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CHANGES IN UNIT INPUTS, COSTS OF PRODUCTION

AND AGRICULTURAL PRICE POLICY--CASE OF POLISH PRIVATE FARMING

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Introduction

In this paper a theoretical model is utilized to analyze efficient growth paths of agricultural production in the private sector of Polish agriculture. The basic desirable interrelationship for productivity growth and profitability growth in relation to factor price changes is discussed. The policy implementation of farm output prices is presented as well. It is assumed in this paper that two major goals of Polish national farm policies are: (1) the maximization of the rate of growth of output per unit of land; and (2) the attainment of income parity between farm and non-farm employment. We consider government interventions in procurement farm prices. The reasoning is essentially macroeconomic.

Agricultural Intensification Process

In Poland the increment in intensification of land use has been very crucial. This is a country in which small-scale farming prevails and the supply of agricultural land has been inelastic. Therefore, it is natural that more stress is put on attaining higher productivity per unit of land. The growth of demand on food has also been massive because of rather high population growth and high income elasticity of food demand. The agricultural productivity growth has been toward an increase in land productivity rather than an increase in labor productivity to save the scarce resource (land) and use the abundant resource (labor). Since the increase in land productivity (basically output per unit of land) has been important in

Polish agriculture, the process of growth in agriculture is considered here in terms of the growth in land productivity.

The intensification of agriculture, which is a process of growth in the total use of labor and capital inputs per unit of land, can be expressed for time 1 and 2 as:

$$(1) \quad \frac{C_1 + L_1}{A_1} > \frac{C_0 + L_0}{A_0} \qquad \text{for } A_1 \neq A_0, \ A_1 > 0, \text{ and } A_0 > 0$$

where: C_i - quantity of the capital inputs and depreciation of fixed assets at time i (in real terms)
L_i - quantity of the labor input at time i (in real terms)
A_i - land at time i

(1) can be rearranged to represent the following relationship.[1]

$$(2) \quad \alpha c + \beta \ell > 0 \qquad \text{for } \alpha + \beta = 1$$

where:

$$\alpha = \frac{C_0}{C_0 + L_0}$$ - structural parameter describing the share of capital input in total inputs

$$\beta = \frac{L_0}{C_0 + L_0}$$ - structural parameter describing the share of labor input in total inputs

$$c = \frac{C_1/A_1 - C_0/A_0}{C_0/A_0}$$ - rate of growth of capital input per unit of land

$$\ell = \frac{L_1/A_1 - L_0/A_0}{L_0/A_0}$$ - rate of growth of labor input per unit of land

Equation (2) describes the process of land use intensification which represents the agricultural intensification process (Wos and Tomczak). In reality, the decrease of labor input per unit of land is observed ($\ell < 0$). Therefore, in the current stage of agricultural development, the capital-intensive type of intensification ($\alpha > \beta$) is the most characteristic.

Productivity Changes in the Process of Agricultural Intensification

A condition for an _efficient_ process of intensification can be defined as (in real terms):

$$(3) \quad \frac{Q_1/A_1}{Q_0/A_0} > \frac{C_1 + L_1/A_1}{C_0 + L_0/A_0}$$

where Q_1 and Q_0 are the output level at time 0 and the output level at time 1 in constant prices. Expression (3) shows the condition for output per unit of input increase, i.e., that the growth rate of output per unit of land is larger than the growth rate of total input use per unit of land. This relationship can be further developed to:[2]

$$(4) \quad q > \alpha C + \beta \ell$$

$$\text{for } q = \frac{Y_1/A_1 - Y_0/A_0}{Y_0/A_0}$$

where Y = output and q = growth rate of output per unit of land.

The relationship expressed in (4) economically means that the growth rate of output is larger than the sum of products of a factor share and a growth rate of the factor which, in conditions of real terms, leads to growth of physical output/input relationships. An indicator of the growth of output per

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unit of land relative to the growth of input use can be defined as "e" in the output/input index in the following equation.

