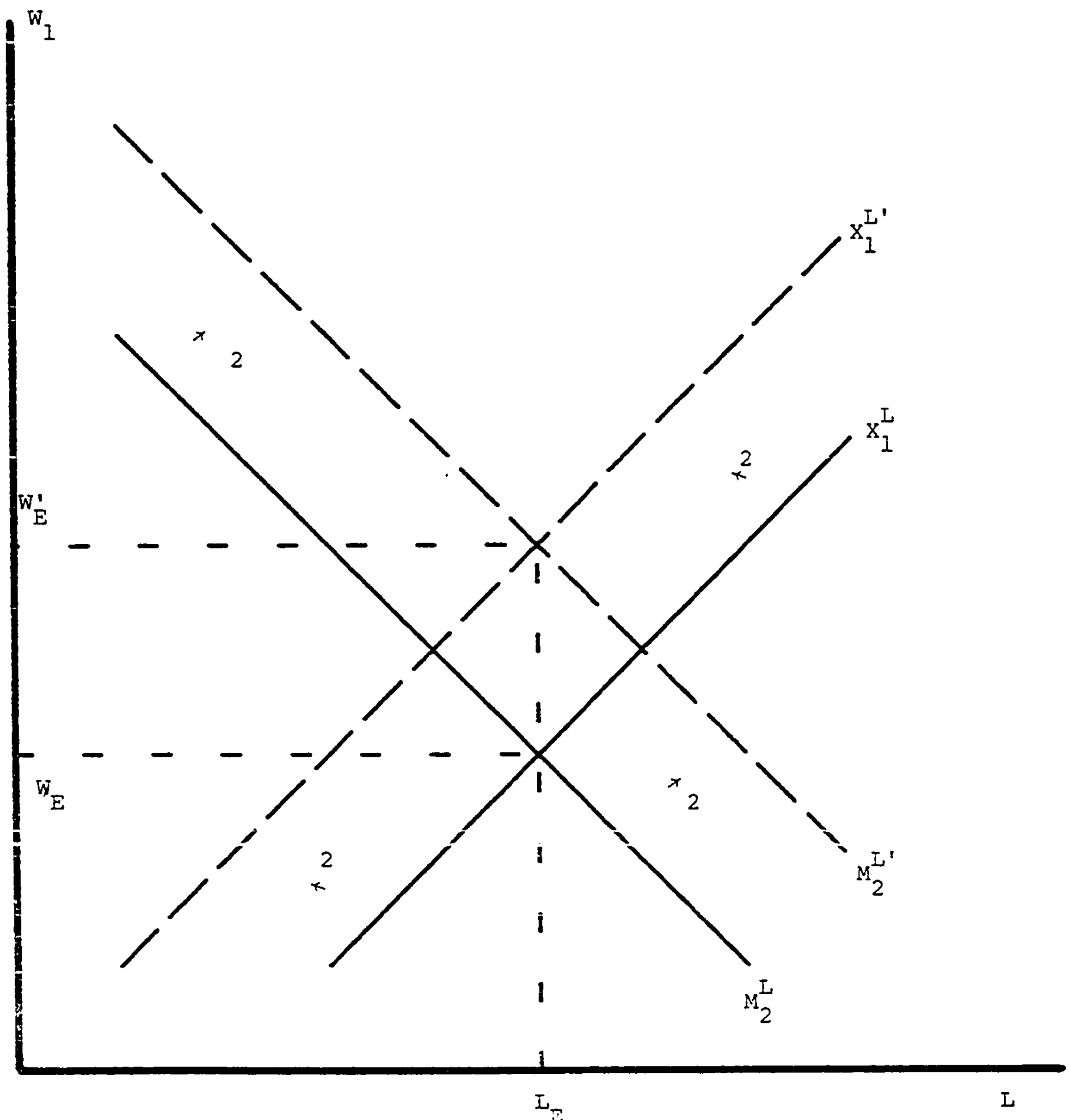

Figure A.4. Labor exchange market

An increase in (b_{11}) will have a first-round effect of shifting X_1^Q to the left to $X_1^{Q'}$ (because D_1^Q increases). Given that there exists no income effects in Country 1's labor market, then the supply of labor S_1^L will be unaffected by the income change. The second-round effect occurs as output price increases, which will shift M_2^L to the right to $M_2^{L'}$ (because D_2^L increases) and will shift X_1^L to the left to $X_1^{L'}$ (because D_1^L increases). The quantity of output imported by Country 2 declines and the quantity of labor immigrating will depend on the relative elasticities of X_1^L and M_2^L. If X_1^L is more elastic, then the quantity of labor immigrating to Country 2 increases.

An increase in $(b_{12}$ and $s_{12})$ will have a first-round effect of shifting X_1^Q to the left to $X_1^{Q'}$ (because D_1^Q increases) and shifting X_1^L to the right to $X_1^{L'}$ (because S_1^L increases). The second-round effect occurs as output price increases and the wage rate falls, which shifts M_2^L to the right to $M_2^{L'}$ (because S_2^L increases) and shifts M_2^Q to the left to $M_2^{Q'}$ (because S_2^Q increases). The quantity of labor immigrating to Country 2 increases and the quantity of output imported by Country 2 decreases.

An increase in $(a_{21}$ and $u_{21})$ or $(a_{22}$ and $u_{22})$ will have a first-round effect of shifting M_2^Q to the left to $M_2^{Q'}$ (because S_2^Q increases) and shifting M_2^L to the right to $M_2^{L'}$ (because D_2^L increases). The second-round effect occurs as output price declines and the wage rate increases, which shifts X_1^L to the right to $X_1^{L'}$ (because D_1^L decreases) and shifts X_1^Q to the left to $X_1^{Q'}$ (because S_2^Q decreases). The quantity of labor

