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The Joint Dynamics of Off-Farm Employment And the Level of Farm Activity

by

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The Joint Dynamics of Off-Farm Employment and the Level of Farm Activity

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Abstract

We analyze the simultaneous determination and evolution over time of two decisions made by self-employed farm operators: off-farm work and the level of farm activity. Using a panel of Israeli farm households observed in 1981 and 1995, we estimate jointly a multinomial choice model of work activity and an endogenous switching regression of farm size that enables us to account for unobserved heterogeneity and correct for simultaneity bias. The results show that changes in farm size are closely linked to the off-farm labor decisions. In particular, we identify two different paths in the evolvement of farm families over time. Farms that expand and have a low likelihood of working off the farm follow one path, while other farms downsize their farming operation and increase their engagement in the off-farm labor market. Therefore, the distribution of farms is converging towards a bi-modal distribution, with large farms operated by full-time farmers on one extreme and smaller part-time farms on the other extreme, whose income is derived mostly from off-farm sources. These results could not have been obtained without treating the level of farm activity as endogenous to the work choice decisions.

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1. Introduction

Farm sectors in developed countries have experienced a sharp decline in their relative size and employment during the second half of the 20th century. For example, the number of farms in the United States has declined from 5.6 million in 1950 to 2.1 million in 2003. As the cultivated land did not change much during that period, the average cultivated area of farms has risen from 213 acres to 441 acres per farm. Moreover, while the real value of farm products per farm has tripled from 1974 to 1997, agriculture's share in the labor force dropped from 12% in 1960 to 2% in 1999, meaning that productivity growth led to exit of farmers. The fraction of farm operators working off the farm went up from just under 40% in 1950 to almost 60% in 1997, and the increase in off-farm participation rates of spouses was even stronger (Mishra et al. 2002).

These trends are not unique to the U.S. farm sector. Similar trends are observed in other developed economies. Between 1966 and 1997, the number of farms in France and Germany dropped by almost 60%, while the average farm size in these countries grew by a factor of more than two and a half during the period. Similar trends have been reported for Canada (Bollman, Whitener and Tung 1995), Britain (Lobley et al. 2002), and for other European countries (Bryden et al. 1992). Figure 1 shows that the real value of agricultural production divided by the size of the farm population has increased in virtually all parts of the world. Interestingly (because of reasons that will be discussed later), the changes in Israel were more dramatic.

The share of agriculture in the labor force in Israel declined from 17.6% in 1955 to 2.3% in 1998. The number of active farms dropped from 43,450 in 1981 to 25,900 in 1995, while total cultivated land remained roughly the same. As a result, the average cultivated area of farms increased by more than a half during the same period. Off-farm labor also increased during the period, mostly by females and young farmers. Figure 2 shows the decline in the number of farms and the parallel increase in average farm size over the years. Kimhi (2004) has shown that off-farm work of farm operators increased from 1971 to 1981 but decreased from 1981 to 1995. This is likely because of the high exit rate during the latter period. Off-farm work by spouses increased in both periods.

Increases in farm size have been studied before, especially for the United States. Gardner and Pope (1978) attributed the increase in average farm size to technological change. Kislev and Peterson (1982) found that the increase in the size of the average farm was explained almost exclusively by changes in relative prices. Thirtle (1985) claimed that biased technical change was responsible for the rise in the land to labor ratio in wheat farms. Mishra et al. (2000) found that the shift from small and medium American farms towards large farms has been enhanced by government policy.

Baur (2000) showed that small and medium Swiss farms grew on average but the larger farms remained stagnant. Weiss (1999), on the other hand, found that the size distribution of farms in Austria converges to a bi-modal distribution, with concentration of both small farms and large farms, but a disappearing mid-size class. Ahearn, Yee and Korb (2004) also reported a “disappearing middle” phenomenon in the U.S. Kahanovitz et al. (1999) documented an increase in the size of the average family farm in Israel, and found that the increase varied considerably by farm and family characteristics.

Kislev and Peterson (1996) discussed the co-movement of farm size and off-farm labor in the U.S., and suggested that this is evidence against the existence of economies of scale in agriculture. Huffman and Evenson (2001) found that increases in farm size and off-farm labor are positively associated and the causality goes both ways. Ahearn, Yee and Korb (2004) found, on the other hand, that farm size affects off-farm labor negatively while off-farm labor affects farm size positively. The effect of off-farm labor on farm size could be indirect, through the effect on farm exits, because exits increase the size of remaining farms. Several authors examined this effect and reached mixed conclusions. While Kimhi and Bollman (1999), Kimhi (2000), Goetz and Debertin (2001), Pietola, Vare and Lansink (2002), and Glauben, Tietje and Weiss (2003) found that part-time farming decreases exit, Roe (1985), Pfeffer (1989), and Weiss (1999) found the opposite, and Baur (2000) and Ahearn, Yee and Korb (2004) did not find statistically significant effects.

The overall trend is, undoubtedly, towards fewer and larger farms that rely less on family labor. These structural changes have been a reaction to several processes: technological progress, government policies, and changes in market conditions: decreasing terms of trade, increasing alternative opportunities, and urbanization pressures. As these factors continue to change, so would the structure of the agricultural sector.

The purpose of this paper is to analyze the linkages between these two important aspects of farm dynamics (farm size and farmers' off-farm employment) in Israel between 1981 and 1995, using farm-level longitudinal data. The main methodological innovation of this paper is the investigation of these dynamic phenomena jointly rather than separately, and the explicit treatment of the interactions among them. The studies by Huffman and Evenson (2001) and by Ahearn, Yee and Korb (2004) examined these dynamics jointly, but used state-level data, while we use individual farm data. Phimister and Roberts (2002) used individual farm data and allowed farm size to depend on the off-farm participation decisions but not the other way around. The use of individual data is more demanding econometrically but reveals more information on farmers' behavior. This is because following individual farmers over a relatively long period of time avoids the problem of changes in the composition of the farm population over time.

The paper proceeds as follows. Section 2 presents the theoretical and empirical background. Section 3 lays out the analytical framework, and Section 4 describes the estimation strategy. Section 5 presents the data, and Section 6 lays out the results, while Section 7 concludes.

