Agricultural Household Model with Wage Uncertainty: An Application to Subsidiary Post-Soviet Agriculture

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Abstract

The labor supply decision under wage uncertainty is studied in the context of an agricultural household model. The recent sharp growth of post-Soviet subsidiary subsistence agriculture is consistent with the model predictions of an increase in farm labor supply in response to the fall and uncertainty in real wage.

1. Introduction

Subsidiary private agriculture has grown sharply in many post-Soviet countries since the beginning of economic reforms in the early 1990s. It represented nearly a half of gross agricultural output in Russia and Ukraine by 1997, up from approximately a quarter of gross agricultural output in the Soviet Union in 1990. However, in contrast, the share of gross agricultural land under the subsidiary plots increased from approximately 8 percent to only 12-15 percent.

Private subsistence agriculture always coexisted with collectivized agriculture in the former Soviet Union. Both rural and urban households worked relatively small plots of land for supplementary food and income. Although the land remained state property, the rights to work plots were inheritable and plot output belonged to producers. The producer households mostly consumed the production with any surplus sold either at farmers' markets or through state channels. This study seeks to show theoretically that the growth of subsidiary subsistence farming is consistent with another phenomenon of transitional economies: falling and uncertain real wages.

According to official statistics, real wage declined more than five times from 1990 to 1994. In 1995, 70 percent of Ukraine's population lived on an official salary received from state organizations. Wage arrears and deferments in government-provided social benefits lasting for several months became systematic in Ukraine and Russia.

Remuneration of collectivist farm workers has become uncertain as well. Even though the price of the collectivist farm output was fixed by a state order, uncertainty on whether wages would be paid in time, the inflation rate, adjustment for inflation in the output price, and timely payment for the output remain.

Intuitively, when an individual has two sources of income, wage work and subsidiary farming, uncertainty in the wage should force risk averse agents to increase their effort in the relatively safe income-generating activity, subsidiary household production. Therefore, at least a part of the growth in subsidiary agriculture productivity may be explained by the declining probability of timely payment of wages that causes increased supply of labor to the subsidiary farming. Below we discuss some theoretical foundations for this conjecture.

The uncertainty of income in the post-soviet economies due to political and structural changes raises a research question that has received little attention in the literature: the effect of wage uncertainty on agricultural labor supply. One of the objectives of the study is to fill this gap. The other objective of the study is to examine the growth of subsidiary agriculture in terms of response to a decline in real wages, uncertainty in wage income, and an increased availability of land for subsidiary production.

The paper is organized as follows. The next section provides background to the role of subsidiary household plots in post-Soviet economies. Changes in wages are discussed in Section 3. A theoretical model and results are presented in Section 4. Finally, Section 5 offers some concluding comments.

2. Role of subsidiary household plots (SHP) in Post-Soviet countries

The private sector of Ukrainian agriculture consists of the SHP of collectivist farm employees, garden and vegetable plots of urban citizens, and officially registered private family farms. The difference between the officially registered private family farms and the rest of the private sector is that the latter are worked part-time by people otherwise employed somewhere else or by those previously employed and now retired. The officially registered

private farmers, in contrast, operate their farms full-time (Schmelev).

Specialization and size reflect the differences. The average Ukrainian private farm was 23.6 hectares in 1997 (SCSU), while the average SHP was 0.5 hectares (Csaki and Lerman). Being smaller, the SHPs produce predominantly fruits, vegetables, and livestock products; much of the production is for subsistence. The large private farms specialize in grains, sugar beets, and sunflower production (Csaki and Lerman).

In 1991, private household plot production occupied 10 percent of the Ukrainian agricultural land, and contributed 26 percent of total crop production and 34 percent to total livestock production. By 1996, the shares grew to 14, 49, and 56 percent respectively. The household plots accounted for 95 percent of the country's potato production, 82 percent of total vegetable production, and 74 percent of Ukrainian fruit crop in 1996 (SCSU).

The degree of citizen's involvement in household plot production is large for such an industrialized country as Ukraine. Estimates from the International Labor Office (ILO) indicate that in 1993, every second urban family worked a household plot (6.8 million private plots in total). Surveys in Russia reveal similar trends. According to a USIA-sponsored survey of 2,000 residents of the Russian Federation, some 55 percent of Russians grow a half or more of their food on private plots (Goble). These numbers reflect the under-development of both labor and food markets as labor has no better opportunities than to work land to secure subsistent levels of food consumption.

Household plot production is an important *source of cash income* for Ukrainians (Johnson, Kauffman, and Ustemko; Perotta (1999a); Brainerd). Family Budget Surveys show that 28 to 30 percent of the collective farm workers families' income came from subsidiary plot production in 1980-1990 years (Ministry of Statistics of the Ukrainian SSR).