<u>Case 3</u>: (b_{12} and s_{12}) increase in population in Country 1

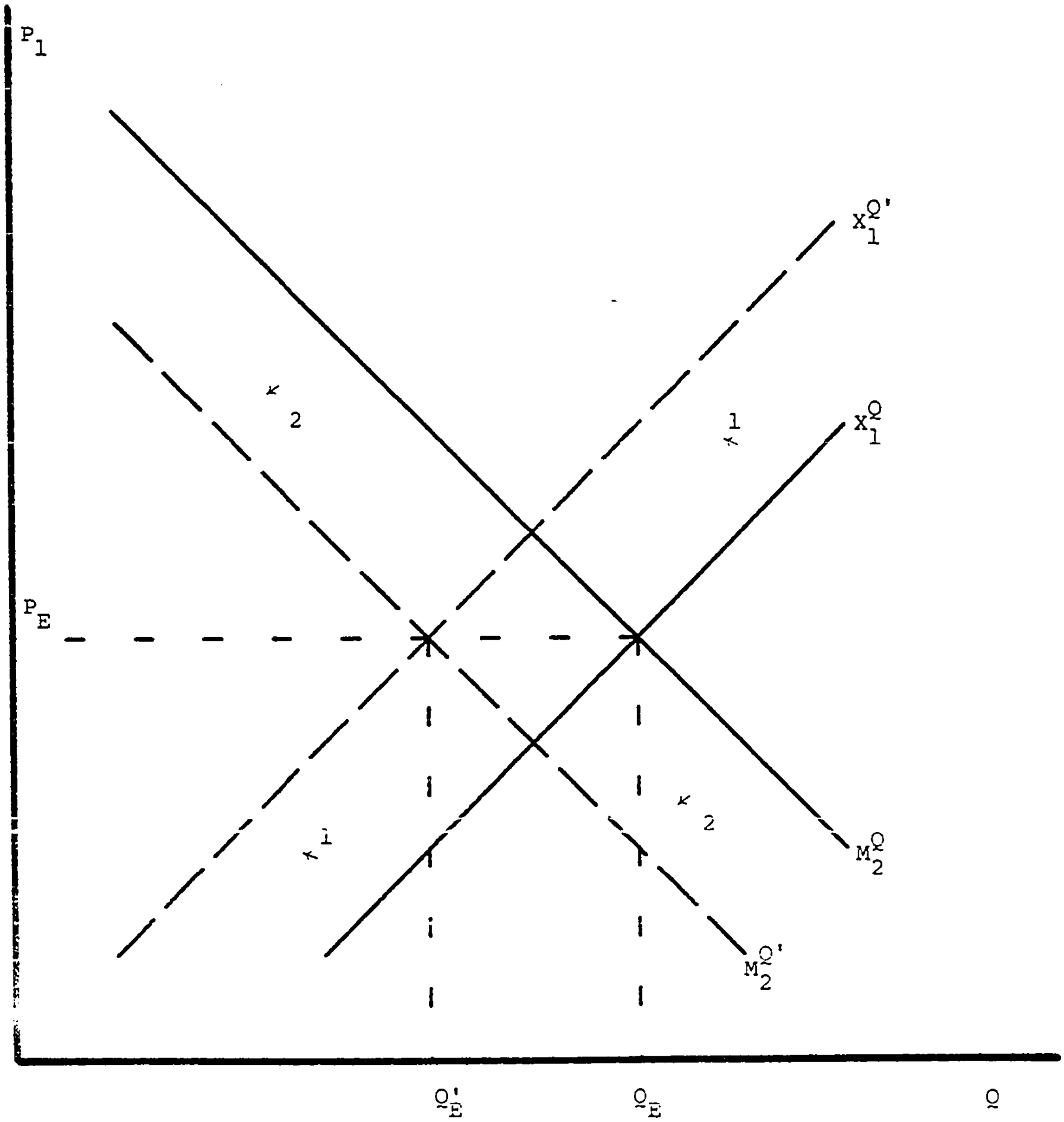

Figure A.5. Output exchange market

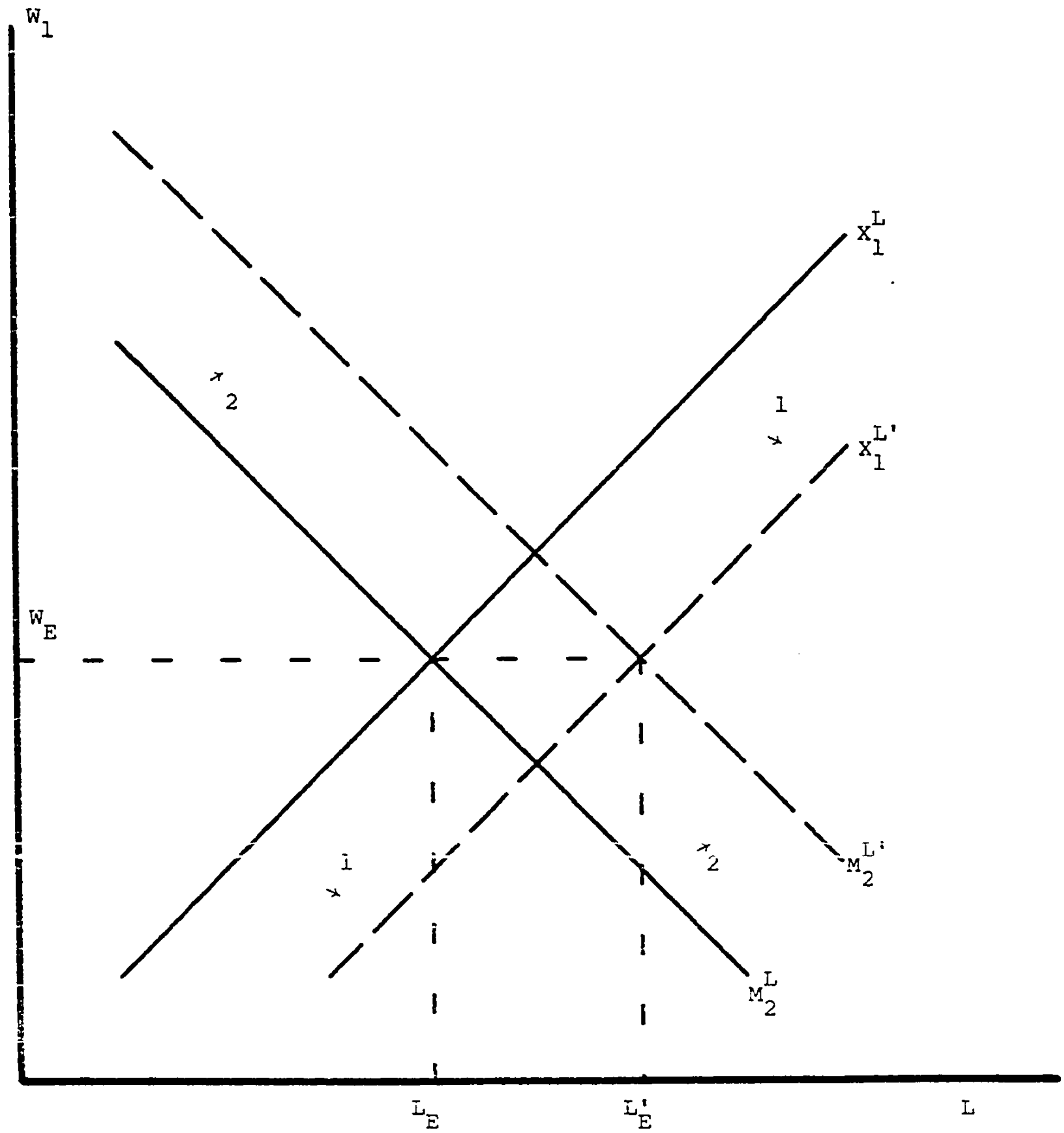

Figure A.6. Labor exchange market

Case 4: (a_{21} and u_{21}) increase in favorable weather conditions in Country 2 or (a_{22} and u_{22}) increase in technology in Country 2

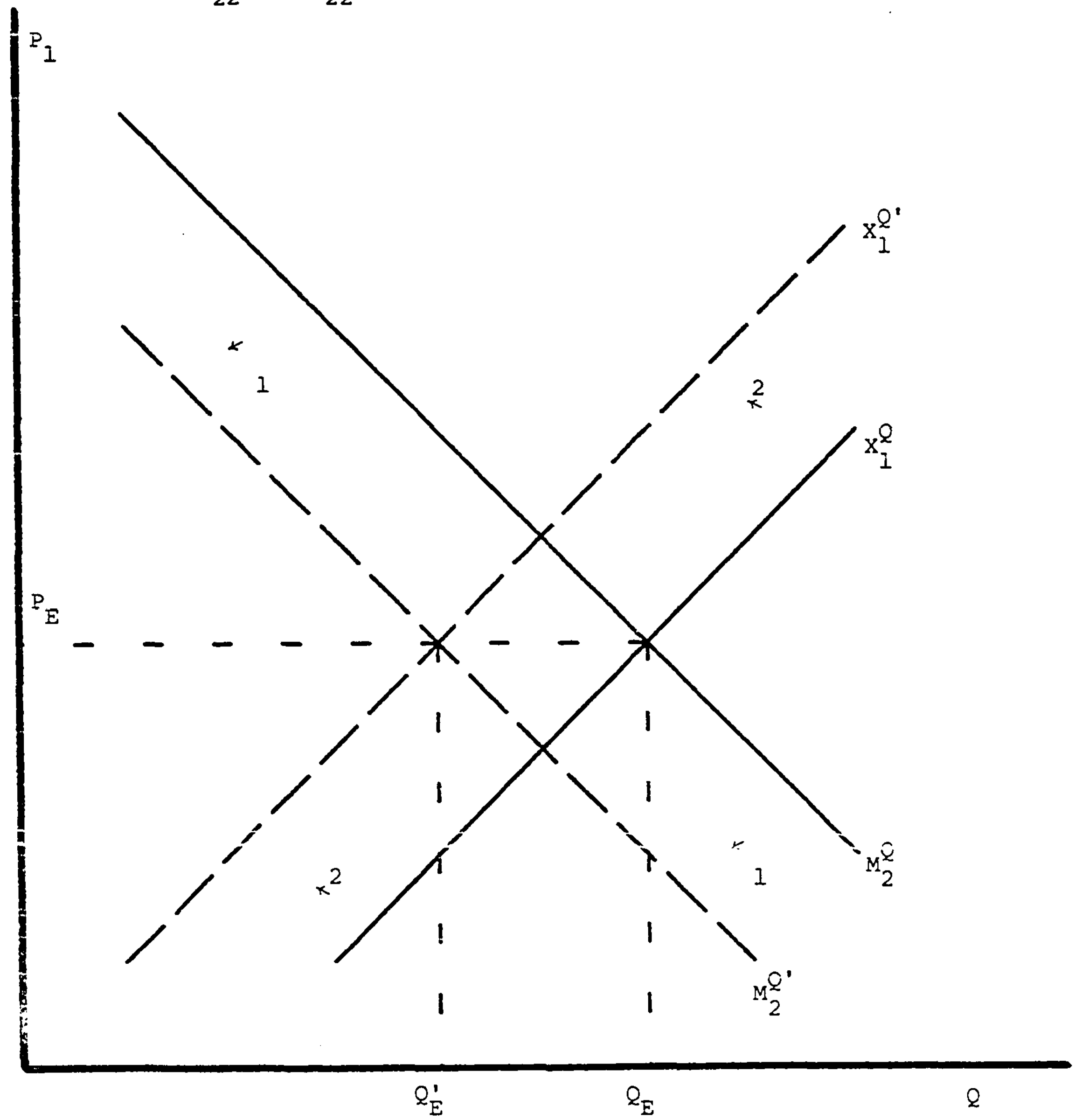

Figure A.7. Output exchange market

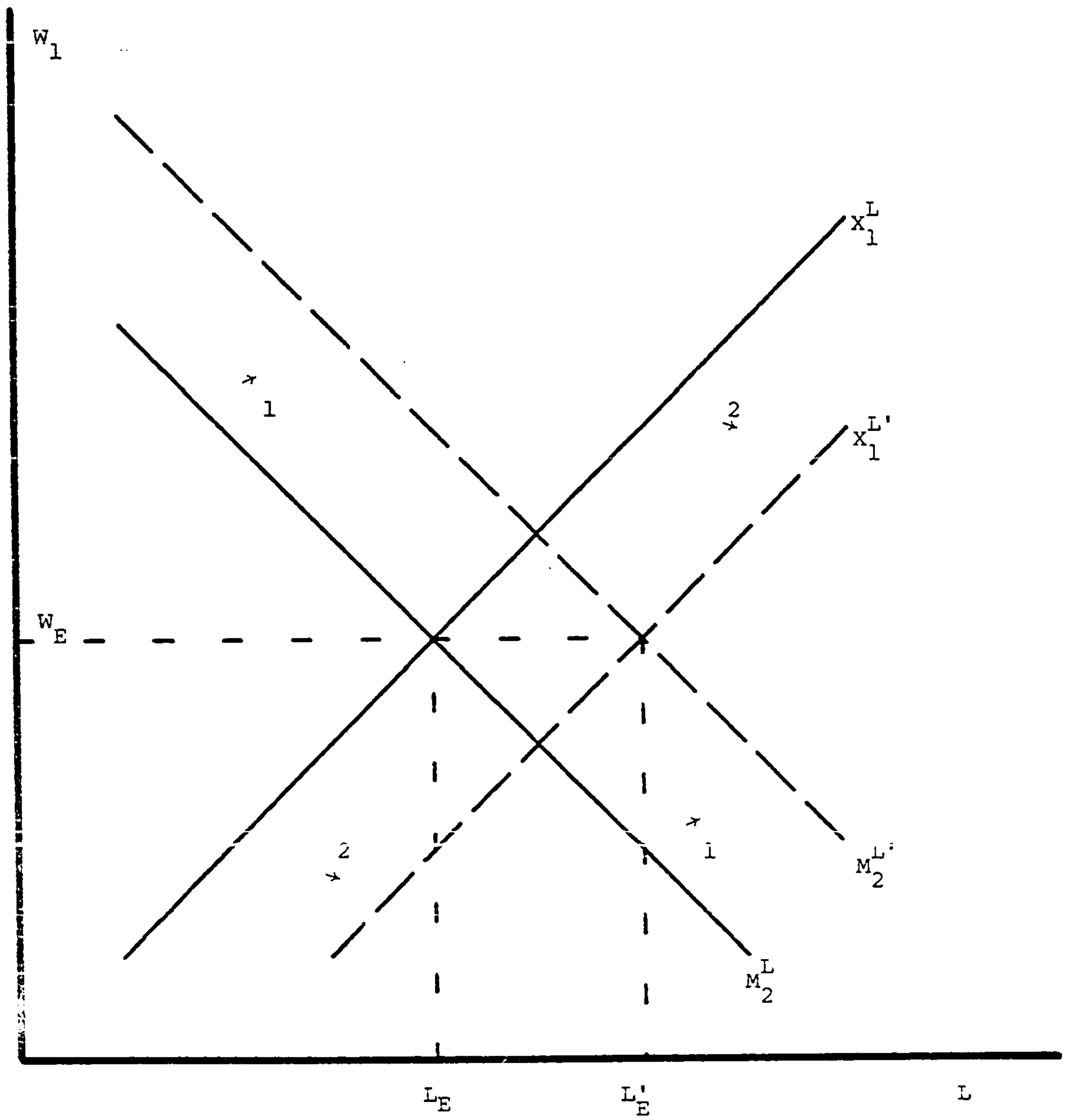

Figure A.8. Labor exchange market

immigrating to Country 2 increases and the quantity of output imported by Country 2 declines.