2. Theoretical Motivation and Previous Empirical Findings

The theory of the farm household recognizes that farm operation decisions and off-farm labor decisions are made jointly (unless rural labor markets are perfect, which is far from reality). However, it does not give a clear prediction of whether off-farm labor and farm size are positively or negatively correlated. On one hand, a larger farm is likely to require more labor and hence divert labor away from off-farm employment. The income effect of farm size on the demand for leisure can also reduce off-farm labor participation. On the other hand, farms can grow by investing in labor-saving technologies and thereby release labor to alternative uses. The correlation is also likely to depend on farm specialization. For example, field-crop farms require very little labor even when they are very large, while vegetable farms need more labor as they increase their size.

Numerous empirical studies of the off-farm labor supply of farmers have been conducted in the last few decades, starting with the seminal work of Huffman (1980). Most of these studies looked at the effect of demographic variables and farm attributes on the off-farm labor supply decisions. Extensions have been made to deal with joint husband-wife decisions (e.g. Huffman and Lange 1989), local labor market conditions (e.g. Tokle and Huffman 1991), joint farm and off-farm labor participation decisions (e.g., Kimhi 1994) and farm income variability (Mishra and Goodwin 1997). All of these studies relied on cross-sectional data.

The use of longitudinal data sets to analyze farmers' off-farm labor supply decisions in developed countries is still rare, although Sumner (1991) has pointed it out as one of the most useful extensions of the early literature.[1] Gould and Saupe (1989) and Weiss (1997) used two-period panel data sets to account for state dependence in off-farm labor participation decisions. Corsi and Findeis (2000) tried to distinguish between true state dependence and unobserved heterogeneity in a dynamic model of off-farm labor participation. Kimhi (2000) linked the decisions on off-farm participation and farm exit, while Weiss (1999) linked the decisions on off-farm participation and farm growth. All these studies have treated farm attributes as exogenous or at least pre-determined to the off-farm labor decision.

Phimister and Roberts (2002) used farm panel data to model farm input and output decisions as dependent upon off-farm labor participation of the farmer and his spouse in a dynamic setting. They considered the farmer's off-farm participation as endogenous but not the spouse's. The work of Ahituv and Kimhi (2002) is the first attempt, as far as we know, to treat farm attributes as endogenous in a farm-level analysis. They used a two-period panel data set to jointly analyze off-farm labor participation and level of farm capital stock. They found that off-farm work and farm capital are strongly correlated. In particular, the observable part of the model showed a strong negative dependence in both directions between these variables. However, unobserved heterogeneity seemed to point at a positive correlation, meaning that there seemed to be a group of "high ability" farmers who could concurrently participate in off-farm labor activities and maintain a capital-intensive farm enterprise.

This paper extends the empirical application of Ahituv and Kimhi (2002) in several dimensions. First, it analyzes a more recent panel data set, capturing a period (1981 to 1995) with more rapid farm structural changes in Israel. Second, it examines the interaction of work choices with the level of farm activity, rather than with capital stock. Capital investment represents expectations for future revenue, while farm production is also a function of land size, water rights, livestock inventories, and production efficiency. Thus, here we analyze how the size of the farm affects household labor, while Ahituv and Kimhi (2002) also examined if capital can replace labor. Third, we use data on work choices of all adult household members, rather than the head of household only. Accordingly, we also deal with non-employment. As in Ahituv and Kimhi (2002), we control for simultaneity between farm size and work choices, and allow for unobserved heterogeneity that affects both variables. However, we consider household-level heterogeneity, and do not control for within-household individual heterogeneity, as will be elaborated in the following sections.

3. Analytical Framework

In this section we present the analytical framework on which we base our empirical strategy. Each farmer is assumed to live through T periods. At the beginning of each period, he/she chooses one of three mutually exclusive work alternatives: (1) do not work; (2) work only on the farm; and (3) work also off the farm. The farmer chooses the work alternative that maximizes the expected present value of the stream of utility levels he/she attains during his/her lifetime. That is, the farmer chooses state k from the set J={1,2,3}, such that

$$V_{itk} = \max_{j \in J} \{V_{itj}\}, \qquad (1)$$

where V_{itj} denotes the expected lifetime value of individual i that chooses the j^{th} work alternative at age t. Note that if the farmer's decisions are governed by dynamic programming rules, the reward from each choice of work status has two implicit components: the present utility, and the option value of the human capital that is accumulated.

In addition to work choices, each farmer also decides on changes in the structure of the farm, and in this paper we specifically focus on farm size. Farm size is an outcome of past decisions such as capital investments, crop choice and specialization. These decisions determine the future levels of expected farm income and its variability, and also farm labor requirements. Note that farm size and labor decisions are mutually interlinked, and this why it is crucial to control for endogeneity. A larger farm requires more labor and hence reduces off-farm participation. On the other hand, increases in the size of the farm may be through labor-saving capital investments, and off-farm labor participation may affect farm operation decisions through wealth creation. All these decisions are clearly dependent over time. Farm decisions are likely to affect farm structure in the future through irreversible investments, while off-farm labor decisions affect future time allocation decisions through the accumulation of sector-specific human capital. The mutual dependence of all these decisions and their time dependence make it complicated to estimate the true effect.

4. Econometric Specification and Implementation

The solution to an individual farmer's optimization problem (1) is our primary dependent variable. Note that although the solution is deterministic for each farmer, it is probabilistic from our point of view, because we do not observe all the information that the farmer possesses. Given our focus on analyzing the interrelation between work experience (human capital) and the evolution in farm size, we adopt a linear "semi-reduced form" specification of the conditional valuation functions. For each individual *m* in household *i* in time *t*, the valuation function conditional on choosing *j* is specified as a linear function of pre-determined explanatory variables (*X*), the endogenous indicator for farm size (log of Gross Farm Product, *GFP*), an unobserved heterogeneity factor (μ), and an idiosyncratic error term:

$$V_{mitj} = X_{mit}\beta_j^x + GFP_{itj}\beta_j^G + \beta_j^\mu \mu_i + \varepsilon_{mitj} \quad , \mathrm{j} \in \{1,2,3\}. \tag{2}$$

The coefficients of these equations can be estimated using the multinomial probit model, under the necessary normalizations that all β_1's are zero. Our primary interest is in estimating $\beta^G{}_2$ and $\beta^G{}_3$, the effects of GFP on work decisions. This estimation is potentially subject to two related sources of bias, endogeneity and unobserved heterogeneity. Unobserved heterogeneity bias arises if variables that are not changing over time such as ability of family members, which influence GFP, are omitted from equation (2). Endogeneity bias arises if unobserved variables, such as idiosyncratic shocks to prices of specific farm inputs and products, influence the level of GFP and the likelihood to work on-farm at the same time. In both cases GFP will be correlated with the residual of equation (2), and thus the estimates of $\beta^G{}_2$ and $\beta^G{}_3$ will be inconsistent. We apply both Instrument Variable (IV) and Random Effect models to control for these two biases. It is well known that applying only one of the methods may enlarge (rather than reduce) the bias under some conditions on the correlation between GFP and the residual.[2]