These numbers might be under-estimated due to valuing all of the consumed SHP production at state prices as opposed to valuing the marketed SHP production at the actual sale prices. According to World Bank conducted surveys, the sales from household plots provided 20 percent of total cash income of average collectivist farm worker families in 1996 (Csaki and Lerman). In 1998, some 66 percent of rural residents derived cash income from subsidiary farming, with an average 58 percent of total income coming from this activity (Perotta, 1999b). Lazarenko and Zvihlianych report that the number of individuals cultivating individual plots for income has increased by 500,000 annually since 1990.

The cash income share does not capture the much larger importance of the plots *as a source of food*. Recent World Bank surveys (1993/94 and 1995/96) indicate that about 90 percent of rural families identify the household plot as a channel of food supply (Csaki and Lerman). In sum, the sector of private household plots plays a prominent role in both providing income and also supplying agricultural products in Ukraine in the transition period.

3. Wages

Real have wages declined rapidly in all sectors of the economy since the beginning of reforms in the early 1990s. In 1996, the real average wage accrued in agriculture was merely 27 percent of that in 1991 (SCSU) and, even worse, these wages were often delayed. According to official Ukrainian statistics, virtually all of the 3 million employees of collectivist farms were affected by wage arrears at the end of 1998 with an average delay in wage payments of 7.6 months per employee (Ministry of Agricultural Production Complex of Ukraine). (See Figure 1.) Farm-level surveys provide similar data: Perotta (1999b) found that none of the 959 respondents of a survey of Ukrainian farm employees enjoyed timely

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paid wages. Some 47 percent of the respondents were not paid more than six months of wages at the end of 1998, and 13 percent have not been paid cash wages for two years and more. Not surprisingly, the sale of surplus from subsidiary farming was often claimed to be the main or only source of cash for rural residents in this survey.

4. Model

We study the labor supply decision of a collective farm household that involves the decision about allocation of the time between the collective farm work, subsidiary farming, and leisure. The agricultural household model (AHM), as presented, for example, in Singh, Squire, and Strauss, has been used extensively to study economic behavior of peasant households, where the latter are defined as those facing both consumption and agricultural production decisions. The institution of collective farming imposes two constraints in a generic AHM. Firstly, households can sell labor to the collective farm, but can not hire any labor for the SHP. Secondly, households must sell some of their labor to the collective farm in order to have the right to work the subsidiary plot. With these constraints, an AHM applied to collective farming in the (post-) Soviet economy stands in between the basic AHM and the AHM with completely absent labor markets discussed by Strauss.

The AHM-type models of collective farms have been applied predominantly in deterministic settings (Bradley (1971), Cameron (1973a), Ireland and Law, Chandler, Sincular). The model predicts that *ceteris paribus*, an increase in subsidiary plot causes a decline in both total and wage labor supplies, and an increase in the SHP labor supply (Chandler). A decrease in wage increases subsidiary plot labor supply (Chandler). Consequently, increased land availability for subsidiary plots and declining real wages are

consistent with the recent relative growth of subsidiary farming in post-Soviet countries. Here, we extend the agricultural household model to collective farming in the wage uncertainty setting.

Model set up

An individual (household) maximizes expected utility subject to a budget constraint. The individual derives utility from consumption of *leisure* and *food*. The food can either be produced at the subsidiary household plot (SHP) or bought in the market at a certain price. Household income comes from wage work and sales of the SHP production. The wage income is uncertain as the hourly wage has a non-degenerate distribution. The individual has a choice between off-SHP work for a wage, SHP work, and leisure. The time allocation is decided *ex ante*, while consumption of the food is decided after the uncertainty in wage is realized. The individual is risk averse in food gambles.

The household is assumed to maximize expected utility $E[U]$ subject to a total time constraint, $l + h^c + h^p = T$, to a budget constraint $x = Wh^c + f(h^p, m)$, to the constraint of no labor from outside of the household, $h^p > 0$, and to the mandatory collective farm work constraint $h^c > 0$. Here x denotes food consumption; l is leisure consumption in hours; $U(x, l)$ is the agent's utility function; $f(h^p, m)$ is the SHP production function; W is the random hourly wage rate measured in units of food per hour; m is the size of subsidiary plot land; h^c is the time spent working for the wage in hours; h^p is the time spent working in the SHP in hours; and T denotes total hours available to the agent. We use the notation g_i, g_{ij} for a partial derivative of the function g with respect to the *i-th* argument, and a second partial derivative of g with respect to the *i-th* and *j-th* arguments respectively, *i, j = 1,2* ; $g = U, f$.

