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Are Changes in Farm Size and Labor Allocation Structurally Related? Dynamic Panel Evidence from Israel

by

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Are Changes in Farm Size and Labor Allocation Structurally Related? Dynamic Panel Evidence from Israel

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Abstract

This paper deals with structural changes that are observed in farm sectors in many developed economies: the increase in farm size and the shift of labor away from agriculture. Using panel data on Israeli farm communities for the years 1992-2001, we estimate a system of simultaneous equations in which farm size and the fraction of labor devoted to agriculture are determined jointly in a dynamic setting. We employ the Arellano and Bond dynamic panel GMM algorithm for each of the equations, treating the other variables as endogenous and allowing for unobserved heterogeneity and for time trends that depend on geographical and institutional factors. The results exhibit positive and statistically significant autoregressive effects in both size and labor allocation. We find, as in earlier studies, that the association between farm size and farm labor allocation is positive, but the causality goes from size to labor and not in the opposite direction. This implies that independent factors that increase the level of agricultural activity help to moderate the rate of labor exodus from farming. On the other hand, independent factors that pull labor out of agricultural production do not significantly reduce the level of agricultural activity, perhaps because family labor is replaced by hired labor and/or capital investments. Farm growth seems to be quite heterogeneous across types of farm communities, with aggregate farm growth occurring mostly in relatively young communities in the south of the country, while agricultural activity on other farm communities is stagnant or even shrinks over time. Continuation of these processes could lead, in the long run, to concentration of agricultural production in a small number of large, business-oriented, farm enterprises.

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Introduction

In this paper, we investigate the structural dependence of farm size and farmers' labor allocation in the context of Israel. There is ample worldwide evidence about the changes in these two variables over time. Figure 1 shows the increases in average farm size in Europe and North America during the 1980's and 1990's. The reliance of the farm sector on income from off-farm sources has increased as well. Mishra et al. (2002) report that off-farm income in the US tripled between 1987 and 1999, while farm income increased only slightly. Canadian statistics show a similar although more moderate trend (Agriculture and Agri-Food Canada, 2002). Benjamin and Kimhi (2006) report an increase in off-farm labor participation of French farmers (especially women) between 1988 and 2000.

In Israel, the situation is not much different. The average farm size increased from 9.5 hectares in 1981 to 14.7 hectares in 1995. Off-farm labor participation has increased as well during the same period, mostly among family members other than the farm operator (Kimhi 2004). These structural changes have been a reaction to market conditions. Figure 2 shows that the terms of trade in Israeli agriculture went down by more than 20% from 1988 to 2001. This has lead to a deterioration of income from agriculture, and at the same time alternative employment opportunities became more attractive. Figure 3 shows that during the same period, income of the self-employed in agriculture has somewhat decreased and became more volatile, while the alternative income, represented here by the income of employees in industry, has increased. In order to maintain an acceptable level of household income, the self-employed in agriculture had to increase the scale of their farming operation, and this could only be achieved through the exit of other farmers. Overall, the number of self-employed in agriculture decreased from almost 50,000 in 1988 to less than 20,000 in 2001 (figure 4). The value of agricultural production has not changed significantly over the period, but it is now produced in a much smaller number of larger farms.

The decline in farm income can therefore increase the size of remaining farm operations and at the same time encourage farmers to allocate more time to off-farm income generating activities. Since these two strategies are substitutes, we expect that off-farm labor will be more prevalent on smaller farms. This is evidently true at the aggregate level, as has been shown by Kislev and Peterson (1996), but this is a reduced-form result. The question we ask in this research is whether the negative association between farm size and off-farm labor is a structural phenomenon. Theoretically, structural dependence between these two variables could go in both directions, and this also apply in the case of farm size and farm labor allocation. An increase in farm size increases the demand for farm labor and hence decreases the supply of off-farm labor, while an increase in off-farm labor reduces the availability of family farm labor and may therefore reduce farm size. It should be noted that in this discussion we refer to farm size as the level of farm activity rather than simply the size of operated land, because farm activity can be increased through capital investments and a shift to high-value crops even when cultivated land remains unchanged. For a discussion of the farm size concept see Yee and Ahearn (2005).

Risk considerations could also affect the structural dependence between farm size and off-farm labor. Off-farm labor not only increases household income but may also reduce household income risk (Mishra and Goodwin 1997). As a result, if an increase in farm size also increases farm income risk, it may lead to an increase in off-farm labor. In addition, an increase in off-farm labor that reduces household income risk, may allow the farm household to bear more farm income risk by increasing farm size. Hence, risk considerations may lead to a positive rather than negative association between farm size and off-farm labor. Recall, however, that this will not be true if an increase in farm size is associated with lower rather than higher farm income risk (McNamara and Weiss 2005). The bottom line is, therefore, that the sign of the association between farm size and off-farm labor is theoretically ambiguous.

A number of researchers tried to offer an empirical assessment of the mutual dependence between farm size and off-farm labor. Tavernier, Temel and Li (1997) allowed farm production to affect off-farm labor but not the other way around. On the other hand, Weiss (1999) allowed off-farm labor participation to affect farm growth but not the other way around. Both these studies found a negative association between off-farm labor and farm production/growth. Phimister and Roberts (2002) allowed off-farm labor participation to affect farm size in a simultaneous framework, and found a similar but less conclusive result.

Several recent studies allowed for a simultaneous determination of farm size and off-farm labor, with causality going both ways. Huffman and Evenson (2001) found that farm size and off-farm labor participation are positively associated, and the causality is statistically significant in both directions. Yee, Ahearn and Huffman (2004), on the other hand, found a negative association that is statistically significant in both directions. Ahearn, Yee and Korb (2005) also reported a negative association, but only the negative effect of off-farm labor on farm size was statistically significant. All three studies used longitudinal US state level data, and the conflicting results demonstrate the sensitivity of the results to the data used and the empirical model chosen. For Israel, Ahituv and Kimhi (2006) used individual data in a simultaneous analysis and found that farm size affected off-farm labor participation negatively while off-farm labor participation affected farm size negatively. Dolev and Kimhi (2006), on the other hand, found no significant effect of labor allocations on farm growth.

In this study, we use community-level panel data for the years 1992-2001, and estimate farm size and the fraction of labor allocated to agriculture simultaneously, in a dynamic setting. Dynamics is introduced by explicitly including the lagged dependent variable among the explanatory variables in each equation. We estimate the model using the dynamic panel GMM estimation method of Arellano and Bond (1991). The effects that we obtain using this estimation framework are short-run effects that do not carry over from one year to the next. In this sense, our hypothesis testing is more conservative, as it would be more difficult to obtain significant coefficients using our estimation strategy. This is the first study, as far as we know, that uses an explicit dynamic model to estimate farm size and labor allocation simultaneously.

In the next section, we describe the data used in this study. Then we present the empirical model and the estimation strategy. The following section presents the empirical results and some simulations. The last section concludes.

Data

Due to historical reasons, agricultural production in Israel is heavily concentrated in cooperative farm communities. Motivated both by ideology and by circumstances, the Zionist pioneers of the early 20th century set up unique forms of cooperative settlements, the two dominating types of which have been the Kibbutz and the Moshav (Kislev, 1992). The Kibbutz was a collective community in which each member produced according to his ability and consumed according to his needs. The Moshav was a cooperative village made of individual family farms, in which certain activities such as purchasing, marketing, and financing were handled jointly in order to exploit economies of scale in these activities. A third type of cooperative community, Moshav Shitufi (collective village), was a compromise between Kibbutz and Moshav: production was handled collectively while consumption was handled individually. Since a relatively small number of collective villages exist, we group them together with Kibbutz collectives and call them “collective farms”. In total, 75% of cultivated land in Israel was cultivated by these cooperative communities in 2002 (43% in collective farms and 32% in cooperative villages). The remaining 25% was cultivated by private farms.

