Models of Demand for Capital in Agriculture of Kazakhstan

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Abstract

The financing of agricultural producers is one of the most acute problems along the entire scope of economic reforms in Kazakhstan. The issue is: What kind of financial sources could maintain the development of agricultural production? Internal sources such as profit, depreciation capital, and various reserve and insurance funds can not be considered as a key financial base. State financial support of agriculture in Kazakhstan (which plays a significant role in the most developed countries), is episodic in nature, small in size and typically does not reach the recipients. In these circumstances, a potential supplier of financial and investment resources could be a banking system and such non-banking credit institutions as credit cooperatives.

In this study capital demand functions were used to analyze an influence of a number of factors on capital demand in agriculture. The results of simulations suggest the most significant factors are a rental price of capital and a price of production output. Major determinant of credit demand is collateral, that is, size of arable land possessed by the agricultural enterprise and a cost of equipment. Despite subsidized credit plays significant role existing corruption in this sphere decreases capital demand and investment opportunities for agricultural producers.

Keywords: agricultural finance in Kazakhstan, production functions, capital demand

1. Introduction

Development of rural financial market is of high importance for Kazakhstan, as 44 percent of population live in rural areas and about 24 percent of the total population is engaged in agricultural production. There are three main sources of formal credit in the agricultural sector of Kazakhstan: commercial banks, rural credit partnerships (RCP), and micro-credit organisations (MCO). However, their shares in the total loans for agriculture are unequal. Commercial banks provide the major share of all loans for agriculture, more than 90 percent, the RCPs’ share is declining and accounting for about 5 percent; the MCOs take less than 1 percent of the total loans (Table 1).

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total, million KZT*</td>
<td>198728.3</td>
<td>254677.5</td>
<td>298172.3</td>
</tr>
<tr>
<td>Share of credits, percent:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Commercial banks</td>
<td>90.2</td>
<td>95.5</td>
<td>94.5</td>
</tr>
<tr>
<td>Rural Credit Partnerships (RCPs)</td>
<td>9.3</td>
<td>3.8</td>
<td>5.1</td>
</tr>
<tr>
<td>Micro Credit Organisations (MCO)</td>
<td>0.5</td>
<td>0.7</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Source: Ministry of agriculture of Republic of Kazakhstan, http://www.minagri.kz
Despite commercial banks have such a big share of the loans for agriculture, there is no well-developed rural banking system currently existing in the country. Moreover, only two commercial banks of thirty have limited networks of branches in rural areas. In comparison with urban areas, rural clients in Kazakhstan are more dispersed, with a low average population density of six individuals per square kilometre. According to the statistical data, all banks provide loans to agricultural producers; however, the share of agricultural banking in the total bank loan portfolio is quite insignificant. Additionally, commercial banks prefer to provide loans to large-scale agricultural enterprises; in 2007, the latter obtained 95.5 percent of total credit to agriculture whereas the share of loans to private family farms has been continually decreasing. Banks are wary of lending to small rural households and private family farms because of the unacceptably low return rate, the high risk, a small size of demanded loan, and high transaction costs (Table 2).

Table 2: Loans provided by commercial banks to agriculture in Kazakhstan

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loan volume, billion KZT</td>
<td>189.5</td>
<td>243.2</td>
<td>282.0</td>
</tr>
<tr>
<td>Share of agricultural lending in total loan portfolio, percent</td>
<td>6.3</td>
<td>4.6</td>
<td>3.5</td>
</tr>
<tr>
<td>Share of agricultural enterprises in loans granted to agriculture, percent</td>
<td>96.3</td>
<td>96.0</td>
<td>96.5</td>
</tr>
<tr>
<td>Nominal interest rate, percent</td>
<td>14</td>
<td>13.6</td>
<td>15</td>
</tr>
</tbody>
</table>


Although demand for investment is currently covered mostly by remained earnings (Figure 1), the role of external financial sources is of very high importance. The steady growth in agriculture could not be achieved without intensive investment in production. In turn, it is impossible to rely exclusively on own recourses, in particular taking into consideration a very low rate of profitability of agricultural producers in Kazakhstan. Thus, access to bank credit could be considered as a key factor influencing economic growth in rural areas of Kazakhstan.

However, a source of financing such as RCP could be considered as having good prospects in the near future. A rural credit partnership system is a new form for Kazakhstani agriculture. The history of its development accounts for only 7 years, including 2 years as a pilot project. According to the project idea, RCPs had to become prototypes of rural credit cooperatives. However, it is still too early to make a strong
analogy between RCPs and rural credit cooperatives of the Reiffeisen’s type. According to a regulating law on Rural Credit Partnerships, the latter are not allowed to take deposits; they are partly state-owned organisations (although private ones are permitted, none exists) and all credits come from a state budget. Membership in the RCP is very restricted and depends heavily on the production type and size of land plot.

Micro-credit institutions in rural areas are still the least developed financial organisations. There is a state program aimed to cover needs in micro-crediting in rural areas, however, the scope of this program is insignificant and cannot solve problems with crediting small households.

