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Foreign Labor and Farm Structure*

Yoav Kislev

Abstract

The paper reports an analysis of the effect of foreign labor on agriculture in the host country. Israel serves as an example. The core of the analysis is a model of the family farm where labor and capital are complements in production. As low-wage workers appear in the labor market, both inputs—hired labor and capital—are increased and optimal farm size grows. With larger farms, production is conducted with a smaller number of units. In this way, foreign workers crowd out farm operators as well as domestic hired laborers. This effect is mitigated by the expansion of labor-intensive exports or import substitutes.

Migration of foreign farm workers is generally analyzed in terms of its effect on the labor market at home or in the host country, on the communities these workers move into, on poverty, and welfare program. In this paper I am trying to offer an analysis of the effect of foreign labor on agriculture in the host country, Israel serves as an example. (For earlier studies in the Israeli context see Angrist, 1996; Ruppert Bulmer, 2003; Zussman and Romanov, 2003. Taylor and Martin, 2001, particularly P. 497, survey the US experience.)

Israel experienced two groups of foreign workers. The First were Palestinians who came from the territories Israel occupied in 1967 and the second group started coming in the late 1980s when labor immigration from other countries was allowed in the wake of the Palestinian uprising and disturbances in the labor market. To distinguish between the groups I shall call them Palestinians and migrants.

The number of Palestinians working in agriculture in Israel, never exceeded 15% of the farm labor force (including operators) and their share is now less than 5%. No migrants were registered in the labor statistics before 1992 and today they form

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approximately 36% of the workers in the industry.[1] The number of self-employed in agriculture has decreased 50% over the last decade. It seems therefore that the migrants have replaced farm operators as well as laborers who had worked in agriculture before their arrival. Labor migration had a profound effect on the economics of agriculture in Israel. This observation is the motivation of the study. The analysis will focus mainly on family farms; I shall comment on other sectors of agriculture toward the end of the paper.

The farm model

The engine of the major part of the analysis follows a model developed in an earlier paper (Kislev and Peterson, 1982). That model, although of wider application, was constructed in terms of a field crops farm. Its main finding was that farm size is determined by economic considerations: technology and factor prices. The number of farms is determined by the demand for the product of agriculture; call it food. Where the demand is relatively high and all arable land is cultivated, the number of farms is simply the ratio of land area to the area of the farm (farms are identical). If the demand is low and some land is left idle, the number of farms is determined by equilibrium conditions in the market for food. These features are maintained in the present analysis, but two simplifying features of the 1982 model—that capital (machinery) and labor are only substitutes in production and that farm size can be measured in land area—are not consistent with the structure and technology of the farms in Israel and farms employing significant numbers of migrant laborers in other places. These features will have to be modified in the following analysis.

Most of the family farms in Israel produce fruits, vegetables, flowers, or livestock products. In these lines, labor and capital are often complements in production, not substitutes as they may be on field crops farms. In particular, orchards and greenhouses are labor-intensive enterprises in which the inputs of capital and labor mostly move together. The factors are complements in production. In addition, farms specializing in horticulture may be of small land area but large in terms of other input and output. Land cannot therefore serve as a reasonable measure of farm size.

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[1] As of the mid 1990s, the share of US farm workers who were foreign born was 70% (DOL, 1997).

Consider a family farm producing vegetables. It is run by a single operator—this is the fixed factor of the farm-firm. In addition, the farm employs hired workers, capital (greenhouses), land, and biological inputs: water, fertilizers, pesticides, and others. The production function, of constant returns to scale, is viewed in the model as a two-stage function. The first stage is the stage of structures, labor and machines. Here operator's labor, O (=1), hired labor, H, capital, K, and land, L, are combined to create an intermediate factor q. q is actually the product, the value added on the farm, but viewed from the side of production, q is more appropriately taken as an imaginary (unobserved) intermediate factor. The second stage of production is biological; at this stage q is combined with the biological inputs, B, to form the output of the farm, y.

