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Capital market imperfections in economic transition: empirical evidence from Ukrainian agriculture

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Abstract

This article investigates the link between financing and investment in Ukrainian agriculture during economic transition. The main contribution of the study is to provide empirical evidence for the coexistence of financial constraints and soft budget constraints (SBCs). This is of particular importance because credit constraints and SBCs have completely different economic effects. The lack of differentiation between these forms of capital market imperfections yields overlapping effects of financing on investment and may therefore cause a misinterpretation of econometric results. Our empirical analyses are based on an econometric estimation of the Euler investment equations for 529 large farms from three Ukrainian regions between 2001 and 2005. The results confirm that financial variables significantly influence farms' investment, providing empirical evidence of an imperfect capital market in Ukrainian agriculture. It turns out that credit constraints in the Ukrainian agricultural sector are more important than SBCs. We show that the estimated level of financial constraints for profitable farms with access to loans is higher if both types of capital market imperfections are appropriately distinguished.

JEL classification: D92, Q12, Q14

Keywords: Transition agriculture; Investment; Credit constraints; Soft budget constraints; Ukraine

1. Introduction

Financial resources are a major determinant of farm development. This is particularly true for transition economies, where modernization and rationalization investments are required to increase economic performance. Neoclassical investment theory asserts that investment decisions are separable from financial decisions under perfect capital market conditions. However, there is much empirical evidence that the assumption of perfect capital markets does not apply in transition economies (Hanousek and Filer, 2004; Lizal and Svejnar, 2002; Rizov, 2004a, 2004b). In the case of imperfect capital markets, neo-institutional finance theory is commonly applied when explaining investment decisions, and within this theory, two different concepts can be distinguished. Credit rationing theory (Stiglitz and Weiss, 1981) focuses on the presence of information asymmetries in the lender–borrower relationship. Credit rationed firms are unable to borrow the desired amount of capital despite their willingness to pay current interest rates. As a result, these firms face an underinvestment problem. Empirical applications of credit rationing theory and capital market imperfections are comprehensively reviewed in Hubbard (1998) and in Petrick (2005). Credit rationing can be mitigated by measures that reduce informational asymmetry, for example, monitoring activities. However, such measures are costly and drive a wedge between the costs of external and internal financing. This leads to a financial pecking order (Myers and Majluf, 1984).

The second relevant approach in this context is the concept of soft budget constraints (SBCs) (Kornai et al., 2003), which focuses on state bailouts for unprofitable organizations with subsidies, credits, tax privileges, and other policy instruments. The SBCs phenomenon in former socialist countries is caused by governments' paternalistic objectives of providing post-transition economic and social stability. Moreover, this

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Data Appendix Available Online

A data appendix to replicate main results is available in the online version of this article. Please note: Wiley-Blackwell is not responsible for the content or functionality of any supporting information supplied by the authors. Any queries (other than missing material) should be directed to the corresponding author for the article.

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concept may apply to firms, nonprofit institutions, and local government authorities. Under soft macroeconomic conditions, firms' investment rates are comparably high, as capital access is increased due to public support.

A number of studies analyze the impact of financial constraints on investment in the agricultural sector of post-socialistic countries. For example, Petrick (2004a, 2004b), when investigating the evidence of credit rationing in Polish agriculture, reveals that this phenomenon is determined by a lack of collateral and that subsidized credits are important for farms' investment decisions. Moreover, Latruffe (2005) explains the presence of an imperfect rural capital market in Poland with comparably high borrowing costs for new loans. Bokusheva et al. (2007) show for Russian farms that deviations from the optimal investment path are due to the limited availability of internal funds as well as permanent sales shocks. Colombo and Stanca (2006) find a nonsignificant relationship between the firms' performance and capital access, which is interpreted as proof of SBCs. Bezlepkina and Oude Lansink (2003) investigate the impact of capital structure on the efficiency of large farms in Russia; special attention is paid to credits and subsidies that weaken the unprofitable enterprises' optimizing behavior and thus may provoke the persistence of SBCs. However, existing empirical studies about the financing–investment relationship in economic transition focus on either credit rationing or SBCs and do not consider both phenomena in one unified empirical model.

In this article, we investigate the link between investment and financing in the Ukrainian agricultural sector by means of an econometric model. For this purpose, we take up an established Euler investment equation and try to adapt it to the particular situation of transition countries. Our main contribution is to distinguish different types of capital market imperfections, that is, we want to know if empirical evidence exists for the coexistence of financial constraints and SBCs. We conjecture that SBCs are still present in those large Ukrainian farms that have inherited good relationships with the authorities and financial institutions. At the same time, we expect that many farms face financial constraints. It is important to distinguish both types of capital market imperfections because they have completely different causes and implications for both farms and agricultural policy. Virtual financial constraints hinder profitable farm investments. Signaling or screening activities or foreign direct investments could be appropriate measures in this situation. SBCs, on the other hand, lead to over-investment in unprofitable farms and result in capital misallocation. In such cases, strengthening financial discipline might be adequate.

Testing for the presence of the two types of capital market constraints is not a trivial task. A common approach is to include cash flow into the firm's investment demand function (Fazzari et al., 1988). A significantly positive cash flow–investment relationship is then interpreted as evidence for the presence of financial constraints. The reasoning behind this conclusion is that when the firm's opportunity costs of internal funds are substantially lower than its cost of external finance, internal and external funds are no longer perfect substitutes. As a result, realized investments are sensitive to the availability of cash. Accordingly, a negative or nonsignificant cash flow coefficient is interpreted as signifying perfect capital market conditions. However, such a conclusion is questionable since a zero or nonsignificant cash flow sensitivity could also be a result of SBCs. Moreover, the existence of SBCs farms may also dilute the impact of financial constraints on farms in the same sample. Here, we try to overcome this problem of inference by choosing appropriate sample selection criteria when estimating our econometric model. In so doing, we face the challenge that a model designed to test the presence of credit constraints has to simultaneously cope with SBCs.

The remainder of the article is organized as follows. In the second section, we provide some background information on investment and finance in Ukrainian agriculture. The third section develops a structural model of investment using a Euler equation approach. Thereafter, this model is applied to three Ukrainian regions representing agricultural production under various environmental and economic conditions. Data and estimation methods are discussed in the fourth section. The fifth section presents the empirical results, whereas the final section discusses the relevance of our findings in understanding the role of financial constraints in lagging transition economies.

2. Investment and financing in Ukrainian agriculture

The agricultural sector still makes up a considerable part of the national economy in Ukraine, with respective shares in GDP and employment of about 11% and 10% (State Statistical Committee of Ukraine, 2006). The transition process in the Ukrainian agricultural sector can be characterized by two main phases of agricultural reform: from 1991 to 1999, dominated by large Soviet-style enterprises, and after 1999, with many newly established small- and medium-sized farms. Despite an increasing number of emerging small farms, large enterprises, that is, former state and collective farms, remain important because of the land-intensive farming tradition in Ukraine, as well as the government's desire to maintain control over agricultural production (Swinnen, 2006). The internal structure of large farms often reveals the persistence of traditional central management and organization features that have remained unchanged for several decades.

The lowest level of investment in Ukrainian agriculture can be observed in the pre-reform period between 1996 and 2000 (Table 1). This period showed a drastic decline in investment of about 59% in the national economy and an 86% decline in the agricultural sector. From 2000 onward, the absolute sum of on-farm investment increased, though it reached only 32% of the sum invested between 1991 and 1995. As economic development has shifted toward the industry and service sectors, the gap between agricultural and nonagricultural investment should have increased. The current investment share of agriculture in the national economy is hovering around the 5% level,

Table 1
Investments in Ukrainian agriculture

Years	National economy	Agriculture			Processing industry		% of 1991–1995		
	Mio. UAH	Mio. UAH	UAH per ha	Ratio (%)	Mio. UAH	Ratio (%)	National economy	Agriculture	Processing industry
1991–1995	30,316	4,853	116	16.0	1,726	5.7	100.0	100.0	100.0
1996–2000	12,462	690	16	5.5	756	6.1	41.1	14.2	43.8
2001–2005	28,761	1,542	37	5.4	2,408	8.4	94.9	31.8	139.5

Notes: Monetary values are given as an annual average in the national comparison prices, developed and introduced by the State Statistical Committee of Ukraine, reference year is 2000. UAH is the abbreviation for the Ukrainian currency, with 1 USD = 5.05 UAH (National Bank of Ukraine, 2008).
Source: Institute of Agricultural Economics of Ukraine (2005), own calculations based on data from the State Statistical Committee of Ukraine (2006, 2007).

compared to 16% at the beginning of the 1990s. However, the level of on-farm investment per hectare of agricultural land is far from optimal when compared to Western standards, and thus a huge demand for modernization and rationalization investments is present. For example, Morton et al. (2005) assess the total obsolescence of assets in Ukrainian agriculture at about 80%. The question thus arises whether low investment rates result from weak competitiveness and lacking human capital (Lissitsa and Odening, 2005), or whether financial constraints may be a major factor influencing the farms' investment behavior.