(5) $e = q - (\alpha c + \beta \ell)$

This "e" is the residual of the growth of output per unit of land which cannot be explained by the growth in input use. This "e" can also be interpreted as an "efficiency" index of the intensification process showing the rate of technical change in the agricultural production growth process. Equation (5) can be rearranged to exhibit the following relationship:

(6) $q = \alpha c + \beta \ell + e$

This explains that the growth of output per unit of land is a function of the share of each input, the growth rate of each input use, and the rate of technical change. This form is basically the same as a Cobb-Douglas type growth accounting model used by Hayami and Ruttan (1971). The right hand side of Equation (6) reflects the process of agricultural intensification. The left-hand side of this equation depicts the consequence of the intensification process in agriculture.

In order to conduct further discussion, Equation (6) can be rearranged to the following equation:

(7) $q = \alpha c + \beta \ell - i$
where:
(7a) $i = -e = (\alpha c + \beta \ell) - q$

means the rate of change of physical input/output relationship. The decrease of coefficient (i) with assumption that prices received and paid are held constant should lead to reduction of unit cost in production. The economic

meaning of coefficient (i) is the same as the meaning of the changes in Total

Factors Productivity (TFP) (Ruttan 1979).   The coefficient in question (i) is

calculated as an inverse index of TFP rate of change.

The following derivation will show the structure of this coefficient

which is the weighted sum of the rate of change of partial (labor and capital)

productivity indices.

We can assume that the rate of growth of physical capital input per unit

of output (real unit capital outlays), i.e., (i_c) can be expressed as the

difference between the rate of growth of capital input per unit of land and

the rate of growth of output per unit of land. This can be expressed as

follows:

(8) $i_C = c - q$

Similarly, the rate of change of physical labor input per unit of output (real

labor unit input) can be presented as:

(9) $i_L = \ell - q$

Hence, the rate of change of coefficient (i) can be expressed in terms of i_C

and i_L. The substitution of $c = i_C + q$ and $\ell = i_L + q$ into (7a) leads to:

(10) $i = -e = \alpha(i_C + q) + \beta(i_L + q) - q = \alpha i_C + \beta i_L + q - q(\alpha + \beta)$

By the assumption of $\alpha + \beta = 1$, (10) becomes:

(11) $i = -e = \alpha i_C + \beta i_L$

This means that the change rate of physical total input/output ratio (i)

is a function of the weighted rates of changes in real labor input (i_L) and

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real capital unit outlays (i_C) and the change of the structure of total inputs
($\alpha + \beta$). For the Total Factor Productivity increase in the process of
agricultural intensification, coefficient "i" has to be negative (so that "e"
will be positive).

As has already been mentioned, private farming is currently in the
capital intensive (consuming) stage of agricultural intensification. In this
stage it is observed that the rate of growth of capital inputs per units of
land is faster than that of output per unit of land (Rajtar, Wisniewski).
Therefore, we have c > q and i_C > 0. This means an increasing physical
capital/output ratio over time. Of course this doesn't have to lead to
(i > 0) if an increment in capital/output ratio (i_C) is being compensated by
the decrease of physical labor/output ratio (i_L). This means that the
following relationship has to be satisfied:

(12) $i = -e = \alpha i_C + \beta i_L < 0$

        or

(13) $\qquad \dfrac{\alpha i_C}{\beta i_L} < -1$

Equation (13) explains that the ratio of the weighted growth rate of real
capital unit input to the weighted growth rate of real labor unit input has to
be smaller than -1. When the intensity of one factor increases, the intensity
of another factor has to decline in order to satisfy this efficiency
condition. The necessary rates of growth and decline in factor intensities
vary according to the factor shares. If the factor share of capital is much
larger than that of labor and the capital intensity is increasing, the labor
intensity must decrease very fast to maintain efficient growth.

