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SURVIVAL AND GROWTH OF FAMILY FARMS IN ISRAEL: 1971-1995

by

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Yuval Dolev and Ayal Kimhi*

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Abstract

We analyze the growth of family farms in Israeli cooperative villages between 1981 and 1995, using longitudinal data. We use instrumental variable techniques to account for the endogeneity of initial farm size, and correct for selectivity due to farm survival. Both endegeneity and sample selection are found important in this case. We find that smaller farms grow faster, so that there is convergence of farm sizes at the bottom end of the size distribution. There is weak evidence that this convergence process slows down at the upper part of the size distribution. We also find a positive effect of farm specialization on growth, indicating the possibility of scale economies. Farm capital stock affects farm survival but not growth itself, once accounting for selectivity due to survival. Farm growth is faster in larger farm households, indicating that family labor is important even when farms become more commercialized.

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Introduction and background

Farm sectors in developed economies are continuously undergoing structural changes. One of the key structural features that are changing is the size distribution of farms. The increase in the size of the average farm over time has been documented in numerous countries. Moreover, several studies identified a convergence towards a bimodal size distribution. Weiss (1999), for example, found that intermediate-size farms either grow fast and specialize in farming or grow slowly and supplement their income with non-agricultural earnings. He also found that the growth process is not independent of the survival/exit decision, with large farms more likely to survive. Farm growth is an evolutionary process due to limited resource mobility (Chavas 2001), and this may be the reason for the heterogeneity of observed farm growth and for the fact that structural changes are not independent of the life cycle of the farm family.

The purpose of this paper is to study the growth process of Israeli family farms with particular emphasis on the role of farm survival, using panel data for the years 1971, 1981 and 1995. The later part of this period was characterized by extreme turbulence in the farm sector. During the 1970s the farm sector was relatively stable due to the generous farm support policies that also involved almost unlimited availability of cheap credit. By the end of the decade the government gradually reduced its involvement in the planning and support of agriculture. The 1985 anti-inflationary policy resulted in a sharp rise in the real rate of interest, and caught the farm sector in deep short-term debt that could not be serviced (Kislev, Lerman and Zusman, 1991). This has lead to the collapse of the cooperative system that governed the vast majority of farm activity in the country. Exit from agriculture and other structural changes accelerated as a result of the crisis. As farm income continued to decline, farmers had to increase the scale of their operation in order to make a living, and/or diversify to other income-generating activities. Another factor that contributed to the structural change in agriculture and especially to farm growth was the increased availability of foreign workers since the early 1990s (Kislev 2003). This allowed farms that were initially limited by the availability of labor to expand faster.

Earlier studies that used this data set did not explicitly consider the role of farm survival. Kahanovitz, Kislev and Kimhi (1999) offered a rather descriptive analysis of farm growth, emphasizing its dependence on geographical conditions and institutional factors. Ahituv and Kimhi (2006) emphasized the interdependence between farm size and off-farm labor participation, but did not explicitly consider the dynamic aspect of farm growth. Kimhi and Rekah (2005) estimated a dynamic model of farm size for the years 1992-2001, but used village-level data, which obviously did not allow for the treatment of survival.

The literature on firm growth was stimulated by the observed empirical regularity that the firm's growth rate declines with its size. The modeling approach has gone through an evolutionary process. Early models were based on stochastic growth processes, while later models offered frameworks in which growth depends on firm decisions as well (Sutton 1997). Some of these models focused on economies of scale in production and/or marketing. Jovanovic (1982) suggested that heterogeneous firms learn gradually about their ability, and then decide to grow or exit the industry. These theoretical developments have lead to a series of empirical applications. We start with the papers of Sumner and Leiby (1987) and Shapiro, Bollman and Ehrensaft (1987), who estimated a regression of farm size on lagged farm size. Evans (1987) used growth rather than firm size as a dependent variable and initial size and its square as explanatory variables. He also corrected for selectivity due to firm survival.