Kobzev et al. (2004) report that equity capital, though inadequate, provides about 80% of the agricultural enterprises' financial resources. Between 1991 and 1999, bank credits to the agricultural sector were often replaced by so-called commercial credits, that is, prolonged obligations to suppliers, customers, and the state (Sedik et al., 2000). Later, the government supported large farms by writing-off old debts, state orders, and state commodity credits. During the 2000s, bank loans have contributed about half of the external financial resources received by agricultural enterprises, with the remainder being credits from input suppliers, the processing industry, leasing companies, credit unions, and other corporate and private enterprises (Chapko, 2003). Since 2000, the state has subsidized interest rates for agricultural bank loans, primarily on a "first-come-first-served" basis. Agriculture currently receives about 7% of the total bank loan volume in Ukraine compared to 18% at the beginning of the 2000s (Table 2). Between 2000 and 2007, the increase in borrowing has been almost three times higher in the whole economy than in the agricultural sector. Comparing the figures of investments per hectare and loans per hectare, one might be tempted to conclude that available loans are sufficient for financing investments. However, only a small part of the loans is used for investments, whereas the major portion is spent on variable inputs. Chapko (2003) even states that the issued loans cover only 50% of the credit demand for variable inputs, and 2% for long-term debt. It should also be noted that most of the long-term loans have a duration of one to three years, which is much shorter than in developed Western economies (Morton et al., 2005).

3. Modeling investment under financial constraints

3.1. Theoretical background

This section derives an investment demand function from the first-order conditions of a firm's dynamic optimization problem (Euler investment equation). The Euler equation comprises the marginal productivity of capital and the cost of capital, including the marginal adjustment costs of investing now and the marginal costs of investing in the next period (Whited, 1992). This marginal condition allows us to take into account financial constraints expressed by increasing costs of debt in the case of growing leverage (Bond and Meghir, 1994). Following Rizov (2004b), we consider a firm that maximizes the following value function:

$$V_t = \max_{I_t, L_t} E_t \left[\sum_{\tau=0}^{\infty} \theta_{t+\tau} d_{t+\tau} \right], \tag{1a}$$

Table 2
Agricultural bank loans in Ukraine

Years	National economy		Agriculture			
	Mio. UAH	% of 2000–2001	Mio. UAH	UAH per ha	Ratio (%)	% of 2000–2001
2000–2001	22,165	100.0	9,352	94	17.8	100.0
2002–2003	46,196	208.4	6,873	164	14.9	173.9
2004–2005	99,554	449.1	9,004	214	9.0	227.8
2006–2007	206,464	931.5	13,628	324	6.6	344.8

Notes: Monetary values are given as an annual average in the national comparison prices, developed and introduced by the State Statistical Committee of Ukraine, reference year 2000. UAH is the abbreviation for the Ukrainian currency, with 1 USD = 5.05 UAH (National Bank of Ukraine, 2008).
Source: Own calculations based on data from the National Bank of Ukraine (2001–2008).

subject to:

$$d_t = \pi_t(K_t, L_t, I_t) - r_t D_{t-1} + B_t - g(B_t) - R_t, \tag{1b}$$

$$d_t \geq \bar{d}_t, \tag{1c}$$

$$K_t = (1-\delta)K_{t-1} + I_t, \tag{1d}$$

$$D_t = D_{t-1} + B_t - R_t, \tag{1e}$$

$$B_t \geq 0. \tag{1f}$$

Herein, V_t is the firm's value function, d_t is a dividend payment, that is, a private benefit, to the farm owners as defined in Eq. (1b). $\pi_t(.)$ is the net revenues, K_{t-1} is the beginning-of-period capital stock, L_t is a vector of variable inputs, I_t is an investment, and r_t is an interest rate. D_{t-1} is the beginning-of-period debt, B_t is new borrowing, and R_t are repayments. In what follows, the transaction costs $g(B_t)$, associated with new borrowing (e.g., arrangement and commission fees), are assumed to be proportional to the debt volume: $g(B_t) = \gamma B_t$. E_t is an expectation operator, and the discount factor $\theta_{t+\tau}$ is defined by:

$$\theta_{t+\tau} = \left\{ \begin{array}{ll} \prod_{n=0}^{\tau-1} 1/(1+r_{t+n}), & \forall \tau > 0 \\ 1, & \tau = 0 \end{array} \right\}. \tag{2}$$

Maximizing the objective function (1a) is equivalent to maximizing the expected present value of farm profits. Equation (1c) introduces a floor, $\bar{d}_t$, to the dividends. This floor is comparable to a minimum consumption level in a family farm. Setting $\bar{d}_t$ equal to zero means that shareholders are unwilling to grant money to the firm. Equations (1d) and (1e) describe the motion of capital and debt, respectively. Therein, δ is the depreciation rate of capital. The nonnegativity constraint (1f) rules out financial investments at interest rate r_t. Considering K_{t-1} and D_{t-1} as state variables, the maximization function given in Eq. (1) can be rewritten as a dynamic programming problem:

$$\begin{aligned} V_t(K_{t-1}, D_{t-1}) = \max_{I_t, L_t} \{&\pi_t((1-\delta)K_{t-1} + I_t, L_t, I_t) - r_t D_{t-1} \\ &+ B_t - \gamma B_t - R_t + \theta_{t+1} E_t[V_{t+1}((1-\delta) \\ &\times K_{t-1} + I_t, D_{t-1} + B_t - R_t)]\}, \end{aligned} \tag{3}$$

subject to:

$$\pi_t((1-\delta)K_{t-1} + I_t, L_t, I_t) - r_t D_{t-1} + B_t - \gamma B_t - R_t \geq \bar{d}_t,$$
$$B_t \geq 0.$$

In Eq. (3), the expectation formation E_t is conditional on information at the beginning of period t. This implies that t-dated variables in Eq. (3) are assumed to be certain, whereas future variables are random.[1]

Bond and Meghir (1994) show that under perfect capital market conditions, that is, if there is no transaction cost for borrowing, the following Euler investment equation can be derived from the first-order conditions of problem (3):

$$-(1-\delta)\theta_{t+1}\frac{\partial \pi_{t+1}}{\partial I_{t+1}} = -\frac{\partial \pi_t}{\partial I_t} - \frac{\partial \pi_t}{\partial K_t} + \varepsilon_{t+1}, \tag{4}$$

where ε_{t+1} is an expectation error term. Therein, the left side expresses the shadow value of an additional unit of capital in $t+1$ discounted back to its value in t, and the right side contains the marginal costs of investing in an additional unit of capital in t.

In what follows, Eq. (4) serves as a benchmark model. Deriving a Euler investment equation that accounts for capital market imperfections is more complicated, because an unobservable Lagrange multiplier for the borrowing constraint in Eq. (3) comes into play. It is important to distinguish two borrowing regimes: In the first situation, no borrowing constraints apply and hence the Lagrange-multiplier is equal to zero. This situation can be assumed to hold if borrowing in two consecutive periods can be observed ($B_t > 0$ and $B_{t+1} > 0$). Firms receiving new loans in consecutive periods are classified *a priori* as financially unconstrained.[2] If, on the other hand, firms do not receive loans, borrowing constraints potentially exist. Firms falling in this second regime are termed *a priori* financially constrained. The Euler investment equations for these two regimes can be expressed as

$$-(1-\delta)\frac{\partial \pi_{t+1}}{\partial I_{t+1}} = \begin{cases} -\left(\dfrac{1+r_t-\gamma}{1-\gamma}\right)\dfrac{\partial \pi_t}{\partial I_t} - \left(\dfrac{1+r_t-\gamma}{1-\gamma}\right)\dfrac{\partial \pi_t}{\partial K_t} + \varepsilon'_{t+1} & \text{if } B_t > 0, B_{t+1} > 0 \quad \text{(5a)} \\ -\chi_1\dfrac{\partial \pi_t}{\partial I_t} - \chi_2\dfrac{\partial \pi_t}{\partial K_t} + z(X) + \varepsilon''_{t+1} & \text{otherwise.} \quad \text{(5b)} \end{cases}$$

[1] Our model does not mention the sources of uncertainty. Modeling a specific type of uncertainty is beyond the scope of this article as it would lead to a stochastic control problem and complicate the derivation of the investment demand functions. For an empirical analysis of the impact of uncertainty on investment demand, we refer the reader to Hinrichs et al. (2008). Neither do we make an explicit assumption on the risk preferences of farmers. Maximizing the expected present value of dividends suggests risk neutrality, but risk aversion could be captured by using an appropriate risk adjusted discount rate.