There are some empirical evidences that during the agricultural intensification process in Polish agriculture, the above conditions were satisfied. Modest growth rates of technical change have been observed in the sixties, the seventies, and the eighties. (Gemma, Rembisz, Lazarcik, etc.)

The negative rate of change in physical labor/output ratio under the circumstances of employment stability per unit of land has been accomplished by fairly high rates of growth in agricultural output per unit of land which has averaged between three to four percent per year. It has been enough to recompensate the rate of growth of physical capital/output ratio. Of course, any decline in labor force in private farming would achieve a higher level of a positive rate of technical change.

The question is now whether the observed level of the rate of decrease of labor unit input (i_1) is sufficient enough to satisfy not only the conditions of formula (13) but also to compensate the growth of capital input prices in order to keep costs of production down. The rate of growth of the prices paid for industrial inputs for farming is very high. This reflects inflation which is transmitted to agriculture from the rest of economy.

The rate of decrease of physical labor/output ratio, or the rate of growth of labor productivity has also to cover the increase of labor price. The increase of labor price is caused by inflationary increase in consumer good prices and the steady growth of wages in non-farm sectors of national economy. This would block an increase in per capita farm income in private farming with the assumption that prices received for farm-output products are held constant.

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Changes in Unit Costs in the Process of Agricultural Intensification

So far in the discussion, the prices of outputs and inputs have remained constant over time. Here, we are going to investigate the basic interdependence necessary to reduce the unit cost of production. Namely, we are going to examine the conditions necessary to compensate the cost-effect of input's price increment. In order to answer this question we assume no changes in farm output prices while the price of inputs are allowed to vary over time. Taxes and credits are not considered for the propose of simplicity. The concept of "costs" introduced in this section of discussion means the value of inputs in nominal terms in relation to the value of output in real terms. This will allow us to examine the effect of the change in input prices upon the cost of production. We assume a positive rate of technical change $(i < 0)$.

First, the unit cost of capital and the unit cost of labor are defined as follows:

$$(14) \quad C* = \frac{C \ p_C}{Q} \qquad\qquad (15) \quad L* = \frac{L \ W}{Q}$$

where:

C* = unit capital cost

p_C = aggregated current price of capital

Q = output (in real terms)

L* = unit labor cost

W = current money wage

The unit cost is defined as the cost of a factor per unit of output. After taking logarithm transformation and total differential, the following relationship can be derived.

$$(16) \qquad i_C^* = i_C + p_C$$

$$(17) \qquad i_C = i_C^* - p_C$$

$$(18) \qquad i_L^* = i_L + p_W$$

$$(19) \qquad i_L = i_L^* - p_W$$

where i_C^* = growth rate of unit cost of capital

$\quad\quad i_L^*$ = growth rate of unit labor cost

$\quad\quad i_0$ = growth rate of capital unit input

$\quad\quad i_L$ = growth rate of labor unit input

$\quad\quad p_C$ = growth rate of P_C

$\quad\quad p_W$ = growth rate of W

The growth rate of unit cost of capital is the approximative sum of the growth rate of capital unit input and the growth rate of capital price (p_C). The coefficient (p_C) is an exogenous variable to the system. This can indicate how inflation is transmitted to private farming. The impact of inflation upon unit cost of capital can be estimated as relation of p_C/i_C^*. The same can be said as to the growth rate of unit labor cost. This is the sum of the growth rate of unit labor input and the growth rate of wage. This rate of growth is considered to be equal to non-agricultural labor opportunity cost, since the income parity between farm and non-farm employment is taken as a goal of agrarian policy in Poland.