2. Characteristics of the data

The model discussed herein is a static model, with cross-sectional data and it considers one production period (year). The agricultural enterprises data in this study was obtained from data of the Regional Agency of Statistics (Pavlodar Region, Kazakhstan). This data source includes annual records on all medium and large-scale agricultural enterprises, which are submitted to local statistical offices annually (and some of them quarterly). The data on agricultural land was obtained from the Regional Land Committee (Pavlodar Region, Kazakhstan) and contains all data of the amount of land rented or owned by agricultural enterprises, distinguishing arable and pasture land, and the land is measured in hectares (ha). This research is focused on middle and large-scale agricultural enterprises, the successors of kolkhozes (collective farms) and sovkhozes (state farms), additionally, only grain producing agricultural enterprises with more than 40 ha of arable land were taken into consideration. This selection has been used because of the situation in the rural credit market, where about 90 percent of all credits come from commercial banks and the overwhelming majority of credits are granted to large-scale enterprises. In the Pavlodar region large-scale enterprises are mostly specializing in grain production. State agricultural enterprises and the enterprises with livestock production specialization were excluded from the sample.

From 157 agricultural enterprises only 93 enterprises submitted reports to the Agency of Statistics in 2006. With respect to all agricultural enterprises that reported to the Agency of Statistics in 2006, the sample covers 81 percent of the total number of reported agricultural enterprises, 91 percent of the employment, and 75.5 percent of agricultural land, as reported by the Agency of Statistics. Next, such variables as labour and land are measured in people and hectares respectively. Agricultural enterprise output is measured as gross production in a metric center. It should be noted that the analysis is confined to the agricultural part of the enterprise. A problem of obtaining the value of capital was encountered here, because it was not available: neither on the regional level nor on the enterprise level. The value of capital was measured as the costs of expenditure (seeds, fodder, mineral fertilizers, oil products, energy, spare parts, and other) and the cost of buildings and machinery calculated using a sum of depreciation from annual reports and measured in Kazakh Tenge (KZT). For calculating a total cost of production, the cost of labour was measured as a payment for farm employees engaged in plant production and the cost of land was measured as a rent for arable land, in KZT. Both labour and land are not corrected for quality, due to a lack of data on quality. Regional price indices for aggregated agricultural output were used.
3. Production function estimations

3.1 Measurement of inputs and outputs

In order to answer research issues in this study, agricultural production is assumed to be a function of productive inputs, which are defined as productive resources, or the services they provide, used over a given production period to produce a certain amount of outputs (Upton 1976). There is a vast variety of the inputs involved in producing a particular output. Some inputs are under a producer’s control, some of them are completely out of it such as rainfalls and sunshine, some are partly controllable such as pests, quality of soil, and diseases.

For some study purposes it is necessary to consider very specific inputs, but it is also possible to aggregate inputs into the broad groups of land, labour, and capital. Thus, there is a technical relationship between inputs and outputs, that is, to achieve a certain level of output it is necessary to use a certain quantity of inputs in a given period of time.

A production function describes a way that output and inputs are related. This relationship can be expressed using different mathematical approaches. It describes the maximum output obtainable, at the existing state of technological knowledge, from given amounts of factor inputs (Humphrey 1997). The production function, \( f(X_1, X_2) \), is assumed to be linearly homogeneous, increasing, strictly quasi-concave and twice-continuously differentiable in its arguments. We can write the output, \( y \), of a farm as:

\[
y = f(X_1, X_2, ... X_i),
\]

where \( y \) is a quantity of output and \( X_i \) is a quantity of inputs (Silberberg 1990).

According to Heady and Dillon (Heady 1961, p.220) in an ideal case all the input and output variables should be measured in physical units. However, the situation differs for studies based on cross-sectional data. Such inputs as capital goods can not be measured in physical terms, because they have no common physical unit. They must be aggregated and measured in value terms for computation purposes. Thus, in an agricultural production analysis the theoretical distinction between a physical production function and a value production function is generally blurred.

The production function study for firms usually is oriented on the short run of a single production period or year (Heady 1961, p. 221). Therefore, the input of durable assets should be measured using depreciation or maintenance cost relevant to the period of study. Additionally, such variables as equipment and machinery, fuel, lubricants, spare parts, power should be grouped together due to high correlation among them. From the capital inputs should be excluded such items which are determined directly by the volume of production because they could cause rise in the production elasticity and marginal productivity of capital inputs. When farms hire or purchase machine, buildings, and land they should pay some price. Once purchased, these resources are used over several production periods and do not have a purchase price each production period (Doll 1978). However, it is possible to evaluate them through using an opportunity cost, in other words, the money would be used and would earn in an alternative more profitable way, in this study as the opportunity cost of capital could be used a deposit interest rate.

There are three major resource categories: capital, labour and land. Macroeconomics typically uses two types of inputs – capital and labour. Land is even less than a kind of
capital as modern textbooks only mention labour and capital (such as machines, buildings or monetary funds) as production factors and make no reference to land (Metzemakers and Louw 2005). Land is considered as a part of capital. It is true for such sectors of an economy such as industry and service, but in the case of agriculture land should be considered as a separate input, since land and capital are essentially different because capital can be accumulated while land cannot (Echevarria 1998). As Timmer said: “Agriculture is the only major sector that uses the land surface as an essential input into its production function” (Timmer 2007). The measuring of the land input is not associated with large difficulties. The flow of services from the land input could be measured either in physical terms (hectares) or in market value terms (rent price). In this study only land actually used in production is included as input and the differences in land quality are not taken into account. The perceived price of land and land rent price are the same for all producers, and equal their market price. Thus, the amount of land used for production process characterizes the productive quality of land.