The proxy for farm size (GFP) is approximated by a linear function of explanatory variables (Z), the unobserved heterogeneity factor (μ) and an error term, with coefficients that depend on the work choice j:

$$GFP_{itj} = Z_{it}\delta_j^x + \delta_j^\mu \mu_i + u_{itj} \quad , \ j \in \{1,2,3\}. \tag{3}$$

Equations (2) and (3) are estimated jointly with a multinomial probit and a switching regression model, respectively. Exclusion restrictions on X and Z are needed to assure identification. In particular, explanatory variables such as ethnic origin and family composition are excluded from the GFP equation, while village characteristics and crop choices are excluded from the work choice equations.[3]

The joint estimation of the model, using two time periods, is facilitated by assuming that the dependence between the error terms in different equations and in different time periods can be expressed by the common household-specific unobserved heterogeneity factor (μ). The different coefficients associated with μ, in each equation, allow a general correlation structure. As in Ahituv and Kimhi (2002), these random effects are assumed to have a simple discrete distribution and hence the points of support of these distributions and their associated probabilities are estimated jointly with the coefficients of all the equations in the model. Still, the random effects are assumed to be uncorrelated with the explanatory variables in each equation, and therefore correcting for the endogeneity of GFP in the work choice equations is crucial.

By controlling for unobserved heterogeneity, the model coefficients represent the "long run" effects of the explanatory variables. Alternatively, the model could have been estimated with the lagged dependent variables serving as additional explanatory variables. As state dependence is explicit in this model, the estimated coefficients represent "short run" effects of the explanatory variables. In this paper we present only the endogeneity and heterogeneity results.[4]

To conclude this section, note that work choices are taken at the individual level, while farm size and the unobserved heterogeneity are defined at the household level. This does not pose a problem for estimation since we maintain that the unobserved heterogeneity factor in (2) is also household-specific. In other words, we assume that the observed personal characteristics capture all within-household heterogeneity, leading to the optional interpretation of the β^G's as reflecting the demand of the farm enterprise to each of the household members' labor.

5. The Data

The data set used in this research is based on a country-wide farm survey that was conducted in Israel in 1995 (State of Israel, Central Bureau of Statistics). The survey encompassed a representative 10% sample of all family farms, and included approximately 3,000 family farms. About two thirds of the observations were from the Moshav (cooperative village) sector. These observations were matched according to farm identification numbers with earlier data from the 1981 Census of Agriculture, forming a panel. Note that despite the cooperative structure of the Moshav, these farms can be treated as private family farms for all practical purposes, so that on each Moshav farm, farmers make their own production and consumption decisions.

Matching was successful in about 1,700 farms. However, identifying individual family members in both 1981 and 1995 data sets was not always possible, either because of mortality or due to migration and changes in ownership. We also dropped farmers who were older than 65 or younger than 22 in any of the years. Altogether, the cases used in the empirical analysis included 4,021 observations on 2,347 individuals that were observed in at least one of the time periods. These individuals are from 1,115 farm families, where in each family at least one member is observed in both years. Hence, the sample is strongly biased towards families who operated the farm in both periods, as it does not include new entrants and those that sold their farm.

The questionnaires of the two data sources were fairly similar, and included detailed questions about farm production activities, as well as personal and family characteristics. Time allocation of each family member was recorded qualitatively. Here we only use a qualitative labor allocation indicator with three possibilities: not working, working only on the farm, and working off the farm.[5] We measure farm size by Gross Farm Product (GFP), which is defined alternatively as normative gross value added. To calculate GFP, the number of units of crop areas and numbers of livestock are multiplied by normative region-specific coefficients of per-unit gross value added. These coefficients are derived from special farm surveys and consultation with field experts.

The explanatory variables include personal characteristics, farm attributes and village characteristics. Personal characteristics include gender, age, country of birth, years of schooling, and family size and composition. In addition to farm size, farm attributes include land holdings and a set of binary indicators for the existence of major farm enterprises. Village characteristics include geographical region and year of establishment. Means of these variables, by off-farm work status in each of the time periods, are presented in Table 1. The table displays several regularities that motivate the subsequent empirical analysis. For example, farm size is larger on average, in each of the years, for individuals who work only on the farm. Moreover the only group that experienced an increase in farm size from 1981 to 1995 is the group including those working only on the farm, while the other two groups experienced a decrease in farm size. These two observations motivate our basic hypothesis that farm size and work choices are simultaneously determined.[6]

The table also shows that working only on the farm is more common in veteran and young villages as opposed to the majority of villages, which are middle-aged,[7] while working off the farm is more common in central regions. Males constitute 10%-15% of those who are not working and 60%-70% of those who are working either on or off the farm. This indicates that work choices differ considerably by gender. Country of origin is also important: individuals born in Asia or Africa are more likely not to work, while those born in Israel are more likely to work. The statistics on the farm enterprise dummies show 30%-50% reduction in the incidence of each enterprise except for cattle. This indicates that, on average, farms are much more specialized in 1995 than in 1981. These enterprises dummies serve as important instruments in our approach to find the true marginal effect of farm size on work choices.

Finally, the bottom row in Table 1 shows that between 1981 and 1995 there has been a trend away from full-time farming, mostly towards off-farm work but also towards non-employment. This trend can be explained at least in part by the overall trend away from full time farming in Israel that was discussed in the introductory section. It is more moderate, though, because our sample is over-representing continuing farm families, while the process of farm family replacement is responsible for most of this trend in the whole population. In addition, when we examine only family members who are observed in both years, there is virtually no change in the frequencies of the work choices. This means that even the moderate observed trend away from full-time farming is dominated by young entrants into the labor force, within the sample farm families.

6. Empirical results

We present the results of the empirical model in two parts. The multinomial probit results of the work choice equations are in Table 2, and the switching regression results of the farm size equations are in Table 3. Recall that the two parts are linked through the endogeneity of farm size and the work choices and through the common unobserved heterogeneity variable. The models were estimated using both 1981 and 1995 data, allowing for a different intercept in each time period. The distribution of the unobserved heterogeneity factor is assumed to have three points of support between zero and one, where the lower and upper points are normalized as zero and one, respectively. Hence, in addition to the coefficients of the equations, we estimate the intermediate point of support and the probability masses of the distribution of μ.