The data set used in this research is from an annual survey of agricultural activity that was conducted at the locality level by the Ministry of Agriculture and the Central Bureau of Statistics. We have access to the data from the 1992-2001 surveys. The production data gathered is limited to the allocation of cropland to the different crops and the number of livestock. These were converted to gross value added using norms based on 1995 production data.[1] The size of the farm is defined as the aggregate value added of all crops and livestock. As a result, farm size, despite being expressed in value added units, is in fact a measure of physical size, and does not reflect productivity differentials across farms. Labor allocations were reported differently for each type of community. Private farms did not report labor allocations at all; hence they were excluded from the analysis. For collective farms, we have the annual days of work allocated to various work activities, and we simply compute the fraction of days of work devoted to agricultural production on each farm. For cooperative villages, we have the numbers of farm operators that work full time on the farm, part time on the farm, or only off the farm. To obtain a variable that would be as similar as possible to the one obtained for collective farms, we computed the fraction of farm operators working on the farm out of all farm operators who are working, when those working part-time are counted as half.

The data set includes useable observations on 312 collective farms and 409 cooperative villages, which are practically the entire population of these types of localities. Figure 5 shows the trend in farm size over time. The upwards trend is pretty clear. After inspecting the disaggregated data, we found that the year-to-year fluctuations around the trend were mostly the result of changes in vegetable cultivation. This makes some sence because vegetable cultivation is the agricultural activity most sensitive to market fluctuations. We observe that the growth of farm size is uniform across the two types of localities, except that collective farms seemed to stop growing in 1998, while farms in cooperative villages continued to grow in about the same rate up to 2001. Figure 6 shows that the fraction of labor employed in agriculture declined steadily, by roughly 20% over the study period, in both types of communities. Note that the fraction of farm labor in

[1] The Central Bureau of Statistics used more detailed farm surveys to obtain value added per land unit for each crop in each region and also value added per unit of livestock, which is what we call "norms". The data we obtained included only aggregates of agricultural production in four crop categories and six livestock categories. We therefore used weighted averages of the norms for each category, using reported country-level value added statistics as weights.

cooperative villages has been higher than in collective farms by a factor of three. This is at least in part due to the different ways in which the fraction of farm labor was defined in each type of community.

As exogenous explanatory variables, we use three sets of locality attributes: geographic location, year of establishment and institutional affiliation. We divide the data into three groups on the basis of each set of attributes. On the basis of location, the sample is divided into north, south and center (excluded group). Localities in the center have perhaps the most favorable agricultural conditions, but also the best alternatives in terms of off- farm labor opportunities and demand for their land for non-agricultural uses. The north and the south differ considerably in climatic conditions. While the north is more suitable for traditional crops such as fruits and field crops, the south has advantages for high value export crops such as vegetables and flowers. The north is also more suitable for farm-based tourism activities that may complement or substitute agricultural production.

The range of establishment year is divided into pre-1949, 1949-60, and post-1960. The first group includes communities established prior to the independence of Israel. The founding generation of these communities was considered the elite of society at the time, and they enjoyed the most favorable treatment by public institutions for years. The communities established after independence were located in relatively unfavorable areas and obtained fewer resources. At least in cooperative villages, the social composition of the population varied considerably with the year of establishment. After independence, many cooperative villages were settled with newly arrived immigrants that had neither the ability nor the will to succeed in farming. In later years, however, new cooperative villages were established voluntarily by second-generation farmers that chose not to continue in their native communities.

The last set of community attributes, institutional affiliation, is included because it reflects both access to resources at the early years and economic ideology that affected behavior. It has been shown earlier that institutional affiliation affected labor allocation decisions in cooperative villages (Kimhi 1998), and the same may be true for production activities. For each type of community there is a dominant institutional association, United Kibbutz Movement for collective farms and Moshavim Movement for cooperative farms. These are the excluded groups. Another group of associations is composed of mostly religious communities, and the remaining associations are grouped together as “other”. The distributions of these community attributes are shown in figure 7.

In addition, we use as an explanatory variable in the farm labor equation the average wage in the region. This variable is obtained from various publications of the National Insurance Institute of Israel, and expressed in fixed (1995) prices by deflating by the Consumer Price Index. As total wages in each region are predominantly non-farm wages, we hypothesize that this variable has a negative effect on the fraction of labor devoted to agricultural in each community. The average wage variable has a non-degenerate distribution in both the geographic dimension (figure 8) and the time dimension (figure 9).

Empirical model and estimation strategy

The model we chose to use in this research is the dynamic panel data model of Arellano and Bond (1991), which involves a Generalized Method of Moments estimation of a dependent variable as a function of its lagged value and other endogenous, pre-determined and exogenous variables, in the presence of unobserved heterogeneity. We treat the fraction of labor allocated to agriculture as an endogenous explanatory variable when we estimate the farm size equation, and we treat farm size as an endogenous explanatory variable when we estimate the farm labor equation. We use regional average wage as an exogenous explanatory variable in the farm labor equation. We also estimate the autonomous rate of change in each dependent variable over time, and the differences across regions and types of communities in this rate of change.[2]

Specifically, the two equations we estimate for farm size (*S*) and the fraction of labor in farming (*L*), respectively, are:

(1) $$S_{i,t} = \alpha_0 + \alpha_1 S_{i,t-1} + \alpha_2 L_{i,t} + t\cdot\mathbf{D}_i \alpha_3 + \mu_i + u_{i,t}$$

(2) $$L_{i,t} = \beta_0 + \beta_1 L_{i,t-1} + \beta_2 S_{i,t} + t\cdot\mathbf{D}_i \beta_3 + \beta_4 W_{i,t} + \theta_i + v_{i,t}$$

where size is expressed in logarithmic units. Size is also scaled by the size of the locality: by total annual days of work in collective farms and by number of family farms in

[2] We have also tried to use local rainfall and temperatures data as well as soil type dummies as exogenous explanatory variables in the farm size equation, but they turned out insignificant and did not change the results, so we do not report these results here. In addition, we have also tried to include the community-specific water quota as an exogenous explanatory variable in the farm size equation. The problem is that we do not have the water quota data for the last three years in the data set. Including this variable did change the results, but we have noticed that most of the change was due to the loss of the last three years of data rather than to the addition of this new variable. Therefore we have decided not to present these results here (they are available from the corresponding author upon request).

cooperative villages. The lagged dependent variable is included as an explanatory variable to account for year-to-year adjustment costs, a key element in farming. ***D*** is a matrix including a unit vector and dummy indicators of locality attributes, including region, year of establishment and institutional affiliation. These are allowed to affect the autonomous time trend, and hence are multiplied by *t*. *W* is average regional wage, expressed in logarithmic units. Note that *W* has both a geographic dimension and a time dimension, and hence it is likely to be correlated with elements of ***D***. μ and θ represent community-specific unobserved factors (fixed effects) that are unchanged over time, while *u* and *v* are idiosyncratic error terms.

Taking first differences, equations (1) and (2) become:

$$(3) \qquad \Delta S_{i,t} = \alpha_1 \Delta S_{i,t-1} + \alpha_2 \Delta L_{i,t} + \mathbf{D}_i \alpha_3 + \Delta u_{i,t}$$

$$(4) \qquad \Delta L_{i,t} = \beta_1 \Delta L_{i,t-1} + \beta_2 \Delta S_{i,t} + \mathbf{D}_i \beta_3 + \beta_4 \Delta W_{i,t} + \Delta v_{i,t}$$

where $\Delta S_{i,t} = S_{i,t} - S_{i,t-1}$, and all other differenced variables are defined similarly. The differencing eliminates the fixed effects μ and θ. In addition, the estimation procedure corrects for endogeneity by using the Generalized Method of Moments (GMM) estimation procedure on each of the equations. The procedure uses all possible lagged values of ΔS, ΔL and ΔW as instruments for the endogenous explanatory variables. The procedure also corrects for serial correlation by an appropriate transformation of the weighting matrix. See Arellano and Bond (1991) for further details.