[2] Note that this formulation only takes into account credit rationing of type II following Keeton (1979), that is, credit applicants either receive credit or do not. Credit rationing of type I, that is, quantity rationing, which may also exist in Ukrainian agriculture, is not captured. A reviewer suggested introducing an upper limit for the new borrowing to address this kind of capital market imperfection. However, we cannot uncover a way to estimate this phenomenon empirically because we are unable to distinguish constrained and unconstrained farms with the data at hand.

The expression for the unconstrained regime Eq. (5a) is derived in the Appendix and can be regarded as a generalization of Eq. (4) in the case of positive transaction costs ($\gamma > 0$). Expression (5b) represents the constrained financial regime. Herein, χ_1 and χ_2 are arbitrary parameters which differ from those $\frac{1+r_t-\gamma}{1-\gamma}$ in Eq. (5a). These parameters cannot be derived from the first-order conditions of problem (3), as the Lagrange multiplier for the borrowing constraint is not equal to zero in this case. Moreover, Eq. (5b) is complemented by a function $z(.)$ of a vector X of state and other exogenous variables that represent the difference between the two financial regimes. Problems (4) and (5), respectively, form the basis of the empirical model, which tests for the presence of capital market imperfections.

3.2. Empirical specification

For the empirical specification of the firm investment model, we define the net revenues function $\pi_t(.)$ as follows:

$$\pi_t = p_t F(K_t, L_t) - p_t G(I_t, K_t) - w_t L_t - p_t^I I_t, \tag{6}$$

where w_t is the price of variable factor inputs, p_t is the output price, and p_t^I is the price of investment goods. $F(K_t, L_t)$ is assumed to be a linear homogeneous production function with constant returns to scale. $G(I_t, K_t)$ is a quadratic adjustment cost function, which is linearly homogeneous in investment and capital:

$$G(I_t, K_t) = \frac{\alpha}{2}\left(\frac{I_t}{K_t} - \beta\right)^2 K_t, \quad \alpha, \beta \geq 0. \tag{7}$$

Herein, α is an adjustment cost parameter and β is a "normal" rate of investment (Whited, 1992). This functional form does not refer to the possible irreversibility of investment decisions and builds on the assumption that firms minimize their adjustment costs if β is close to the average investment–capital ratio. Actually, adjustment costs reflect a variety of factors that are difficult to measure directly. These factors may include: learning costs of new technologies, disruption costs during installation or dismantling of new or replacement capital, delivery lags, as well as the lack of secondary markets for used capital goods.[3]

As the output function $Y(K_t, L_t, I_t) = F(K_t, L_t) - G(I_t, K_t)$ is also linearly homogeneous, it follows that:

$$\frac{\partial \pi_t}{\partial I_t} = -\alpha p_t \left(\frac{I}{K}\right)_t + \alpha\beta p_t - p_t^I, \tag{8a}$$

$$\frac{\partial \pi_t}{\partial K_t} = p_t \left(\left(\frac{Y}{K}\right)_t - \frac{\partial F}{\partial L}\left(\frac{L}{K}\right)_t\right) + \alpha p_t \left(\frac{I}{K}\right)_t^2 - \alpha\beta p_t \left(\frac{I}{K}\right)_t. \tag{8b}$$

Furthermore, the marginal product of variable factors $\partial F/\partial L$ is approximated by w_t/p_t, without specifying a parametric form of the production function. The first term in Eq. (8b) expresses the relative operating profit, which highly correlates with the relative cash flow (CF). Combining expressions (8a) and (8b) leads to the following equation:

$$\left(\frac{I}{K}\right)_{t+1} = \beta\left(1 - \frac{1}{\phi_{t+1}}\right) + \frac{1+\beta}{\phi_{t+1}}\left(\frac{I}{K}\right)_t - \frac{1}{\phi_{t+1}}\left(\frac{I}{K}\right)_t^2 - \frac{1}{\alpha\phi_{t+1}}\left(\frac{CF}{K}\right)_t + \frac{1}{\alpha\phi_{t+1}} J_t + \varepsilon_{t+1}, \tag{9}$$

where $\phi_{t+1} = p_{t+1}/p_t((1-\delta)/(1+r_t))$ and $J_t = 1/p_t((r_t p_t^I + (p_t^I - p_{t+1}^I + \delta p_{t+1}^I))/(1+r_t))$. The factor ϕ_{t+1} denotes a firm-specific real discount factor on new investment, and J_t reflects the Jorgensonian user (opportunity) costs of capital.[4] As we do not attempt to estimate J_t directly, this term can be replaced in the empirical equation by firm- and time-specific effects. Furthermore, we consider two additional variables in the model specification. The first is the output–capital ratio, which has been eliminated from the Euler equation assuming perfect competition and constant returns to scale. Introducing the output–capital ratio controls for imperfect competition and nonconstant returns to scale. Following Bond and Meghir (1994), we also include the squared debt-to-capital ratio, which accounts for the inseparability of investment and borrowing decisions in the case of imperfect capital markets. This can be motivated by the increased bankruptcy probability of leveraged farms and a nonzero bankruptcy cost. These modifications lead to the empirical Euler equation:

$$\left(\frac{I}{K}\right)_{i,t} = b_0 + b_1\left(\frac{I}{K}\right)_{i,t-1} + b_2\left(\frac{I}{K}\right)_{i,t-1}^2 + b_3\left(\frac{CF}{K}\right)_{i,t-1} + b_4\left(\frac{Y}{K}\right)_{i,t-1} + b_5\left(\frac{D}{K}\right)_{i,t-1}^2 + q_i + s_t + \varepsilon_{i,t}, \tag{10}$$

where $(I/K)_{i,t}$ is the investment–capital ratio of the firm i in the period t. $(CF/K)_{i,t-1}$ represents the lagged cash flow–capital ratio, $(Y/K)_{i,t-1}$ is the lagged output–capital ratio, and $(D/K)_{i,t-1}^2$ stands for the lagged squared debt-to-capital ratio. q_i and s_t reflect farm- and time-specific effects, respectively, and $\varepsilon_{i,t}$ is an i.i.d. composite error term.

Under the null hypothesis of perfect capital markets, it can be shown that if $\beta \geq 0$ and $\phi_{t+1} \leq 1$, then $b_1 = (1+\beta)/\phi_{t+1} \geq 1$,

[3] The use of a quadratic adjustment cost function for capital is a standard assumption in the neoclassical investment-modeling framework (see, e.g., Summers, 1981). However, there is an intensive debate about the appropriateness of this assumption. Abel and Eberly (1994) introduce a more general class of adjustments costs functions showing nonconvexities and discontinuities. This choice allows for an explanation of lumpy investments and the irreversibility of investment decisions. Nevertheless, we believe that the assumption about convex adjustment costs is reasonable for our analysis since further on we focus on positive investments.

[4] The user cost of capital can be interpreted as the minimum required rate of return of an investment project, which depends on interest rates, inflation, and depreciation (Jorgenson, 1963).

if $\phi_{t+1} \leq 1$, then $b_2 = -1/\phi_{t+1} \leq -1$, and if $\alpha > 0$ and $\phi_{t+1} \leq 1$, then $b_3 = -1/\alpha\phi_{t+1} < 0$. As indicated earlier, we expect $b_4 = 0$ under perfect competition and constant returns to scale. The coefficient of the debt variable is expected to be zero under perfect capital markets ($b_5 = 0$) and positive in the case of significant bankruptcy costs of debt ($b_5 > 0$).