The separation of the first stage of production from the second rests on the assumption that the quantity of the biological inputs per unit of product or output is independent of the scale of production; for instance, the basket of biological input per acre is the same basket in a ten acres orchard as in a one hundred acre orchard. This fixed proportion assumption is also implicitly adopted when using value added in economic analysis; for example, in productivity calculation.[2] Formally, let b be the quantity of biological input per unit of q. Then

(1) $$B = bq$$

The first stage production function is

(2) $$q = q(O, H, K, L)$$

and the second stage function is

(3) $$y = f(q, B)$$

[2] Naturally, labor is involved in the application of the biological inputs. Under fixed proportions, this labor can be measured with the labor employed in the first stage of production.

All factors, including q, are defined in terms of annual service. Let z be the price of q, the price of one unit of the intermediate factor per year. In empirical application, since q is unobserved, z can only be defined as an index. This measure suffices for our needs. Per-unit prices of the purchased factors of production are w for H, u for K, and v for B. The price w and v can be observed on the market. The price u is the service cost of a unit of capital. It is often unobservable but can sometimes be seen; for example, in markets for machine rental. These three prices are given exogenously to agriculture. The "price" of the input of an operator, ω, is the alternative cost of the self-employed, the earning an operator could have in non-agricultural occupations. The value ω is also given exogenously and it affects decisions on the farm in the long run. One price is endogenous in the farm sector; it is ρ, the return to land. Its determination is discussed below.

As indicated, I assume, again for simplicity, that agriculture produces one product, food. The price of food is P. Equation (3) can now be rewritten in monetary terms as

(3') $$Py = zq + vB$$

The additive formulation in (3') makes the separation of the stages of production explicit. Sato (1967) discusses a more general case.

The first order condition for profit maximization as applied to the production of q is the familiar rule that VMP equals the price of the factor. Given O=1, a constant, profit is maximized in the solution of the triplet

(4) $$zq_H(O,H,K,L) = w$$

(5) $$zq_K(O,H,K,L) = r$$

(6) $$zq_L(O,H,K,L) = \rho$$

Equation (6), the first order condition with respect to L, will be disregarded from now on. Land is still a factor of production—food is produced on land. The factor land will be disregarded only in the calculation of maximum profit. The disregard of (6) will be justified below; in the meantime, its absence will simplify the exposition.

The two conditions, (4), (5), define graphs in the space *H*, *K*. For concreteness, let the first stage production function be Cobb-Douglas. The function is of constant returns to scale by the assumption that (3) is characterized by constant returns and by the additive form of (3')

(7) $$q = AO^{\alpha}H^{\beta}K^{\gamma}L^{\delta} \quad \alpha+\beta+\gamma+\delta=1$$

With some rewriting, equations (4), (5) are now

(8) $$H = \left(\frac{z}{w}\beta AO^{\alpha}K^{\gamma}L^{\delta}\right)^{\frac{1}{1-\beta}}$$

(9) $$K = \left(\frac{z}{u}\gamma AO^{\alpha}H^{\beta}L^{\delta}\right)^{\frac{1}{1-\gamma}}$$

Figure 1 depicts the graphs of equations (8) and (9). The point c_1 marks one equilibrium, an equilibrium combination of the factors *H* and *K* for given values of the parameters in the equations. A reduction in *w*, the wage rate of hired labor, shifts the graph of (8) upward and moves the equilibrium combination to c_2 with greater quantities of both labor and capital. An increase in *z* raises both graphs [(9) "rises" to the right).

The comprehensive representation of production on the farm is depicted in Figure 2. For simplicity, prices are not marked in the figure, this amounts to assuming that they are all equal to unity, P=z=v=1. Operator's labor is combined in quadrant I with *H* and *K*. The three primary factors produce the intermediate factor *q*; the product can be read either on the isoproduct curves in I or on the graph in quadrant II. An operator (O=1) and c_1 (from Figure 1) produce q_1; q_2 is produced with c_2. The intermediate factor is combined with the biological input *B* in quadrant III to produce farm output *y*.