The model can be estimated in one stage or in two stages. The two-stage method involves using the residuals of the first stage to compute an optimal weighting matrix, which is subsequently used to re-estimate the model in the second stage. The advantage of the two-stage method is in the efficiency of the parameter estimates. The disadvantage is that the standard errors of the coefficients tend to be underestimated, and this may lead to incorrect inference. We estimated each model with both methods, and as a rule, the results were not qualitatively different. In the following, we present only the one-stage estimates, mainly because for these estimates it is feasible to compute robust standard errors. We also conduct the Arellano and Bond test of second-degree serial correlation in the differenced error terms. A failure of this test implies that the first lag of a dependent variable cannot serve as an instrument. The results of this test were always favorable in our case.

Results

The farm size regression results are in table 1. Two sets of regression results are presented: one with community attributes and one with a uniform time effect only. In all cases we found that the inclusion of community attributes does not change the other coefficients qualitatively. We observe that farm size is affected positively by its lagged value, meaning that there is persistence in farm size. This implies that a one-time shock to farm size has a lasting effect. The coefficient of lagged size is less than unity, meaning that this lasting effect vanishes over time. The fraction of farm labor has a positive effect on farm size. However, this effect is close to being statistically significant only in collective farms. The overall time trend of farm size is positive, but it is statistically significant only for collective farms. Breaking the trend by locality attributes shows that collective farms in the south grow faster over time than other collective farms, while cooperative villages established after 1960 grow faster than other cooperative villages.

Table 2 shows parallel results for the farm labor equation. We find that the lagged fraction of farm labor has a positive and significant effect on its current value. The coefficient is less than unity as in the case of farm size, and is larger in collective farms than in cooperative villages. This implies that labor allocation in cooperative village is likely to respond better to changes in the economic environment than in collective farms. This makes sense because as a rule, most farm workers in collective farms work full-time on the farm, while most farm operators in cooperative villages split their time between farming and off-farm work. Off-farm workers do not face the fixed costs of multiple jobholding when adjusting their labor allocation and hence are more likely to respond to economic incentives. The effect of farm size on the fraction of farm labor is positive and statistically significant, meaning that exogenous factors that lead to a decrease in agricultural production indirectly lead to a shift of labor away from agriculture. This is the well known “push” effect on farm labor. Wage has a negative effect of the fraction of labor employed in agriculture, but it is not significantly different from zero. This implies that the “pull” effect on farm labor is not strong. However, it is likely that the actual negative effect of off-farm wages on farm labor is stronger, because the variation of wages across regions captures only a part of the overall variation in off-farm wages. The time trend in farm labor is negative and statistically significant, and does not vary significantly by community attributes. However, in the case of collective farms it seems like the negative time trend is mostly due to collective farms established after 1960.

These results imply that the association between farm size and farm labor is positive as in the earlier results of Ahituv and Kimhi (2006), but the causality only goes from farm size to farm labor and not in the opposite direction. This implies that independent factors that increase the level of agricultural activity help to moderate the rate of labor exodus from agriculture. On the other hand, independent factors that pull labor out of agricultural production do not significantly reduce the level of agricultural activity, perhaps because family labor is replaced by hired labor and/or capital investments.

The time trend coefficients deserve some further attention. Our results imply that while farm labor has a relatively homogeneous negative time trend, the time trend of farm size varies significantly by region (in collective farms) and by establishment year (in cooperative villages). This is consistent with the earlier results of Kahanovitz, Kislev and Kimhi (1999). This raises the concern that the aggregate farm size results are driven by a particular group of communities. To delve deeper into this issue, we have estimated the farm size equation again after allowing for a different time trend for each category of communities defined by the interaction of region and establishment year. We have left out the institutional affiliation since it did not seem to have any significant effect in the previous results.

The farm size results with the disaggregated time trends are shown in table 3. Two versions are shown: one with the full set of category-specific time trends, and another in which the apparently similar categories are grouped together with the excluded category. Several conclusions emerge from the table. First, the interaction between region and establishment year is important. For example, in cooperative villages, farm size grows autonomously over time only in young communities in the south. In the case of collective farms, farm size increases over time in all communities except for the young collective farms in the center of the country. Also, farm size increases significantly faster over time in young collective farms in the south. Second, allowing for interactive effects of geographic location and year of establishment results in a stronger positive effect of farm labor on farm size in collective farms. This effect becomes statistically significant at the 10% level.

To further examine the importance of the category-specific time trends, we conducted simulations of the evolution over time of farm size and farm labor for different categories of communities. For farm labor we have used the results in the first and third columns of table 2, while for farm size we have used the results in the second and fourth columns of table 3. As initial conditions we have used the sample means of farm size and farm labor for the years 1992 and 1993. For the exogenous wage variable, we used actual data in the first 10 years, and assumed a fixed annual growth rate of 2.24% in subsequent years. This is the annual average growth rate of wages in the first ten years, in our sample. The simulated results for 30 years are shown in figures 10 and 11 for collective farms and cooperative villages, respectively. The figures include simulations for the majority group of communities (those that form the excluded category in columns 2 and 4 of table 3) as well as for the other categories that had significantly different time trend coefficients in table 3.

For collective farms (figure 10), we observe that farm size tends to grow slowly over time in communities belonging to the majority category (86% of all collective farms). This is due to the positive coefficient on lagged farm size, as well as the positive time trend. As can be seen in the lower panel of figure 10, farm labor declines over time in these communities, and this, combined with the positive coefficient on farm labor in the farm size equation, implies a negative time trend of farm size. What we observe in the upper panel of figure 10 is the net effect, which is positive, meaning that the effect of the decline in farm labor only moderates the increase in farm size but does not reverse it.

Relatively young collective farms in the center of the country, on the other hand, exhibit a negative growth path, and a faster decline of farm labor compared to the majority category. In fact, our simulations show that farm labor will decline to zero in these collective farms by the year 2012. It could be that these collective farms found it easier to adjust to the declining agricultural profitability because they had a shorter agricultural "tradition," smaller fixed capital stock and relatively younger labor force. While this could be true for all young collective farms, those in the center of the country probably had better access to non-farm labor markets. However, this group of collective farms comprises less than 3% of our sample, so we cannot attach too much importance to this result.

The opposite is true for relatively young collective farms in the south (11% of all collective farms). In our simulations, these communities exhibit a growth in farm size and in farm labor. This means that the positive effect of the increase in farm size on farm labor outweighs the negative time trend. This unique pattern of structural changes in these collective farms can be explained on two grounds. First, young communities are relatively early in their institutional life cycle, meaning that it takes them time to build the knowledge base and the capital stock that enhance agricultural production. In addition, perhaps these communities were planned to have farm growth potential, more than their veteran counterparts. The second explanation relates to the southern location of these communities. Non-farm earnings opportunities in the south are not as developed as in the center and in the north, and this may have motivated these communities to rely more on agricultural production.

For cooperative villages (figure 11), farm size declines slightly over time in the majority category (90% of all cooperative villages). As both the coefficient of farm labor and the time trend in these communities are not significantly different from zero (table 3), we can consider farm size as practically fixed over time. This implies that the decline in farm labor in these communities is dominated by the negative time trend. In relatively young cooperative villages in the south (10%), on the other hand, farm size increases continuously in the long run, and the decline in farm labor becomes more moderate as a result. Note that this is the same group of communities that exhibited an increase in farm size among the collective farms. The explanation is therefore similar. However, as opposed to the collective farms, in the case of cooperative villages the autonomous decline in farm labor dominates the increase due to the increase in farm size.

We conclude that the observed aggregate increase in farm size on Israeli farm communities may be due to a relatively small number of farm communities that increase the level of agricultural activity, while in the majority of farm communities agricultural activity is more or less stagnant. As a final sensitivity check of our empirical results, we have estimated the model again using the communities in the majority groups only. These comprise 86% and 90% of collective farms and cooperative villages, respectively. The results (table 4) are not qualitatively different from any of the earlier results (tables 2 and 3). However, several changes in the significance of the coefficients are observed. In the case of collective farms, the cross-effects of farm size on farm labor and of farm labor on farm size become statistically insignificant. On the other hand, in the case of cooperative villages, the coefficient of farm labor in the farm size equation becomes larger and marginally significant. This supports our earlier conclusion that the results are somewhat sensitive to the way we control for community-specific time-invariant attributes, and in particular geographic location and year of establishment.