In measuring of labour input two factors should be taken into consideration: 1) distinction between a measure of total labour and labour actually utilised in the given production; and 2) variation in labour quality, namely, farm family labour and hired labour. In the case of labour the rental price could be expressed as an average wage in the economic sector, in the case of land the rental price is expressed as a land rent. In this study the importance of factor prices, especially the cost of capital, is emphasized. Thus, capital, land and labour can be hired in competitive markets at (exogenously given) prices i, r and w, respectively. The price, P, of output is also exogenously given - determined, say, in the world market (Eswaran and Kotwal 1986).

A production function including three major inputs as capital, labour and land in general form could be express as follows:

\[ y = f(K, L, N) \]

\( y \) – output, metric centner
\( K \) – capital, 1000 KZT
\( L \) – labour, people
\( L \) – arable land, ha.

The factor demands, obtained from the firm’s profit-maximization problem, are the firm’s optimal choices of input quantities and are a function of input prices and the price of the output product. The most common application of factor demands is the calculation of comparative statics with respect to input and output prices (Taylor B. 2009). The following assumptions will be maintained: 1) a firm is a price taker, that is, the firm is not large enough to influence the sales price, which is assumed to be a random variable. Furthermore, the prices of the inputs, capital, land, and labor, are given to the firm; 2) the decisions concerning a volume of output and inputs must be made prior to the knowledge of the market price; 3) a firm seeks to maximize profits (Batra and Ullah 1974).

Assuming farms are operating in a perfectly competitive market, one can expect that the main problem of a producer is maximizing profit, \( \pi \). The profit function possesses many desirable properties and without loss of generality, one can consider only profit functions
in the empirical analysis of the behaviour of profit-maximizing, price-taking firms (Yotopoulos and Lau 1972).

A profit function (defined as current revenues less current total costs) can be written as follows:

\[
\max \pi = Pf(K,L,N) - (iK + wL + rN)
\]

where

- \(P\) – price for grain, 1000 KZT
- \(i\) – interest deposit rate (1+deposit interest rate)
- \(w\) – average wage rate in agriculture, 1000 KZT
- \(r\) – agricultural land rent, 1000 KZT
- \(K\) – capital, 1000 KZT
- \(L\) – labour, people
- \(N\) – arable land, ha.

A firm chooses input quantities so as to maximize expected utility from profit. The first-order conditions for the maximum should be found by taking the derivative of profit, \(\pi\), with respect to each the inputs and setting this derivative equal to zero (Batra and Ullah 1974):

\[
\frac{\partial \pi}{\partial K} = P* \frac{\partial f}{\partial K} - i = 0 \\
\frac{\partial \pi}{\partial L} = P* \frac{\partial f}{\partial L} - w = 0 \\
\frac{\partial \pi}{\partial N} = P* \frac{\partial f}{\partial N} - r = 0.
\]

The demand for each variable factor of production is obtained by solving this system of three equations for capital, \(K\), labour, \(L\), and land, \(N\). One would get a relationship of factors to price of the products, \(P\), the wage rate, \(w\), the price of capital, \(i\), the land rent, \(r\). Also one can put into the equations additional parameters characterizing debt capital demand such as a loan interest rate, transaction costs, a size of collateral. Taking into account the fact that agricultural production is one of the high risky types of production one can enter into equations a probability of default depending on a probability of getting bad or good yield. Considering subsidized credit one can put into equations such a factor as a bribe rate.

### 3.2 Functional forms

The production function has been widely applied in agricultural studies focusing on the impact of different factors. Significant model specification problem is a selection of a functional form and methods of dealing with potential data.

Agricultural economics uses diverse algebraic equation forms for deriving production functions. Guides on appropriate algebraic forms may come from previous investigations and the theories of the sciences involved (Heady 1961, p.73). A selection process of any specific type of functional form imposes a number of certain restraints and assumptions concerning relationships involved and optimum resource quantities which will be specified. However, there are some functional forms traditionally used for agricultural production studies. As proposed by several authors (Heady 1961, Debertin 1986, Griffin et al. 1987, Felipe 2005, Mohaddes 2008) those types of production functions are follows: the Cobb-Douglas, Transcedental, and Translogarithmic production functions. In
this study these three types of production functions were estimated. All these functions can be expressed in a linear form and can be estimated using the OLS method.