Hall (1987) extended this model to account for endogeneity of initial firm size, and also used a third-degree polynomial of initial size to explain firm growth. Weiss (1999) applied this approach to a three-period panel of Austrian family farms, using the first period of data to instrument second-period farm size, which in turn was used to explain farm growth between the second and third periods. Given the nature of our data (see below), this is the empirical model we adopt in this paper. Different varieties of this modeling approach were recently applied to family farm growth in various countries by Rizov and Mathijs (2001), McErlean et al. (2004), Juvančič (2005), and Kostov et al. (2005), among others. Most of these applications reached the conclusion that growth is inversely related to initial farm size, and some of them showed that this is particularly true for the lower part of the size distributions but not necessarily for the larger farms. Weiss (1999), in particular, concluded that the effect of initial farm size on growth becomes positive again after a certain size threshold.

The interest in the size distribution of farms has increased in recent years due to the increased recognition of the multifunctional role of family farms in shaping rural landscapes, rural economies and rural societies. This applies to Israel as well, and this paper aims to explore the dynamic aspects of the size of farm families in Israel. The data we use is described in the next section, and after that we present the empirical approach, which follows Weiss (1999) to a large extent. The next section includes the empirical results, and the final section offers concluding comments.

Data

We use data from the two recent Censuses of Agriculture, 1971 and 1981, and a 1995 farm survey, all conducted by the Central Bureau of Statistics in Israel. We focus on family farms in cooperative villages (*Moshavim* in Hebrew), because these are the farms for which we could link the records across time periods and generate a longitudinal file. About a third of all cultivated land in Israel is in cooperative villages, and they include more than a half of the self employed in agriculture. A family farm in cooperative villages is a physical unit that is easy to identify and track over time. The 1971 Census data set includes 21,929 family farms, while the 1981 Census data set includes 27,047. The increase in the number of farms is in part due to establishment of new cooperative villages between 1971 and 1981, and in part due to a more inclusive definition of a farm in 1981, with the latter responsible for about three quarters of the increase. A farm record could be matched across the Census data sets if the farm remained in the hands of the same extended family. We were able to match 15,382 farm records in this way.

The 1995 farm survey covered about 10% of the farms in cooperative villages. Of the roughly 3,000 observations, about half were successfully matched to the 1981 Census records. It should be noted that matching was not successful in certain villages because farm identification numbers were changed in those villages between 1981 and 1995. We consider this as an exogenous selection mechanism. Obviously, another reason for lack of matching was a transfer of ownership, which is not exogenous. A total of 1,040 farms could be identified and matched across all three periods. These are farms (but not all farms) that remained in the hands of the same extended family from 1971 to 1995.

The description of the data and the matching process makes it clear that it is impossible to track entry and exit of farms using these data. We employ a rather narrow definition of exit that we are able to identify, namely farms that stopped producing between two consecutive data periods, conditional on remaining in the hands of the same extended family. Thus, we are not able to account for farm exit that is accompanied by the sale of the farm outside the family. It should be noted that selling a farm in Israeli cooperative villages involves selling the whole farm unit including the family residence. This limits the attractiveness of this type of farm exit and enables us to identify farm families that stopped operating their farm for all practical purposes but are still living on it. The data show that less than 4% of farms in our sample became inactive between 1971 and 1981, while another 16% became inactive between 1981 and 1995. Ahituv and Kimhi (2006) have shown that the overall exit rate among Israeli farmers was much higher during those periods. They concluded that entry and exit are responsible for most of the observed changes in farm size between 1981 and 1995.

We measure farm size by the real value of output. There is more than one way to measure farm size (Lund 1983, 2005). However, Yee and Ahearn (2005) have shown that alternative size concepts do not affect the farm growth results in a significant way. We have therefore chosen the simplest measure that was available for all three periods. Most researchers use the size of operated land as a measure of farm size. Weiss (1999) used the number of livestock as a measure for farm size in Austria. For Israeli cooperative-village family farms, which tend to be diversified despite their relatively small size, and engage in both crop and livestock enterprises, a measure of output is more appropriate than either land-based or livestock-based measures. It should be noted that the value of output that we use is computed normatively, whereas for each type of crop or livestock, the plot size or the number of livestock is multiplied by an average coefficient of output that varies only by geographic location. In this sense this size measure mostly reflects the volume of inputs used on the farm rather than actual output. In particular, it does not reflect individual farm productivity or price heterogeneity.