An increase in (b_{21}) will have a first-round effect of shifting M_2^Q to the right to $M_2^{Q'}$ (because S_2^Q increases). If there exist no income effects in Country 2's labor market, then the supply of labor S_2^L will be unaffected by the income change. The second-round effect occurs as output price increases, which will shift X_1^L to the left to $X_1^{L'}$ (because D_1^L increases) and will shift M_2^L to the right to $M_2^{L'}$ (because D_2^L increases). The quantity of output imported by Country 2 increases and the quantity of labor immigrating to Country 2 will depend on the relative elasticities of X_1^L and M_2^L. If X_1^L is more elastic, then the quantity of labor immigrating to Country 2 increases.

An increase in (b_{22} and s_{22}) will have a first-round effect of shifting M_2^Q to the right to $M_2^{Q'}$ (because D_2^Q increases) and shifting M_2^L to the left to $M_2^{L'}$ (because S_2^L increases). The second-round effect occurs as output price increases and the wage rate decreases, which shifts X_1^L to the left to $X_1^{L'}$ (because D_1^L increases) and shifts X_1^Q to the right to $X_1^{Q'}$ (because S_1^L increases). The quantity of labor immigrating to Country 2 declines and the quantity of output imported by Country 2 increases.

A decline in nonfarm income in Country 1 (s_{11}) will have a first-round affect of shifting X_1^L to the right to $X_1^{L'}$ (because S_1^L increases), if the decline in nonfarm income does not affect the demand for output in Country 1, then X_1^Q is initially unaffected. The second-round effect occurs as the wage rate declines, which will shift M_2^Q to the left to $M_2^{Q'}$ (because S_2^Q increases) and will shift X_1^Q to the right to $X_1^{Q'}$ (because