The substitution of (19) and (2) into equation (11) will result in:

$$(21) \qquad i - -e - \alpha(i_C^* - p_C) + \beta(i_L^* - p_W)$$

and

$$(22) \qquad i* - i + (\alpha p_C + \beta p_W) - \alpha i_C^* + \beta i_L^*$$

The change rate of total unit cost (i*) is a linear function of the change rate of total unit input (i) and the weighted sum of the growth rates of factor prices for both factors (p_C and p_W). This is also equivalent to the weighted sum of the growth rates of the unit cost for each factor (i_C^* and i_L^*). If output price is constant and only factor prices are increasing ($p_C > 0$ and $p_W > 0$) the total unit input rate of change has to be negative in order to avoid a growth of the total unit cost (i*). Under the current conditions surrounding the development of Polish private farming, however, it is not easy to obtain a negative rate of growth in (i*). The rate of technical change (e) which originates from the condition as it was shown in equation (13) is not large enough to compensate the cost-effect of factor prices increase. As a result, instead of (i* < 0) or at least (i* - 0) an increase of total unit cost of production (i* > 0) is being observed. This leads to the necessary growth of farm procurement prices to maintain the profitability of the farm sector. It would add inflationary effects to the rest of economy.

The question then is what economic relationships have to be retained in order to have a decrease of total unit cost of production in the private farming performance in Poland--that is, to have (i* < 0). As was previously mentioned, a typical situation is that capital unit cost grows positively ($i_C^* > 0$). This is because the capital unit input and the capital price have

positive rates of growth ($_C > 0$ and $p_C > 0$) in Poland. Under such circumstances, in order to have a decrease of total unit cost of production, an existence of negative rate of change of labor unit cost ($i_L^* < 0$) becomes inevitable. This condition has to be associated with the relationship where the decrease of weighted labor unit cost ($ßi_L^*$) is larger than the weighted rate of growth of capital unit cost (αi_C^*).

$$(23) \qquad \alpha i_C^* \quad < \quad - \quad ßi_L^*$$

This is, of course, related to the condition which has been shown in equation (13).

Then the next question is in what condition we will have a negative rate of change of labor unit cost of agricultural production ($i_L^* < 0$). The answer can be derived from Equation (18) that is: $i_l^* - i_L + p_W$. This tells us that if the labor price (money wage) increases and the unit labor decreases (labor productivity increase) at the same rate ($i_l^* - P_W$) then the labor unit cost remains constant (Branson). Hence in order to have the labor unit cost diminishing, the rate of decrease of physical labor/output ratio (i_ℓ) has to be larger than the rate of growth of labor price (p_W) that is:

$$(24) \qquad i_L \quad < \quad - \quad p_W$$

This is a basic condition for the effective economic development in any production activities. The question is, next, whether it is feasible to accomplish a reduction of of production cost under the given economic conditions which regulate the performance and development of private farming. If all interventions would be feasible, an increase in procurement farm prices

would not be the only necessary solution to improve its profitability and to keep income parity. This subject will be discussed in the following section.

Farm Output Price Adjustment

The conditions described above for cost-reduction of production in private farming are very difficult to implement under current states of the national economy. It is hard to attain the negative rate of labor unit input (growth of labor productivity)--(i_L)--which would be sufficient enough to cancel out labor price increase. In order to briefly explore this problem, it is handy to recall the factors determining the change of this coefficient as shown in equation (9) i.e., ($i_L = 1 - q$). The rate of growth of output per unit of land (q) has its limit in a given period of time. In Poland, the average rate of growth of output per unit of land amounts to between 1.5 - 3.5 percent annually (long term trend). With the assumption taken from the real condition of Polish agriculture--that there is no change in the number of employment per unit of land ($1 = 0$), this leads to attain a 1.5 - 3.5 percent rate of decrease in physical labor/output ratio (increase of labor productivity). However, this is neither enough to pay for labor price increase nor to compensate cost. The nominal rate of growth of agricultural labor price (p_W) is a function of the rate of inflationary increase in consumer good prices and the rate of the inflationary growth of wages in non-farm sectors. This is again due to the income parity policy which is a major goal of official agrarian policy in Poland. At the same time the price of capital inputs (p_C) grows fast as well.