The data show that between 1971 and 1981, the average family farm grew at about 7% annually, while the annual rate of growth between 1981 and 1995 was about 5.5%. These rates of growth are higher than the rate of increase in the quantity index of output in Israel as a whole reported by Kislev and Vaksin (2003). This could reflect a faster farm growth in cooperative villages relative to other sub-sectors, and/or selectivity of survival that is biased towards larger farms. Ahituv and Kimhi (2006) divided this quantity index by the number of self-employed farmers and obtained somewhat lower growth rates for 1971-1981 but much higher growth rates for 1981-1995. This reflects the higher rate of exit from farming in the latter period.

Figure 1 shows Lorenz curves for farm size in the three years, for all farms and for active farms. Comparing the two parts of the figure, it can be seen that much of the increase in farm size inequality between 1981 and 1995 is due to our definition of exit (farms becoming inactive). This confirms the important role of farm survival in the analysis of farm growth at the micro level.

Empirical specification

We start with a log-linear regression of farm growth (G) on initial size (Y) and its square and a set of additional explanatory variables (**X**), where $G_t = \ln Y_t - \ln Y_{t-1}$:

$$(1) \qquad G_t = \alpha_1 \ln Y_{t-1} + \alpha_2 (\ln Y_{t-1})^2 + \mathbf{X}_{t-1}\boldsymbol{\beta} + u_t$$

Potential endogeneity of Y_{t-1} is evident from the definition of G_t. Hence, we use time t-2 explanatory variables as instruments for Y_{t-1}. This implies that we can only estimate (1) for t=1995, where 1971 variables are used as instruments for 1981 farm size.

In order to correct for selectivity due to farm survival that is not independent of farm growth, we introduce a latent survival equation:

$$(2) \qquad Z_t = \gamma_1 \ln Y_{t-1} + \gamma_2 (\ln Y_{t-1})^2 + \mathbf{X}_{t-1}\boldsymbol{\delta} + v_t$$

where observed survival is defined as:

$$(3) \qquad d_t = \begin{cases} 1 & Z_t > 0 \\ 0 & \text{otherwise} \end{cases}$$

We also explicitly specify that growth is observed only for farms that survived:

$$(4) \qquad G_t^o = \begin{cases} G_t & d_t = 1 \\ 0 & \text{otherwise} \end{cases}$$

Assuming that u_t and v_t are jointly distributed as bivariate normal, we estimate the model (1)-(4) using the maximum likelihood approach of Heckman (1979).

As explanatory variables we use farm attributes, demographic characteristics of the farm household, and village location and year of establishment. Farm attributes include, in addition to initial farm size, landholdings, capital stock, level of specialization, and the labor input of the farm operator. As landholdings are zero for some farms, which turns out to be due to specialization in livestock, we also include a dummy variable for farms with zero reported landholdings. Capital stock is measured in fixed prices, and excludes the value of land. Specialization is measured by ΣS_i^2, where S_i is the share of crop i in total output. This measure tends to zero when the number of different crops tends to infinity, and is equal to one when the farm is cultivating a single crop. Labor input is measured as an index ranging from 0 to 100, with 100 indicating that the operator is working full-time on the farm. Demographic characteristics include age and age squared, a set of educational dummies, and a set of country-of-birth dummies, all reported for the farm operator. Also included are the index of off-farm labor supplied by the farm operator, household size, and a dummy variable for the engagement of other household members in off-farm work. Village location is represented by a set of regional dummies, and village establishment year is also grouped categorically.

Table 1 compares the means of these explanatory variables across the three periods. The process of ageing of farm operators is evident, and also leads to a decrease in labor supplied by the operators to both farm and off-farm work. However, since the increase in average age is lower than the number of years between surveys, there is also a gradual replacement of older operators by their younger successors. This is also reflected in the increase in the level of education and in the increased fraction of Israeli-born farm operators. Off-farm labor engagement of family members has increased, especially between 1981 ad 1995, despite the gradual decrease in household size. Farm size has increased dramatically, as discussed above. The size of landholdings went down, especially between 1971 and 1981, while the level of specialization increased, especially between 1981 and 1995. Capital stock more than doubled in size between 1971 and 1981 (see Ahituv and Kimhi 2002), but declined by almost 50% between 1981 and 1995.