Case 5: (b_{21}) increase in income in Country 2

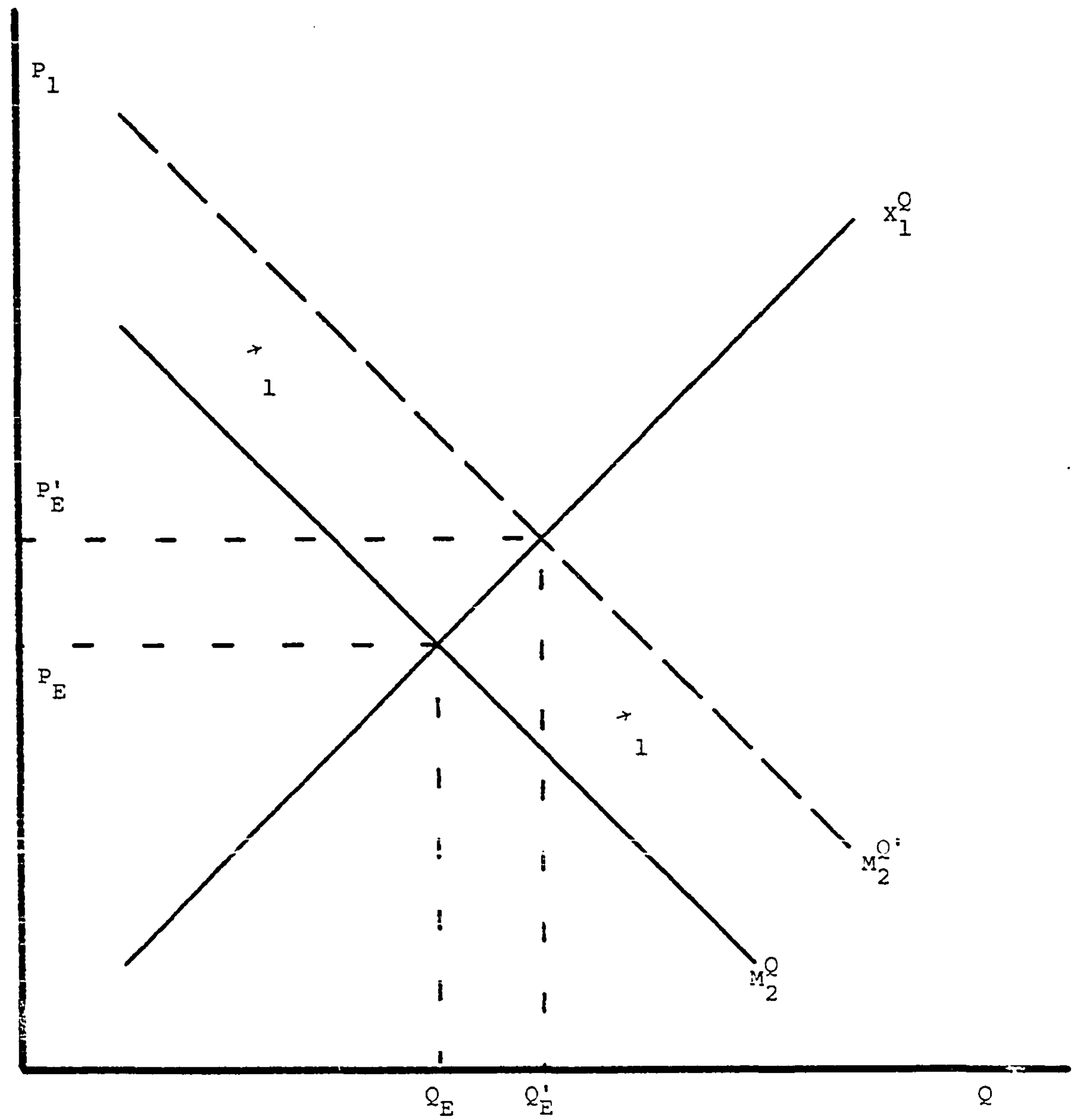

Figure A.9. Output exchange market

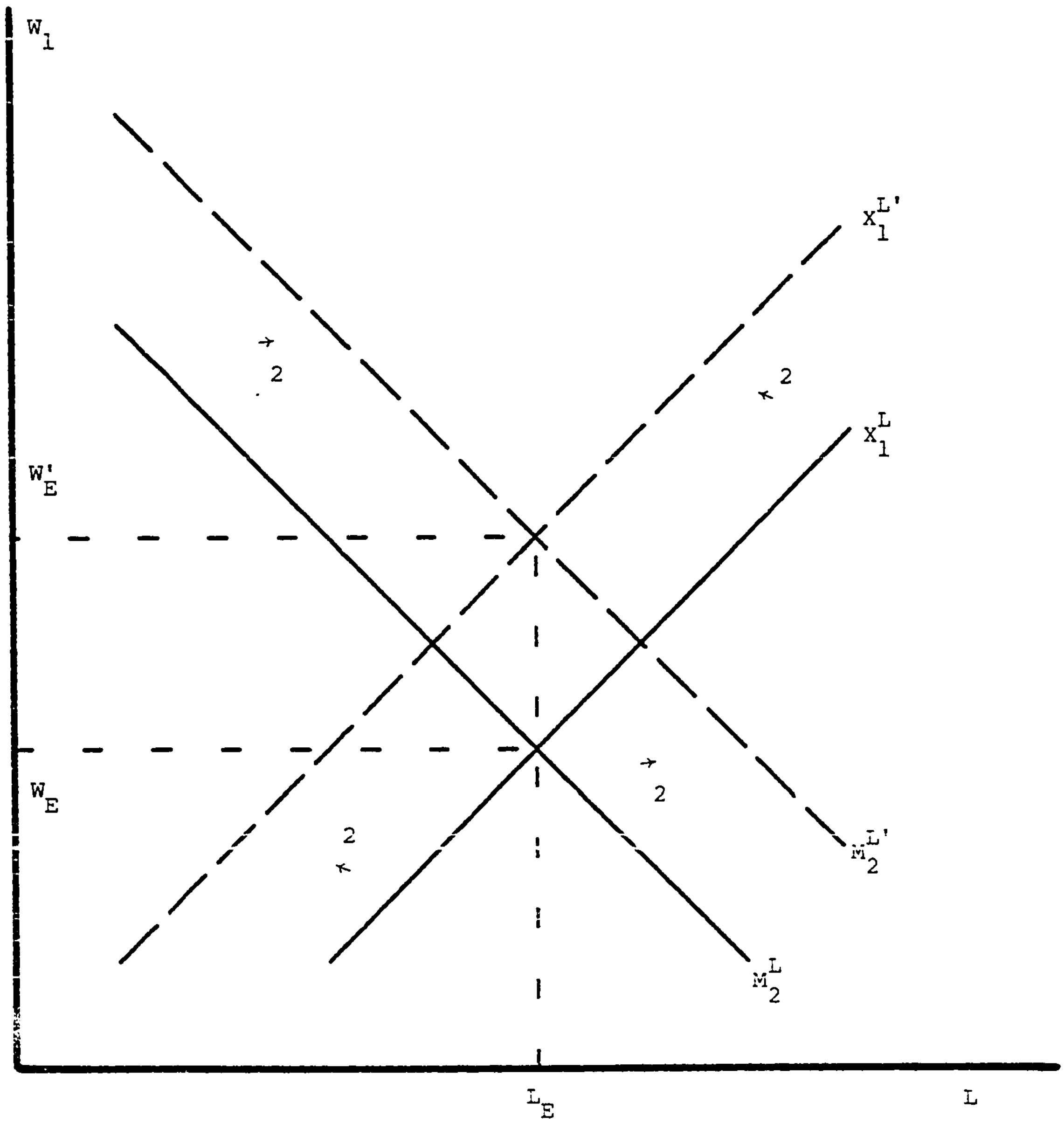

Figure A.10. Labor exchange market

Case 6: (b_{22} and s_{22}) increase in population in Country 2

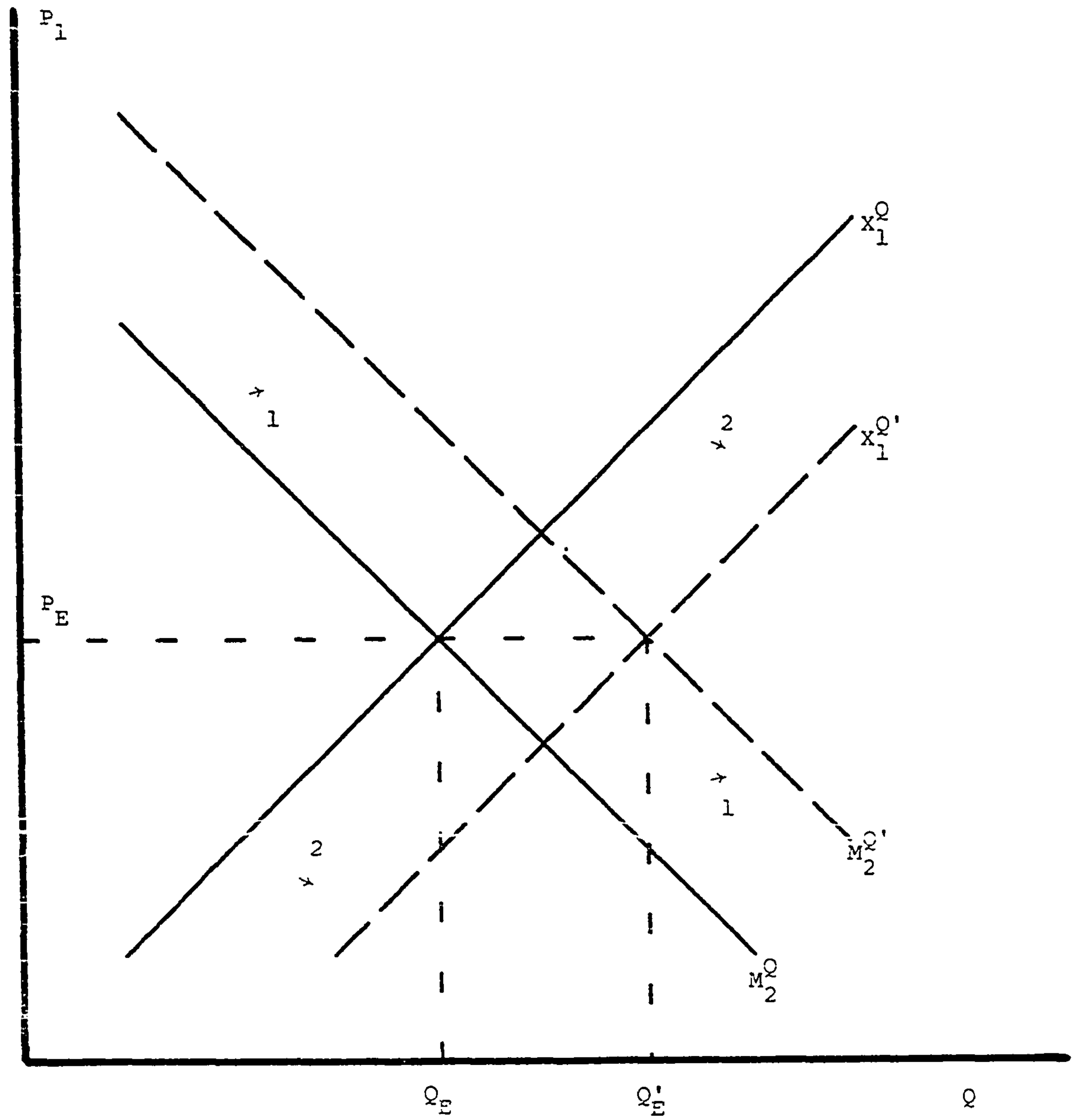

Figure A.11. Output exchange market

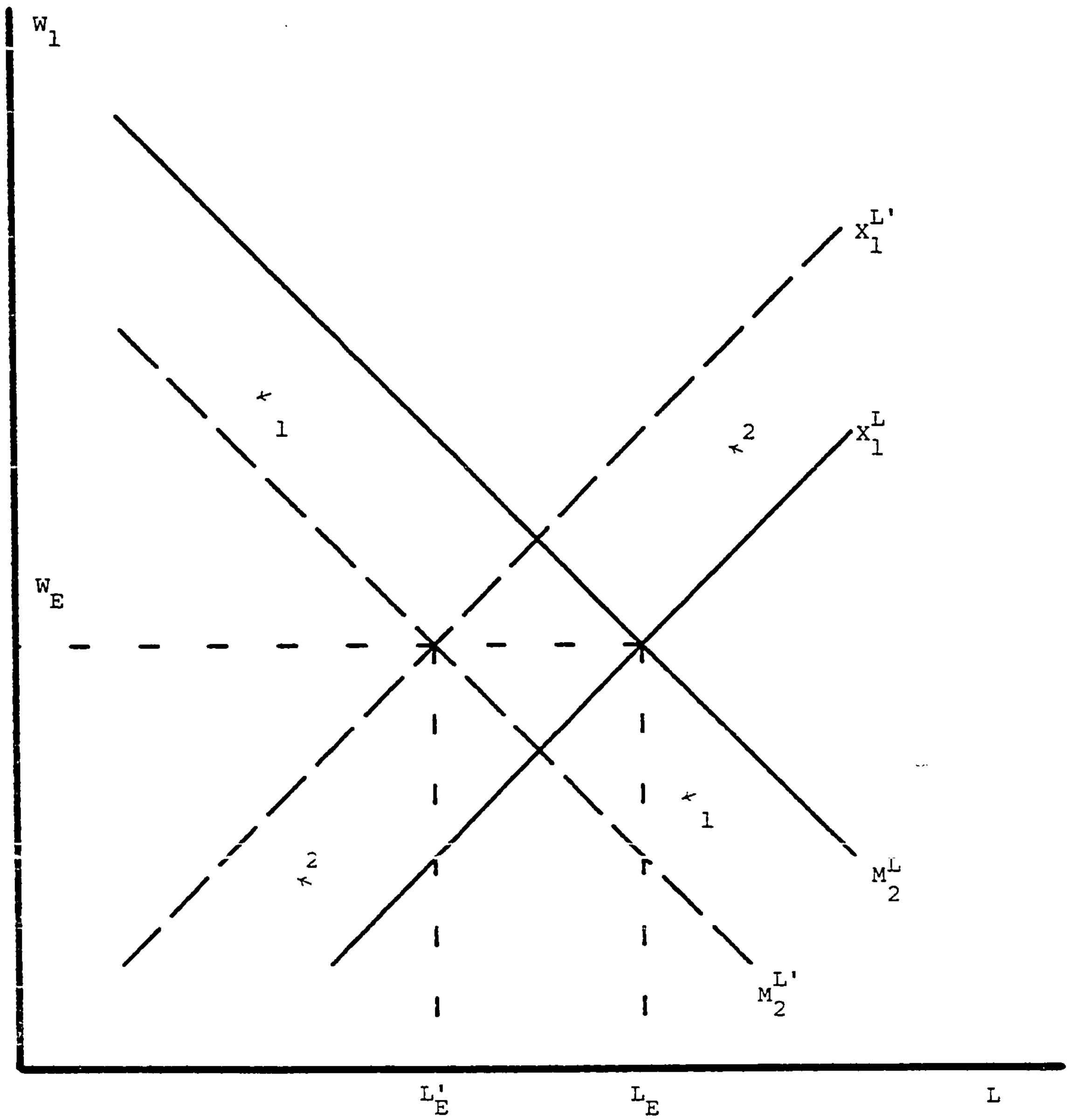

Figure A.12. Labor exchange market

Case 7: (s_{11}) decrease in nonfarm income in Country 1

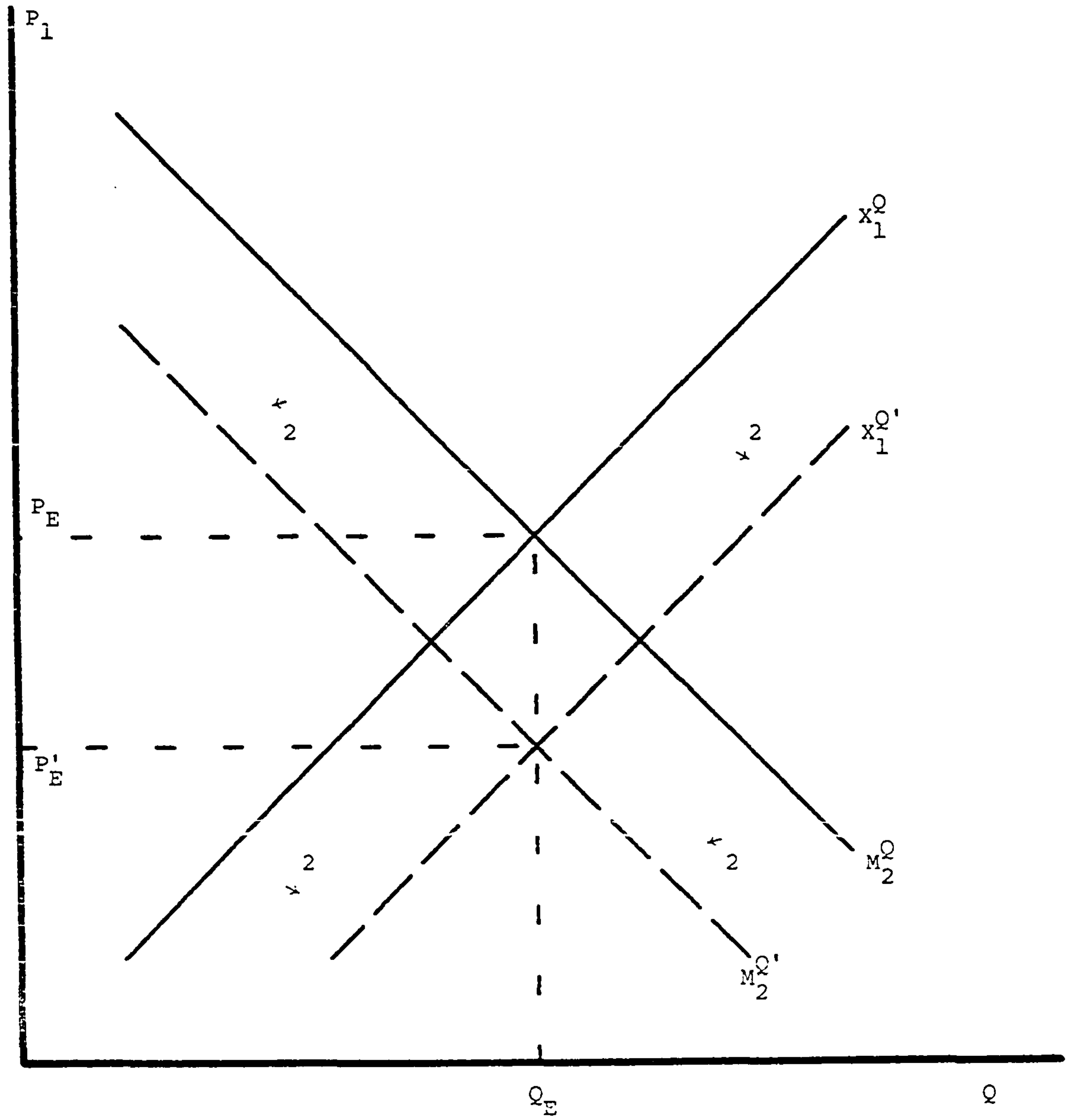

Figure A.13. Output exchange market

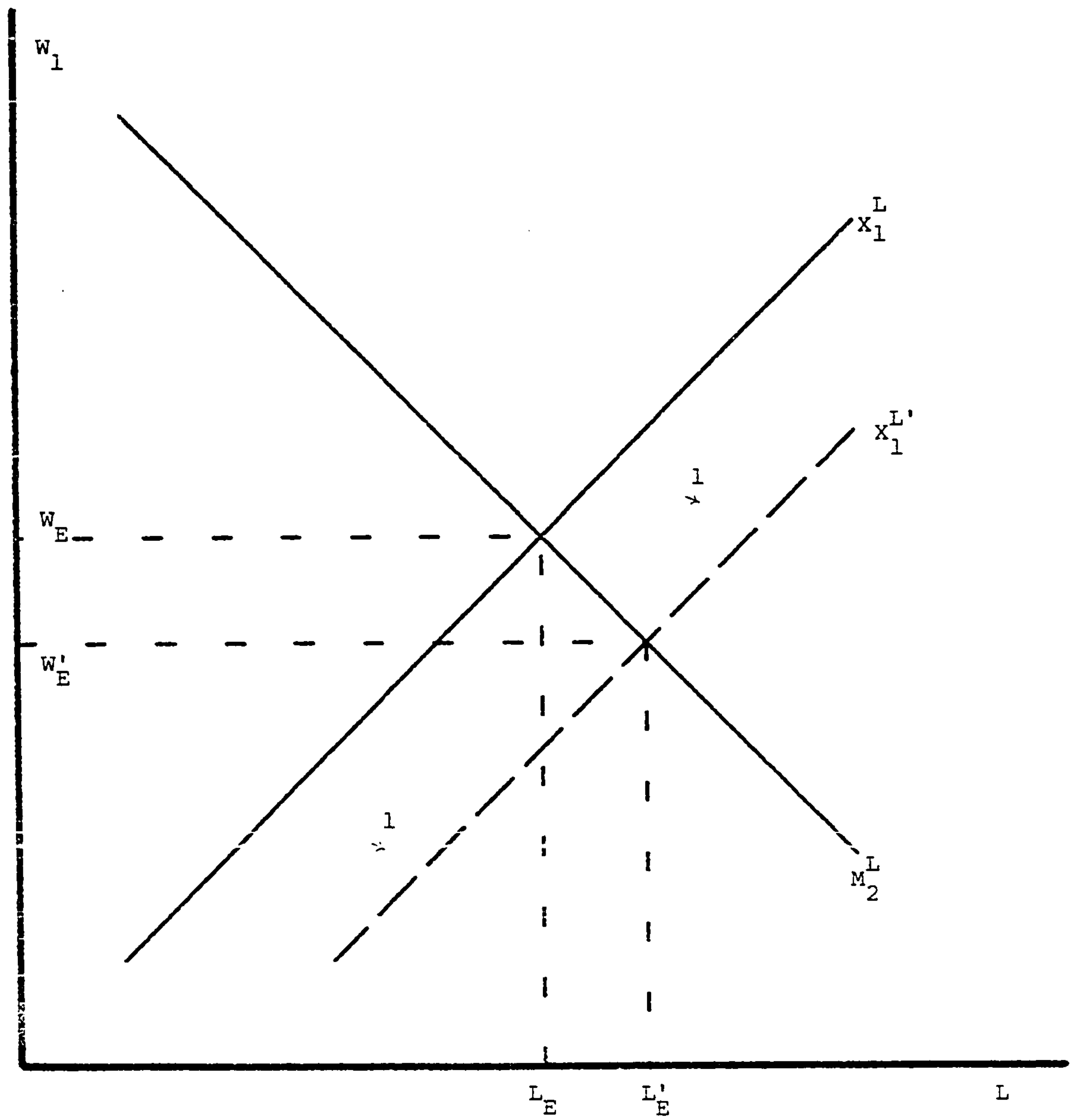

Figure A.14. Labor exchange market

S_1^Q increases). The quantity of labor immigrating to Country 2 increases and the quantity of output imported by Country 2 depends on the relative elasticities of X_1^Q and M_2^Q. If X_1^Q is more elastic, then the quantity of output imported by Country 2 declines.

A fall in nonfarm income in Country 2 (s_{21}) will have a first-round effect of shifting M_2^L to the left to $M_2^{L'}$ (because S_2^L increases), if the decline in nonfarm income does not affect the demand for output in Country 2, then M_2^Q is initially unaffected. The second-round effect occurs as the wage rate declines, which will shift X_1^Q to the right to $X_1^{Q'}$ (because S_1^Q increases) and will shift M_2^Q to the left to $M_2^{Q'}$ (because S_2^Q increases) and will shift M_2^Q to the left to $M_2^{Q'}$ (because S_2^Q increases). The quantity of labor immigrating to Country 2 declines and the quantity of output imported by Country 2 depends on the relative elasticities of X_1^Q and M_2^Q. If X_1^Q is more elastic then the quantity of output imported to Country 2 declines.

An increase in (Z_{01}), (Z_{02}) or (Z_{03}) will have a first-round effect of driving a wedge between P_1 and P_2, i.e., the output price in Country 1 falls and the output price in Country 2 rises. The second-round effect occurs as output prices change in both countries, which will shift X_1^L to the right to $X_1^{L'}$ (because D_1^L decreases) and will shift M_2^L to the right to $M_2^{L'}$ (because D_2^L increases). The quantity of labor immigrating to Country 2 increases and the quantity of output imported by Country 2 declines.