The theoretical model implies that under perfect capital market hypothesis, a farm can raise as much finance as desired at a given level of capital costs. In the empirical model, financial constraints manifest themselves in the sensitivity of investment to measures of internal finance. In the case of developed market economies, a low cash flow sensitivity of investment ($b_3 \leq 0$) is usually interpreted as evidence of perfect capital markets. In transition countries, however, this conclusion is not stringent (see, for instance, Maurel, 2001). The reason is that in a soft financial environment, even unprofitable firms may be provided with credit. This provision of money allows for the realization of investments independent of cash flow. As a result, these firms exhibit a lower cash flow sensitivity of investment, which translates into a nonsignificant cash flow parameter in the Euler equation. That means a nonpositive cash flow parameter may indicate the presence of the SBCs phenomenon rather than perfect capital market conditions. Accordingly, a significant sensitivity of investment with regard to cash flow ($b_3 > 0$) may reflect the process of budget constraints' hardening, or binding liquidity constraints.[5]

Directly modeling SBCs is hampered by the complexity of the SBCs phenomenon. Many SBCs sources and impacts are discussed in the literature. First, one strand of literature refers to the altruistic behavior of the political system (Kornai et al., 2003). Given that local governments believe in the advantages of large-scale agriculture, they may use their access to resources and authority mechanisms to favor large farms. Another strand of the literature refers to SBCs as a dynamic commitment problem (see Dewatripont and Maskin, 1995). The source of the commitment problem is sunk costs. That is, when creditors decide whether or not to refinance a defaulting debtor, the initial investment is sunk. The latter prevents the creditor from refusing to refinance a debtor whenever this debtor is *ex post* loss-making. Moreover, some authors refer to the concept of creditor passivity. According to Mitchell (2000), SBCs are created by passive creditors (which rollover and refinance debt in default to hide their own financial difficulties). This can result in refinancing of nonviable firms. Regarding this complexity, it is difficult to establish a clear relationship between the presence of SBCs and the farm's financial strategy.

Accounting for the investment–financing relationship in a simple linear fashion as in Eq. (10) is obviously inadequate because of the nonlinearity implied by the two financial regimes in Eq. (5). Besides the borrowing farms that are considered as *a priori* unconstrained, a considerable part of those farms do not receive loans and thus should face a different sensitivity of investment demand to the capital structure. Thus, we split the total sample into two subsamples according to their financial status as in expression (5). A difficulty arises from the fact that it is almost impossible to identify the exact years during which a firm is constrained. In other words, it is difficult to differentiate between the firm-specific effects on investment and the effects of financial constraints (Kaplan and Zingales, 1997), which requires determining exogenously the premium on external finance, and furthermore, whether a firm is confronted with more or less severe market imperfections. A remedy for separating the impact of the financial constraints is to use the indicator for the availability of external funds, that is, the financial status, as a time-specific dummy variable, *X*. This variable equals one when no new borrowing is present, and zero otherwise. The dummy interacts with the other variables from Eq. (10) for the constrained regime and expresses the difference between the two financial regimes. This leads, in turn, to the final estimation model:

$$\begin{aligned}\left(\frac{I}{K}\right)_{i,t} = {} & b_0 + b_1\left(\frac{I}{K}\right)_{i,t-1} + b_2\left(\frac{I}{K}\right)^2_{i,t-1} + b_3\left(\frac{CF}{K}\right)_{i,t-1} \\ & + b_4\left(\frac{Y}{K}\right)_{i,t-1} + b_5X^*\left(\frac{I}{K}\right)_{i,t-1} \\ & + b_6X^*\left(\frac{I}{K}\right)^2_{i,t-1} + b_7X^*\left(\frac{CF}{K}\right)_{i,t-1} \\ & + b_8X^*\left(\frac{Y}{K}\right)_{i,t-1} + q_i + s_t + \varepsilon_{i,t}. \qquad (11)\end{aligned}$$

4. Data and estimation methodology

Our empirical analyses are based on data provided by the State Statistical Committee of Ukraine. This is an unbalanced panel data set collected from 700 agricultural enterprises in three Ukrainian regions (*oblasts*) between 2001 and 2005. We examined 3,426 observations from Zhytomyr, Cherkasy, and Mykolayiv oblasts, which represent different natural and economic zones of agricultural production. The Zhytomyr region is located in the northern part of the country, the Cherkasy region is in the central portion, and the Mykolayiv region is in southern Ukraine. Controlling for outliers reduced our sample from 700 to 636 farms and 3,136 observations of negative, zero, and positive investments. Outliers are defined as follows: (i) the debt/equity levels and/or the capital stock are negative; (ii) the capital accumulation equation is not consistent; (iii) investments exceed the beginning-of-period capital stock more

[5] This interpretation may be disturbed by additional impacts of the cash flow on investments. For example, a large cash flow may be regarded as an indicator of high (expected) marginal productivity of capital and thus of investment opportunities. Gomes (2001) points out that a significant cash flow variable does not necessarily account for financial frictions, but might rather be the result of an inappropriate model specification. Moreover, Kaplan and Zingales (1997) note that the cash flow–investment relationship may be nonmonotonic because of the different levels of the cost premium for external funds. However, Bond et al. (2003) acknowledge that the danger of misinterpreting the impact of the cash flow is lower in structural models (e.g., Euler equation models) than in reduced form models (e.g., simple accelerator models).

than two times, implying that the investment–capital ratio is larger than two; and (iv) the cash flow–capital ratio is larger than five. A few special farm types, for example, mainly perennial crop production, have been excluded from the analyzed sample. Moreover, in line with the common rules applied in the investment literature we remove all observations from the data sample that are below the 1‰ and above the 99‰ of the (squared) investment rate, cash flow rate, output rate, and squared debt rate.

Our choice of regions under consideration aims to discover main regional disparities across the country and thus to create a representative data sample. Thereby, some differences in size of farmland can be observed.[6] However, those are rather regional-specific and do not contradict the assumption of farm-size homogeneity within the regional farm groups. On average, corporate farms in the south and central Ukraine are larger than those in the north. The mean farm size is 1,040 ha in the Zhytomyr region, 1,257 ha in the Cherkasy region, and 1,608 ha in the Mykolayiv region. The overlap in sizes is more pronounced for the Cherkasy and Mykolayiv regions. This fact can at least be partially explained by local natural conditions and respective farm specializations. Farms in the Zhytomyr region are mainly livestock and mixed producers (42% and 41%), whereas those in the Mykolayiv and Cherkasy regions are plant producers (95% and 61%). The stylized picture of an average farm in our data sample depicts a farm with plant or mixed production. Existing differences with respect to farm size and production structure between regions can be further taken into account by means of dummies in the investment equation.

The variables for econometric estimation are calculated from the farms' annual balance sheets and income statements. Gross investments are defined as the difference between net capital stock (fixed assets) at both the end and the beginning of a year, plus depreciation. Cash flow is calculated as the sum of pre-tax profits and depreciation expenditures. The output measure is based on the value of real sales, and the borrowing level is calculated as the annual sum of new long-term and short-term loans. All variables are normalized by the value of capital stock and deflated by the respective price indices for industry goods and agricultural products. Unfortunately, we could not obtain the regional price indices to cover financial characteristics of different oblasts. We expect, however, that those will be reflected in farm-specific effects.

Note that farmland is not included in the capital variable because Ukrainian farm balance sheets do not display any value for land. Disregarding this production factor reflects the lack of an agricultural land market in Ukraine, which could provide such values. It is unquestionable that land is an important production factor which, in general, may influence the investment demand. For example, shifts in technologies at threshold firm sizes may occur. Nevertheless, we are confident that our results are not heavily biased due to disregarding land in the capital stock. First of all, in contrast to market economies, land is still not collateralizable in Ukraine and thus does not have a direct impact on loan access. Second, buying or selling land is (officially) impossible in Ukraine. This means investments in land do not take place. Finally, and most importantly from a practical point of view, farm size is rather homogeneous in our sample, at least within a region.

Table 3
Summary statistics of farms with positive investment observations (529 farms, 2001–2005)

Variable	Mean	Standard deviation	Minimum	Maximum
$(I/K)_t$	0.1583	0.2374	0.0010	1.5837
$(CF/K)_t$	0.2222	0.3749	−1.0827	3.0732
$(Y/K)_t$	1.2503	1.2957	0.0139	9.9358
$(D/K)_t$	0.0513	0.1405	0.0000	1.8581

Source: Own calculations.

Between 2001 and 2005, many observed farms carried out negative investments. However, we concentrated our analysis on nonnegative investment observations because we believe that financial constraints are more relevant for investing than for divesting farms. This leaves us with 1,437 observations from 529 farms, or 46% of the total sample. The unbalanced panel data set allows us to switch between financial regimes and obtain robust econometric results (generalized method of moments (GMM) estimates) for a minimum of two consecutive annual observations. Table 3 contains the summary statistics for these farms. The presented variables from Eq. (10) reveal large differences between their minimum and maximum values. For example, a maximum investment rate of about 1.6 implies that farms invest even more than the current level of capital stock. This dimension of capital adjustment, which signifies the great need for economic performance to catch up, is enormous compared with developed market economies. At the same time, a maximum debt rate of 1.9 indicates that highly indebted farms exist which are not going bankrupt and which continue to operate. The latter may be indicative of a soft financial environment (i.e., SBCs).