The estimated equations are expressed as follows:

1) Cobb-Douglas production function:
in log linear form
\[ \ln Y = c + \alpha \ln K + \beta \ln L + \gamma \ln N \]
estimated function
\[ \ln Y = 1.312 + 0.670 \ln K + 0.157 \ln L + 0.160 \ln N, \]
2) Transcendental production function
in log linear form
\[ \ln Y = c + \alpha \ln K + \beta \ln L + \gamma \ln N + aK + bL + dN, \]
estimated function
\[ \ln Y = 2.182 + 0.633 \ln K + 0.181 \ln L + 0.124 \ln N + 8.13868E-07K - 0.0007L + 5.80219E-06N, \]
3) Translogarithmic production function
in general form
\[ \ln Y = \ln c + \alpha \ln K + \beta \ln L + \gamma \ln N + \frac{1}{2}a \ln K \ln L + \frac{1}{2}b \ln K \ln N + \frac{1}{2}g \ln L \ln N \]
estimated function
\[ \ln Y = 145.8 + 0.394 \ln K + 0.81 \ln L - 0.72 \ln N - \frac{1}{2}(0.34) \ln K \ln L + \frac{1}{2}(0.16) \ln K \ln N + + \frac{1}{2}(0.21) \ln L \ln N. \]

After estimating these functional forms a problem of choosing the best form for the given study purposes is arisen. Griffin et al. suggested to consider four choice criteria: 1) an extent of appropriation of a chosen functional form to maintained hypotheses; 2) availability of data and computing recourses; 3) data-specific considerations as goodness-of-fit and general conformity of data by means of use a variety of statistical and econometrical tests; 4) application-specific characteristics, for example, if a chosen form is to be used for simulations or mathematical expressions (Griffin et al 1987). In this study the alternative forms satisfy equally the first two criteria, however undertaken tests showed that not all the functional forms are good enough for the study. Also, a necessity to derive an input demand functions and express them mathematically required a choice of a proper functional form.

If one considers alternative models with the same specification of the dependent variable, the selection procedure is straightforward. The F-test procedure is used broadly for testing nested functions. The main idea is to compare the accuracy of prediction of a more complex model with a subset of the model, in other words, whether the gain in predictive accuracy is large enough to attribute it to something other than chance or random effects. As the Cobb-Douglas production function is nested within the Transcendental production function and the Translogarithmic production function it could be considered as a constrained function and taken as a null hypothesis, whereas the Transcendental and Translogarithmic functions could be considered as an unconstrained function. In this study the calculated F values for both comparisons are equal to 0.193
and 2.21 respectively, the critical point for $F_{crit,6,69}$ is 2.25; therefore, in the case of the Cobb-Douglas and Transcendental production functions $F(0.193)<F_{crit,6,69}$ the null hypothesis is not rejected; the same is in the second case of the Cobb-Douglas and Translogarithmic production functions $F(2.21)<F_{crit,6,69}$ and the null hypothesis is not rejected too. Thus, the constraining $a=b=d=0$ in Transcendental and Translogarithmic production functions would not change the estimated line by very much (Doran 1989). When comparing these functional forms one sees that $R^2$ is practically similar for three models the Cobb-Douglas, Transcendental and Translogarithmic functions: 0.759, .762, and 0.781, respectively, that is very satisfactory for a cross-section equation, and the $t$-statistics are better for the Cobb-Douglas type of production function (Appendix 1).

Thus, being based on the tests and also on the fact that factor demand functions formulated within the framework of the Cobb-Douglas production function have been widely used for the study of production behaviour of farm firms (Chand 1986), one can suggests that the Cobb-Douglas production function could be considered as the most fitting functional form for this study:

$$Y=1.312 K^{0.67}L^{0.157}N^{0.16}.$$ 

Since the parameters $\alpha$, $\beta$ and $\gamma$ yields a value smaller than one ($0.67+0.157+0.16 = 0.987$), the production function displays decreasing returns to scale, as expected. The elasticity of output indicated by the parameters $\alpha$, $\beta$ and $\gamma$ reflects the increase of the output ($Y$) caused by one per cent change of the input factors ($K$), ($N$) and ($L$). Hence, the contribution of capital ($K$, comprising all capital inputs) to output ($Y$) is 67 per cent, of land ($N$) 15.7 per cent and of labor ($L$) 16 per cent.

4. Capital demand functions

Capital being a factor of production along with land and labour contributes services to the process of production. The sum used for financing a production process could be identified as either externally come, through increase in debt, or internally from farm cash flow (net income and depreciation allowances); or the sum could be a combination of external and internal sources of financing (Melichar 1973).

Stronger GDP growth during last decades in Kazakhstan and increased state support of agricultural sector have led to an increase in demand for credit by agricultural producers via income effect, as increased income can sustain higher credit repayments, and via wealth effect, as higher valued collateral can be offered to secure higher credit repayment (Gattin-Turkalj 2007).

The study is aimed to take a closer look at the following questions:

- What sort of factors could influence demand for both own and debt capital?
- How do those factors influence demand for capital?

4.1 Own capital demand function

Own capital formed from the remained earnings is a main source of financing for agricultural production in Kazakhstan. The Cobb-Douglas functional form is taken as a production function:

$$Y=cK^\alpha L^\beta N^\gamma,$$
where
K₀ – own capital, 1000 KZT,
L – labour, people,
N – land, ha,
α+β+γ < 1 – decreasing return to scale,
and the profit function, π, is assumed also to be the Cobb-Douglas in form:

\[ \pi = P \cdot cK^\alpha L^\beta N^\gamma - (iK_0 + wL + rN), \]

where
P – price for crop, 1000KZT,
i – deposit interest rate \((1+i)\),
w – average wage rate, 1000KZT,
r – agricultural land rent, 1000KZT.