Case 8: (s_{21}) decrease in nonfarm income in Country 2

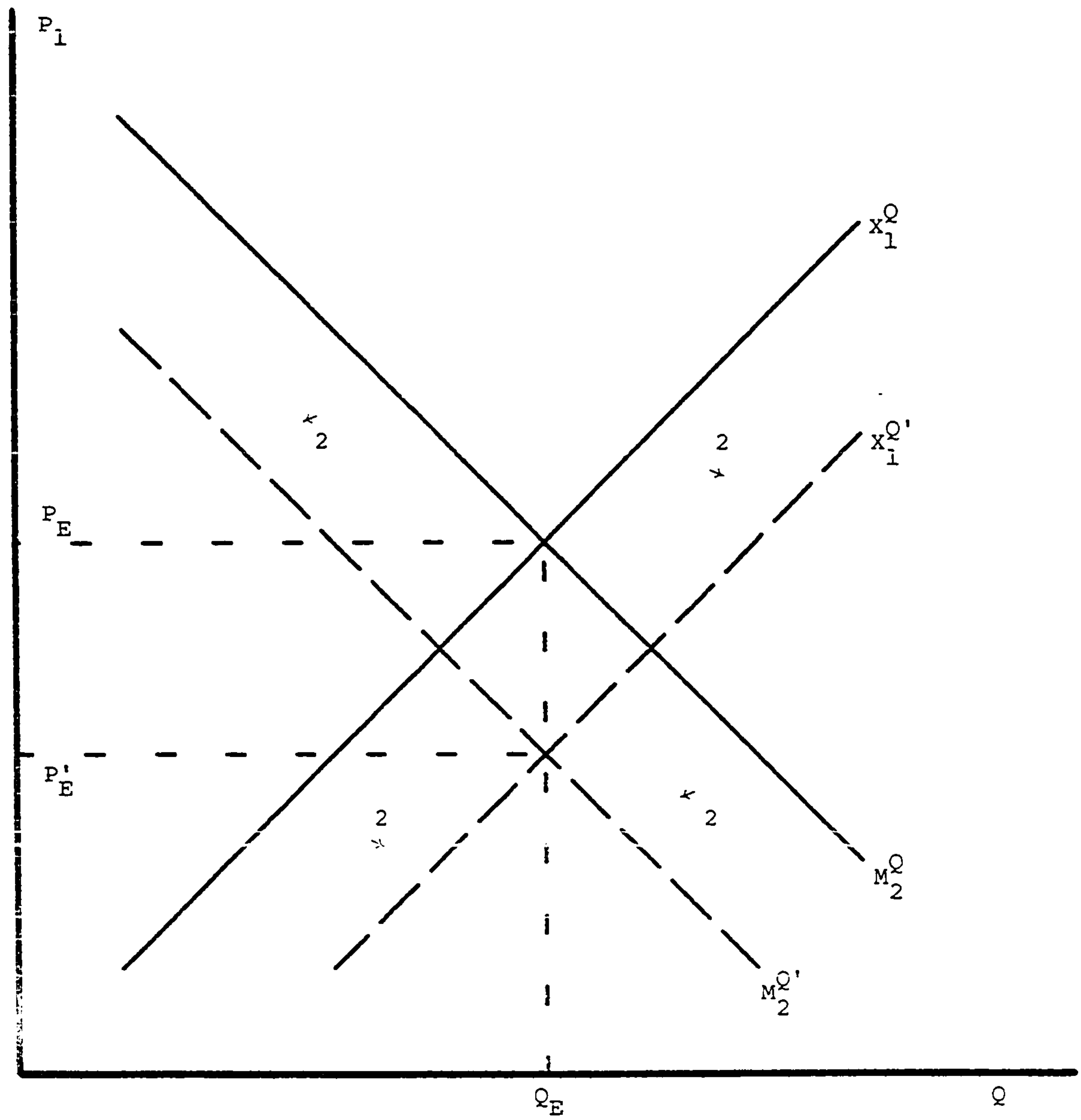

Figure A.15. Output exchange market

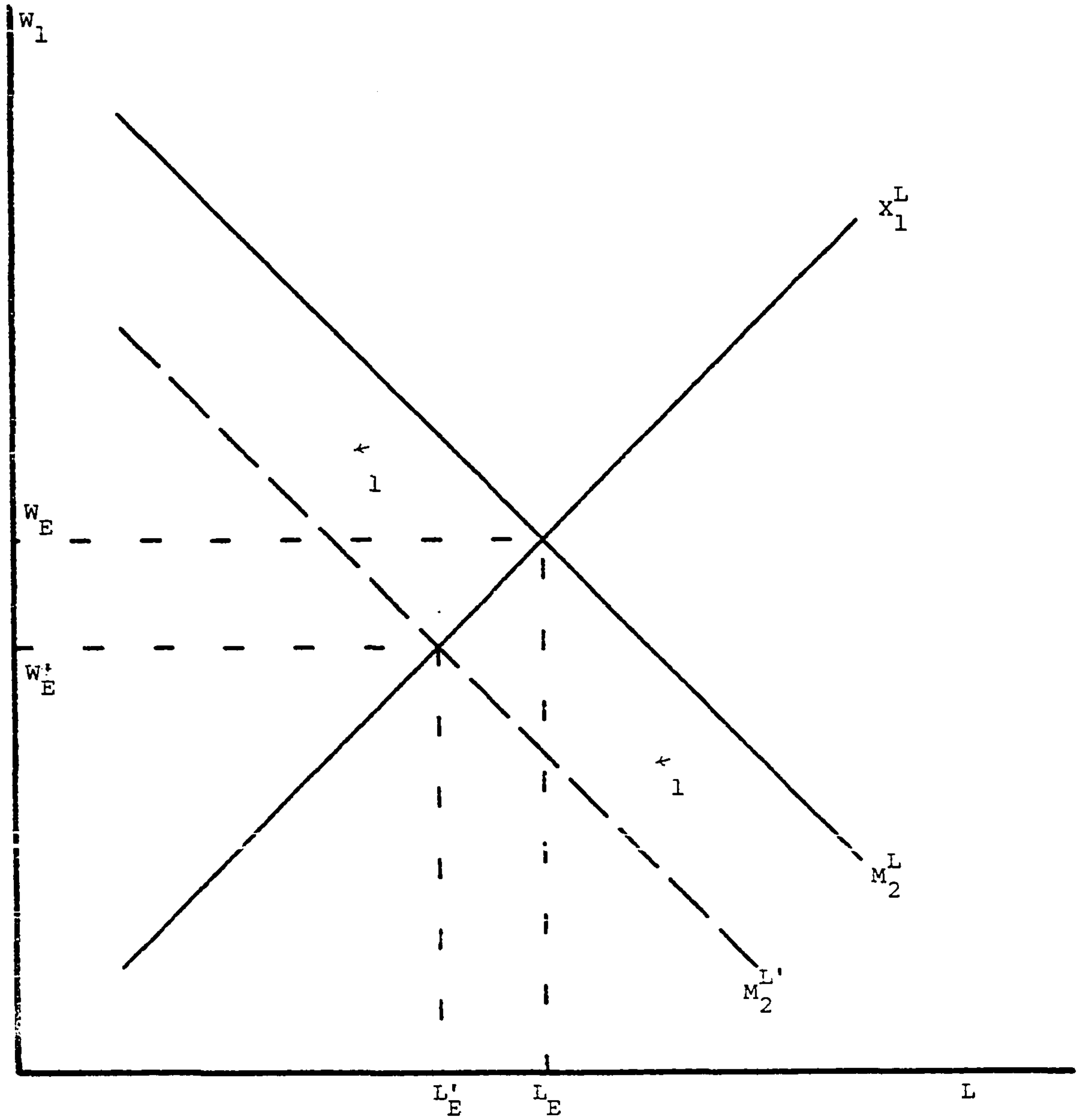

Figure A.16. Labor exchange market

Case 9: (Z_{01}) increase in transportation costs of shipping output, or
(Z_{02}) increase in import tariffs levied by Country 2, or
(Z_{03}) increase in export tariffs levied by Country 1