With the expressions for x and l derived from the constraints, the agent's problem becomes:

$$\max_{T>h^p\geq 0,\, T\geq h^c>0,\, T-h^p-h^c\geq 0} E\left[U\left(Wh^c + f(h^p,m)\,,\, T-h^p-h^c\right)\right] \qquad (1)$$

with assumptions

(A.1) $U_1 > 0, \quad U_2 > 0$;

(A.2) $U_{11} < 0$;

(A.3) $f_1 > 0, \quad f_{11} < 0$.

The first set of assumptions, (A.1), ensures that marginal utility is positive everywhere over the set of relevant consumption bundles, i.e. the agent is not satiated with the consumption of food and leisure. Inequality (A.2) formalizes risk aversion in food gambles. Assumptions (A.3) means that the SHP production function displays positive decreasing marginal product of labor over a relevant range of inputs.

To determine the impact of risk on the agent's decisions, we compare the solution to problem (1) to the agent's choices in the case when the random wage W is set identically to its mean. The certainty counterpart of problem (1) is

$$\max_{T>h^p\geq 0,\, T\geq h^c>0,\, T-h^p-h^c\geq 0} U\left(E[W]h^c + f(h^p,m)\,,\, T-h^p-h^c\right). \qquad (1\text{-}c)$$

We will call a solution $(h^p,\, h^c)$ to (1) or (1-c) an interior solution, if the optimizing values of h^c and h^p are both positive.

Throughout our analysis, we consider interior solutions only. That means that neither the option of quitting the wage job, nor the option of quitting the SHP farming is considered. While these seem to be strong assumptions, they are supported to some extent by the results

of earlier surveys. The results reported by ILO; SCSU; Csaki and Lerman; and Perotta (1998)

show that quitting SHP farming is not an option for most households. However, the question

of quitting wage work to concentrate on farming alone is a subtler one.

The model we consider is applied to both city dwellers and rural residents possessing

subsidiary household plots. Several studies found that both the unfavorable social image of

farm work and the perceived transitory nature of uncertainties with wages preclude many city

workers from quitting the wage jobs to start farming. In addition, relatively little agricultural

experience might also contribute to an unwillingness to become a private farmer.

As for rural residents, quitting wage work while keeping the SHP was legally

impossible up to the early 1990s. Nowadays, with adoption of new land laws, quitting the

wage work means breaking the ties with a collectivist farm that provides their wages and

becoming a new legal entity, a private farmer. It is a common knowledge (see, for example,

Maggs, Rumer, Perotta (1999b); Bonanno et al.) that in addition to the wages, the collective

farms supplied their workers with payments in kind and subsidized inputs to their subsidiar

plot production.

In this study, we treat these fringe benefits as a part of the hourly wage and implicitly

assume that after taking into account these benefits, the expected wage is higher than the

marginal product of labor in the SHP production. In addition, leaving the collectivist farm is

difficult because of poorly specified leaving procedures, under-developed farming

infrastructure, high production risks due to under-developed input markets, and insufficient

business experience for the most of the dwellers (Csaki and Lerman; Perotta (1999a)). For

these reasons, we focus only on *redistribution of effort* between wage job and subsidiary

farming due to uncertainty. Modeling quitting the collective farm to establish a private farm

is beyond the scope of our study.

Proposition 1

Let the assumptions (A.1) - (A.3) hold. Let (h^{p*}, h^{c*}) and (h^{p**}, h^{c**}) be interior solutions to (1) and (1-c) respectively. Then $h^{p*} > h^{p**}$.

Proof of Proposition 1

The solution to (1) satisfies the following first-order necessary conditions:

$$\frac{\partial E[U]}{\partial h^p} = E[U_1 f_1 - U_2] = 0 \tag{2}$$

$$\frac{\partial E[U]}{\partial h^c} = E[U_1 W - U_2] = 0 \tag{3}$$

Subtracting (3) from (2), we get

$$f_1(h^{p*}, m) = E[W] - \frac{Cov\left[U_1\left(Wh^c + f(h^p, m), T - h^p - h^c\right), f_1 - W\right]}{E[U_1]} \tag{4}$$

The covariance term in (4) is positive, because

$$\frac{\partial U_1\left(Wh^c + f\right)}{\partial W} = U_{11} h^c < 0 \text{ by the assumption (A.2), and } \frac{\partial(f_1 - W)}{\partial W} = -1 < 0.$$

Consequently, (4) implies

$$f_1(h^{p*}, m) < E[W] \tag{5}$$

If the wage W were fixed at its mean, the first order conditions for utility maximization would imply equality in (5) instead of the inequality, i.e. $f_1(h^{p*}, m) < E[W] = f_1(h^{p**}, m)$.

Since $f_{11} < 0$ (assumption (A.3)), the statement of the proposition follows.