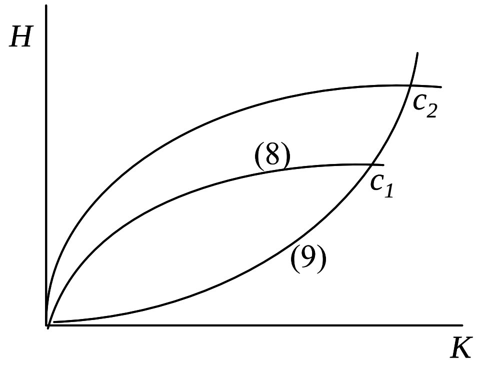

Figure 1: First order conditions, equations (8), (9)

Note in quadrant I, the cost of *c* is the cost of the combined input *H* and *K*. Recall that the long run cost of *O* is ω. A reduction in *w* (Figure 1) reduces the cost of *c* relative to the cost of operator labor. Along the isoproduct q_1 this is a change of the price ratio from the line tangent at the intersection of the ray 1 with q_1 to the price ratio tangent at the intersection of ray 2 with the same isoproduct curve. But equilibrium product will not stay, after a reduction of *w*, at q_1, it will move to q_2 and farm output will correspondingly go from y_1 to y_2. Other changes in exogenous parameters can also be traced with the help of the diagram.

The rays from the origin in quadrant IV indicate farm size in terms of total farm output. Actually, two magnitudes can be used to measure farm size—*q*, value added, or *y*, value of output. When farms produce identical products with identical technologies, the two measures relay the same information. But for real life situations, the preferred measure often is farm product, *q*, the value added.

Industry equilibrium, prices and rent in the long run

We start with the long run and a closed domestic market for the product of the farm sector. Given constant returns to scale, the accounting identity of the farm is

(10) $$Py = \omega + wH + uK + \rho L + vB$$

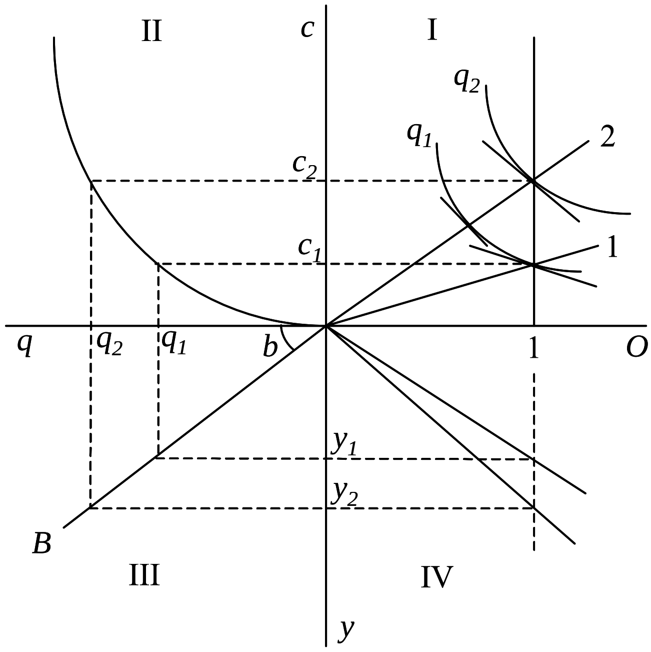

Figure 2: The farm production process

In (3'),

(11) $$zq = \omega + wH + uK + \rho L$$

By assumption, the factor prices, ω, *w*, *u*, and *v*, are exogenous to the farm sector. *P* is determined in the market for food, the product of the industry; it is the price equating demand and supply. Since production is of constant returns to scale, agriculture is a constant cost industry. Its production is constrained, however, by the area of arable land. In Figure 3, total food production in the industry is *Y*. The supply function is kinked and made of two line segments, the horizontal segment at P_0 up to Y_0 (maximum production with the available land), and a vertical line from this point on. Food is produced at a cost P_0 so long as not all land is cultivated and this will be the market price if the demand is D_1 and the amount produced is Y_1 (P_1 will be introduced below). If the demand is D_2, production is at its maximum, Y_0, and the market price will be higher than P_0.

