Investment and financial constraints of Polish farmers

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Abstract

Based on an investigation of the investment behaviour of a panel of individual Polish farms during the period 1996-2000, the objective of the paper is to test for the persistence of imperfections on the rural credit market in Poland after more than half a decade of transition. An accelerator model augmented with a liquidity variable is used. In this model the liquidity coefficient is significant and positive in case of poorly functioning rural capital market, as the latter implies that external funds are more expensive than internal funds for some farms. Farms facing more severe credit constraints can then be identified by splitting the sample into two groups as suggested by Fazzari *et al.* (1988).

The results provide support for the presence of imperfections in rural capital market during the period 1996-2000. The identification of more and less constrained farms suggests that asymmetric information between banks and farmers mainly concerned the assessment of farmers' creditworthiness. In the sample used, farms less collateralisable are indeed found to have experienced more severe constraints. This finding is in line with other existing studies on Polish farms and is in contradiction with Polish government intervention that favoured subsidised loans rather than guaranteed credit during the period studied.

Keywords: investment, accelerator model, financial constraints, farmers, Poland

JEL Classification: D24, P34, Q12

Investissement et contraintes financières des exploitants agricoles polonais

Résumé

A partir d'une analyse du comportement d'investissement d'un panel d'exploitations agricoles individuelles en Pologne sur la période 1996-2000, l'objectif du papier est de vérifier si des imperfections persistent sur le marché du crédit rural en Pologne plus de cinq ans après le début de la transition. Un modèle d'accélérateur augmenté d'une variable de liquidité est utilisé. Le coefficient associé à la variable de liquidité est significatif et positif lorsque le fonctionnement du marché rural du capital est affecté par des imperfections. De telles imperfections signifient en effet que les fonds externes sont plus coûteux que les fonds internes pour certaines exploitations. Les exploitations qui font face aux contraintes de crédit les plus fortes peuvent être identifiées en séparant l'échantillon total en deux groupes, comme le proposent Fazzari et *al*. (1988).

Les résultats supportent la thèse de la présence d'imperfections sur le marché du crédit rural polonais pendant la période 1996-2000. L'identification des exploitations plus ou moins contraintes suggère que l'information asymétrique entre les banques et les agriculteurs portait surtout sur l'évaluation *ex ante* de la capacité d'emprunt de ces derniers. Dans l'échantillon utilisé, ce sont en effet les exploitations ayant le moins de collatéral qui ont subi les plus fortes contraintes. Cette conclusion confirme les résultats d'autres études portant sur les exploitations agricoles polonaises, mais semble en contradiction avec l'intervention gouvernementale sur le marché du crédit rural en Pologne, qui favorisait les prêts à taux subventionné plutôt que les garanties de crédit.

Mots-clés : investissement, modèle d'accélérateur, contraintes financières, exploitants agricoles, Pologne

Classification JEL : D24, P34, Q12

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1. Introduction

1 May 2004 Poland will become a member of the European Union. Fears that its farming sector will have difficulties to compete with the current members' sector are justified by the slow pace of restructuring (in terms of enlargement and modernisation) that has taken place since the beginning of transition. Farms are still small and present obsolete machinery and equipment. The average size of a farm in Poland is 7 hectares (European Commission, 2002) and farms with more than 15 hectares are considered large, while they would be classified as small by Western standards. For example, farms in France have an average land size of 42 ha (Commission Européenne, 2002). Several studies acknowledge the obsolescence of the capital used on Polish farms (e.g. Bafoil *et al*., 2003), and according to official statistics the average age of a tractor was for example 18 years in 1998 (Ministry of Agriculture and Rural Development in Poland, 1998). Most of the equipment was inherited from communist time and little has been renewed. Although it is widely acknowledged that investing is essential for restructuring, investment in the farming sector is known to be low (Christensen and Lacroix, 1997; Petrick *et al*., 2002).

Whether the low investment level is mainly due to the lack of sales prospects or the lack of financing is still unclear (World Bank, 2001). But the lack of financing seems to be a fact on Polish farms. Their small operating scale does not enable them to accumulate sufficient self-financing, and claims of the low use of credit by farms is widespread (SAEPR/FAPA, 2000; Khitarishvili, 2000). During the communist time, credit to the farming sector was allocated by the central bank in charge with rural credit, the Food Economy Bank (BGŻ). BGŻ channelled funds to the few state and collective farms, which operated under soft budget constraints, and credit to individual farms was provided by co-operative banks that were under BGŻ control (Schrader, 1996). A reform of the banking sector was implemented after the collapse of the communist regime. Besides the BGŻ/co-operative system are now in operation newly-created private (Polish and foreign) banks, and the allocation of loans is now market-based. During the period studied here (1996-2000), expensive commercial loans mixed with highly subsidised loans on the rural credit market. Under the subsidised loans programme the government supported a share of the interest rate, and thus the effective interest rate that farmers paid was below the market rate. The public intervention took another form, the loan guarantees. Under this scheme the government provided a share of the collateral in case of default, and thus farmers could contract a loan with a collateral requirement greater than the asset they owned. The largest part of the loan guarantees (90%) was however extended to enterprises involved in grain intervention purchases for the purpose of a price stabilisation (Christensen and Lacroix, 1997). Individual farmers did therefore not benefit from this programme. Despite the existence of subsidised loans, high costs of borrowing affected the rural credit market as they resulted in low demand for credit. Indirect costs of credit were indeed not negligible, taking the form of transportation costs (numerous visits to the bank), bribes or cash fees (e.g. Petrick and Latruffe, 2003; World Bank, 2001). Besides prior discouragement due to high transaction costs, the restricted credit access took the form of credit rationing. Several studies covering the second half of the transition decade have provided evidence that farmers were credit rationed, that is to say they were denied, totally or partially, from credit when applying in banks (e.g. Petrick *et al.*, 2000; World Bank, 2001). Lack of collateral was the most frequently invoked reason for it.