To find input demand function for capital, K, labour, L, and land, N, first order conditions for profit maximization in respect to each input should be undertaken and then those first order equations should be solved for K, L, and N. First order condition equations could be expressed as follows equations:

\[ \frac{\partial \pi}{\partial K} = P \cdot cK^{\alpha} L^{\beta} N^{\gamma} - i = 0 \quad (1) \]
\[ \frac{\partial \pi}{\partial L} = P \cdot cK^{\alpha} L^{\beta-1} N^{\gamma} - w = 0 \quad (2) \]
\[ \frac{\partial \pi}{\partial N} = P \cdot c\gamma K^{\alpha} L^{\beta} N^{\gamma-1} - r = 0. \quad (3) \]

If one solve the equations (1)-(3) for K, L, and N, independently, it would mean that all the inputs are technically independent; in other words, the marginal product of one input would be unaffected by the quantity of the other input that is available. However, this situation is very unlikely. That is, if the price of one input increases the farmer might response on this increase by substitution another input for the first one. Thus, an approach for finding the input demand function needs to take into account the possibility of substitution; the use of one input should be a function not of the quantity of other factors, but rather of the prices of other factors. Thus prices and production function parameters should be treated as known terms, the quantity of K, L, and N, as unknowns. Equations (1)-(3) represent three equations in three unknowns that should be solved as a system of equations (Debertin 1986, p. 221).

Taking logs and rearranging the system of equations (1)-(3) as a following system of equations:

\[ (\alpha-1)\ln K_0 + \beta \ln L + \gamma \ln N = \ln \left( \frac{i}{Pc} \right) = k_1 \]
\[ a \ln K_0 + (\beta-1) \ln L + \gamma \ln N = \ln \left( \frac{w}{Pc} \right) = k_2 \]
\[ a \ln K_0 + \beta \ln L + (\gamma -1) \ln N = \ln \left( \frac{r}{Pc\gamma} \right) = k_3, \]

and considering decreasing returns to scale, the system of equations (4)-(6) could be solved using the Matrix Inversion method. This method is an alternative method of the Gauss-Seidel iteration and has two advantages:

- errors do not accumulate during the calculation. If the procedure converges, it approaches the correct answer without rounding errors such as can occur during
inversion of large matrices. As a result, very large sets of equations can be solved; the method has been applied to sets of thousands of equations.

- the method can be used for nonlinear sets of equations.

To solve the linear system of equations \( A \mathbf{X} = \mathbf{b} \), one can multiply both sides by the inverse of \( A \), provided this exists, to give \( A^{-1}A \mathbf{X} = A^{-1}\mathbf{b} \) (Croft 2000).

But \( A^{-1}A = I \), the identity matrix. Furthermore, \( Ix = x \), because multiplying any matrix by an identity matrix of the appropriate size leaves the matrix unaltered. So, \( \mathbf{X} = A^{-1}\mathbf{b} \), if \( A\mathbf{X} = \mathbf{b} \), then \( \mathbf{X} = A^{-1}\mathbf{b} \).

Assuming that \( 1-\alpha-\beta-\gamma=\eta \) and solving the system of equations (4)-(6) using the Matrix Inversion method one can get a matrix of parameters (Figure 2).

\[
A = \begin{pmatrix}
\alpha^{-1} & \beta & \gamma \\
\alpha & \beta^{-1} & \gamma \\
\alpha & \beta & \gamma^{-1}
\end{pmatrix}
\]

\[
\mathbf{X} = \begin{pmatrix}
\ln K \\
\ln L \\
\ln N
\end{pmatrix}
\]

\[
\mathbf{b} = \begin{pmatrix}
\ln (i/Pc\alpha) \\
\ln (w/Pc\beta) \\
\ln (r/Pc\gamma)
\end{pmatrix}
\]

\[
1/det A = 1/ (\alpha+\beta+\gamma-1) \text{ or } = 1/(-\eta)
\]

\[
\begin{pmatrix}
(1-\beta-\gamma)^{-\eta/\alpha} \\
\alpha^{-\eta} \\
\alpha^{-\eta}
\end{pmatrix}
\]

\[
\begin{pmatrix}
\beta^{-\eta} \\
(1-\alpha-\gamma)^{-\eta/\alpha} \\
\alpha^{-\eta}
\end{pmatrix}
\]

\[
\begin{pmatrix}
\gamma^{-\eta} \\
(1-\alpha-\beta)^{-\eta/\alpha} \\
(1-\alpha-\beta)^{-\eta/\alpha}
\end{pmatrix}
\]

\[
= \mathbf{A}^{-1}
\]

Figure 2. Matrix

Substituting parameters from the matrix (Figure 2) in the equations (4)-(6) and solving for \( K_0 \), one can get an own capital demand function, \( K_0 \):

\[
K_0 = (\alpha/ i)^{\eta/\alpha} (\beta/w)^{\eta/\alpha} (\gamma/r)^{\eta/\alpha} (Pc)^{1/\eta}
\]

(7)

Looking at the given equation in general, the demand for capital as derived from the profit maximization process is a function of the price of inputs, like \( w = \) wage, \( r = \) land rent, the price of the product, \( P \), and the opportunity cost of capital \( i \). As one can see from the (7) \( \partial K/\partial i < 0 \), or as the cost of own capital increases, then demand for own capital decreases; \( \partial K/\partial P > 0 \), so as the price of the product increases, then there is increased demand for the capital input to produce more output in response to the price increase.