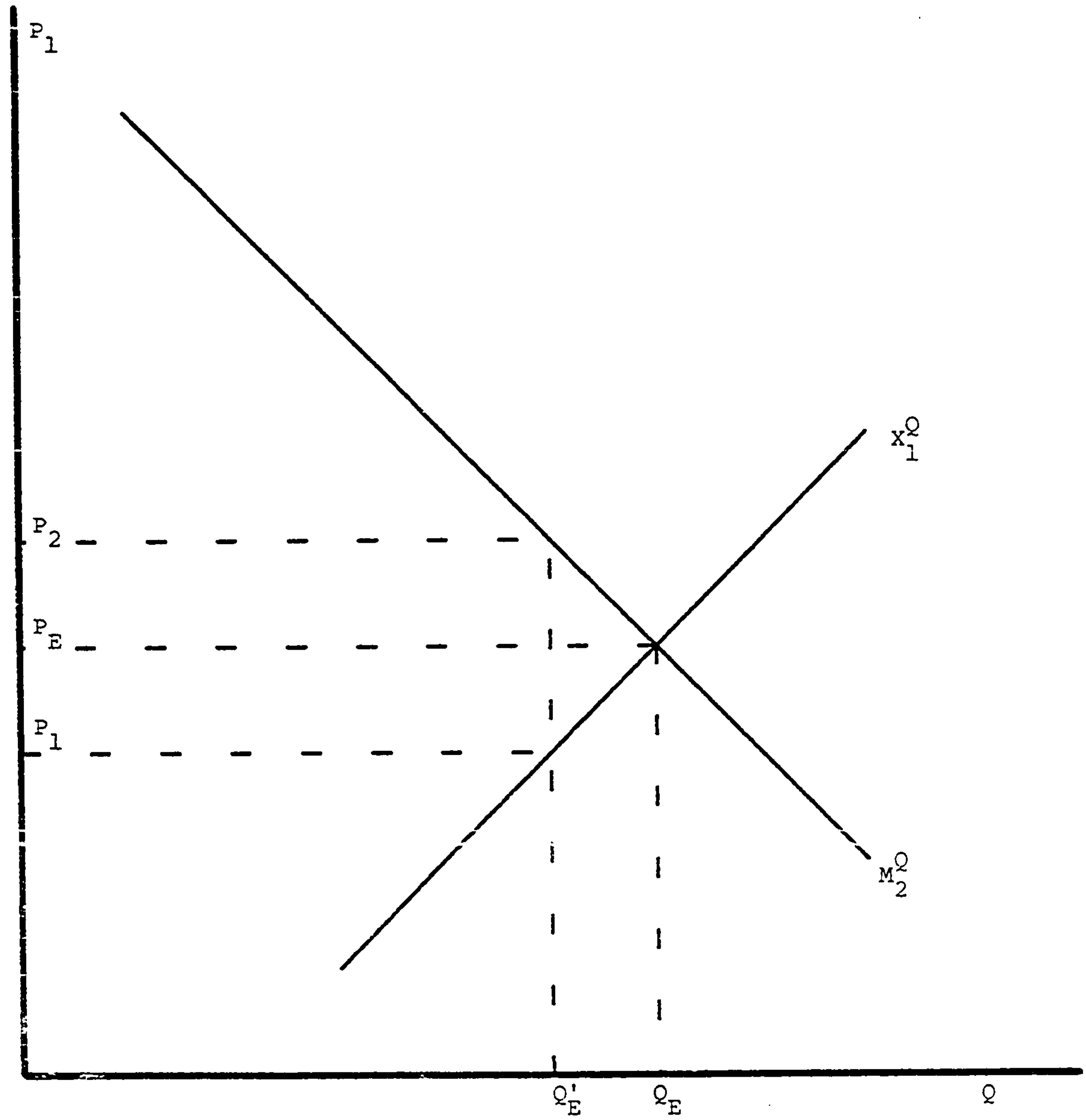

Figure A.17. Output exchange equation

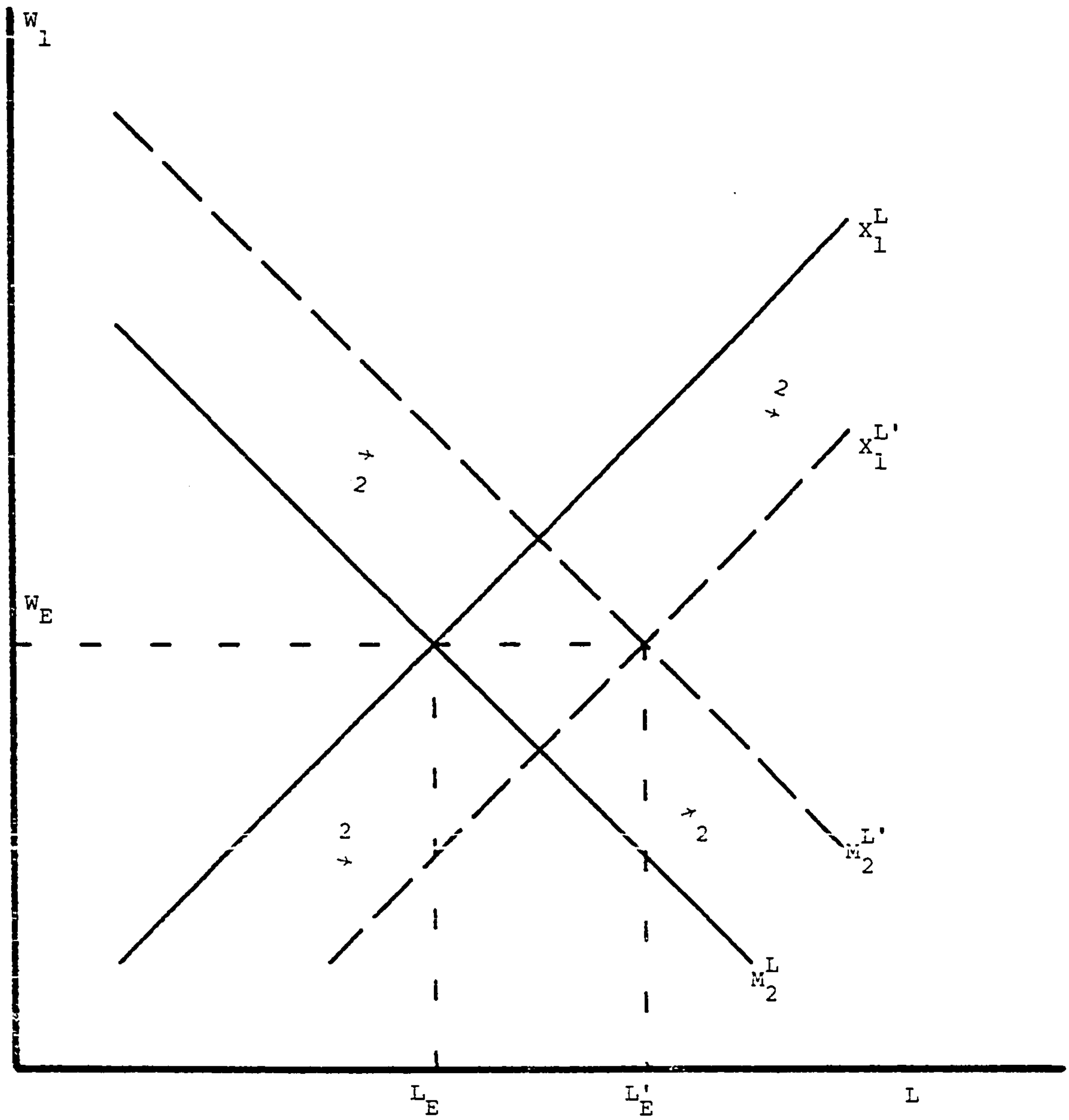

Figure A.18. Labor exchange equation

Case 10: (Y_{01}) increase in transportation costs of labor services, or
(Y_{02}) increase on factor import taxes levied by Country 2, or
(Y_{03}) increase in factor export taxes levied by Country 1