The primary credit sources for the analyzed Ukrainian farms are bank loans with a typical credit period of one year. Average annual interest rates between 2001 and 2005 vary between 17% and 25%. *A priori* all farms have the opportunity to obtain loans at a government-subsidized interest rate during the observed period. We suspect that there is no systematic bias of parameter estimates in the investment demand function, which could result from the possible deviations within a few credit contracts. All in all, the contract terms across farms have been rather homogeneous (e.g., relatively high interest rates, short-term contracting, and high collateral requirements in the form of agricultural machinery, equipment, and/or crops in the field).

Because our whole sample includes negative investments, that is, censored data, a sample selection bias may arise. We deal

[6] Our sample counts for about 5% of Ukrainian large (commercial) farms, which are successors of the former socialist farms. In total, commercial farms use more than 50% of the agricultural land in Ukraine when producing about 40% of the agricultural output.

with this problem by applying Heckman's two-stage estimation (Heckman, 1979). The first step consists of estimating a Probit (selection) equation for 636 farms, which yields the probability of investing or not. From the probabilities, the inverse Mills ratio λ can be calculated for each observation. The second step is then to run a linear regression model for the investment volume that includes the inverse Mills ratio as an additional variable. The following specification of the selection equation was chosen: The first set of explanatory variables includes those from Eq. (10) which determine the size of investment. The second set of regressors also uses twice-lagged variables that determine investment adjustments in period $t - 1$ and are, by assumption, uncorrelated with the error term in period t (Polder and Verick, 2004). In fact, these instrumental variables improve the quality of Probit estimates by considering the possible endogeneity of the once-lagged regressors.

Moreover, to analyze the impact of farm specialization, size, organizational form, and regional location, we introduce corresponding dummy variables as additional regressors. For farm specialization, we define three dummies (plant, livestock, or mixed production) according to the share of the average farm output from the respective branch. Three dummies are used for farm size (large, medium, and small) based on the relationship between the farm's and the region's average capital stock and output. Across the organizational forms, we distinguish between private enterprises, limited liability companies, joint stock companies, and other organizational forms. For regional location, dummies for three oblasts (Zhytomyr, Cherkasy, and Mykolayiv) are used.

Further, we introduce the inverse Mills ratios from the Probit (selection) equation into the Euler investment equation and estimate a dynamic linear regression for 529 farms with positive investments. To remove individual specific effects in our dynamic panel data set (which have been indicated by a Sargan-difference test), we apply the GMM estimator.[7] The first-differenced GMM estimator (Arellano and Bond, 1991) is based on removing individual effects and then performing a modified instrumental variables procedure. This estimation method requires the validity of crucial assumptions regarding the absence of a second-order autocorrelation of the error terms ($\Delta\varepsilon_{i,t}$). Because the once-lagged regressors are correlated with the disturbances, their second- and higher-order lags are valid instruments for equations in differences.

An improved GMM estimator, system GMM (Blundell and Bond, 1998), also uses the respective lagged differences as instruments for the level equations. The latter significantly improves the results in the case of weak initial instruments and short panels. As our data set covers a relatively short time period, we expect the system GMM estimator to provide more satisfactory results. This can be confirmed by the Hansen (Sargan) test for overidentifying restrictions, which proves the orthogonality conditions for instruments involved in the GMM estimation. Actually, we tested different sets of instruments; the most satisfactory results in terms of test statistics were obtained when using second- and third-order lags from the endogenous regressors, as well as first- and higher-order lags from the exogenous regressors specified in Eqs. (10) and (11). Among other variables, the X-regressors from Eq. (11) are also instrumented using their respective lags. Additionally, we test the sample for the absence of second-order autocorrelation.[8] Where possible, we consider the estimated GMM coefficients, which are not corrected for heteroscedasticity (first-step GMM), to avoid the possible distortion of standard errors. In all estimations, time dummy variables are included to control for time-specific effects. Besides the model specification for the whole sample described by Eq. (10), we also estimate the model from Eq. (11) with different financial regimes.

5. Results and discussion

Table 4 presents the results for the selection equation. A likelihood ratio test for the joint significance of regressors performs at the 5% level for both specifications, with and without instrumental variables. However, the P-value of the likelihood ratio test for independent estimates from the Probit equation, and from the linear regression, improves from 0.06 to 0.01 when using instruments. As this improvement implies the plausibility of the two-step Heckman procedure, we concentrate further on the results from the specification with instrumental variables. The marginal effect (elasticity) of the cash flow variable supports the hypothesis that the availability of internal funds has a significant positive impact on farms' decisions of whether or not to invest. The significance of the debt variable also reveals that investment and financing decisions cannot be separated. The dummies' coefficients indicate that large-sized farms and farms with mixed production are more apt to invest. Moreover, joint stock companies and farms that are located in Central and Southern Ukraine (Cherkasy and Mykolayiv regions) also show a higher probability to invest.

Tables 5 and 6 depict the results of the second-stage estimation. We report only those system GMM estimates that provide more satisfactory results. The overidentifying restrictions associated with the empirical investment model are not rejected by the data. We start by interpreting the results for the entire sample without selection for the financial status (Table 5). The most important consideration in our context is the positive and significant parameter estimate of the lagged cash flow, which confirms strong financing–investment relationships across the farms and, therefore, capital market imperfections. The small parameters of the squared investment term indicate that under unstable macroeconomic conditions (nontransparent agricultural policy, high inflation rates, price fluctuations, etc.) farms use large discount rates in investment planning ($\phi_{t+1} > 1$).[9]

[7] Econometric estimations are carried out with STATA 9.

[8] For details on the test for second-order autocorrelation, see Arellano and Bond (1991).

[9] Bond and van Reenen (2003) argue that the unobserved heterogeneity of the real discount factor on the new investment, ϕ, complicates the parameter

Table 4
Parameter estimates of the Probit investment regression (636 farms, 2001–2005)

Variable	Without instruments	With instruments
$(I/K)_{t-1}$	0.0979	0.0619
	(0.0839)	(0.0858)
	[0.0402]	[0.0262]
$(I/K)^2_{t-1}$	0.1497*	0.1254
	(0.0782)	(0.0794)
	[0.0588]*	[0.0493]
$(CF/K)_{t-1}$	0.4713**	0.3763***
	(0.1052)	(0.1104)
	[0.1909]***	[0.1533]***
$(Y/K)_{t-1}$	0.2193**	0.2329***
	(0.0326)	(0.0396)
	[0.0879]***	[0.0940]***
$(D/K)^2_{t-1}$	0.6941*	0.7154*
	(0.4260)	(0.4166)
	[0.2669]	[0.2761]*
$(I/K)_{t-2}$		0.1846**
		(0.0848)
$(I/K)^2_{t-2}$		0.0824
		(0.0782)
$(CF/K)_{t-2}$		0.2824***
		(0.1094)
$(Y/K)_{t-2}$		−0.0579
		(0.0378)
$(D/K)^2_{t-2}$		0.6933**
		(0.3414)
Mixed specialization	0.1135**	0.1118**
	(0.0574)	(0.0574)
Joint stock company	0.1351*	0.1400*
	(0.0793)	(0.0795)
Cherkasy region	0.4269***	0.3539***
	(0.0611)	(0.0685)
Mykolayiv region	0.3823***	0.4092***
	(0.0676)	(0.0622)
Lambda	−0.0489**	−0.0585**
	(0.0196)	(0.0174)
Pseudo R^2	0.088	0.092
LR test 1	0.000	0.000
LR test 2	0.064	0.011

Notes: Standard errors are reported in parentheses, while ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. Marginal effects for regressors are given in brackets. LR test 1 is the likelihood ratio test for joint significance of regressors. LR test 2 is the likelihood ratio test for the independence of estimates from the Probit regression and the linear regression on initial variables.
Source: Own calculations.

Table 5
GMM estimates of the Euler investment equation without sample selection (529 farms, 2001–2005)

Variable	Parameter	Without debt variable	With debt variable
$(I/K)_{t-1}$	b_1	0.4705***	0.5336***
		(0.0874)	(0.0763)
$(I/K)^2_{t-1}$	b_2	−0.3384***	−0.3495***
		(0.0582)	(0.0521)
$(CF/K)_{t-1}$	b_3	0.0858***	0.0874***
		(0.0225)	(0.0209)
$(Y/K)_{t-1}$	b_4	0.0191	0.0315***
		(0.0145)	(0.0127)
$(D/K)^2_{t-1}$	b_5		0.1931***
			(0.0241)
m_2 test		0.224	0.441
Hansen (Sargan) test		0.048	0.094

Notes: Standard errors are reported in parentheses. All equations include time dummies, while *** denotes significance at the 1% level. The *P*-values of the Wald test for joint significance of regressors are not higher than 5%. The m_2 test is the test for absence of second-order autocorrelation, and the Hansen (Sargan) test is the test for overidentifying restrictions.
Source: Own calculations.