Results

Table 2 summarizes the regression results. The first column shows the estimated coefficients of a simple OLS regression of equation (1). Only a small number of coefficients are statistically significant. Among them are the coefficients of initial size and its squared value, which are negative and positive, respectively. This implies that the rate of farm growth is declining with farm size up to a certain size threshold, and beyond that threshold the growth rate starts increasing with farm size. Other statistically significant effects are obtained for capital stock and household size, both positive. The second column shows the coefficients of the instrumental variable regression, in which initial farm size is instrumented by lagged (1971) explanatory variables (the first-stage results of the 1981 farm size regression are in table 3). We observe that the coefficients of initial farm size and its squared value become practically zero under the IV estimation. The coefficient of capital stock remains positive and significant, and the coefficient of specialization becomes positive and significant. It may be that specialization is negatively correlated with initial size, as shown by Kimhi and Rekah (2005), so that it captures part of the negative effect of farm size after size is instrumented. While the results of the IV regression are disappointing in that they do not show a significant effect of farm size on growth, they do illustrate the importance of taking care of the endogeneity of initial farm size in growth regressions. One qualification to this conclusion stems from the difference in the number of observations, as many observations are lost due to missing values in the first-stage regression. It is difficult to imagine, though, that the sharp reduction in the coefficient of initial farm size is due to the loss of observations alone.

The last two columns show the results of the selection model specified in equations (1)-(4). The only significant effect in the farm survival equation is that of capital stock, which is positive. This is in contrast to the results of Kimhi and Bollman (1999), who found no effect of capital stock on farm exits between 1971 and 1981. Capital investment decisions reflect a long-run strategy to continue farming (Ahituv and Kimhi 2002), and are to a large extent irreversible. Therefore, a larger stock of farm capital makes it easier for farmers to remain in farming. The Wald test for the correlation between the error terms in the survival equation and the growth equation cannot reject the hypothesis that the residuals are uncorrelated. This, together with the lack of significance of most coefficients in the survival equation, probably stems from the fact that roughly 84% of the farms "survived" between 1981 and 1995 (in fact, only 78% of farms remained active when excluding observations with missing values). In light of this, one cannot expect vast changes in the coefficients of the farm growth regression after controlling for selectivity. However, several notable changes do occur. First, the coefficient of initial farm size becomes negative and statistically significant, although its value is still way below what it was in the OLS regression. Second, the coefficient of the squared value of initial farm size increases in size and in significance, although its p-value is still short of being satisfactory. Third, the coefficient of capital stock becomes negative and insignificant. Recalling that this variable had the only significant coefficient in the farm survival equation, it turns out that the positive effect of capital on farm growth in the OLS and IV regressions was solely due to selectivity bias. This highlights the importance of selectivity correction due to farm survival in farm growth regressions. It should also be noted that the coefficient of specialization remains positive and statistically significant as in the IV regression, and that the positive coefficient of household size becomes statistically significant, after correcting for selectivity.

Using the coefficients of initial farm size and its squared value from the selectivity-corrected growth regression in the last column of table 2, we can compute the threshold level of farm size, beyond which the effect of size on growth becomes positive. In logarithmic form, this threshold turns out to be 4.21, which is below the mean value of log farm size in 1981 (4.25). This implies that despite the fact that the coefficient of squared initial size is not statistically significant, there is reason to suspect that the effect of initial size on farm growth is nonlinear, so that the negative effect is mostly valid for the smallest size categories. This is in line with previous findings in the literature as discussed above.

Concluding comments

We have analyzed the growth of family farms in Israeli cooperative villages between 1981 and 1995, using longitudinal data. We followed the empirical approach of Weiss (1999) by focusing on the potentially nonlinear effect of initial farm size on its subsequent growth, by using instrumental variable techniques to account for the endogeneity of initial farm size, and by correcting for selectivity due to non-random survival of farms throughout the period of analysis. Our results support the earlier findings that both endegeneity and sample selection are important in this kind of analysis.