For comparison, we also present the results of estimating the "naïve" model without controlling for endogeneity and unobserved heterogeneity. We find that the effects of unobserved heterogeneity are statistically significant in all farm size equations and in the work only on farm equation. Overall, the hypothesis of no unobserved heterogeneity is strongly rejected (likelihood ratio statistic of 199 with 8 degrees of freedom), and the estimated coefficients are sometimes very different. Especially different are the coefficients of the endogenous explanatory variable GFP in the work choice equations (Table 2). The GFP coefficient in the work only on-farm equation doubles in magnitude after correcting for endogeneity and heterogeneity, while the coefficient in the work also off-farm equation becomes negative and statistically significant.

6.A. Work choice

Farm size, as measured by GFP, has a strong positive effect on the tendency to work only on the farm and a negative effect on the tendency to work off the farm (Table 2). As those who work only on-farm have larger farms on average in both 1981 and 1995 (Table 1), this implies persistence of work choices over time. Note that the GFP coefficients in the naive model are biased towards zero (see Appendix figures A1 and A2 for graphical illustration). This means that without correcting for endogeneity and heterogeneity, one may conclude that farm size is not very important for work decisions. Obviously, it is impossible to discern which of the two, endogeneity or heterogeneity, generates the above bias. It could be, for example, that unobserved farmer's ability affects both farm size and labor decisions, but it could also be that certain shocks (such as temporary price or policy changes) affect both decisions.

Looking at the coefficients of the 1995 dummy in Table 2, we find that holding everything else constant, the likelihood of working only on the farm has decreased significantly from 1981 to 1995, while the likelihood of working off the farm has not changed significantly. Note that the coefficient in the work only on-farm equation becomes four times larger in magnitude after controlling for endogeneity and heterogeneity. This suggests that the farmers in our sample over invested in farm-specific human and physical capital (because of subsidies in the 70's), and that's why they keep on working on the farm against the overall trend, while they would have been better off working off farm otherwise.

The number of adults has a significantly negative effect on the likelihood of working only on the farm, and a smaller negative effect on the likelihood of working off the farm. This is consistent with the conclusions of Kimhi (1996), that other adults substitute for the labor supply of the farm couple in both farm and off-farm work. The number of adults in the average household has increased from 1981 to 1995 (Table 1), so this change works in the same direction as the intercept, namely towards an increased likelihood of not working. Being born in Asia or Africa has a significantly negative effect on the likelihood of working only on the farm, and a larger negative effect on the likelihood of working off the farm. The fraction of those born in Asia or Africa has decreased from 1981 to 1995, so this change helps to explain the observed trend.

The effect of age is to increase the likelihood of working at younger ages and to increase it at older ages. The age in which the maximum likelihood to work occurs is, according to the estimated coefficients of age and age squared, is 47 years for on-farm work only and 42 years for off-farm work. The population has naturally become older from 1981 to 1995, but the mean age is still below these thresholds (Table 1). Hence, the effect of the change in population age was to increase farm and off-farm participation, contributing to the observed trend. Schooling has a positive effect on the tendency to work off the farm, implying that general human capital is more productive in off-farm employment than in farm work (Jollife 2004). Schooling has increased somewhat between 1981 and 1995, hence this contributed to increase participation in off-farm work. Land has a negative effect on the tendency to work off the farm, and this is quite obvious.[8]

Interestingly, land holdings reduce both on-farm and off-farm work, holding the level of farm activity fixed. This counter-intuitive result with respect to the effect on work only on-farm is obtained only after controlling for endogeneity and heterogeneity. The results also show that males are much more likely than females to work either on or of the farm, but the fraction of males in the sample remained roughly the same throughout the period, so this does not help explain the observed changes in the work tendencies. Altogether, the overall trend of reduced on-farm work can be explained by the decrease in the fraction of the population born in Asia or Africa, the increase in age and schooling, and the decrease in the level of farm activity.

6.B. Farm size

The GFP equations are essential as a first-stage in a 2SLS estimation of work choices. The results (Table 3) show an increase in GFP from 1981 to 1995 for farmers who work only on the farm and a decrease in GFP for farmers working also off the farm, all else equal. This demonstrates again that despite the fact that in the aggregate we observe parallel increases in the level of farm activity and in the tendency to work off the farm, at the micro level these two decisions go in the opposite directions. This also shows up in the age effects, which go in the opposite directions. Up to age 47, GFP increases for farmers working only on the farm and decreases for farmers working off the farm, while the opposite occurs after age 47.

Schooling decreases GFP, but the effect is marginally significant only for farmers who are working off the farm. Land holdings increase GFP for all farms, especially for those working only on-farm. We also observe regional patterns, with larger farms in the north of the country and smaller farms in the south. Farms seem to be larger in veteran villages, but only for farmers who work only on-farm. GFP also depends significantly on the crop portfolio. Diversifying into additional crops or livestock leads to an increase in the level of farm activity. The strongest effects are of cattle and flowers. The effects are smaller in the on-farm only equation, implying that full-time farmers tend to increase farm activity by expanding existing farm branches more than part-time farmers.

6.C. Simulation

We have simulated the work-choice probabilities and GFP for each (unobserved) farm type using the estimated coefficients, and the results are illustrated in Figures 3 and 4, respectively. In all simulations, we have taken the average observation in the whole sample, and only changed the value of the heterogeneity variable.

In figure 3, we observe that "type 1" farmers are much more likely to work only on the farm and less likely to work off the farm than "type 3" farmers, while "type 2" farmers are in between. Between 1981 and 1995, all three types of farmers become more likely to work off the farm and less likely to work only on the farm. Figure 4 shows that "type 1" (μ=0) farmers are expected to have smaller farms while "type 3" (μ=1) farmers are expected to have larger farms, conditional on their work choice. In 1981, GFP does not depend much on the work choices within types, while in 1995 GFP is considerably larger for farmers in all farm types who work only on-farm. In addition, we observe that GFP of those who work only on farm increased from 1981 to 1995, while GFP of those who are either working off the farm or not working at all has decreased, for all types of farms.

As in Ahituv and Kimhi (2002), we conclude that unobserved heterogeneity results in a positive association between off-farm work and the level of farm activity, opposite to the association due to observed characteristics. In other words, "type 1" farmers operate smaller farms and have lower access to the of-farm labor market, while "type 3" farmers are able to operate a large farm enterprise and still engage in off-farm employment.