Small and nonsignificant positive coefficients of the output–capital ratio do not contradict the assumption of perfect competition on agricultural product markets in Ukraine or constant returns to scale for the model specification without the debt variable. Including the debt-to-capital ratio improves the model fit as indicated by the value of the Hansen (Sargan) test. The coefficient on this variable is positive and significant, reflecting a strong relationship between the investment volume and the availability of external financing.

However, the estimated general specification of the Euler investment equation does not account for different financial regimes which imply the unequal sensitivity of farms' investments to financial restrictions. To separate the impact of the financial constraints, we apply new borrowing as an indicator for the two regimes. Because the level of new borrowing is implicitly incorporated in the debt-to-capital ratio, there is no need to keep the latter variable in the specification with a sample separation. The effect of an *ex ante* sample separation into the financial regimes is examined in Table 6. Three different criteria are used to separate the entire sample into *a priori* unconstrained and constrained subsamples. The first two sample selection criteria have been suggested by Rizov (2004b). According to the first criterion, farms are considered as unconstrained if borrowing occurs in at least two consecutive years; 27% of the observations belong to this subsample. According to the second criterion, farms are unconstrained if they borrow in two consecutive years and show nonnegative profits at the same time; 17% of the observations fall into this group. From the second and third column in Table 6, we find significantly positive parameters for the cash flow variable. This finding contradicts the hypothesis that financial constraints are not present in this group and hence investment decisions are independent from the availability of internal funds. Even more striking is the negative cash flow parameter for the constrained subsample in the case of the second selection criterion.

How can these unexpected findings be explained? Kaplan and Zingales (1997) argue that there may be different reasons why the positive correlation between cash flow and investment is weak or nonsignificant in the *a priori* constrained subsample.

estimation in the Euler investment equation. This heterogeneity in ϕ can reflect the differences in the structure of capital assets used by different farms, or the differences in the required rates of return.

Table 6
GMM estimates of the Euler investment equation with sample selection (529 farms, 2001–2005)

Variable	Parameter	First criterion	Second criterion	Third criterion
		Unconstrained subsample		
		With borrowing	*With borrowing and nonnegative profits*	*With borrowing and negative profits*
$(I/K)_{t-1}$	b_1	0.4541***	0.4582***	4.2233*
		(0.0451)	(0.0459)	(2.5962)
$(I/K)^2_{t-1}$	b_2	−0.4130***	−0.4018***	−8.8191*
		(0.0259)	(0.0261)	(4.2888)
$(CF/K)_{t-1}$	b_3	0.1175***	0.1507***	−0.9094***
		(0.0064)	(0.0058)	(0.2562)
$(Y/K)_{t-1}$	b_4	−0.0016	−0.0078	−0.2928*
		(0.0045)	(0.0051)	(0.1673)
		Constrained subsample		
		Without borrowing	*Without borrowing + with borrowing and negative profits*	*Without borrowing + with borrowing and nonnegative profits*
$X*(I/K)_{t-1}$	b_5	−0.1697***	−0.1666***	−4.4048*
		(0.0588)	(0.0602)	(2.7136)
$X*(I/K)^2_{t-1}$	b_6	0.2447***	0.2026***	8.7253*
		(0.0377)	(0.0366)	(4.3376)
$X*(CF/K)_{t-1}$	b_7	0.0047	−0.0255**	0.9369***
		(0.0138)	(0.0122)	(0.2181)
$X*(Y/K)_{t-1}$	b_8	0.0025	0.0137***	0.2706*
		(0.0043)	(0.0046)	(0.1579)
m_2 test		0.303	0.229	0.052
Hansen (Sargan) test		0.178	0.117	0.999

Notes: Standard errors are reported in parentheses. All equations include time dummies, while ***, **, and * denote significance at the 1%, 5%, and 10% level, respectively. The *P*-values of the Wald test for joint significance of regressors are not higher than 5%. The m_2 test is the test for absence of second-order autocorrelation, and the Hansen (Sargan) test is the test for overidentifying restrictions.
Source: Own calculations.

First, one should note that farms in the *a priori* constrained group have lower investment rates than those in the unconstrained group (0.15 and 0.18, respectively). Because relatively small amounts of credit are required for the investment expenditures, the role of cash flow as a proxy for net worth (collateral) is questionable. Profits, being a considerable part of cash flow, may not play a crucial role for investment decisions when they are used to cover variable costs, are used for dividend payments between managers, or are even used for social consumption.

In contrast, *a priori* unconstrained firms invest more, on average, and therefore require additional capital volume for growth. With regard to Hubbard (1998), if the capital demand can be covered by debt capital, the availability of internal finance (vs. collateral) is required. Hence, the role of cash flow is significant at a higher level for the unconstrained subsample, which is expressed in terms of a positive cash flow parameter in the investment equation. Consequently, farms defined as unconstrained according to the second sample separation criterion are in fact constrained because of an excessive demand for capital. Thus, it seems questionable whether the two sample selection criteria used by Rizov (2004b) are sensitive enough to divide the farms into constrained and unconstrained financial regimes. With respect to farms being constrained, when there is no access to credit they must exhibit a demand for credit. Farms without a credit demand are not really constrained, even though they do not borrow. However, it is difficult to measure the level of the farms' real investment demand, which has to be compared with the current state of financing across the *a priori* constrained subsample. Also, it is challenging to distinguish *ex ante* from the truly constrained and unconstrained farms which receive credits in consecutive years.

As it is difficult to clarify specific financial goals for every analyzed farm due to a lack of required qualitative data, we concentrate on the appropriate sample separation criteria for different financial regimes. We mentioned before that enterprises in transition exhibit evidence of a high investment demand for structural improvements, which is confronted with a low supply of funds in the underdeveloped capital markets. Therefore, Ukrainian farms can be classified as potentially credit constrained in two cases. In the first case, a farm does not receive credit at all, which coincides with the first sample separation criteria. The second case occurs when a profitable farm does not have sufficient credit access. Accordingly, the group of constrained farms should consist of those from the first case, plus farms from the *a priori* unconstrained sample due to the second sample separation criteria.

In addition to these explanations for positive cash flow sensitivity, which can be found in the literature, we suggest using a further and more sophisticated sample selection criterion that takes into account the existence of SBCs. According to Schaffer (1998), SBCs firms receive credits despite facing financial distress (irrespective of the various motivations and mechanisms of SBCs). Our sample separation criterion for SBCs farms in Ukraine is in line with this definition. For implementation, a definition of "financial distress" is required. Here we specify this term by the occurrence of negative profits before taxes during two consecutive years. This definition is somewhat arbitrary, but in view of the general caution and reluctance of Ukrainian banks in approving loans we believe it is not overly casual. Admittedly, such a selection criterion may ignore the presence of SBCs for firms showing positive profits. However, we believe that such cases are rare, because in the short-term providing access to cheap capital primarily improves the liquidity of the farm and not its profit.

Thus, the third criterion in our analysis is that farms with negative profits and borrowing in two consecutive years face SBCs. According to this criterion, about 10% of the observations belong to the unconstrained regime. When looking at farms without credits, a large portion (44% of the total number of farms or 60% of farms without borrowing) exhibits nonnegative profits. These farms can be classified as "really financially constrained," as they potentially face binding liquidity restrictions in the form of credit rationing. Another portion of those farms without borrowing (29% of the total number of farms or 40% of farms without loans) are nonprofitable. This nonprofitability may be a primary reason why banks do not consider farms to be reliable borrowers in the case of lacking credit history. Thus, we classify those farms as "not really financially constrained."

The estimation results are depicted in the last column of Table 6. The group of constrained farms in this case consists of those without any borrowing and those that do borrow and are profitable. As both types of constrained farms face a positive relationship between cash flow availability and amount of investment, it is not surprising that the significant parameter of the cash flow variable for the *a priori* constrained subsample is higher than in the two previous cases. This also holds for the (squared) investment–capital and output–capital ratios. Apparently, the model is now able to differentiate better between two financial regimes. The cash flow coefficient is negative in the *a priori* unconstrained subsample and positive in the constrained subsample. The difference between the cash flow coefficients in both subsamples are significant at a 5% level. Thus, the empirical results of the finance–investment relationship confirm the SBCs hypothesis that a portion of the large Ukrainian farms are in the unconstrained financial regime. Moreover, in the unconstrained subsample, the negative coefficient of the squared investment term is smaller than those from the first and second estimations. In other words, farms from the third subsample that are less affected by unstable macroeconomic conditions use smaller discount rates in investment planning, which is plausible for the case of SBCs. While unconstrained farms reveal strong evidence for a soft financial environment, the major portion of observed farms faces credit constraints.