### 4.2 Debt capital demand function

When using debt capital for the production process a firm maximization expected profit, \( \pi \) in general form could be express as follows:

\[
\pi = (\partial f(H) – (1+R) \omega H)
\]

where \( \omega \) – the rental rate per unit of input employed; since firm borrows the entire amount required to rent the capital input, its costs are incurred at the end of period when it pays off the loan; \( R \) – the interest rate charged by the intermediary (supplier of loan); \( \omega H \) – loan payment, the amount borrowed to finance production; \( R\omega H \) - the interest charges incurred over the production period; \( (1+R)\omega H \) – the total payment.
The level of production realized by the firm at the end of the period is given by \( \theta f(H) \), where \( H \) is the amount of the capital input employed by the firm, \( f(H) \) is a non-random term and the random term in the production function is \( \theta \), which is considered as an indicator of solvency.

This equation states that the firm chooses to maximize expected profits taking as given both the rental price of capital and the loan rate. Realized profits are the excess of revenues over loan payments provided the difference is positive (the firm is solvent) and zero otherwise. (Hughes et al. 1986)

In reality farmers make decisions in a risky environment every day. The consequences of their decisions are generally not known when the decisions are made. Furthermore, the outcome may be better or worse than expected. Variability of prices and yield are the biggest sources of risk in agriculture (Kaan 2009).

Thus, the profit function of the Cobb-Douglas form for the case of debt capital as a source of financing is:

\[
\pi = \theta P(cK_d^\alpha L^\beta N^\gamma) + (1- \theta) K_d - \theta RK - (1- \theta) sK_d - \mu K_d - wL - rN
\]

where

\( P \) – price for crop, 1000KZT
\( w \) – average wage rate, 1000KZT
\( r \) – agricultural land rent, 1000KZT
\( \theta \) – probability of success, percent
\( R \) – \((1+\text{loan interest rate})\)
\( s \) – share of collateral, percent of credit
\( \mu \) – share of a transaction cost, percent of credit.

“Risk” and “uncertainty” are two terms basic to any decision making framework. Risk can be defined as imperfect knowledge where the probabilities of the possible outcomes are known, and uncertainty exists when these probabilities are not known (Hardaker et al 1997). Incorporating risk in the production function means incorporating random variables in the decision problems faced by farm managers. (Antle 1983).

In agriculture, in particular in grain production, uncertainty is reduced to two main outcomes:

1) with probability, \( \theta \), farmers have such a level of revenue which covers all the production costs and, in the case of borrowing, allows to cover interest and principles;
2) with probability, \((1- \theta)\), farmers receive output only to repay the capital expenditures (K), and in the case of taking a loan no interests could be paid. Additionally, farmers will face a loss of assets given as collateral.

In this study the probability of success, \( \theta \), is supposed to be equal to the probability of situation when an enterprise realizes values to cover both principal in the amount of debt capital and the interest.

Taking first order conditions for a system of equations with debt capital as a term, and employing the Matrix Inversion method, and solving for capital, \( K \), one can get the debt capital demand (\( K_d^d \)) function:

\[
K_d = \left( \omega/\theta R + (1- \theta)(s-1) + \mu \right)^{(\eta+\alpha)/\eta}(\beta/w)^{\beta/\eta} (\gamma/r)^{\gamma/\eta} (\theta P_c)^{1/\eta}
\]  

(8)
From the equation (8) it is seen that $\partial K/\partial R < 0$, or as the cost of debt capital increases, then demand for debt capital decreases; the higher share of transaction cost and collateral, the lower demand for capital; $\partial K/\partial P > 0$ and $\partial K/\partial \theta > 0$, so the price of production and the probability of success increases, then demand for capital increases too.

### 4.3 Mixed capital demand function

The capital demand could be financed by debt and retained earnings. Most agricultural enterprises in Kazakhstan rely mainly on their own financial sources, but formal credit is very desirable and needed. The demand for debt capital and demand for own capital is strongly related. The question is what factors influence a proportion of debt and own capital and in what way.

Given the assumptions of profit-maximizing and price-taking behaviour on the part of the agricultural enterprises, the decision variables are the quantities of output and inputs. Thus, the profits function under combination of debt and own capital could be expressed as follows:

$$\pi = \theta P (cK^a m L^\beta N^\gamma) + (1 - \theta)K_m - \theta RbK_m - (1 - \theta) sbK_m - \mu bK_m - vbK_m - iaK_m - wL - rN,$$

where

- $a$ – share of own capital,
- $b$ – share of debt capital,
- $P$ – price for crop, 1000KZT,
- $w$ – average wage rate, 1000KZT,
- $r$ – agricultural land rent, 1000KZT,
- $\theta$ – probability of success, percent,
- $R$ – (1+ loan interest rate),
- $s$ – share of collateral, percent of credit amount,
- $\mu$ – share of transaction cost, percent of credit amount,
- $v$ – bribe rate, percent of credit amount in the case of subsidised credit.