The time trends identified in Figures 3 and 4 imply that there is a differentiation process that evolves over time and creates a bimodal farm distribution, with large farms operated by farmers who work only on the farm and smaller farms operated by farmers who work off the farm. While this conclusion is not different from what we saw in the raw data

(Table 1), our results show that it is unobserved heterogeneity, rather than observed attributes alone, that are taking a central role in this differentiation process.

7. Summary and Conclusions

The level of farm activity and off-farm employment are two important life-cycle decisions made by self-employed farm operator households. In this paper we perform an empirical analysis of these decisions and their simultaneous determination and evolution over time. Using panel data from Israel for the years 1981 and 1995, we estimate a model consisting of two parts: a multinomial choice model of work decisions (not working, working only on the farm, and working also off the farm) and an endogenous switching regression model of the level of farm activity. The two parts of the model are linked in several ways: log of Gross Farm Product (GFP) serves as an endogenous explanatory variable in the work choice equations, the endogenous work choice determines the switching regime of GFP, and a common factor of unobserved heterogeneity that affects both decisions. The results help to explain the dynamic process by which technological progress, changes in market conditions, and urbanization pressures lead to fewer and larger farms that rely less on family labor input and allow the farm population to rely more heavily on the off-farm labor market.

Our results show that as opposed to the overall trend, the level of farm activity has decreased, on average, among farms that remained in business throughout the study period, which means that the process of entry and exit of farms drive much of the observed increase in average farm size. At the same time, the tendency of farm household members to engage in off-farm work has increased. However, this increased tendency was not automatic. In particular, our results identify two opposite trends of farm family adjustment. On one hand, there are farms that increase the scale of their farming operation over the years, and have a lower likelihood of working off the farm. Naturally, without farm expansion, this likelihood would have risen for these farms. On the other hand, there are farms that downsize their farming operation and increase their engagement in the off-farm labor market. Therefore, it seems like the distribution of farms in Israel is converging towards a bi-modal distribution, with large farms operated by full-time farmers on one extreme and smaller part-time farms on the other extreme, whose operators derive most of their income from off-farm sources. This is similar to what Weiss (1999) found in Austria.

We conclude that behind the overall trend, which is observed throughout most of the developed world, of increasing farm size and increasing engagement in off-farm activities, there is a complex dynamic process at the micro level that may behave very differently in different circumstances. For Israel, we found that changes in the level of farm activity are negatively related to off-farm labor participation, opposite to the observed macro trend. For future empirical work, our findings imply that the dynamics of the off-farm labor decisions in farm households should be analyzed jointly with the farm size decision. Also, we found that unobserved heterogeneity was responsible for an important part of the dynamic process in Israel, and implies persistence in both decisions. Finally, future research should study this dynamic process jointly with the entry and exit decisions. Our analysis was limited by the availability of data, but the results suggest that there is an important role for these decisions in the structural change process in family farms.

Appendix A: Illustration of Bias towards Zero of GFP Coefficients in the Naïve Model

The bias towards zero is illustrated separately for each of the two labor choice equations, based on the estimated coefficients. In particular, the illustration takes as given that the true effect of GFP is positive in the "work on-farm only equation" and negative in the "work also off-farm" equation, that μ=1 farmers are less likely to work only on-farm and more likely to work also off-farm than μ=0 farmers, and that μ=1 farms are larger (have higher GFP) that μ=0 farms. Each unbroken line in figures A1 and A2 shows the true effect of GFP on indirect utility conditional on working only on-farm and working also off-farm, respectively. Dashed lines show estimated effects if unobserved heterogeneity is ignored, and the points A and B represent data points.

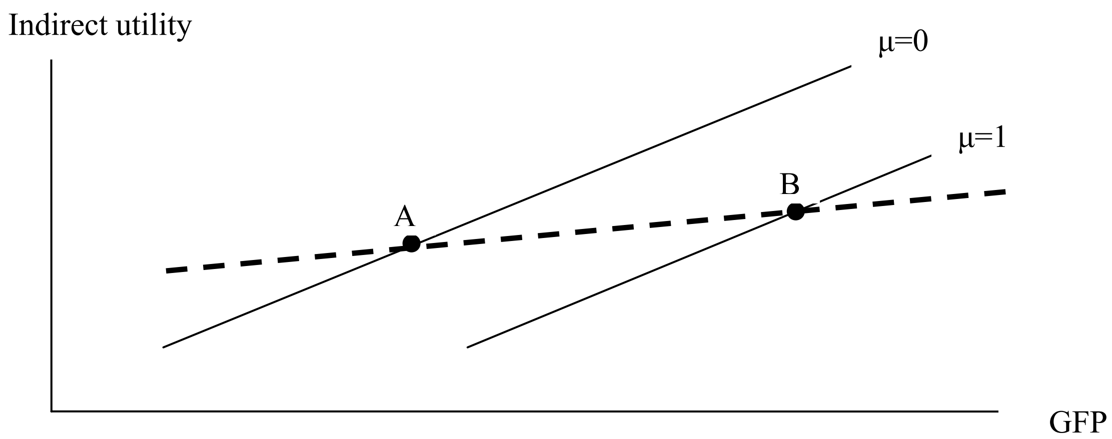

Figure A1. Work on-farm only

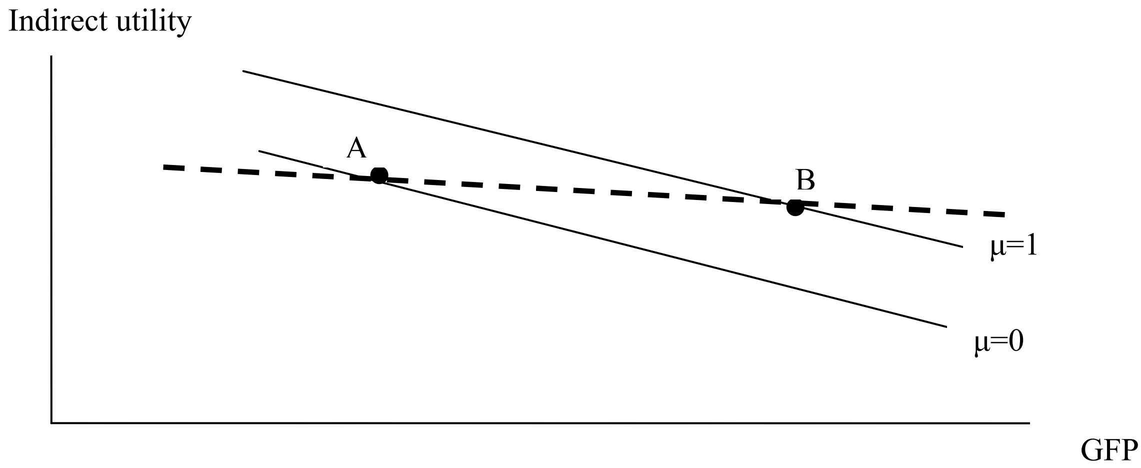

Figure A2. Work also off-farm

Notes

[1] However, many more such applications for developing countries appear in the literature, for example Skoufias (1996).