6. Conclusions and implications for future research

In this study, we empirically analyzed the linkages between financing and investment behavior of large Ukrainian farms. For this purpose, the Euler investment equation, which is based on the investment demand function of a farm, has been econometrically estimated. The results confirm that financial variables significantly influence farms' investment. Moreover, we provide empirical evidence of an imperfect capital market in Ukrainian agriculture. These findings are not surprising. However, the results enable us to confirm the simultaneous presence of the various forms of capital market imperfections. In fact, we can distinguish between credit constraints and SBCs. This is of particular importance since the capital market imperfections have completely different effects. For example, credit constraints may appear as credit rationing or as an increase of credit costs due to burdensome transactions in the credit market. Thus, profitable investment projects cannot be realized, while SBCs farms invest even though they are unprofitable. Our methodological contribution is an attempt to show that the lack of differentiation between capital market imperfections yields overlapped effects of financing on investment and may therefore cause a misinterpretation of econometric results. On the contrary, appropriate differentiation raises the level of financial constraints for profitable farms with loan access, and the financial indifference of investment can be shown for the SBCs farms.

What conclusions for (agricultural) policy makers can be derived from our results? With respect to SBCs, it is often argued that the large farm sector in Ukraine absorbs a considerable share of labor under lacking employment alternatives in economically underdeveloped rural areas. For Ukrainian agricultural policy makers, large farms play the role of a social buffer and are thus not permitted to be liquidated in the case of serious financial problems. However, our hypothesis about a soft macroeconomic environment (SBCs) is only supported for about 10% of the observed farms. So we question whether a hardening of SBCs would really cause a huge loss of workplaces in Ukrainian agriculture. We rather expect that certain production factors of insolvent farms will be taken over, at least partially, through step-by-step acquisition by more successful agricultural enterprises. The government can facilitate takeovers of the SBCs farms by profitable ones by tightening financial constraints for weak enterprises, namely by reducing randomly distributed subsidies, and by establishing and implementing a bankruptcy law.

With respect to our empirical findings, the presence of credit constraints in the Ukrainian agricultural sector is actually more important than SBCs. Indeed, in our sample, 44% of farms are profitable and yet do not have access to loans. A further 17% of the analyzed samples are profitable farms with new borrowing, which can, however, be classified as financially constrained. Therefore, the group of farms with financial constraints represents about 61% of the total sample. This makes the extent of capital market imperfections in Ukraine quite clear. The financial frictions lead to reductions in farms' investment activity, which in turn induces slower adjustment processes across farms and delayed structural change in agriculture.

In this application, the SBCs phenomenon is captured via the sample selection criterion, but more direct modeling and testing of SBCs could be a promising direction for future research. Furthermore, the disadvantage of the chosen methodological approach is that it does not trace back to the exact factors that cause binding liquidity restrictions of farms. The observed positive cash flow sensitivity of the investment rate, as well as the significant impact of the debt capital, actually prove the existence of capital market imperfections. These may also be implied by credit market disequilibrium, inefficiency of the banking sector, or transaction costs due to asymmetric information. Still, to fully answer this question, future research is necessary.

However, it can be expected that many or even all of the mentioned reasons for capital market imperfections are present in Ukraine (Chapko, 2003). Therefore, there are different starting points with regard to how financial constraints may be reduced. At the farm level, creditability has to be improved and signaled to banks. The latter may be encouraged by making use of various activities that aim to reduce credit risks and the costs of loan defaults, for instance, risk management and financial controlling, and/or a personnel assumption of liability by members of senior management. Other sources of external finance for farms are direct investment and vertical integration within the agribusiness sector. At the banking level, an efficient rating system such as that found in Western European countries must be developed to facilitate the selection of viable borrowers during the credit approval process.

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Appendix: Derivation of the Euler investment equation

To solve the dynamic programming problem defined in Eq. (3), the following Lagrangean function applies[10]:

$$\begin{aligned}\Lambda = {} & \pi_t((1-\delta)K_{t-1} + I_t, L_t, I_t) - r_{t-1}D_{t-1} + B_t - \gamma B_t \\ & - R_t + \theta_{t+1}E_t[V_{t+1}((1-\delta)K_{t-1} + I_t, D_{t-1} + B_t - R_t)] \\ & + \mu_t(\pi_t((1-\delta)K_{t-1} + I_t, L_t, I_t) - r_{t-1}D_{t-1} \\ & + B_t - \gamma B_t - R_t - \bar{d}_t) + \lambda_t B_t. \end{aligned} \tag{A.1}$$

Here, two Lagrangean multipliers (LM) are introduced. μ_t is the LM on the minimum liquidity level, and λ_t is the LM on the nonnegativity constraint for new borrowing. From first-order conditions for variable factor inputs, investment, new borrowing and introduced Lagrangean multipliers, the following equalities hold:

$$L_t : (1+\mu_t)\frac{\partial \pi_t}{\partial L_t} = 0, \tag{A.2}$$

$$I_t : (1+\mu_t)\left(\frac{\partial \pi_t}{\partial I_t} + \frac{\partial \pi_t}{\partial K_t}\right) + \theta_{t+1}E_t\left[\frac{\partial V_{t+1}}{\partial K_t}\right] = 0, \tag{A.3}$$

$$B_t : (1+\mu_t)(1-\gamma) + \theta_{t+1}E_t\left[\frac{\partial V_{t+1}}{\partial D_t}\right] + \lambda_t = 0, \tag{A.4}$$

$$\begin{aligned}\mu_t : {} & \pi_t((1-\delta)K_{t-1} + I_t, L_t, I_t) - r_{t-1}D_{t-1} \\ & + B_t - \gamma B_t - R_t - \bar{d}_t \geq 0,\end{aligned} \tag{A.5}$$

$$\lambda_t : B_t \geq 0;\ \lambda_t \geq 0;\ \lambda_t B_t = 0. \tag{A.6}$$

From the Lagrangean function, we apply the envelope theorem for two state variables, K_{t-1} and D_{t-1}, giving:

$$E_t\left[\frac{\partial V_{t+1}}{\partial K_t}\right] = -(1-\delta)E_t\left[(1+\mu_{t+1})\frac{\partial \pi_{t+1}}{\partial I_{t+1}}\right], \tag{A.7}$$

$$E_t\left[\frac{\partial V_{t+1}}{\partial D_t}\right] = -E_t\left[(1+\mu_{t+1})(1+r_t-\gamma) - \lambda_{t+1}\right]. \tag{A.8}$$

Substituting Eq. (A.7) into Eq. (A.3) gives

$$\begin{aligned}& -\theta_{t+1}(1-\delta)E_t\left[(1+\mu_{t+1})\frac{\partial \pi_{t+1}}{\partial I_{t+1}}\right] \\ & = -(1+\mu_t)\frac{\partial \pi_t}{\partial I_t} - (1+\mu_t)\frac{\partial \pi_t}{\partial K_t}.\end{aligned} \tag{A.9}$$

This equality supplements Eq. (4), which holds for the perfect capital market through a liquidity constraint.

Similarly, after substituting Eq. (A.8) into Eq. (A.4)

$$\begin{aligned}& (1+\mu_t)(1-\gamma) + \lambda_t \\ & = \theta_{t+1}E_t\left[(1+\mu_{t+1})(1+r_t-\gamma) + \lambda_{t+1}\right].\end{aligned} \tag{A.10}$$

From Eq. (A.9) and Eq. (A.10), it can be seen that the liquidity constraint, μ_t, and the transaction costs for new borrowing, γ, are present in the case when the financial health of the firm has any impact on its investment behavior.

The direct estimation of the model with transaction costs is impossible because of unobservable Lagrangean multipliers in Eq. (A.9) and Eq. (A.10). From conditions in Eq. (A.6), it follows that $\lambda_t = 0$ when the firm optimally chooses a positive borrowing in period t. Substituting Eq. (A.9) for $(1+\mu_t)$ and using Eq. (A.10) under rational expectations gives:

$$\begin{aligned}& -\left((1-\delta)\frac{\partial \pi_{t+1}}{\partial I_{t+1}} - \left(\frac{(1+r_t-\gamma)}{1-\gamma} + \frac{\lambda_{t+1}}{(1-\gamma)(1+\mu_{t+1})}\right)\right. \\ & \quad \left.\times\left(\frac{\partial \pi_t}{\partial I_t} + \frac{\partial \pi_t}{\partial K_t}\right)\right) = \varepsilon'_{t+1},\end{aligned} \tag{A.11}$$

where $\varepsilon'_{t+1} = \frac{e_{t+1}}{(1+\mu_{t+1})}$ is the modified expectation error term.