Our results imply that smaller farms grow faster, so that there is convergence of farm sizes at the bottom end of the size distribution. There is also weak evidence that this convergence process slows down at the upper part of the size distribution. Our data do not capture the full scale of the effect of the availability of foreign labor, which peaked in the second part of the 1990s. Perhaps the faster growth of the larger family farms would have been more evident, have we had data on later years. We also found a positive effect of farm specialization on growth, indicating the possibility of scale economies. We found that farm capital stock, which was largely determined in earlier periods, affected farm survival but not growth itself, once accounting for selectivity due to survival. Finally, we found that growth is faster in larger farm households, which could indicate that family labor is still important, perhaps for the supervision of hired workers, even when farms become more commercialized. However, this result should be evaluated with caution, since household size and composition are not necessarily exogenous to farm size and profitability. A more complete analysis of farm growth would involve succession considerations. This is left for future research.

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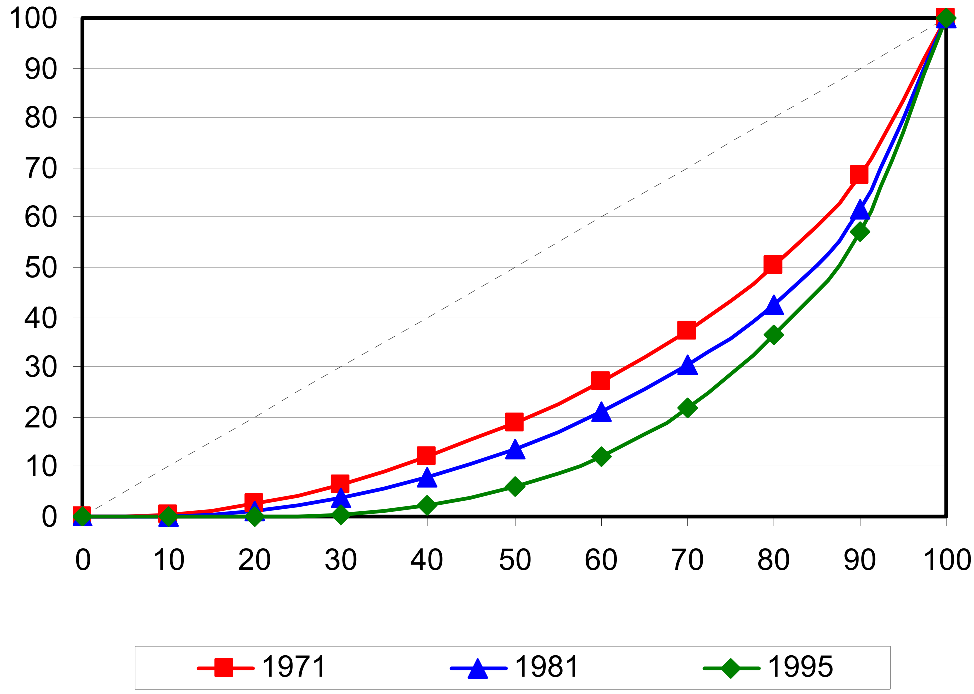
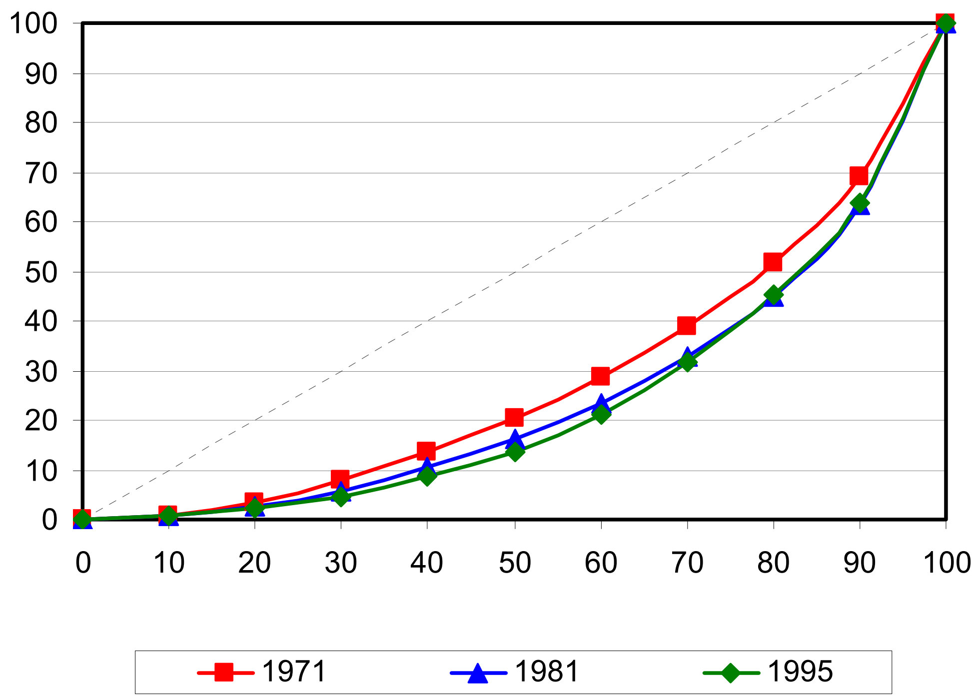