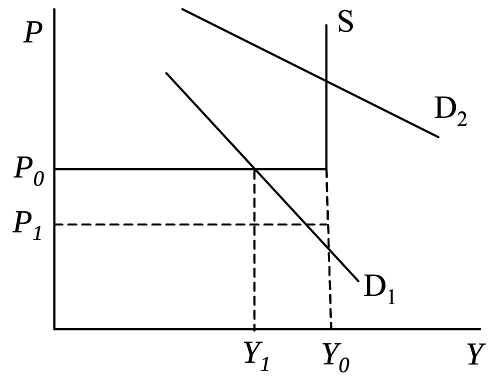

Figure 3: Supply and demand for the farm product

The price of land services, ρ, is endogenous to the industry. When the demand for the farm product is relatively high, all land is cultivated, production is Y_0, and ρ is rent, the shadow price of land

(12) $$\rho = \frac{Py - \omega - wH - uK - vB}{L}$$

For the individual farm, ρ is exogenously given, it is the cost of renting one unit area of land for one year. The purchasing price of a unit of land is

(13) $$D = \rho / r$$

where r is the rate of interest.

If, on the other hand, the demand for the farm product is relatively low, the price of the product is determined by the cost of production

(14) $$P = \frac{\omega + wH + uK + vB}{y}$$

and land does not fetch any rent. This is the zero rent case, $\rho = 0$.

It is important to realize that the size of the farm is not affected by the rent of land. It will be the same size, determined as in Figure 2, whether $\rho > 0$ or $\rho = 0$. Let y_0 be the long run equilibrium size of the farm defined in terms of output, food. The number of farms, N, will be

$$N_0 = Y_0 / y_0 \\ N_1 = Y_1 / y_0 \qquad (15)$$

when production is at Y_0 or Y_1, respectively.

In a small open economy, the price is set equal to the world price of food and the country either imports or exports the farm product, depending on the intersection of the world price with domestic supply and demand. In the real world, where agriculture produces more than one product, the country may both export and import different kinds of food. We shall encounter this possibility below.

The time has come to justify the above disregard of the land equation (6). Land can be disregarded in the zero rent case. If the rent is zero, land is not part of the calculus of profit maximization; the farmers decide on labor and capital and take as much land as is consistent with the size of the farm. In Israel, some land is left idle. Sixteen percent of the arable land in the country is not cultivated, in the major family farm sector of the moshavim, that share is 21%. Thus we are in the zero rent case. Analytically, the discussion could have been conducted in terms of the three equations (4)-(6), but the two-equation exposition was here "permissible" and simpler.

Recapitulation and implications

Tables 1a and 1b summarize the comparative static effects of the influx of foreign labor. The effects are separated in the tables according to whether they depend or do not depend on the rent. The analysis is long run in nature. The rent, ρ, will increase with the immigration of foreign labor where land is scarce and rent is positive. There is no rent in the zero rent case. Low cost migrant labor will replace local workers and—where the supply curve is rising—lower their wages (Table 1b); farms will grow in size for both rent possibilities (Table 1a). The number of farms can be

Table 1a: Influx of foreign workers—effects depend on rent

Rent	ρ	Farm		Operators		Food	
		Size	Number	Earning	Number	Production	Price
Positive	↑	↑	↓	-	↓	-	-
Zero	-	↑	?	-	?	↑	↓

Table 1b: Influx of foreign workers—effects do not depend on rent

Local hired labor		Investment	Export and import substitution	
Wages	Number		Production	Price
↓	↓	↑	↑	-

Note: - means no change.

expected to decrease in most cases: where rent is positive, the area of cultivated land in the country is given and as farm size grows their number, defined in (15), decreases. The zero rent case is more complicated and the effect is uncertain. The introduction of foreign workers reduces cost—in Figure 3 from P_0 to P_1. Total output of food increases, but optimal farm size also increase. Where the demand for food in inelastic, as is often the case, the number of farms likely will decline. But if the demand is elastic—as the case may be in a sector producing for export or competing with imports—the increase in industry production may outweigh the growth of the individual farms and their number will increase. A formal treatment is shown in the Appendix.