Conclusions

We have estimated the simultaneous evolution of farm size and the fraction of labor devoted to agriculture in Israeli farm communities using panel data for the years 1992-2001. We found that behind the aggregate trends of increasing farm size and decreasing farm labor, there are differential processes at the micro level that should not be overlooked. In particular, we found that farm labor decreases steadily over the years, and increases in farm size are only able to moderate its rate of decline, except for a small group of collective farms in which the increase in farm size leads to an increase in farm labor. Changes in farm labor do not seem to have a statistically robust effect on the evolution of farm size. The autonomous increase in farm size is minimal, on average, but a closer look reveals that farm size increases significantly over time in certain types of farm communities and decreases in other. The geographic dimension seems to be a key factor, with farms in the south responsible for all farm growth observed at the aggregate level.

There is one qualification of these conclusions that needs to be kept in mind. Recall that in the case of cooperative villages we deal with average farm size. There are likely changes in farm size at the individual farm level that we do not observe. For example, the decrease in farm labor could be, at least in part, because some farmers decrease their farm labor allocation or even quit farming altogether, while others remain full-time farmers. It is likely that farm resources would flow from the former to the latter *within the same community*, due to both economic factors and institutional constraints. If some farmers reduce the level of farming activity while other increase it, in a way that keeps aggregate farm activity unchanged at the aggregate, we may end up underestimating the effect of changes in farm labor allocation on farm size in cooperative villages.

The heterogeneity in farm growth across the different types of farm communities reflects our inability to account for all relevant structural characteristics. The conclusion that agricultural production gradually shifts to the south is straightforward, but it may be interesting to break it down into other dimensions. For example, comparative advantage in different types of crops and livestock across geographical regions may be behind this result. The fact that changes in the composition of farm output depends to a large extent on agricultural policy (e.g., water quotas and permits to employ foreign workers) makes the crop composition issue even more interesting. This is left for future research.

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Figure 1. Farm Growth in Selected Developed Countries

Sources:
Canada: Census of Agriculture (various years), www40.statcan.ca/l01/cst01/agrc25a.htm.
US and Europe, 1980's: FAO, www.fao.org/es/ess.
US, 1990's: Agricultural Statistics (various years), www.usda.gov/nass/pubs/agstats.htm.
Europe, 1990's: EUROSTAT, epp.eurostat.cec.eu.int/portal/page?_pageid=0,1136206,0_45570467&_dad=portal&_schema=PORTAL

Notes:

- In parentheses: average farm size (ha) in 2000.
- Most 1980's statistics relate to the period 1979-1990. Exceptions are Canada (1981-1991), France (1980-1990), and Spain and Italy (1982-1990).
- Most 1990's statistics relate to the period 1990-2000. Exceptions are Canada (1991-2001) and the US (1993-2000). In the case of the US, there was a change in the definition of a farm in 1993.

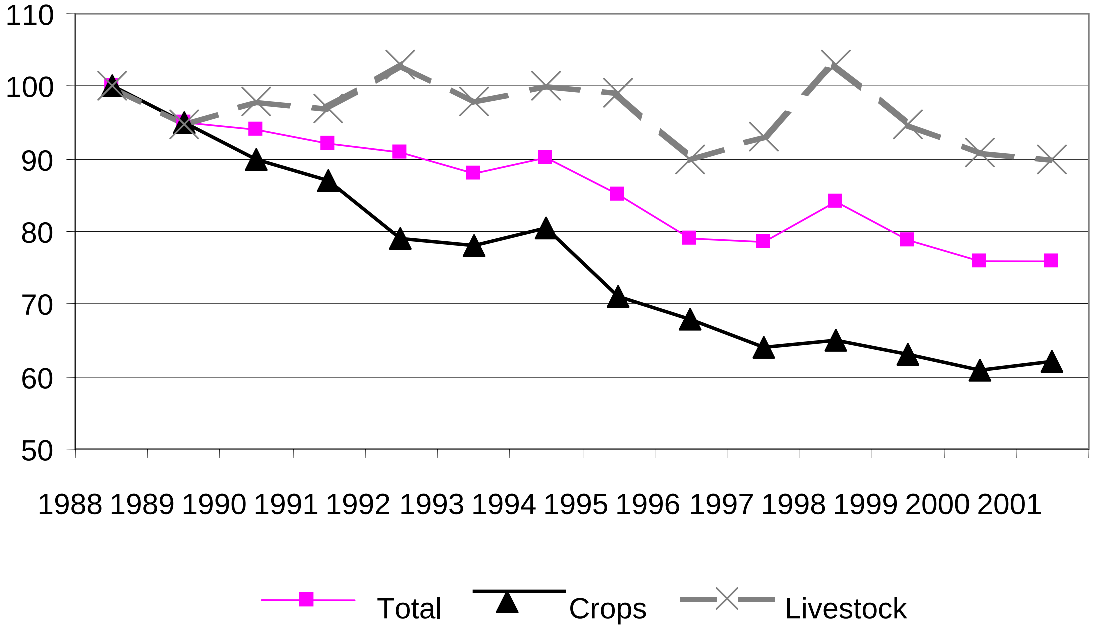


Figure 2. Terms of Trade in Israeli Agriculture

Source: Statistical Abstract of Israel (various years)

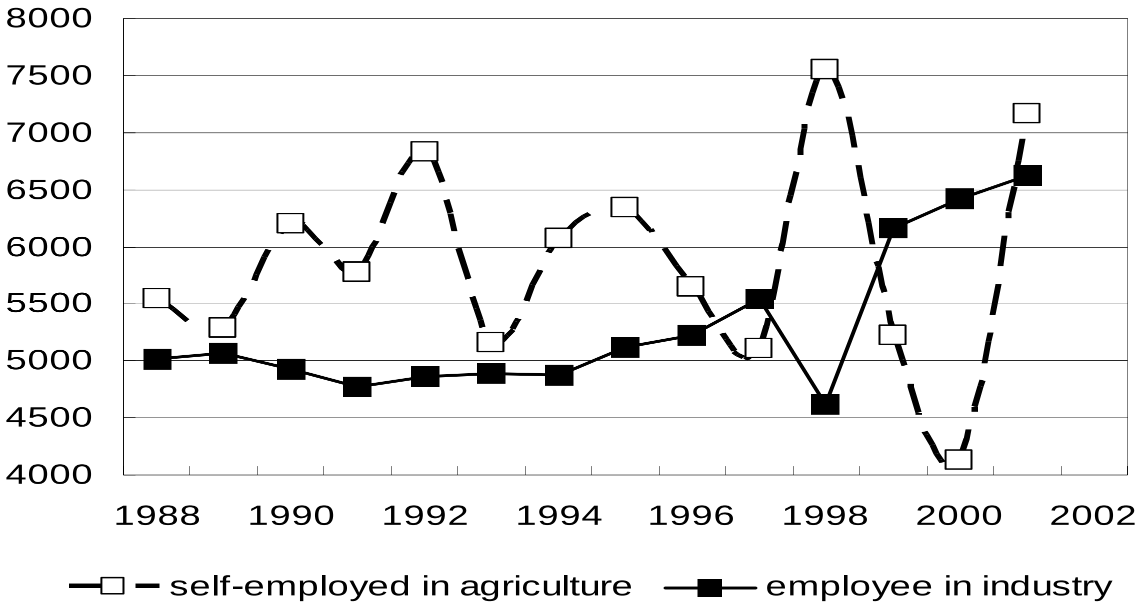


Figure 3. Monthly Income of Self-Employed in Agriculture and Employees in Industry (NIS)

Source: Statistical Abstract of Israel (various years)