The first-order conditions for the maximum is found by taking the derivative of profit, $\pi$, with respect to each of the inputs and setting this derivative equal to zero

$$\partial \pi/\partial K_m = \theta Pc\alpha K_m^{-1} L^\beta N^\gamma + (1 - \theta) Rb - (1 - \theta) sb - \mu b - vb - ia = 0 \quad (9)$$

$$\partial \pi/\partial L = \theta Pc\beta K_m^{a-1} L^{\beta-1} N^\gamma - w = 0 \quad (10)$$

$$\partial \pi/\partial N = \theta Pc\gamma K_m^{a-1} L^{\beta-1} N^{\gamma-1} - r = 0. \quad (11)$$

Undertaking above used algebraic steps for solving this system of equations (9) – (11) one can get the following function for mixed capital demand ($K_m$) in the case of decreasing returns to scale:

$$K_m = \left(1/ \theta Rb + (1-\theta) (sb-1) + \mu b + ia + vb\right)^{(\eta+\alpha)/(\eta \gamma)} \left(\beta/w \right)^{\eta/(\eta \gamma)} \left(\gamma/r \right)^{\eta/(\eta \gamma)} (\theta P c)^{1/\eta} \quad (12)$$

From the equation (12) it is seen that demand for debt capital decreases with increasing a bribe rate; the higher share of transaction cost and collateral, the lower demand for capital; $\partial K/\partial P > 0$ and $\partial K/\partial \theta > 0$, so the price of production and the probability of success increases, then demand for capital increases too.

### 4.4 Simulations
The “economic problem” to be solved is for a firm to maximize an objective function (profit function) in the face of constraints and cost (Anderson and Ross 2005). The firm faces constraints both with the physical nature of production (the production function) and costs (due to the production function and input prices).

In this study constrains are following:
1) own capital <= mean value of capital expenditures from the sample;
2) debt capital <= size of collateral;
3) labour <= mean value of labour in man power from the sample;
4) and land <= mean value of land size from the sample.

The size of collateral is taken as a lending limit equal .5 of equity (guarantee). In this study a mean value of equity is 25000 thousand KZT. An optimal ratio of own and debt capital is found using a sum of profit and of equity by the end of period as objective functions. Additionally, for the simplicity a sum of transaction cost is taken equal to zero.

Six factors influencing the ratio of own and debt capital are taken in simulations (Figure 3):
1. Price for output (price of wheat). As it is seen from Figure 3 (a) demand for debt capital increases with increasing of price for output. The increase in the price of product encourages a producer to increase the production, that is, there is a need to undertake additional investments. As the own capital is limited, the producer will inevitably resort to the debt capital.
2. Loan interest rate. Demand for debt capital decreases with the increased loan interest rate. At the rate of 1.09, the producer uses equally both own and borrowed capital (Figure 3 (b)). The interest rate of 1.09 corresponds to a loan interest rate by Rural Credit Partnerships and state favorable credit programs. Despite a high level of the interest rate for debt capital, agricultural producers still have a certain demand for debt capital.
3. Collateral. In economies with underdeveloped agricultural sector, credit is always rationed according to the ability to offer collateral. The amount of capital the agricultural producer can mobilise depends on the amount of land he owns or rents, which could be a good proxy for the overall wealth and, thus, his ability to offer collateral (Eswaran and Kotwal 1986). Agricultural land in Kazakhstan has not been accepted as collateral for bank loans during the 1990s due to an absence of clear ownership rights. However, even when property rights were established by the new Land Code of 2003, banks are still often refusing to accept agricultural land as collateral because of the absence of a functioning land market. Typically banks require residential property in urban as collateral. Decline in the amount of collateral reduces the ability of producer to apply for the loan; in the context of Kazakhstan it is impossible to receive the credit without collateral. Simulations show the proportion of debt capital in the total amount of capital increases with increase in the value of collateral up to a value of 6000 thousand KZT, after reaching this value the demand for debt capital is not longer dependant on size of collateral (Figure 3 (c)).
4. Deposit interest rate. In this study a deposit interest rate is taken as an opportunity cost of own capital. With increasing a deposit interest rate a producer is interested to put his own capital to a bank instead of investing it into production process and the lower a loan interest rate and the higher a deposits interest rate, the more profitable to
borrow capital than to use own capital. In this study, with deposit interest rate of 1.16 a producer will benefit using exclusively debt capital (Figure 3 (d)). Obviously, a producer would prefer to invest his own capital to the projects with higher opportunity costs than to have his capital tired in the less profitable activity.

5. **Probability of success.** When the probability of success is of 40 percent it becomes unprofitable to use own capital and the usage of the debt capital becomes inefficient when the probability of success is lower than 90 percent. The average probability of good harvest in the Pavlodar region based on data for the last 15 years is about 80 percent (Figure 3 (e)). Thus, agricultural producers have every reason to expect not to be rejected in obtaining credit from formal sources.