The proven result is very intuitive: uncertainty in off-SHP wage forces a risk averse agent to shift towards the certain source of income, SHP production. The uncertainty reduces

the mean wage in terms of behavioral actions: the agent responds to the risk as if the wage were below its mean.

Note that implicit in Proposition 1 are some additional assumptions about preferences. The existence of the interior solution for the problem (1-c) implies that the utility function is concave in the neighborhood of the solution. The next proposition imposes more restrictions on the utility function and on the structure of randomness in W to provide a stronger statement about the impact of wage uncertainty on labor supply.

More Assumptions

(A.4) $\qquad U_{11} < 0, \quad U_{22} < 0, \quad U_{11}U_{22} > U_{12}^2, \quad U_{12} \geq 0$

Assumption (A.4) ensures that the utility function is strictly concave. The last inequality in (A.4) means that incremental utility derived from an additional unit of leisure increases with the amount of food, and that incremental utility derived from an additional unit of food increases with leisure. This assumption is not overly restrictive, as, for example, any CES utility function satisfies it.

Proposition 2

Let the assumptions (A.1) – (A.4) hold.

Let W be a discrete random variable with a probability distribution

$P(W = w) = p, \quad P(W = 0) = 1 - p$, where w is a constant and $p \in (0,1)$. The agent is assumed to know the distribution. Let the necessary first order conditions (2) and (3) be satisfied for some positive h^{p*} and h^{c*}. Then

(i) The pair (h^{p*}, h^{c*}) is the solution for the problem (1);

(ii)   A decrease in probabilit p of receiving wage increases SHP labor supply h^{p*}; and

(iii)   A decrease in probability of receiving wage decreases wage work labor supply h^{c*}.

Proof of Proposition 2

The statement (i) is proven by checking the second order conditions at (h^{p*}, h^{c*}). Statements (ii) and (iii) are proven by applying standard comparative static techniques to the first order conditions at the interior maximum.
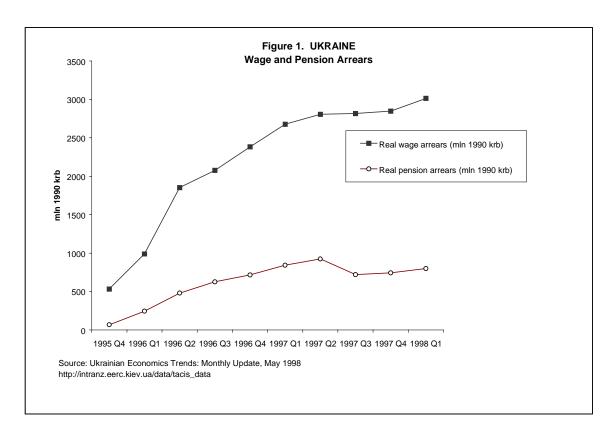
5. Discussion

The share of subsidiary household farming in gross agricultural output increased in many post-Soviet economies. The neo-classical agricultural model led us to infer that the decline in real wages increases supply of labor to subsidiary farming. Our research relates the growth in subsidiary farming to another phenomenon of transition, wage uncertainty. We found that the impact of wage uncertainty for risk averse households is similar to that of declining wage in the certainty case; households increase the subsidiary farming labor supply. Moreover, under the assumption of a discretely distributed wage, we proved a negative relationship between probability of receiving wage and subsidiary plot labor supply, and a positive one between probability of receiving wage and wage labor supply. These results provide theoretical support to the intuitive conjecture that was discussed by Bradley (1971, 1973), Cameron(1973b), and was proven previously by Bonin under an unduly restrictive leisure allocation.

The results provide a theoretical explanation for the growth of involvement of the population in subsidiary farming. In an increasingly volatile economic and political situation in the countries in transition, part-time private plot farming is a way for households to spread

the income risk. Farming is subject to its own intrinsic volatility due to weather, animal

disease, pests, etc. Because of that, farm operators in market economies often diversify

income by working off-farm (Mishtra and Goodwin). However, in contemporary transition

economies, the riskiness of wage income is so high, that it overweighs that of farming. That

is why we ignored SHP yield uncertainty in our analysis. Incorporating both types of

uncertainties into a model is a subject of future research.

The retreat towards more subsistence agriculture is an alarming sign that the reforms

are not achieving their goals. The observed growth in subsidiary farming reflects great

distortions in labor and agricultural markets. The findings lead us to believe that greater

stability in general labor markets and, perhaps, improvements in agricultural marketing

channels, would decrease the distortions caused under the current transition policies.

Figure 1. UKRAINE Wage and Pension Arrears

Source: Ukrainian Economics Trends: Monthly Update, May 1998
http://intranz.eerc.kiev.ua/data/tacis_data

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