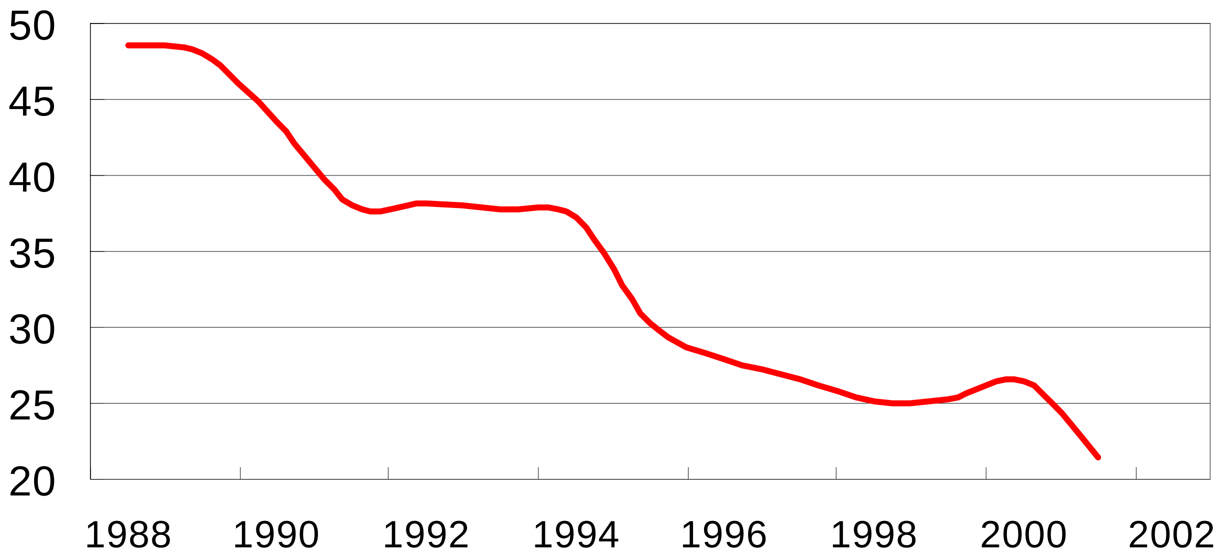


Figure 4. Number of Self-Employed Farmers in Israel (Thousands)

Source: Statistical Abstract of Israel (various years)

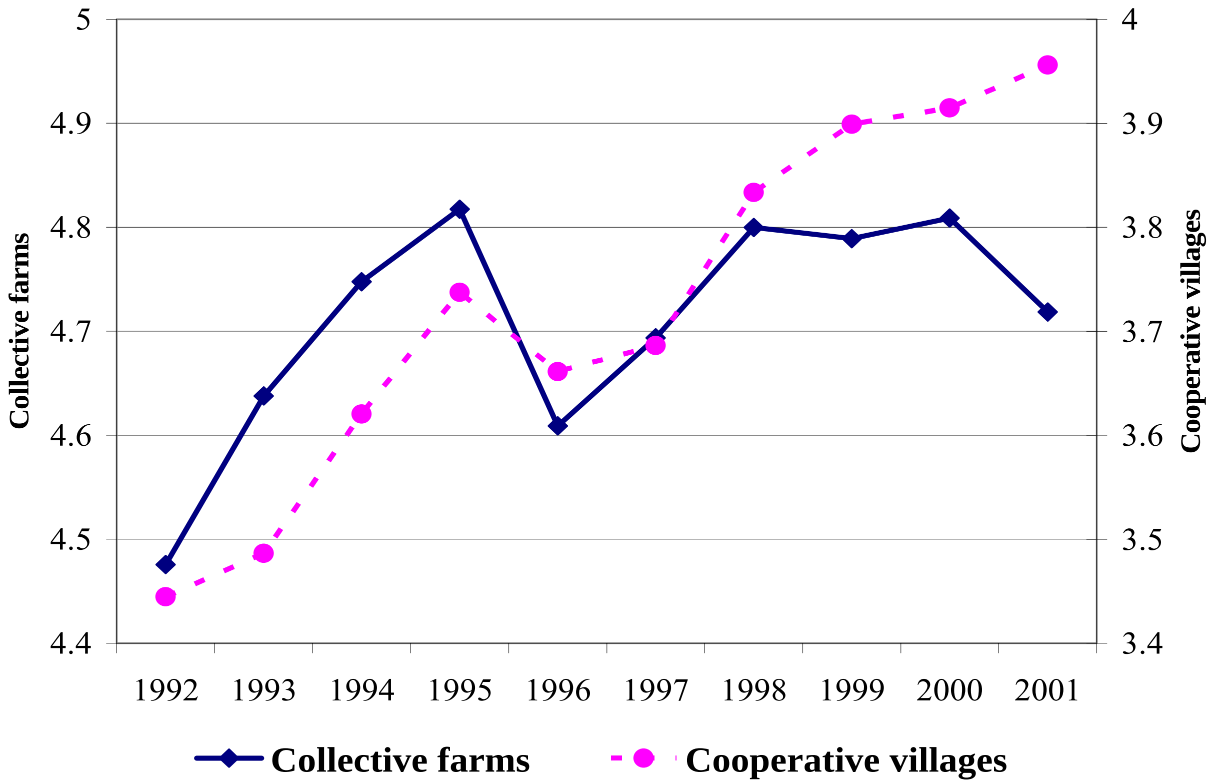


Figure 5. Trends in Average Farm Size in the Sample (Million NIS, 1995 values)