In order to achieve higher rates of labor productivity growth ($-i_L$), there are two choices: (1) to increase the rate of growth of agricultural

output per unit of land (q); or (2) accelerate labor movement from agriculture to the urban industrial sector to retain a negative rate of change of (1). Both solutions are very difficult to conduct. As stated earlier, the rate of growth of output per unit of land seems to have its limit in a given period of time. In order to increase this rate of growth beyond its current level, a higher rate of industrial input growth is required. The output growth rate is highly dependent upon the industrial input supply and scientific and technological possibilities conditioned by research systems and available biological progress. So far a shortage of industrial fixed and current inputs--especially modern power--has been observed. Industry is not prepared enough to satisfy current agricultural need. Only about four to five percent of final industrial production currently goes to the agricultural sector as inputs for production.

It is also difficult to accelerate the migration from agriculture to non-farm sectors of the national economy in its current state. One reason for this slow progress is the relatively low demand of labor in the industrial sector. The undeveloped service sector can also be blamed. The shortage in urban housing is a serious problem. One emerging constraint to the faster labor movement is the aging of private farmers. More than 60 percent of the private farmers are now over 50 years old. But the most important problem is a shortage of capital inputs which can be substituted for the rural labor. Given such conditions it is hard to assume higher than a one percent rate of decrease of labor employment per unit of land. This would result in substantial reduction of real farm income since the cost of living due to inflationary increase in consumer good prices grows at the rate of 25-50 percent annually. But under the assumption of official income parity economic

policy, the rising cost of living is partly compensated by the increase in agricultural procurement prices. The rate of farm procurement price increase is currently, however, the result of negotiations taking place between the Government and organizations representing private and socialized farms. The supply of the products enumerated in these negotiations constitutes about 50-60 percent of the total procurement of farm products. This procedure results, of course, in farm labor price increase ($p_W > 0$). As a consequence of this condition instead of a negative rate of change of labor unit cost ($i_L^* < 0$), we have ($i_L^* > 0$) in equation (24) because the rate of decrease of labor unit input (i_L) is much lower than nominal labor price increase (p_W). Under these conditions it is not possible to satisfy the interdependence which has been shown in equation (23). It means that there is no source which would compensate the growth of capital unit cost (i_C^*) caused by the increase of physical capital/output ratio (i_C) and capital factor price (p_C). The increase rate of the latter is very high and has inflationary character. Given the assumption that output prices are held constant, it would result either in farm income and living standard decline or in reduction of capital outlays. The latter option, as previously stated, is unlikely to occur. The second solution (the reduction of industrial capital input use per unit of land) would give as a result a zero or even negative rate of change of agricultural output. It is not acceptable from an economic policy point of view since the demand for food is not fully satisfied by supply and the main target of national farm policy is food self-sufficiency. Also, further deterioration of farm real income is not acceptable since income parity with nonagricultural workers and guaranteed profitability for farming is one target of economic policy when a main incentive to increase production. To cope with

the situation in question is not easy. To maintain the profitability, price increases in inputs and consumer goods have to be accompanied by commensurate increases in agricultural procurement prices. Another option is to impose control over the input price increases. To conduct such a policy, however, is a very complicated process since the prices of inputs are a subject of free market regulations. The shortage of many inputs for farming, especially modern ones is a permanent problem. The production of many producer goods for farming is highly monopolized. In many areas it is very difficult to break the monopoly. There is limited access to the international markets; hence, the import of inputs for farming doesn't play any role on the farm input markets. This causes a situation where the prices of inputs are determined by the domestic demand/supply relationship. Of decisive importance are the costs of production of monopolistic manufacturers who have no motivation to lower the cost. On the other hand, all the costs which are raised transmit over to the price of the final product, i.e. inputs for farming purchased by private agriculture. In this way inflation is transmitted to agriculture which is not able to compensate it by commensurate improvement in productivity.