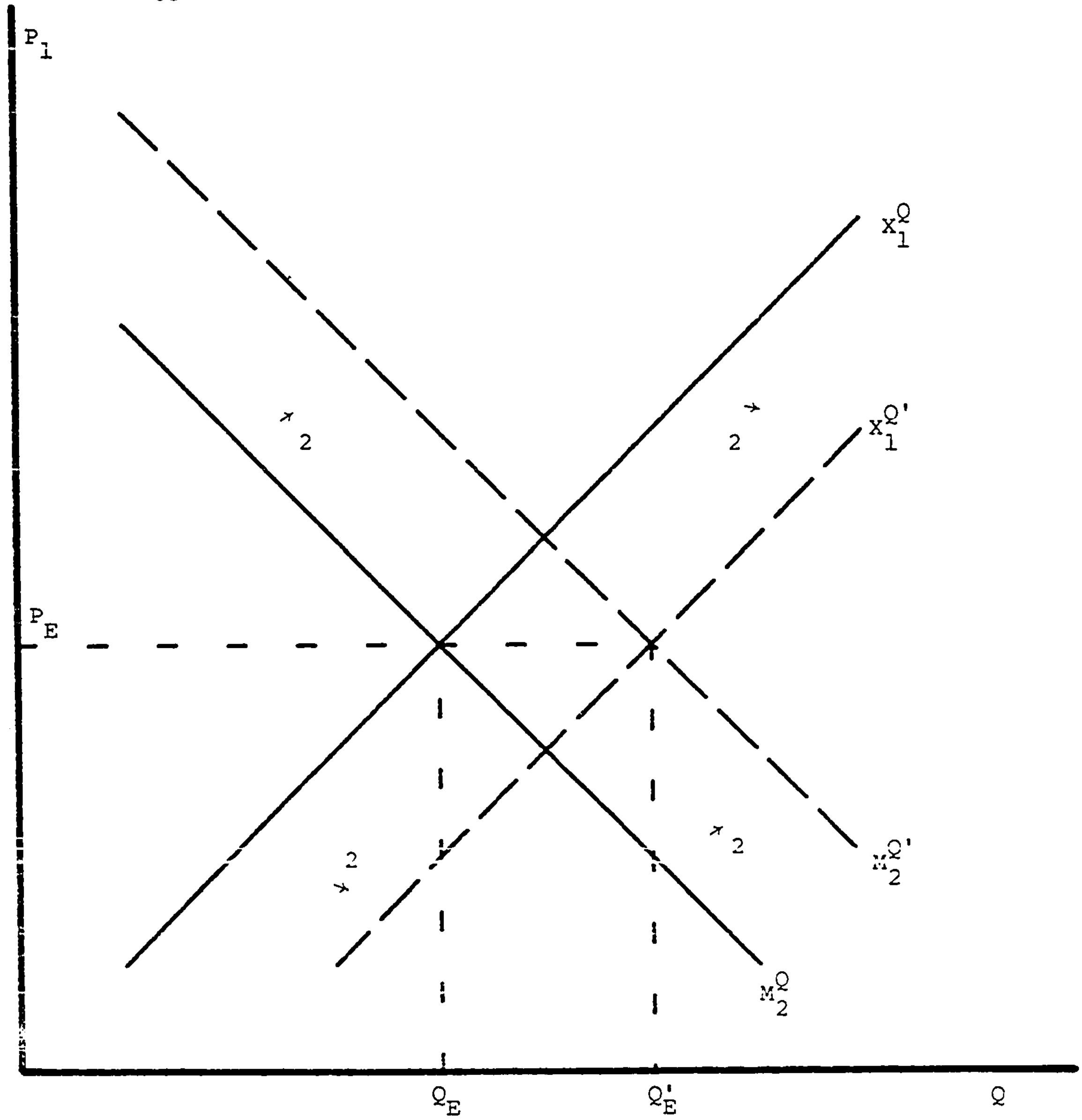

Figure A.19. Output exchange equation

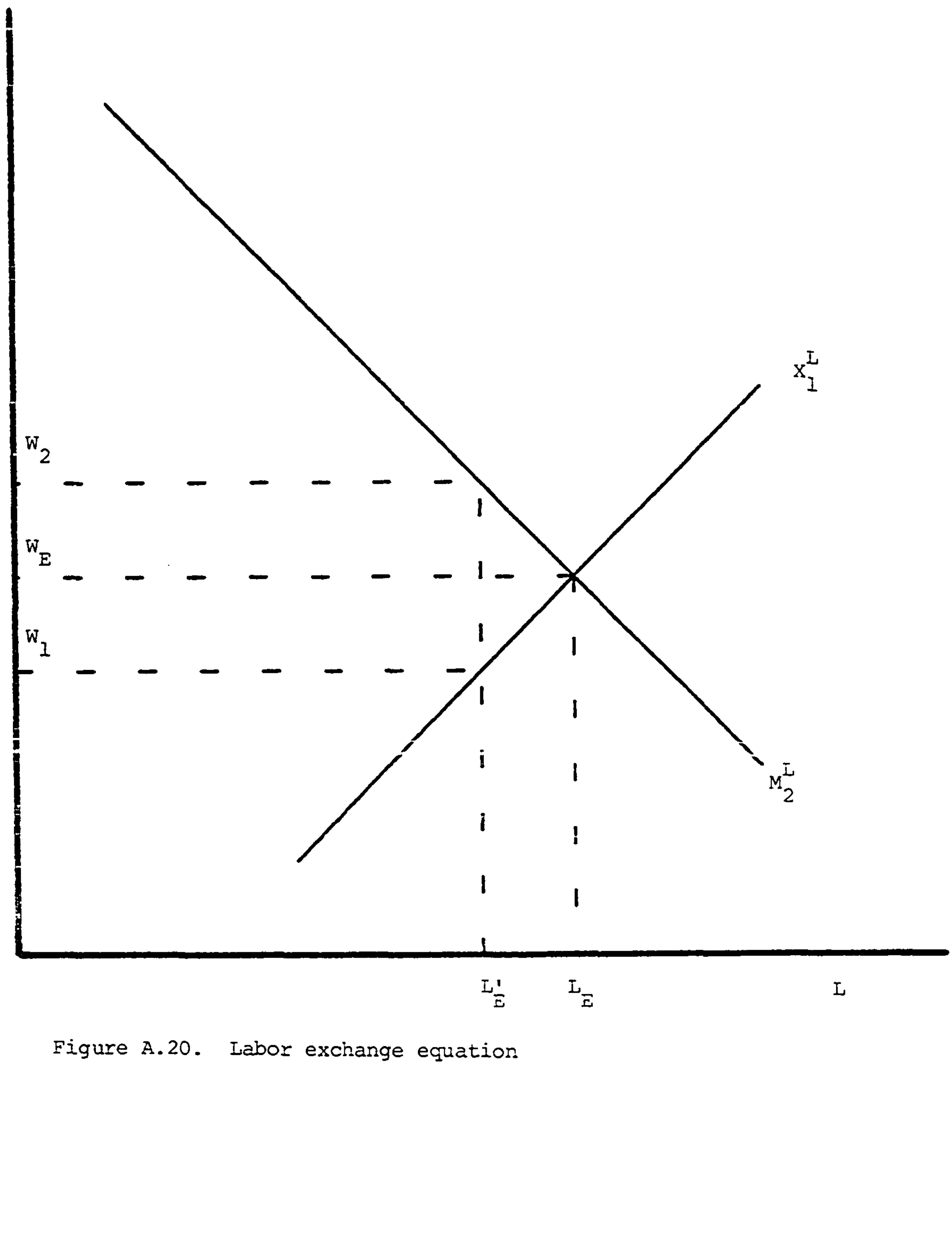

Figure A.20. Labor exchange equation

An increase in (Y_{01}), (Y_{02}) or (Y_{03}) will have a first-round effect of driving a wedge between w_1 and w_2, i.e., the wage rate in Country 1 falls and the wage rate in Country 2 rises. The second-round effect occurs as the wage rates in both countries change, which will shift X_1^Q to the right to $X_1^{Q'}$ (because S_1^Q increases) and will shift M_2^Q to the right to $M_2^{Q'}$ (because S_2^Q decreases). The quantity of labor immigrating to Country 2 declines and the quantity of output imported to Country 2 increases.

APPENDIX B

Mexican Laborers Decision to Illegally Immigrate to the U.S. and the Decision to Hire Illegal Mexican Aliens by Florida Tomato Growers

Supply of labor by Mexican laborers

The Mexican laborer has two possible choices for employment: 1) work in Mexico at the prevailing wage rate; 2) work in the U.S. at a higher wage rate. For both alternative labor markets, the unskilled Mexican laborer must consider his probability of being unemployed. Furthermore, the decision to immigrate to the U.S. includes travel costs, differences in living expenses between the U.S. and Mexico, and the probability of being apprehended and deported to Mexico. For simplicity, assume no non-pecuniary costs or benefits associated with immigrating to the United States.

An optimization model can be developed to derive a supply of labor function to the U.S. for Mexican laborers. It is assumed that a Mexican laborer maximizes the following utility function subject to a time constraint and a budget constraint.

Utility function:

B.1) $U = U(X_m, L)$

Time constraint:

B.2) $T = L + H_m + H_a$

Full income budget constraint:

B.3) $$I^F = V_m + [P_{rA}(u_A, e_A) \cdot w_A \cdot H)_A] + [P_{rm}(u_m) \cdot w_m \cdot H_m]$$

$$- [P_A \cdot X_A(H_A)] = P_m \cdot X_m$$

where:

X_m - market goods consumed in Mexico

L - hours of leisure

T - total time available

H_m - hours worked in Mexico

H_A - hours worked in the United States

I^F - full income

V_m - unearned Mexican income

P_{rA} - probability of being employed in the U.S. (a function of the U.S. unemployment rate and the probability of apprehension and deportation)

u_A - U.S. unemployment rate

e_A - probability of apprehension and deportation

w_A - agricultural wage rate in the U.S.

P_{rm} - probability of being employed in Mexico (a function of Mexico's unemployment rate)

u_m - Mexico's unemployment rate

w_m - agricultural wage rate in Mexico, in dollars

P_A - consumer price index in the U.S.

X_A - market goods consumed in the U.S. including transportation costs of immigrating (a function of the hours worked in the U.S.)

P_m - consumer price index in Mexico

Solving for H_m in Equation B.2 yields:

B.4) $H_m = T - L - H_A$

Substituting Equation B.4 into Equation B.3 yields:

B.5) $V_m + [P_{rA}(u_A, e_A) \cdot w_A \cdot H_A] + [P_{rm}(u_m) \cdot w_m (T-L-H_m)]$

$- [P_A \cdot X_A(H_A)] - (P_m \cdot X_m) = I^F$

The utility maximization model is represented by Equation B.6. The first order conditions for utility maximization are given by Equations B.7 to B.10.

B.6) $\phi = u(X_m, L) + \lambda [V_m + [P_{rA}(u_A, e_A) \cdot w_A \cdot H_A]$

$+ [P_{rm}(u_m) \cdot w_m (T-L-H_A)] - [P_A \cdot X_A(H_A)] - P_m X_m]$

B.7) $\frac{\partial \phi}{\partial X_m} = \frac{\partial U}{\partial X_m} - \lambda P_m = 0$

B.8) $\frac{\partial \phi}{\partial L} = \frac{\partial u}{\partial L} - \lambda [P_{rm}(U_m) \cdot w_m] = 0$

$$\left.\begin{matrix} \text{B.7} \\ \text{B.8} \end{matrix}\right\} \frac{Mu_L}{MuX_m} = \left[\frac{P_{rm}(U_m) \cdot w_m}{P_m}\right]$$

B.9) $\frac{\partial \phi}{\partial H_A} = \lambda [[P_{rA}(u_A, e_A) \cdot w_A] - P_A \cdot \frac{\partial X_A}{\partial H_A} - [P_{rm}(u_m) \cdot w_m]] = 0$

B.10) $\frac{\partial \phi}{\partial \lambda} = V_m + [P_{rA}(u_A, e_A) \cdot w_A \cdot H_A] + [P_{rm}(u_m) \cdot w_m (T-L-H_A)]$

$[P_A \cdot X_A(H_A) - P_m \cdot X_m] = 0$

Assume the second order conditions are satisfied.

For an interior solution:

(a) The marginal rate of substitution between leisure and market goods consumed in Mexico equals the ratio of the expected wage in Mexico to the price of market goods in Mexico.

(b) The optimal allocation of time between U.S. and Mexico occurs when working time is allocated such that the expected wage in the U.S. net of living expenses equals the expected wage in Mexico:

$$[[P_{rA}(u_A,e_A)\cdot w_A] - [P_A \cdot \frac{\partial X_A}{\partial H_A}]] = [P_{rm}(u_m)\cdot w_m]$$

Equations B.7 to B.10 can be solved for the supply of labor function to the U.S. by Mexican laborers:

$$H_A^{supply} = H_A[P_{rA}(u_A,e_A)\cdot w_A,P_A,P_{rm}(u_m)\cdot w_m,P_m,V_m]$$

$$= H_A[P_{rA}(u_A,e_A),w_A,P_A,P_{rm}(u_m),w_m,P_m,V_m)]$$

$$= \tilde{H}_A[\mu_A,e_A,w_A,P_A,u_m,P_m,V_m]$$

Hence, the supply of labor to the U.S. by Mexican laborers depends on:

(1) wage rates in the U.S. and Mexico

(2) unemployment rates in the U.S. and Mexico

(3) price of consumption goods in U.S. and Mexico

(4) unearned income in Mexico

(5) Border Patrol apprehension effort in the U.S.

Demand for illegal Mexican labor in the U.S.

The Florida tomato grower faces the choice of hiring U.S. agricultural labor and illegal Mexican aliens (IMA's) immigrating to the United States. Assume that IMA's and U.S. agricultural laborers are perfect substitutes for low quality labor. Also, assume that the U.S. employer pays no cost if illegals are detected (all costs are borne by the deported IMA and the Immigration and Naturalization Service).

An optimization model can be developed to derive a demand for IMA's by Florida tomato growers. It is assumed that Florida tomato growers maximize profit:

B.11) $\pi = P_Q \cdot F(X_1, X_2) - (w_{1L} \cdot X_{1L}) - (w_{1I} \cdot X_{1I}) - (w_2 \cdot X_2)$

where:

π - profits

P_Q - price of fresh market winter tomatoes in Florida

$F(X_1, X_2)$ - tomato production function, depends on X_1 (quantity of low skilled agricultural labor) and X_2 (other inputs in production)

X_1 - quantity of low skilled agricultural labor, $X_1 = X_{1L} + X_{1I}$

X_{1L} - quantity of U.S. agricultural labor employed in Florida

X_{1I} - quantity of IMA's employed in Florida

X_2 - quantity of other inputs in production

w_{1L}, w_{1I} - agricultural wage rates for the two types of labor in Florida

w_2 - price of other inputs in production

The first order conditions for profit maximization are:

B.12) $$\frac{\partial \pi}{\partial X_{1i}} = [P_Q \cdot \frac{\partial F}{\partial X_1} \frac{\partial X_1}{\partial X_{1i}}] - w_{1i} = 0 \rightarrow P_Q \cdot \frac{\partial F}{\partial X_1} = w_1$$

B.13) $$\frac{\partial \pi}{\partial X_2} = P_Q \cdot \frac{\partial F}{\partial X_2} - w_2 = 0 \rightarrow P_Q \cdot \frac{\partial F}{\partial X_2} = w_2$$

Assume second order conditions are satisfied.

Solving Equations B.12 and B.13 for the demand for inputs:

$$X_{1i}^{demand} = X_{1i}(w_{1L}, w_{iI}, w_2, P_Q)$$

$$(i = I,L)$$

$$X_2^{demand} = X_2(w_{1L}, w_{1I}, w_2, P_Q)$$

Given that IMA's and U.S. agricultural labor are perfect substitutes in production, then $w_{1L} = w_{1I}$ must occur. Therefore:

$$X_{1i}^{demand} = X_{1i}(w_1, w_2, P_Q)$$

Hence, the demand for illegal Mexican immigrant labor by Florida tomato growers depends on:

(1) the Florida agricultural wage rate,

(2) price of other inputs in production, and

(3) price of fresh market winter tomatoes in Florda