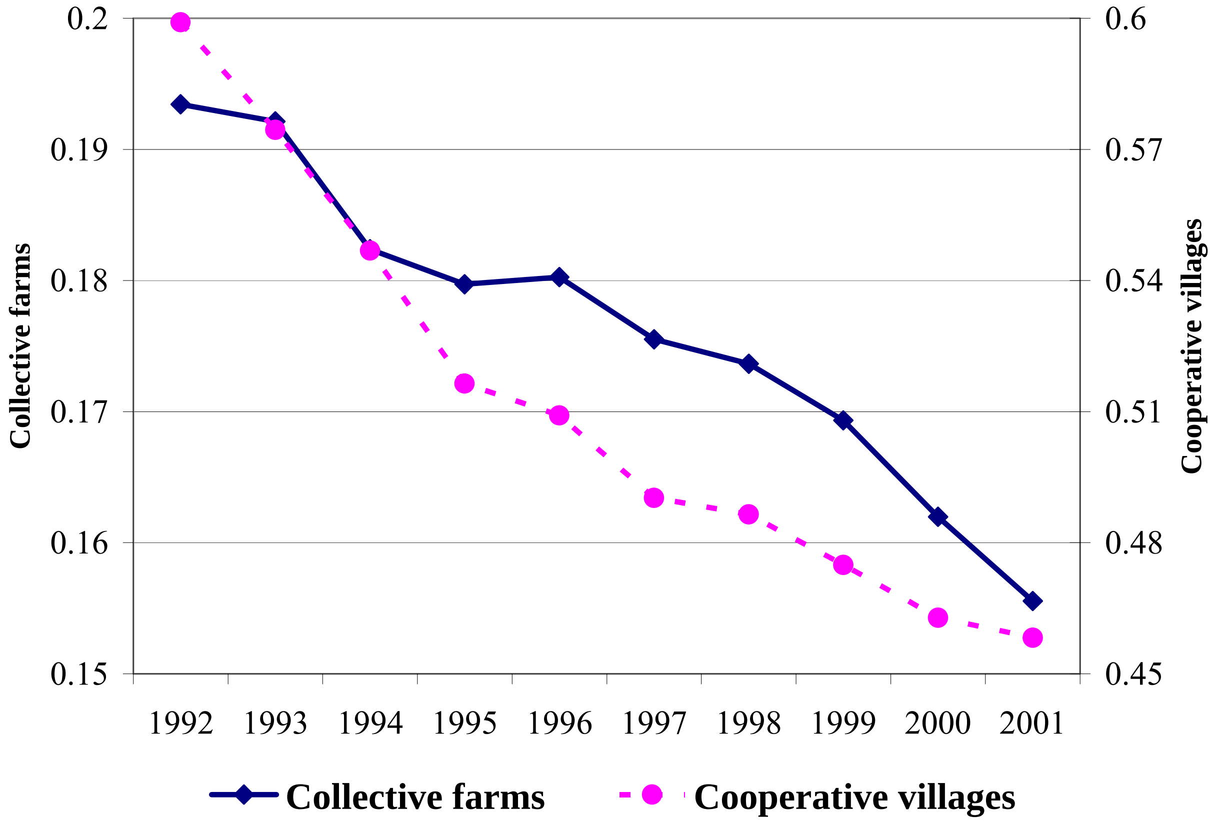
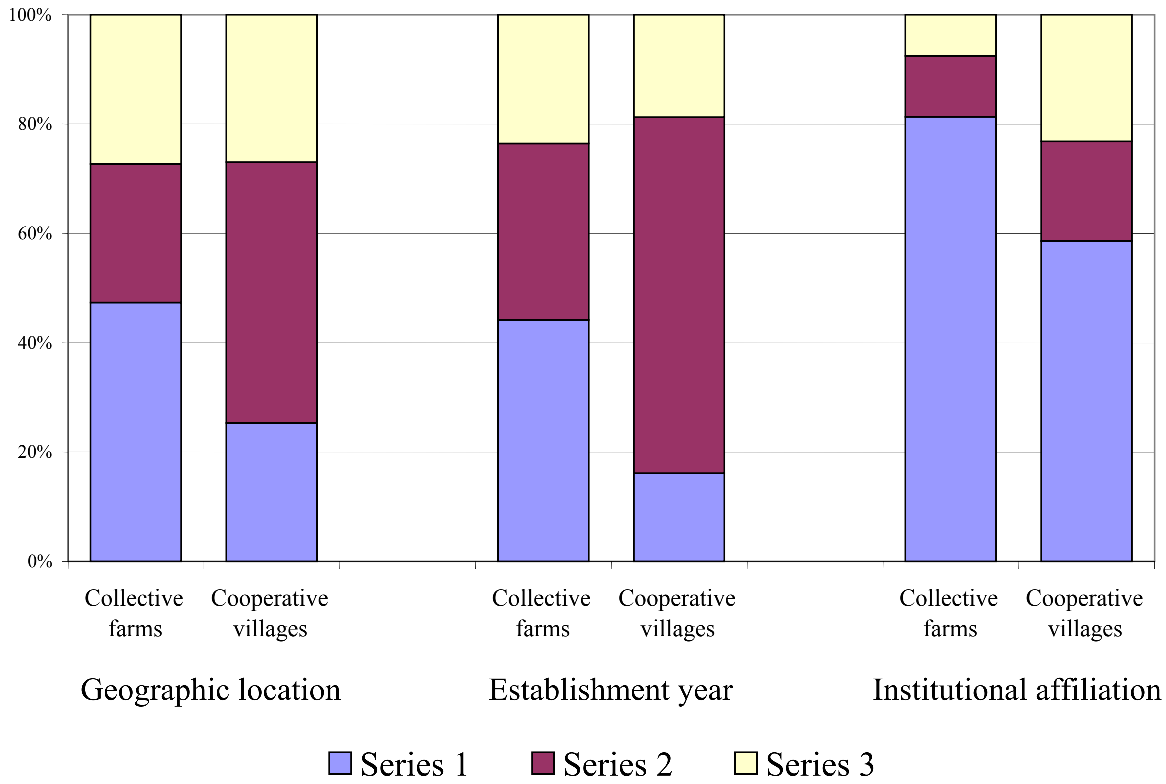


Figure 6. Trends in the Fraction of Farm Labor in the Sample



Key to the series:	Series 1	Series 2	Series 3
Geographic location	North	Center	South
Establishment year	pre-1949	1949-60	post-1960
Institutional affiliation	Majority	Religious	Other

Figure 7. Distributions of Community Attributes

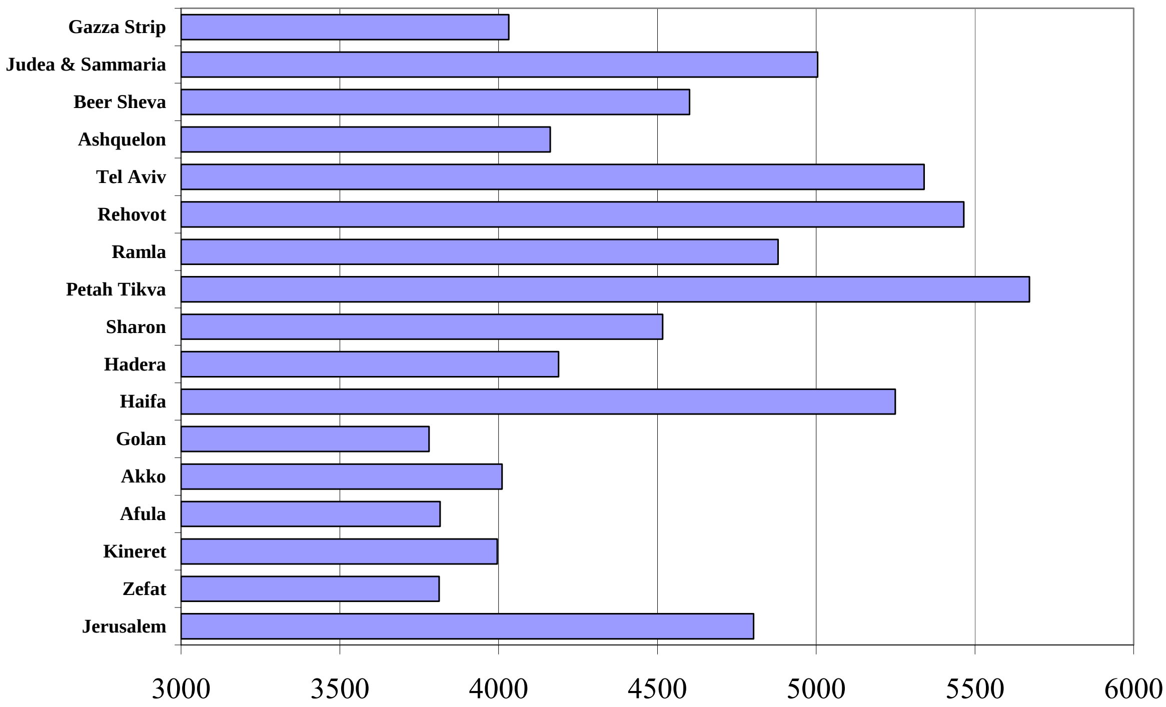


Figure 8. Geographical Distribution of Regional Wages (NIS per month)

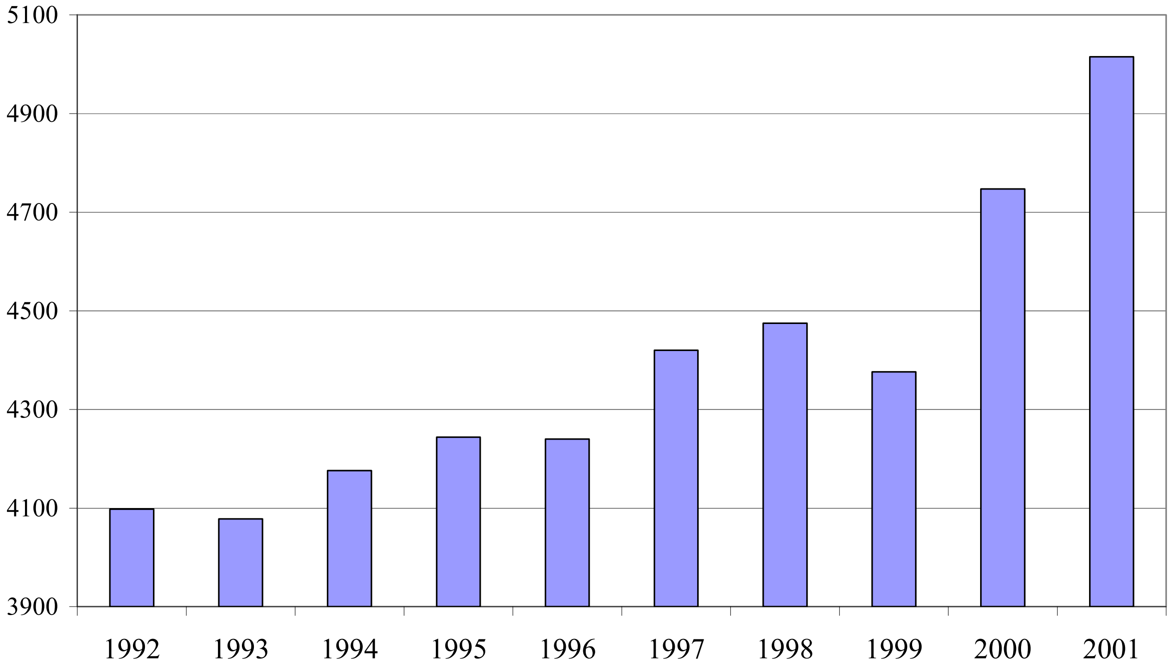


Figure 9. Time Trend of Regional Wages (NIS per month)