In order to examine the condition for commensurate increases in agricultural output prices (procurement prices), the following formulas can be utilized:

$$(25) \qquad c_L^* = c + p_C - (q - p_q) = i_C + (p_C - p_q)$$

$$(26) \qquad c_L^* = 1 + p_L - (q - p_q) = i_L + (p_L - p_q)$$

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Where:

c_C^* = rate of change of capital unit cost (inverse rate of total profit in terms of unit capital)

c_L^* = rate of change of labor unit cost

p_q = growth rate of agricultural output prices

p_C, p_L = growth rate of factor price for capital and labor inputs

Equation (25) shows that the rate of growth of average unit capital cost is a function of the rate of growth of physical capital/output ratio (i_c) and the relationship between the growth rates of capital to output prices (price paid to price received). Since we have ($i_C > 0$) and most of the time ($p_C > p_q$), the unit capital cost rate of change is positive. With the given rate of growth of capital unit input ($i_C > 0$), it is of critical importance to maintain the proper relationship between p_C and p_q. In order to avoid inflationary effects, the rate of (p_C) has to be controlled.

Equation (26) shows that the change rate of labor unit cost is a function of the labor unit input (i_L) and the relationship between the growth rates of labor wage (p_L) and output prices (p_q). If the negative rate of growth in labor unit input ($i_L < 0$) is higher, the commensurate increase of output price (p_q) has to be lower with a given rate of labor price growth (p_L). Of course the basic assumption is that income parity with non-agricultural workers and guaranteed profitability should be maintained. Otherwise, labor price increase would be a function of the relationship between (i_L) and (p_q) for profitable agricultural performance. A positive rate (c_C^*) should be accompanied by a commensurate negative rate of (c_L^*). But the latter can only be achieved by substantial increases in procurement prices which might create price increases in the rest of economy and might end up with increments in factor prices which induced this inflationary process.

In conclusion, agricultural price policy is very much related to the relationship among changes in coefficients i_L, i_C, p_C, p_L, and finally i_L^* and I_C^*. Most of them are exogenous variables to the economy which are generally difficult to control by economic policies. They are a function of overall economic development. This adds extra complications to the establishment of clear-cut agrarian policies for the Polish private agricultural sector.

[1]   (1) can be expressed as:

$$\frac{C_1 + L_1}{A_1} \Big/ \frac{C_0 + L_0}{A_0} > 1$$

and this can be rearranged to:

$$\frac{C_1/A_1 + L_1/A_1}{C_0/A_0 + L_0/A_0} > 1. \quad \text{Since } \alpha = \frac{C_0}{C_0 + L_0} \text{ and } ß = \frac{L_0}{C_0 + L}$$

this can be illustrated as:

$$\alpha(C_1/A_1 + C_0/A_0) + ß(L_1/A_1 + L_0/A_0) > 1.$$

Finally, (2) can be derived by substituting:

$$c + 1 = \alpha(C_1/A_1 + C_0/A_0) \text{ and } L + 1 = L_1/A_1 + L_0/A_0$$

into this last expression.

[2]First, the relationship of

$$q > \frac{C_1 + L_1}{A_1} \Big/ \frac{C_0 + L_0}{A_0} - 1$$

can be derived from (3) using the relationship of

$$1 + q = \frac{P_1/A_1}{P_0/A_0} \, .$$

Since the right hand side of this derived inequality formula is similar to

the one discussed above, the same operation can be undertaken. This will lead to the relationship of

$$\frac{C_1 + L_1}{A_1} \Big/ \frac{C_0 + L_0}{A_0} - 1 = \frac{C_0}{C_0 + L_0} \cdot \frac{C_1/A_1 - C_0/A_0}{C_0/A_0} + \frac{L_0}{C_0 + L_0} \cdot \frac{L_1/A_1 - L_0/A_0}{L_0/A_0}$$

This is equivalent to say $\alpha c + \beta l$. Therefore, after substituting this to the right hand side of the formula, (4) $q > \alpha C + \beta l$ is derived.

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