A.

A. All farms



B.

B. Active farms

Figure 1. Lorenz Curves of Farm Size Distributions

Table 1. Means of Explanatory Variables

Variable	1971	1981	1995	Units
Age	44	50	56	years
Education				
Less than primary	(*)	27.3	25.6	percent
Primary/middle school	(*)	46.8	23.5	percent
High school	(*)	19.5	43.7	percent
Undergraduate	(*)	4.4	5.5	percent
Graduate	(*)	2.0	1.7	percent
Country of birth				
Israel	9.3	19.3	35.2	percent
Europe/America	27.5	21.2	14.6	percent
Asia/Africa	63.3	59.5	50.2	percent
Household size	5.86	5.65	5.34	people
Operator's farm labor	73	61	58	% of full time
Operator's off-farm labor	35	29	29	% of full time
Family off-farm engagement	63.9	60.2	70.5	percent
Farm size	80.9	152.1	264.2	NIS 1,000 (1995)
Landholdings	5.7	3.6	3.0	hectares
Capital stock	168	454	233	NIS 1,000 (1995)
Specialization	69.2	73.9	82.7	percent
Region (**)				
Golan and Upper Galilee		7.1		
Northern valleys		10.1		
Haifa and Akko		7.3		
Central plains		34.7		
Southern plains		18.6		
Jerusalem		6.1		
South		16.1		
Establishment year (**)				
Up to 1947		17.5		
1948-1956		72.5		
1957 and up		10.0		

(*) education was not reported in 1971
(**) village location and establishment year are naturally constant over time