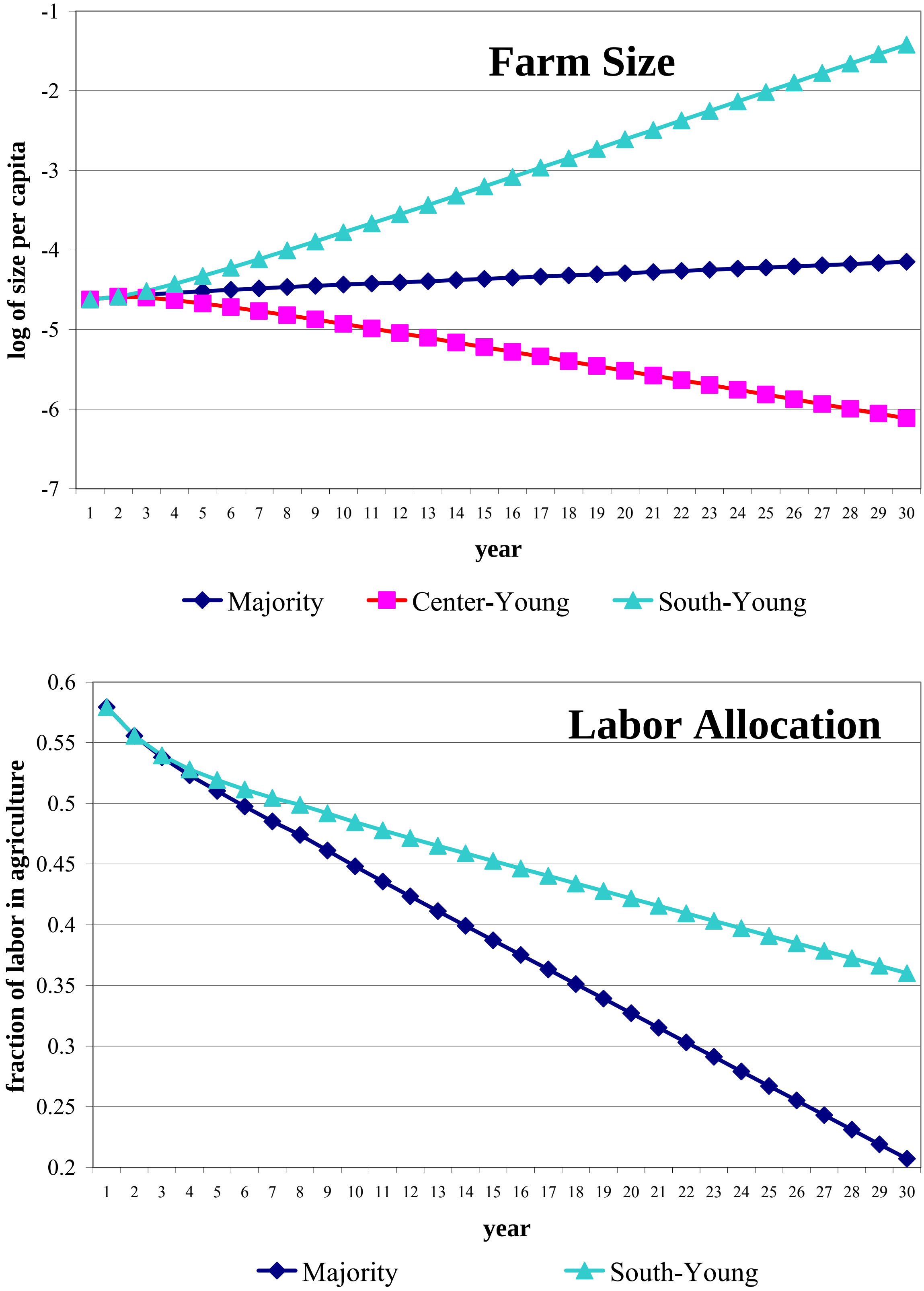
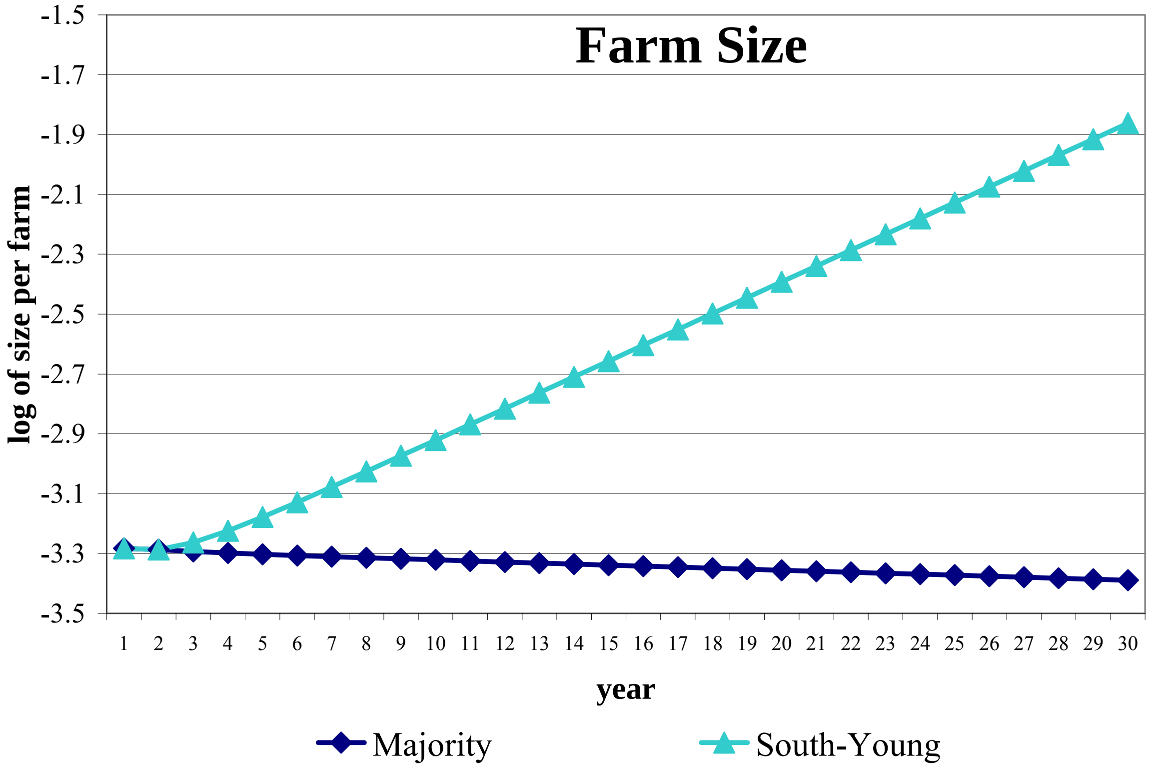