Farm growth entails accelerated investment (Table 1b). In the short run, investment is part of growth; in the long run, investment for replacement will be higher where farms are capital intensive. When the number of farms decreases, some productive assets may be lost. Capital will not grow by the full volume of the investment.

The market effects vary depending on whether the sector is in the zero rent case or all arable land is cultivated and rent is positive and whether the country is open or closed. Start with a closed economy. When rent in such an economy is zero, production of food expands in the wake of the introduction of foreign labor (unless demand is completely inelastic) and food price will decrease. In Figure 3, this is the downward shift of the horizontal segment of the supply function from P_0 to P_1. Foreign workers will not cause food production to increase and its price will not change in a positive rent sector.

Foreign workers affect the welfare of various groups in the economy differently, and some of the effects depend on the scarcity of land. Start with the zero rent case. Farm operators will in the long run continue to earn the opportunity cost, ω; the immigration of foreign workers will not change their income or wealth. The domestic farm workers will see their jobs gone and their wages reduced. Food consumers will benefit, supply will expand and food prices will decrease. In the positive rent case, farm owners will enjoy capital gains, a rise in wealth due to the introduction of foreign workers and lower wages. Farm operators who do not own land and hire it will see rent rising, but with larger farms they will—again in the long run—cover farm cost and earn the opportunity reward, ω. Domestic workers will suffer and consumers will not see a change in supply or price.

An intermediate case may arise, where rent is zero before the influx of foreign workers and it is positive with migrant labor. This could have been the situation in Figure 3 if D_1 was located to the right of its present position. The comparative static and welfare effects will in such a case be divided between those of zero rent and those of positive rent.

In a small open economy, the price of food is determined in the world market. In the zero rent case, production—for export or import substitution—will expand, domestic price will not change. If rent is positive, foreign workers will not affect agriculture's trade sector.

<u>The short run</u>

The effects described above are long run in nature. In the short run, immigration of foreign labor at lower cost will also increase farm size. As the self-employed earn residual income, any increase will be seen as a rise in operators' earning. Gradually, however, the sector will move toward the long run equilibrium where the realized effects will be those discussed in the last section.

Extensions

The motivation of the analysis and its interpretation was the immigration of low wage foreign workers, but other cases can also be examined within the model's framework. Consider an increase in wages outside agriculture; that is an increase in ω. In Figure 2, relative prices will change and production will move from q_1 to q_2 on ray 2. This change will be supported by an increase in the use of both hired labor and capital as can be realized by examination of Figure 1 and equations (11), (8), and (9)—an increased ω increases z in (11) and z appears in the numerator of (8) and (9). Consequently, an increase in ω will have the same effect on farm size and the number of farms as a reduction in w. Rent will however move in the opposite direction, a higher ω reduces rent (if positive) while a lower w increases it. If rent is zero, then, in Figure 3, an increase in ω will raise the horizontal section of the supply curve above P_0, food production will be curtailed and its price increased.