6. **Bribe rate.** From the Figure 3 (f) it is seen that a higher bribe rate leads to decreasing demand for subsidised credit. However, despite the bribe rate approaches a level of the loan interest rate, the demand for capital is still exists. The officials, who are in charge of the credit allocation, often deliberately undertake dilatory tactics with a view to forcing the offer of bribes from the agricultural producers. Let assume the enterprise would like to apply for the subsidized credit. The supply of this credit is controlled by a local agricultural department. The department recommends commercial banks the enterprises which could be considered as potential borrowers. Thus, the enterprises having need for credit are dependent on the local officials’ decision. It creates conditions for the corruption. Thus, even though local officials have no control over the loan interest rate which is administratively determined, the effective interest rate on subsidized credit must include the bribe and the officials concerned determine the bribing rate (Manash and Chaudhuri 1997).

![Graph a. Price for output](image1)

![Graph b. Loan interest rate](image2)
Figure 3. Factors influencing capital demand

5. Conclusions

The main purpose of this paper is to show how various factors influence demand for capital in agriculture of Kazakhstan. A capital demand function was expressed from a profit function of the Cobb-Douglas type of production function.

Demand for capital heavily depends on such a factor as a rental price for both own and debt capital: the higher price for capital the less demand for it. If opportunity cost of own capital is higher than cost of debt capital, the enterprise preferably would use debt capital. However, agricultural enterprises in Kazakhstan are very credit rationed and access to formal credit is very restricted.

Among other factors influencing demand for capital such a factor as a price for output is very significant. An increase in the price of output encourages a producer to increase the production volume, that is, he/she faces a necessity to undertake additional investments. As an own capital is limited, the producer will inevitably resort to the debt capital.
Since grain production in Kazakhstan is very risky, commercial banks are very reluctant in crediting agricultural producers. However, it is so-called an “exclusive circle”, agricultural enterprises need investments into technology and equipment in order to decrease risks of production and as a result they need external financing, at the same time formal credit institutions do want to take risky projects and finance agriculture. In this situation subsidised credits could play a significant role and facilitate access to a formal crediting for agricultural producers. However, this process should be more transparent and exclude such a phenomenon as corruption.

Major determinants of credit rationing are the size of arable land and the cost of equipment expressing an ability to submit them as collateral. Indeed, commercial banks as well as rural credit partnerships in Kazakhstan are reluctant to have any deal with agricultural enterprises having no sufficient collateral to submit. Taking into account that the overwhelming majority of agricultural producers have very worn-out machinery and buildings, they are very strictly rationed by commercial banks. Additionally, underdeveloped land market and unclear regulations concerning implementation of the land use rights in Kazakhstan makes commercial banks accept as collateral preferable land situated in the urban area or very close to it, to be able to sell it without problems in the case of default. As for rural credit partnerships, those enterprises which have large enough land plots have high probability to be granted with credits. Additionally, those enterprises, whose production capacities are higher, that is, they need more fuel and seeds could be considered as the most reliable borrowers.

6. References

Book reference

Journal reference


URL reference


<http://www-sre.wu-wien.ac.at/ersa/ersaconfs/ersa05/papers/220.pdf>


Book chapter reference


Appendix 1

Estimated production functions

<table>
<thead>
<tr>
<th>N=76</th>
<th>Cobb-Douglas</th>
<th>Transcendental</th>
<th>Translogarithmic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residual sum</td>
<td>8.40</td>
<td>8.32</td>
<td>40.5</td>
</tr>
<tr>
<td>Residual variance</td>
<td>34.99</td>
<td>26.68</td>
<td>145.06</td>
</tr>
<tr>
<td>R²</td>
<td>0.76</td>
<td>0.76</td>
<td>0.78</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Estimated coefficients</th>
<th>t-values</th>
<th>Estimated coefficients</th>
<th>t-values</th>
<th>Estimated coefficients</th>
<th>t-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant 1.31 (0.69)</td>
<td>1.89</td>
<td>2.18 (0.99)</td>
<td>1.9</td>
<td>145.87 (3.30)</td>
<td>1.51</td>
</tr>
<tr>
<td>lnCapital 0.67 (0.13)</td>
<td>4.87</td>
<td>0.63 (0.17)</td>
<td>3.7</td>
<td>0.39 (0.57)</td>
<td>0.69</td>
</tr>
<tr>
<td>lnLand 0.16 (0.10)</td>
<td>1.54</td>
<td>0.12 (0.13)</td>
<td>0.9</td>
<td>0.81 (0.78)</td>
<td>1.03</td>
</tr>
<tr>
<td>lnLabour 0.157 (0.14)</td>
<td>1.12</td>
<td>0.18 (0.18)</td>
<td>0.9</td>
<td>-0.72 (0.48)</td>
<td>-1.48</td>
</tr>
<tr>
<td>Capital 8.1E-10 (3.7E-10)</td>
<td>2</td>
<td>Land 5.802E-08 (1.5E-09)</td>
<td>0.4</td>
<td>Labour -0.0007 (0.002)</td>
<td>-0.3</td>
</tr>
<tr>
<td>.5lnCapital lnLabour</td>
<td>-0.34 (0.15)</td>
<td>-2.22</td>
<td>.5lnCapital lnLand</td>
<td>0.17 (0.15)</td>
<td>1.13</td>
</tr>
<tr>
<td>.5lnLabour lnLand</td>
<td>0.22 (0.23)</td>
<td>0.96</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: standard errors in the parentheses