[2] Glick and Sahn (2005) estimated a multinomial logit random effects version of a similar model.

[3] In essence, we assume that the latter affect work choices only indirectly through GFP.

[4] Hyslop (1999), Phimister, Vera-Toscano and Weersink (2002), Lee and Tae (2005) and others accounted for both heterogeneity and state dependence in dynamic labor participation models. We cannot do it here because a two-period panel is insufficient.

[5] Off-farm work includes work on non-agricultural enterprises located on the farm. Initially, we had another category of those who worked both on and off the farm, but their number was too small to generate meaningful results, hence they were merged with those working only off the farm. Those who are not working are naturally engaged in household activities.

[6] In the whole sample, average farm size has decreased somewhat, despite our previous remark that farms in Israel have increased on average. This is because our sample includes only farms that survived from 1981 to 1995 and is therefore not representative for the farm population at large.

[7] Veteran villages are those established prior to statehood in 1948, while young villages are those established after 1967.

[8] Note, however, that this effect becomes statistically significant only after controlling for unobserved heterogeneity.

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Table 1: Mean Characteristics of Farm Population by Work Status, 1981 and 1995

	Not working		Working only On-farm		Working also off-farm	
Variables	1981	1995	1981	1995	1981	1995
Village attributes						
Veteran village	0.11	0.12	0.23	0.21	0.16	0.14
Middle-age village	0.86	0.87	0.71	0.73	0.80	0.81
Young village	0.03	0.02	0.06	0.07	0.04	0.05
Location: North	0.33	0.27	0.31	0.33	0.28	0.26
Location: Center	0.39	0.41	0.48	0.46	0.53	0.53
Location: South	0.28	0.33	0.21	0.21	0.19	0.21
Personal characteristics						
No. of adults	2.72	3.83	2.44	3.63	2.43	3.61
No. of children	2.06	1.20	1.79	1.22	1.90	1.37
Male dummy	0.11	0.21	0.65	0.69	0.62	0.57
Born in Israel	0.37	0.46	0.45	0.57	0.45	0.62
Born in Africa/Asia	0.53	0.46	0.38	0.32	0.39	0.29
Age	38.99	48.20	40.14	48.24	37.80	43.80
Schooling (years)	10.05	11.47	10.39	11.81	11.31	11.83
Farm characteristics						
Land (dunam=0.25 acre)	30.22	32.39	34.97	36.78	26.06	30.67
GFP	4.94	3.64	5.48	6.23	4.72	3.64
Farm enterprise dummies:						
Fruits	0.57	0.33	0.67	0.45	0.57	0.39
Vegetables	0.33	0.17	0.40	0.26	0.26	0.10
Field crops	0.31	0.15	0.37	0.24	0.27	0.13
Flowers	0.20	0.11	0.43	0.37	0.20	0.13
Poultry	0.34	0.21	0.37	0.26	0.36	0.26
Cattle	0.19	0.15	0.27	0.27	0.12	0.13
No. of observations	418	446	954	867	627	709
% of annual observations	20.9%	22.1%	47.7%	42.9%	31.4%	35.1%

Table 2: Coefficient Estimates for Work Choice Equations

	Naive model		Endogenous-Heterogeneous	
Variable	Work only on-farm	Work also off-farm	Work only on-farm	Work also off-farm
Constant	-4.9065***	-3.4991***	-5.1038***	-3.3961***
	(0.4852)	(0.4824)	(0.4600)	(0.4957)
1995 dummy	-0.1863**	0.0253	-0.7357***	-0.0536
	(0.0852)	(0.0828)	(0.0946)	(0.0848)
GFP	0.4438***	0.0070	0.9037***	-0.0539**
	(0.0349)	(0.0238)	(0.0627)	(0.0237)
No. of adults	-0.1488***	-0.0740***	-0.1368***	-0.0654**
	(0.0206)	(0.0193)	(0.0209)	(0.0191)
No. of children	-0.0224	-0.0233	-0.0220	-0.0257
	(0.0191)	(0.0189)	(0.0196)	(0.0189)
Born in Israel	-0.0708	-0.1370	-0.0326	-0.1344
	(0.0938)	(0.0909)	(0.0976)	(0.0925)
Born in Asia/Africa	-0.3178**	-0.4293***	-0.2396**	-0.4654***
	(0.0903)	(0.0895)	(0.0945)	(0.0909)
Age	0.1396***	0.1777***	0.1126***	0.1841***
	(0.0215)	(0.0216)	(0.0217)	(0.0222)
Age squared	-0.0015***	-0.0022***	-0.0012***	-0.0022***
	(0.0002)	(0.0003)	(0.0002)	(0.0003)
Schooling (years)	0.0146	0.0491***	0.0132	0.0497***
	(0.0097)	(0.0093)	(0.0105)	(0.0096)
Land	-0.0020	-0.0048**	-0.0063***	-0.0032**
	(0.0016)	(0.0015)	(0.0017)	(0.0014)
Male dummy	1.4400***	1.1261***	1.3952***	1.1090***
	(0.0637)	(0.0605)	(0.0659)	(0.0596)
α^v (factor loading)			-1.6291***	0.0473
			(0.2605)	(0.1527)
Support point ($0<\mu^*<1$)			0.6975***	
Probability mass (μ=0)			0.0545***	
Probability mass (μ^*=.7)			0.4039***	
Probability mass (μ=1)			0.5417***	
No. of observations	4,021		4,021	
No. of households	1,115		1,115	
No. of parameters	75		83	
Log likelihood	-9,201		-9,102	

Notes: Standard deviations are in parentheses. * p<0.10; ** p<0.05; *** p<0.01. The factor loading corresponds to the coefficient on the unobserved heterogeneity. A three-point heterogeneity distribution is fitted.