The Israeli experience

Israel is a small country and half of it is desert. Population growth is high, partly due to immigration (both permanent residents and migrant workers), and water has been diverted recently from agriculture to the urban sector to satisfy expanding residential demand (Kislev, forthcoming). Agricultural production has increased continuously and markedly throughout the last fifty years. The country has followed protective trade policies but they did not result in sever distortions of comparative advantages: Israel imports essentially all its grain from land abundant countries and it also imports meat, fish, sugar and a few other item of lesser importance. Israel's agricultural exports reflect its advantages in season and expertise—mainly winter vegetables, flowers, and citrus in addition to cotton and seeds of improved varieties. Exports of fresh produce amount to a third of the output of the non-livestock sectors of agriculture, a smaller share is diverted to manufacturing and exported as frozen and canned. Due to technological advances and connections to world markets, terms of trade of the farm sector deteriorated persistently, they have worsened by a third since the late 1970s.

Approximately 60% of the value of the farm output in Israel is produced on family farms, cooperative and private. The rest is produced on the communal kibbutzim. Mostly, labor-intensive production will be found in the family farms; kibbutzim, although growing orchards and keeping livestock, tend to specialize in field crops.

As indicated in the introduction, Israel has experienced two waves of foreign workers. After the war of 1967 Palestinians from the areas occupied by Israel in the West Bank and Gaza Strip came to work in the country. These workers mostly commuted daily and their arrival was often hampered by security constraints. Another wave of foreign workers occurred in the late 1980s when the government allowed laborers from other countries to enter the local market in wake of the Palestinian uprising and effective closure of the territories, more than a few illegal immigrants accompanied this wave. I shall refer to the first group of foreign laborers as Palestinians and the second as migrants.

Most if not all the migrants working in agriculture are from Thailand. They enter the country for a specified period of two years but often return for another stay or two. The wages of the migrants are lower than those of Israeli hired hands in agriculture; furthermore, the Thais are exceptionally skilled workers. They are industrious, reliable, and fast learning. Living in the villages and accumulating remittances, they are willing to work long hours. In terms of unobserved efficiency units, their wages are evidently much lower than those of others. Hence the introduction of Thais into agriculture in Israel has changed significantly the economics of the industry.

I am focusing mainly on the effect of the migrants who arrived first in 1992. The period is too short for an econometric study but examination of the data in light of the model presented above and the summaries of Table 1 will reveal more than a few ways in which foreign labor affected agriculture in Israel. Statistical information is presented in Table 2. The data summarized in the table are for two periods, 1980-91 and 1992-2002. The second column reports ratio of the averages; the average for each variable for the second period divided by the corresponding average for the first period. Columns 3 and 4 report intra-period annual rates of change.

Start with labor remuneration. Immigration is expected to reduce wage in agriculture (Table 1b). Indeed, the ratio of wages in the sector (of both local and foreign workers) to wages in manufacturing decreased, it was 53% in the first period and 45% in the second (these values are not shown in the table) a decrease of 15%. Separate data for the wages of Israeli hired hands and for foreign workers are available only for the second period. Real (deflated by consumer price index) wages of Israelis rose by 2.7% per year in the second period, the wages of foreign workers rose by 8.7%. Wages are reported per employee position (not per hour or day) and the faster rise in the pay of foreigners may reflect the increasing share of migrants who accumulate days and hours of work during their constrained stay in the country.

We turn to employment. During the second period in Table 2 migrant labor increased by 22% per year. Partly, the migrants replaced Palestinians whose employment decreased during the second period, but more than that: the number of migrants coming in the second period was twice as large as the reduction in the number of Palestinians. By the model and Table 1, one would expect the migrants to crowed out Israeli hired hands as well. This however did not happen. Employment of Israelis increased by 16% between the periods, although there was some decrease in the numbers within each period. The stability is puzzling.

I can think of three factors for the relative stability of the employment of Israeli hired labor in agriculture. (a) The Israelis are mostly professionals and migrants cannot replace them. (b) And this argument is put forward by proponents of foreign labor—by expanding production in agriculture, migrants create, do not destroy, local employment. (c) Recent trends of privatization in the kibbutzim have modified the statues of many from members working in their commune to workers employed by the local enterprise. I do not have the data to examine in detail these possibilities and the stability puzzle.