Table 2. 1981-1995 Farm Growth Results

Variable	OLS	IV	Survival	Growth
Instrumented farm size	NO	YES	YES	YES
Farm size	-1.449**	0.061	0.047	-0.261*
	(-7.77)	(0.21)	(0.21)	(-2.03)
Farm size squared	0.120**	0.009	0.008	0.031
	(4.88)	(0.22)	(0.23)	(1.54)
Capital stock	0.420**	0.314**	0.375**	-0.106
	(4.28)	(2.76)	(4.37)	(-1.40)
Specialization	-0.002	0.010**	0.002	0.008**
	(-0.80)	(2.61)	(0.58)	(3.44)
landholdings	0.103	0.158	0.136	0.050
	(0.86)	(0.90)	(0.97)	(0.49)
Landholdings=0 dummy	0.359	0.421	0.531	-0.90
	(0.69)	(0.62)	(1.01)	(0.22)
Operator's farm labor	0.076	0.025	0.026	0.011
	(1.67)	(0.51)	(0.72)	(0.33)
Operator's off-farm labor	0.061	-0.006	0.013	0.000
	(1.79)	(-0.17)	(0.49)	(0.02)
Family off-farm engagement	-0.093	-0.001	-0.062	0.042
	(-0.65)	(-0.00)	(-0.51)	(0.48)
Household size	0.067*	0.064	0.035	0.045*
	(2.24)	(1.92)	(1.46)	(2.34)
Age	-0.061	-0.014	-0.006	-0.013
	(-1.53)	(-0.27)	(-0.16)	(-0.50)
Age squared	0.001	0.000	0.000	0.000
	(1.43)	(0.04)	(-0.10)	(0.50)
Primary/middle school	0.085	0.031	-0.068	0.157
	(0.50)	(0.16)	(-0.48)	(1.58)
High school	0.149	0.074	-0.052	0.259
	(0.69)	(0.30)	(-0.27)	(1.93)
Undergraduate	-0.179	-0.415	-0.186	-0.232
	(-0.51)	(-1.02)	(-0.61)	(-0.72)
Graduate	0.228	0.531	0.454	0.185
	(0.46)	(0.94)	(0.94)	(1.14)
Europe/America	-0.174	-0.003	0.270	-0.248
	(-0.73)	(-0.01)	(1.21)	(-1.81)
Asia/Africa	-0.536*	-0.351	-0.171	-0.121
	(-2.36)	(-1.25)	(-0.78)	(-0.78)
Intercept	2.377*	-3.613*	-1.975	0.842
	(2.35)	(-2.35)	(-1.72)	(0.98)
Region/establishment year	YES	YES	YES	YES
R^2	19.55%	11.01%		
p-value for cov(u,v)=0			0.12	
Number of cases	995	809	812	

* coefficient significant at 5%; ** coefficient significant at 1%.

Table 3. 1981 Farm Size Regression with 1971 Explanatory Variables

Variable	Coefficent
Farm size	0.39**
	(3.06)
Capital stock	0.27**
	(4.84)
Specialization	-0.32
	(-1.70)
landholdings	0.77**
	(5.71)
Landholdings=0 dummy	34.5
	(1.58)
Operator's farm labor	0.02
	(0.19)
Operator's off-farm labor	-0.01
	(-0.34)
Family off-farm engagement	-3.2
	(-0.28)
Household size	-2.2
	(-1.15)
Age	6.5*
	(1.98)
Age squared	-0.9*
	(-2.35)
Europe/America	15.9
	(0.87)
Asia/Africa	-14.0
	(-0.75)
Intercept	-2.1
	(-0.03)
Region/establishment year	YES
R^2	43.63%
Number of cases	902

* coefficient significant at 5%; ** coefficient significant at 1%.

PREVIOUS DISCUSSION PAPERS

1.01 Yoav Kislev - Water Markets (Hebrew).

2.01 Or Goldfarb and Yoav Kislev - Incorporating Uncertainty in Water Management (Hebrew).

3.01 Zvi Lerman, Yoav Kislev, Alon Kriss and David Biton - Agricultural Output and Productivity in the Former Soviet Republics.

4.01 Jonathan Lipow & Yakir Plessner - The Identification of Enemy Intentions through Observation of Long Lead-Time Military Preparations.

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6.01 Zvi Lerman - Perspectives on Future Research in Central and Eastern European Transition Agriculture.

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10.01 Csaba Csaki & Zvi Lerman - Land and Farm Structure in Poland.

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4.02 Yacov Tsur and Amos Zemel - Growth, Scarcity and R&D.

5.02 Ayal Kimhi - Socio-Economic Determinants of Health and Physical Fitness in Southern Ethiopia.

6.02 Yoav Kislev - Urban Water in Israel.

7.02 Yoav Kislev - A Lecture: Prices of Water in the Time of Desalination. (Hebrew).

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9.02 Yacov Tsur and Amos Zemel - Endangered aquifers: Groundwater management under threats of catastrophic events.

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2.04 Ayal Kimhi - Economic Well-Being in Rural Communities in Israel.

3.04 Ayal Kimhi - The Role of Agriculture in Rural Well-Being in Israel.

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