Similarly, for a firm with optimal borrowing in the consecutive period B_{t+1}, $\lambda_{t+1} = 0$. Hence,

$$\begin{aligned}-(1-\delta)\frac{\partial \pi_{t+1}}{\partial I_{t+1}} = {} & -\left(\frac{1+r_t-\gamma}{1-\gamma}\right)\frac{\partial \pi_t}{\partial I_t} \\ & - \left(\frac{1+r_t-\gamma}{1-\gamma}\right)\frac{\partial \pi_t}{\partial K_t} + \varepsilon'_{t+1}.\end{aligned} \tag{A.12}$$

[10] This derivation follows Rizov (2004b).

References

Abel, A., Eberly, J., 1994. A unified model of investment under uncertainty. Am. Econ. Rev. 84, 1369–1384.

Arellano, M., Bond, S., 1991. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. Rev. Econ. Stud. 58, 277–297.

Bezlepkina, I., Oude Lansink, A., 2003. Debts, subsidies and performance of Russian agricultural enterprises. In: Balmann, A., Lissitsa, A. (Eds.), Large Farm Management: Studies on the Agricultural and Food Sector in Central and Eastern Europe, Volume 20. Agrimedia, pp. 67–90.

Blundell, R., Bond, S., 1998. Initial conditions and moment restrictions in dynamic panel data models. J. Econ. 87, 115–143.

Bokusheva, R., Bezlepkina, I., Kupavych, A., 2007. Studying investment patterns in Russian agriculture. Paper presented at the joint IAAE-104th EAAE Seminar Agricultural Economics and Transition: What Was Expected, What We Observed, the Lessons Learned, Budapest, September 6–8.

Bond, S., Elston, J.A., Mairesse, J., Mulkay, B., 2003. Financial factors and investment in Belgium, France, Germany, and the United Kingdom: A comparison using company panel data. Rev. Econ. Stat. 85(1), 153–165.

Bond, S., Meghir, C., 1994. Dynamic investment models and the firm's financial policy. Rev. Econ. Stud. 61(2), 197–222.

Bond, S., Van Reenen, J., 2003. Microeconometric Models of Investment and Employment. Mimeo. Institute for Fiscal Studies, London.

Chapko, I., 2003. Potential of the Rural Credit Market (in Ukrainian), in Agricultural Policy in Ukraine: Analysis and Research. Agricultural Policy for Human Development Project, Kiev, Ukraine, pp. 271–291.

Colombo, E., Stanca, L., 2006. Investment decisions and the soft budget constraint: Evidence from a large panel of Hungarian firms. Econ. Transit. 14(1), 171–198.

Dewatripont, M., Maskin, E., 1995. Credit and efficiency in centralized and decentralized economies. Rev. Econ. Stud. 62, 541–556.

Fazzari, S.M., Hubbard, R.G., Petersen, B.C., 1988. Financing Constraints and Corporate Investment. Brookings Papers on Economic Activity, Volume 1, pp. 141–206.

Gomes, J.F., 2001. Financing investment. Am. Econ. Rev. 91(5), 1263–1285.

Hanousek, J., Filer, R.K., 2004. Investment, credit rationing and the soft budget constraint: What would a well-functioning credit market look like? Econ. Lett. 82(3), 385–390.

Heckman, J.J., 1979. Sample selection bias as a specification error. Econometrica 47, 153–161.

Hinrichs, J., Mußhoff, O., Odening, M., 2008. Economic hysteresis in hog production. Appl. Econ. 40(3), 333–340.

Hubbard, R.G., 1998. Capital-market imperfections and investment. J. Econ. Lit. 36, 193–225.

Institute of Agricultural Economics of Ukraine, 2005. Agro-Industrial Complex of Ukraine: Current State, Tendencies and Development Perspectives (in Ukrainian). National Scientific Center Institute of Agricultural Economics, Kiev, Ukraine.

Jorgenson, D., 1963. Capital theory and investment behaviour. Am. Econ. Rev. 53, 247–259.

Kaplan, S.N., Zingales, L., 1997. Do investment-cash flow sensitivities provide useful measures of financial constraints? Quart. J. Econ., 169–215.

Keeton, W.R., 1979. Equilibrium Credit Rationing. Garland Publishing, Inc., New York.

Kobzev, O., Tsvigun, O., Yakubovych, V., Varodi, O., Pikalov, E., 2004. Agricultural Production and Agribusiness in Ukraine: Analytical Report 2001–2003 (in Ukrainian). IFC, Agribusiness Development Project in Ukraine, Kiev, Ukraine.

Kornai, J., Maskin, E., Roland, G., 2003. Understanding the soft budget constraint. J. Econ. Lit. 41(1), 1095–1136.

Latruffe, L., 2005. The impact of credit market imperfections on farm investment in Poland. Post-Communist Econ. 17(3), 351–362.

Lissitsa, A., Odening, M., 2005. Efficiency and total factor productivity in Ukrainian agriculture in transition. Agric. Econ. 32, 311–325.

Lizal, L., Svejnar, J., 2002. Investment, credit rationing and the soft budget constraint: Evidence from Czech Panel Data. Rev. Econ. Stat. 84(2), 353–370.

Maurel, M., 2001. Investment, efficiency, and credit rationing: Evidence from Hungarian panel data. William Davidson Working Paper 403, William Davidson Institute, Michigan.

Mitchell, J., 2000. Theories of soft budget constraints and the analysis of banking crises. Econ. Transit. 8(1), 59–100.

Morton, R., Sharp, K., Chomiak, B., Stepanets, N., Muliar, O., Oleshko, N., 2005. Farm Reference Handbook for Ukraine. USAID, Kiev, Ukraine.

Myers, S.C., Majluf, N.S., 1984. Corporate financing and investment decisions when firms have information that investors do not have. J. Finan. Econ. 13, 187–221.

National Bank of Ukraine, 2001–2008. Monthly Bulletins (in Ukrainian). Kiev, Ukraine. Available at http://www.bank.gov.ua/Publication/index.htm.

National Bank of Ukraine, 2008. Annual Report. NBU, Kiev, Ukraine.

Petrick, M., 2004a. A microeconometric analysis of credit rationing in the Polish farm sector. Eur. Rev. Agric. Econ. 31(1), 77–101.

Petrick, M., 2004b. Farm investment, credit rationing, and governmentally promoted credit access in Poland: A cross-sectional analysis. Food Policy 29, 275–294.

Petrick, M., 2005. Empirical measurement of credit rationing in agriculture: A methodological survey. Agric. Econ. 33, 191–203.

Polder, M., Verick, S., 2004. Dynamics of labour and capital adjustment—a comparison of Germany and the Netherlands. Working Paper 1212, Institute for the Study of Labour, Bonn.

Rizov, M., 2004a. Credit constraints and profitability: Evidence from a transition economy. Emerg. Mark. Finan. Trade 40, 63–83.

Rizov, M., 2004b. Firm investment in transition: Evidence from Romanian manufacturing. Econ. Transit. 12(4), 721–746.

Schaffer, M., 1998. Do firms in transition have soft budget constraints? A reconsideration of concepts and evidence. J. Comp. Econ. 26, 80–103.

Sedik, D.J., Seperovich, N., Pugachev, N., Chapko, I., Kobuta, I., Noga, V., Zhygadlo, V., 2000. The farm debt problem in Ukraine. Ukraine Agricultural Policy Project, Iowa State University.

State Statistical Committee of Ukraine, 2006. Annual Statistical Yearbook of Ukraine for 2005 (in Ukrainian). Consultant Publisher, Kiev, Ukraine.

State Statistical Committee of Ukraine, 2007. Annual Statistical Yearbook of Ukraine for 2006 (in Ukrainian). Consultant Publisher, Kiev, Ukraine.

Stiglitz, J.E., Weiss, A., 1981. Credit rationing in markets with imperfect information. Am. Econ. Rev. 71, 393–410.

Summers, L.H., 1981. Taxation and corporate investment: A Q-theory approach. Brookings Papers on Economic Activity, Volume 1, pp. 67–140.

Swinnen, J.F.M., 2006. Endogenous agricultural structures: Insights from transition countries. Paper presented at the 96th EAAE Seminar "Causes and Impacts of Agricultural Structures." Tänikon, Switzerland, January 10–11.

Whited, T.M., 1992. Debt, liquidity constraints, and corporate investment: Evidence from panel data. J. Finan. 47(4), 1425–1460.