If migrants did not replace Israeli hired workers, they did crowd out self-employed. The number of the latter decreased by 2.9% per year in the first period and by 9.3% in the second. Since regular counts of the number of farms and their size is not conducted in Israel, the reduction in the number of self-employed can serve as a proxy for the reduction in the number of farms. And this may even be an underestimate since the self-employed are not only farm operators, the count includes gardeners and other independent operators whose numbers may have increased in recent years when

Table 2: Changes of selected variables, 1980-2002

	Ratio of average 1992-02 to 1980-91	Annual rate of change	
		1980-1992	1992-2002
Wages in agriculture and ratio			
Agriculture/manufacturing	0.85	-0.01	-0.005
Israelis			0.027
Foreign			0.087
Labor (number employed)			
Migrants	-	-	0.22
Palestinians	0.59	0.018	-0.058
Israeli hired workers	1.16	-0.013	-0.002
Self employed	0.68	-0.029	-0.093
Members in Kibbutzim	0.61	-0.012	-0.049
Unpaid family members	0.31	-0.070	-
Investment (monetary value)			
Orchards	0.96	-0.082	0.045
Greenhouses	1.60	0.125	0.057
Labor intensive enterprises (area)			
Vegetables in greenhouses	4.10	0.165	0.112
Flowers	2.41	0.048	0.073
Producer price (terms of trade)			
Vegetables	0.99	0.008	0.000
Citrus	1.06	0.026	0.024
Fruits (not citrus)	0.88	-.019	0.011
Output and Export (index)			
Production for the domestic market	1.37	0.026	0.026
Export price (ratio to domestic)	0.77	-0.039	-0.012
Export quantity	1.29	-0.008	0.049

Source: Central Bureau of Statistics, various publications and unpublished material. The complete data set with detailed sources is available on request.
Notes: 1. The ratio in column 2 is of average per year in the second period divided by the corresponding average for the first.
2. All rates of change were calculated in semi-log regressions.
3. The Central Bureau of Statistics ceased publishing information on unpaid family members after 1998. The average for the second period was calculated for the shorter time span for which data were available.

higher national income and structural changes in the farm sector expanded the demand for their services.

By the model, farm size is expected to grow. Indeed, if output grew and number of farms declined, production on individual farms expanded. Direct information is scanty. Output (in constant prices) per active family farm in the moshavim grew by 114% between 1981 and 1995. This reflects however both change in size and change in technology. By the only estimate I am familiar with of change under a constant technology, per farm output grew by a third between 1975 and 1995. (Both estimates are from Kahanovitz, Kislev, Kimhi, 1999.)

The model predicts investment in agriculture in reaction to increased number of foreign workers. The graph of investment in orchards in Israel (not shown) is U-shaped, funds spent on new orchards decreased during the 1980s whereas investments accelerated, as predicted, in the 1990s. Many of the foreign workers are employed in greenhouses and indeed, investments in these structures increased over the two periods surveyed in Table 2.

The theoretical analysis was conducted for a single line of production. In the real world, with multiple lines, foreign workers are naturally allocated mainly to labor-intensive enterprise. Two such lines, vegetables in greenhouses and flowers, grew 4 times and almost 2.5 time between the two periods in the table.

Prices of export products are not expected to change with the influx of foreign workers. In Table 2, the producer prices (divided by the price of inputs) of vegetables and citrus fruits did not decrease. The prices of non-citrus fruits, produced almost exclusively for the domestic market, decreased between the periods by 12%.

With growing population and income, output of farm products increased by 2.6% per year in each of the periods in Table 2. At the same time, price of agricultural exports (relative to products directed to the local market) decreased markedly. Despite these developments, exports grew and they were, in the second period, 29% higher than in the first.

Concluding Remarks

The statistical observations do not confirm all the predictions of the theoretical model but they support, in my judgment, its main insights. Particularly, the reduction in the number of self-employed, the investment in orchards and greenhouses, the expansion of the areas of labor-intensive crops and the increased exports—augment the validity of the theoretical arguments. But this is not the whole story.