Figure 10. Simulated Structural Changes in Collective Farms



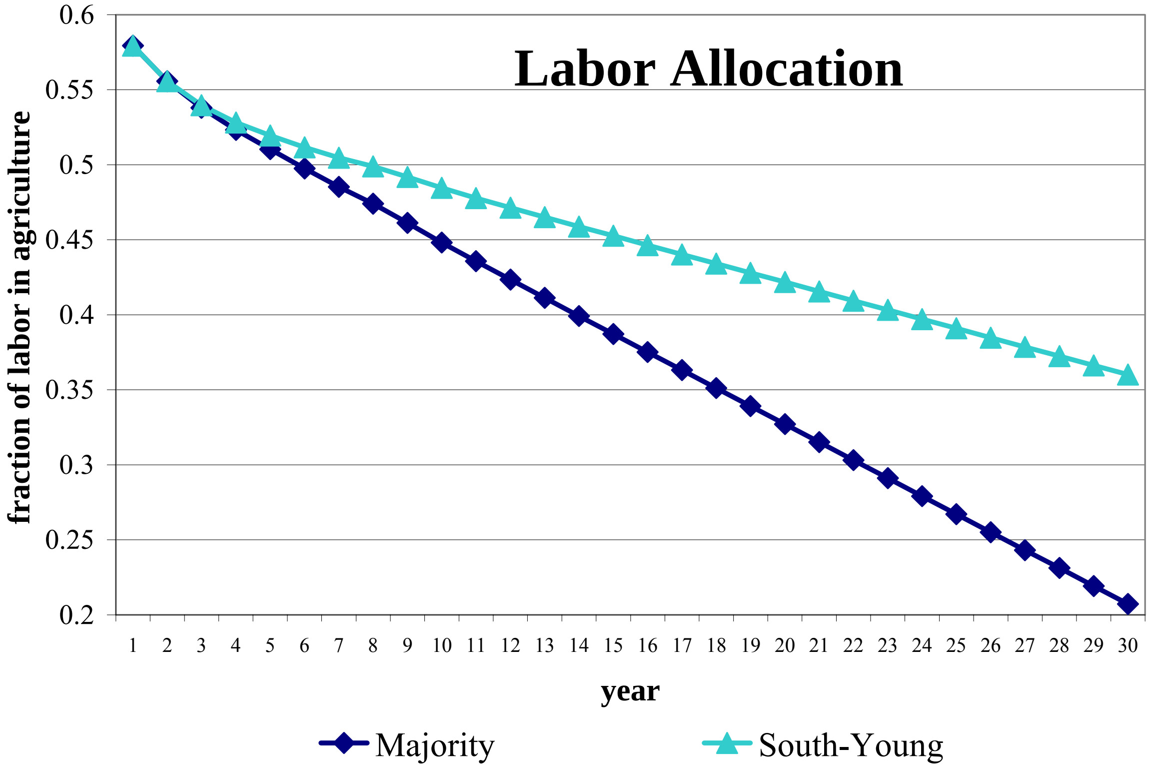


Figure 11. Simulated Structural Changes in Cooperative Villages

Table 1: Farm Size Results

Variable	Collective farms Coefficient (T-value)	Collective farms Coefficient (T-value)	Cooperative villages Coefficient (T-value)	Cooperative villages Coefficient (T-value)
Lagged size	0.465*** (4.27)	0.462*** (3.47)	0.480*** (6.28)	0.453*** (6.10)
Farm labor	1.053 (1.31)	1.408 (1.53)	0.176 (0.66)	0.151 (0.55)
Time	0.018*** (2.78)	0.015* (1.87)	0.003 (0.78)	-0.009 (-1.10)
North		-0.001 (-0.17)		0.003 (0.47)
South		0.024*** (2.81)		0.007 (1.06)
Established 1949-1960		-0.003 (-0.47)		0.009 (1.39)
Established after 1960		0.005 (0.45)		0.025*** (3.01)
Religious affiliation		-0.007 (-0.74)		-0.007 (-1.04)
Other affiliation		-0.008 (-0.70)		0.0004 (0.06)
χ^2 statistic	41.09(2)***	36.16(8)***	55.91(2)**	76.08(8)***
Arellano & Bond test	passed	passed	passed	passed
Number of cases	2486		3231	
Number of communities	312		408	

Notes: T-test is based on robust standard errors; * Coefficient significant at 10%; ** Coefficient significant at 5%; *** Coefficient significant at 1%.

Table 2: Farm Labor Results

Variable	Collective farms Coefficient (T-value)	Collective farms Coefficient (T-value)	Cooperative villages Coefficient (T-value)	Cooperative villages Coefficient (T-value)
Lagged farm labor	0.705*** (8.08)	0.668*** (7.89)	0.479*** (7.97)	0.474*** (8.22)
Farm size	0.031** (2.33)	0.036*** (2.98)	0.052** (2.20)	0.053** (2.23)
Regional wage	-0.010 (-0.39)	-0.019 (-0.76)	-0.020 (-0.47)	-0.701 (-0.41)
Time	-0.002** (-2.36)	-0.001 (-1.36)	-0.006*** (-3.41)	-0.007*** (-2.60)
North		-0.0003 (-0.39)		0.002 (1.33)
South		-0.0003 (-0.29)		-0.0003 (-0.17)
Established 1949-1960		0.00007 (0.11)		0.001 (0.76)
Established after 1960		-0.002 (-1.58)		-0.0005 (-0.18)
Religious affiliation		-0.0007 (-0.48)		-0.00001 (-0.01)
Other affiliation		0.0003 (0.22)		-0.001 (-0.69)
χ^2 statistic	134.4(3)***	205.5(9)***	69.83(3)***	111.3(9)***
Arellano & Bond test	passed	passed	passed	passed
Number of cases	2486		3239	
Number of communities	312		408	

Notes: T-test is based on robust standard errors; * Coefficient significant at 10%; ** Coefficient significant at 5%; *** Coefficient significant at 1%.

Table 3: Farm Size Results with Interactions of Region and Establishment Year

Variable	Collective farms Coefficient (T-value)	Collective farms Coefficient (T-value)	Cooperative villages Coefficient (T-value)	Cooperative villages Coefficient (T-value)
Lagged farm size	0.412*** (2.97)	0.405*** (2.86)	0.443*** (6.04)	0.442*** (6.03)
Farm labor	1.671* (1.75)	1.690* (1.80)	0.203 (0.73)	0.315 (1.19)
Time	0.017** (2.16)	0.019*** (2.73)	0.0003 (0.05)	0.002 (0.48)
North-old	excluded		-0.002 (-0.17)	
North-intermediate	0.003 (0.35)		0.004 (0.57)	
North-young	-0.006 (-0.61)		0.011 (1.40)	
Center-old	0.001 (0.14)		-0.010 (-1.19)	
Center-intermediate	0.001 (0.14)		excluded	
Center-young	-0.034 (-2.31)**	-0.035** (-2.54)	0.006 (0.46)	
South-old	0.016 (1.60)		empty cell	
South-intermediate	0.006 (0.50)		0.001 (0.13)	
South-young	0.046** (2.23)	0.044** (2.13)	0.029*** (2.70)	0.030*** (2.87)
χ^2 statistic	38.21(10)***	36.04(4)***	93.63(9)**	71.01(5)**
Arellano & Bond test	passed	passed	passed	passed

Notes: T-test is based on robust standard errors; * Coefficient significant at 10%; ** Coefficient significant at 5%; *** Coefficient significant at 1%.

Table 4: Results for Communities in the Majority Category

	Collective farms		Cooperative villages	
Variable	Farm Size Coefficient (T-value)	Farm Labor Coefficient (T-value)	Farm Size Coefficient (T-value)	Farm Labor Coefficient (T-value)
Lagged size	0.435*** (5.58)		0.410*** (4.69)	
Farm labor	0.983 (1.50)		0.527* (1.91)	
Lagged labor		0.728*** (8.66)		0.498*** (7.64)
Farm size		0.015 (1.21)		0.097*** (3.89)
Regional wage		0.016 (0.65)		-0.015 (-0.36)
Time	0.015*** (4.04)	-0.002*** (-2.82)	0.005 (1.34)	-0.005*** (-2.98)
χ^2 statistic	33.30(2)***	98.51(2)***	33.99(2)***	106.3(2)***
Arellano & Bond test	passed	passed	passed	passed
Number of cases	2159		2906	
Number of communities	270		367	

Notes: T-test is based on robust standard errors; * Coefficient significant at 10%; ** Coefficient significant at 5%; *** Coefficient significant at 1%.

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