Table 3: Coefficient Estimates for GFP Equations

Variable	Naive model			Endogenous-Heterogeneous		
	Not working	Working only on-farm	Working also off-farm	Not working	Working only on-farm	Working also off-farm
Constant	2.4123**	3.5465***	3.4036***	0.6131	0.7965**	1.9270**
	(0.8221)	(0.2909)	(0.6987)	(0.8141)	(0.2362)	(0.6562)
Veteran Village	-0.2690	0.0864**	-0.2624**	0.0054	0.1773***	0.0303
	(0.1867)	(0.0389)	(0.1007)	(0.2135)	(0.0416)	(0.1108)
Young Village	0.0102	0.0195	0.2109	0.0693	0.0428	0.1971
	(0.4121)	(0.0684)	(0.2580)	(0.4256)	(0.0785)	(0.2385)
Location : North	0.6195***	0.0409	0.6295***	0.5843***	0.1618***	0.6575***
	(0.1455)	(0.0402)	(0.1044)	(0.1508)	(0.0416)	(0.1121)
Location : South	-0.3681**	-0.2975***	-0.4059**	-0.3438**	-0.2226***	-0.3867**
	(0.1300)	(0.0415)	(0.1180)	(0.1272)	(0.0418)	(0.1169)
Age	0.0150	0.0558***	-0.0472	0.0112	0.0474***	-0.0570*
	(0.0372)	(0.0133)	(0.0335)	(0.0343)	(0.0100)	(0.0295)
Age Squared	-0.0003	-0.0007***	0.0005	-0.0003	-0.0005***	0.0006*
	(0.0004)	(0.0001)	(0.0004)	(0.0004)	(0.0001)	(0.0003)
Schooling (years)	-0.0228	0.0078	-0.0197	-0.0194	-0.0029	-0.0302*
	(0.0172)	(0.0066)	(0.0162)	(0.0165)	(0.0059)	(0.0153)
Land	0.0089**	0.0112***	0.0119***	0.0070**	0.0101***	0.0070**
	(0.0029)	(0.0007)	(0.0024)	(0.0029)	(0.0007)	(0.0024)
1995 dummy	-0.1841	0.7714***	-0.3205**	-0.1742	0.7830***	-0.3244**
	(0.1589)	(0.0412)	(0.1208)	(0.1500)	(0.0303)	(0.1154)
Fruits	1.2870***	-0.0364	1.3753***	1.1416***	0.0723**	1.3136***
	(0.1418)	(0.0325)	(0.0914)	(0.1391)	(0.0287)	(0.0950)
Vegetables	1.3991***	0.0668*	1.0513***	1.4142***	0.2506***	1.2031***
	(0.1309)	(0.0346)	(0.1060)	(0.1318)	(0.0301)	(0.1082)
Field Crops	-0.0409	-0.0384	0.3813**	0.0961	-0.0227	0.3789**
	(0.1841)	(0.0463)	(0.1506)	(0.1882)	(0.0397)	(0.1438)
Flowers	1.7563***	0.5357***	1.8431***	1.5944***	0.7749***	1.8322***
	(0.1503)	(0.0311)	(0.1068)	(0.1445)	(0.0319)	(0.1090)
Poultry	1.2142***	0.1301**	1.4706***	1.0629***	0.1356***	1.2868***
	(0.1607)	(0.0355)	(0.1096)	(0.1604)	(0.0332)	(0.1096)
Cattle	2.4077***	0.5866***	1.7122***	2.1054***	0.6493***	1.6144***
	(0.1906)	(0.0437)	(0.1604)	(0.1970)	(0.0421)	(0.1603)
α^y (factor loading)				2.5611***	2.8245***	2.5814***
				(0.3010)	(0.0806)	(0.2108)
S^2_w	2.1506***	0.5127***	2.2047***	1.7604***	0.3214***	1.7710***
	(0.1391)	(0.0116)	(0.1060)	(0.1134)	(0.0118)	(0.0885)

Notes: Standard deviations are in parentheses. * p<0.10; ** p<0.05; *** p<0.01. The factor loading corresponds to the coefficient on the unobserved heterogeneity. A three-point heterogeneity distribution is fitted.

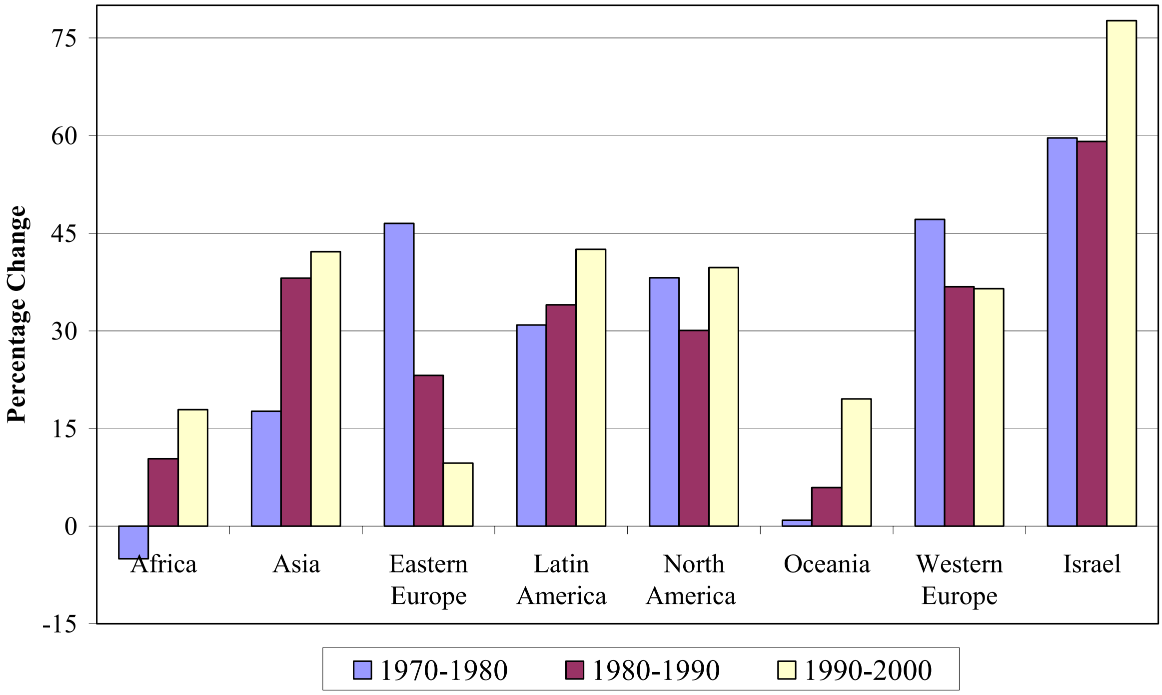

Figure 1. Changes in Agricultural Production Relative to Agricultural Population

Source: FAO Web Site (2004), Statistical Abstract of Israel (various years).