The discussion of foreign labor was conducted in the paper in cold technical terms. But the phenomenon has profound social and political implications. The economy of Israel has been, for several years now, in a recession with unemployment of 10% or more of the labor force. At the same time, the number of foreign workers in the country is similar to the number of unemployed Israelis. Any attempt to reduce the number of foreigners is opposed by strong lobbies of employers arguing that "no Israeli will ever take the jobs that foreigners gladly accept." Indeed, with unemployment benefits and other emergency measure that the recession entails local worker will rather rely on welfare than work for the wages that foreigners are happy to earn.

On the country, the foreign workers have modified the social fabric, particularly in the family farm sector. Operators run now larger enterprises than they did before and "unpaid family members," wives and youngsters, do not participate in the farm work anymore. These people seek alternative occupations that are not always easy to find in rural areas (although some places have developed new lines, tourism is an example). The foreign workers are found not only on the family farms. They replaced many members in the kibbutzim and they are employed by independent professionals who take over the cultivation of orchards or field crops lines—mostly of cooperative farms. If not for the low wage rates and skilled labor of the migrants, these activities would not have been profitable.

Migrant labor has been a blessing for many farmers who built and expanded their operations with the help of the newcomers. Achievements in technology and export are also impressive. Agriculture will therefore face severe crises if migration of temporary workers ever stops. It will be virtually impossible to return to early modes of operation, many family farms will collapse, exports will decrease sharply, and rural communities will suffer. The withdrawal of the migrant laborers, particularly the laborers coming from Thailand, will be painful.

Appendix: Number of farms in the zero rent case

The purpose of the present comparative static analysis is to identify the sign of $\partial N / \partial w$. Three elasticity values are involved,

The elasticity of demand $\frac{\partial Y}{\partial P}\frac{P}{Y} = \eta \leq 0$

The elasticity of average cost with respect to *w* $\frac{\partial AC}{\partial w}\frac{w}{AC} = \varepsilon > 0$

The elasticity of farm size with respect to *w* $\frac{\partial y}{\partial w}\frac{w}{y} = \phi < 0$.

Since $Y = Ny$,

(A.1) $$\frac{\partial N}{\partial w}\frac{w}{N} = \frac{\partial Y}{\partial w}\frac{w}{Y} - \frac{\partial y}{\partial w}\frac{w}{y}$$

In a constant cost industry (Figure 3) the change in price is identical to the change in AC. Hence

(A.2) $$\frac{\partial Y}{\partial w}\frac{w}{Y} = \varepsilon\eta$$

Consequently

(A.3) $$sign(\frac{\partial N}{\partial w}) = sign(\varepsilon\eta - \phi)$$

As explained in the text, with a relatively large elasticity of demand, the change in total industry output may dominate and the number of farms may increase in the wake of an influx of foreign workers (a reduction in w).

To see the magnitudes involved, consider the simplest possible case in which H is the only variable input. Then, at optimum farm size, where *AC=MC*

(A.4) $$\frac{wH + c}{y} = \frac{w}{f_H}$$

with *c* the cost of all non-labor inputs. Differentiating with respect to *w* and using the envelope theorem, (A.5) $$\frac{\partial H}{\partial w} = -\frac{f_H}{wf_{HH}}\left(\frac{H}{y} - \frac{1}{f_H}\right) < 0$$

To justify the sign in (A.5) note that $\frac{1}{w}\left(\frac{wH}{y} - \frac{w}{f_H}\right) = \frac{1}{w}\left(AC - c/y - MC\right) < 0$ and that $f_{HH}<0$.

By (A.5)

$$\phi = f_H \frac{\partial H}{\partial w}\frac{w}{y} = -\frac{f_H^2}{f_{HH}}\left(\frac{H}{y} - \frac{1}{f_H}\right)\frac{w}{y}$$

Also,

$$\varepsilon = \frac{wH}{wH + c}$$

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