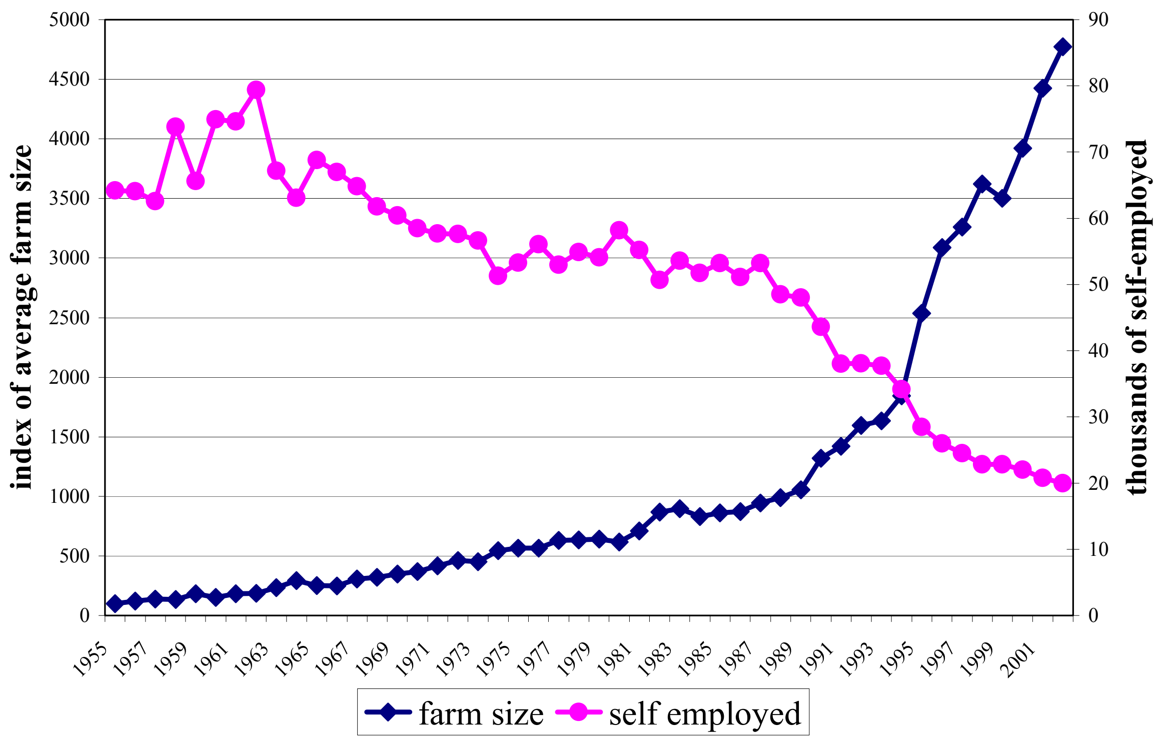

Figure 2. Average Farm Size and the Number of Self Employed in Israeli Agriculture

Source: Kislev and Vaxin (2003) and Kimhi (2004).

Figure 3. Predicted Probabilities of Work Choices

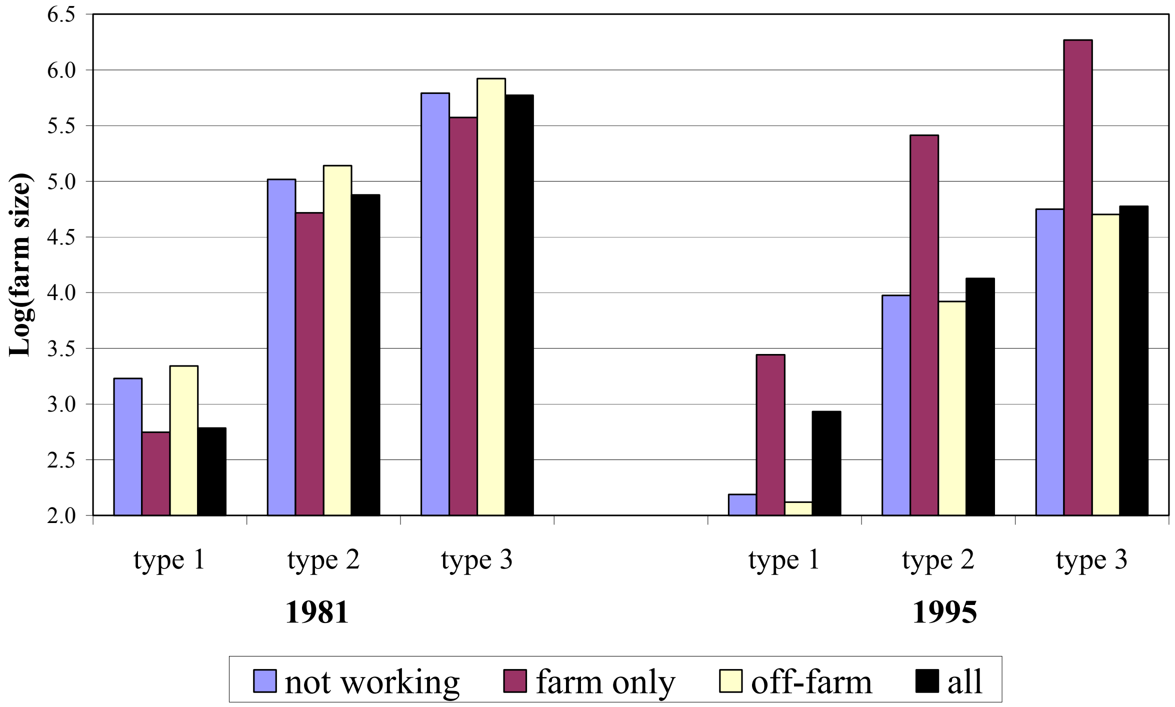

Figure 4. Predicted Values of Farm Size (GFP)

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