It therefore seems that imperfections are persisting on the rural capital market. The objective of the paper is to test for this hypothesis, and, in case of acceptance, to identify farms that are more likely to be affected by these imperfections. One way of investigating the issue is to undertake a survey including direct questions to farmers about their past borrowing experience. Another way is to use farm accountancy data to determine whether liquidity plays a role on investment demand. This latter method is followed in this paper, based on a panel data of individual Polish farms over the period 1996-2000. An investment accelerator model augmented with a liquidity variable is used, following Fazzari *et al.* (1988). The test of imperfectly functioning capital market is based on the significance of the liquidity coefficient. Capital market imperfections imply that external resources are more costly than internal resources. Thus for farms facing limited access to credit, the investment demand is constrained by the availability of self-financing. A positive and significant coefficient for liquidity therefore means that farms in the sample used experienced credit constraints. Farms can then be identified as more or less financially constrained with respect to specific characteristics, by splitting them into two groups and estimating the model for each group. Such a method has been applied very recently to the industrial sector of several Central and Eastern European Countries (CEECs). Little attention however has been paid to the role of liquidity on farm investment demand. The main contribution of the paper is therefore to add to the literature about credit constraints in the farming sector, and more precisely in a transition country where the newly-created credit market is expected to be affected by imperfections.

As the accelerator model relies on the neoclassical assumption of profit maximisation, the study will also help confirming that Polish individual farms (the prevailing form in Poland) behave like their Western counterparts, that is to say as profit maximisers. The hypothesis of profit maximisation is expected to be accepted, due to the specific history of the Polish farming sector. A distinctive feature of Poland in comparison to the other former communist countries is indeed that its farming sector had not been totally collectivised during communist time. Individual farms accounted for the larger share of the agricultural land, namely 80% (European Commission, 2002), and most of the individual farms registered nowadays are not *de novo* farms in opposite to the situation holding in other CEECs. Thus it can be expected that these farms have always tried to maximise their profit, and still do so.

The paper is organised as follows. Section 2 reviews the theory behind investment behaviour and financial constraints. Section 3 introduces the data set and describes the methodology used. Section 4 provides the empirical results and section 5 concludes.

2. Theory

2.1. Investment models

The inventory of the models used for the investigation of firms' investment behaviour reveals three main approaches: the accelerator model, the neoclassical model with its extension the adjustment costs model, and the Tobin's q approach.

Historically the first model to be proposed was the accelerator model, Clark's (1917) basic form being later modified into a flexible form by Chenery (1952) and Koyck (1954). According to Clark, the capital is adjusted toward its desired level, and therefore the firm's net investment is proportional to the change in desired capital. The flexible form proposed in the 50es argues that the capital stock is adjusted only toward a proportion λ of its desired stock, as the adjustment is not instantaneous. The accelerator model relates the change in the desired stock of capital to the output growth. The idea behind originates from Clark's observations of the industry sector's investment and production behaviour.

Although the accelerator model relies on neoclassical assumptions, it is a different model, proposed by Jorgenson in 1963, that was named the neoclassical model. Jorgenson (1963) derived the investment demand from the firm's maximisation objective in a neoclassical framework, and related the change in the desired capital stock not only to the desired output supply, but to other major determinants, namely the output price and the capital user cost (that includes the interest rate). Jorgenson's user cost model was later extended to account for adjustment costs. When investing into new equipment, the firm has not only to pay the purchase price but has also to support adjustment costs that arise from the implementation, such as temporary production discontinuation or staff training (Epaulard, 2001). Treadway (1971) for example, incorporates the adjustment costs by including the investment in the production function. The desired capital is then found to be a function of the output price and the user cost of capital, as well as the input prices.

The third main approach originates by Tobin (1969) who considered that the investment decisions of a firm were driven by its value on the market. According to the author, the rate of investment is determined by the ratio of the value of an additional unit of capital relative to its replacement cost, this ratio being called marginal *q*. Despite being solely based on an intuition, the Tobin's *q* theory was later proved by Hayashi (1982) to be another formulation of the neoclassical theory.

Although it is interesting to consider the impact of interest rate and prices on the capital demand in order to draw policy recommendations with regards to pricing policies, the neoclassical and the Tobin's *q* approaches will not be used in the present study. The study will concentrate on the accelerator model, which allows to test the hypothesis that the rural capital market is still affected by imperfections.

As mentioned earlier, the basic accelerator model specified by Clark (1917) was modified by Chenery (1952) and Koyck (1954) to take into account the fact that the adjustment of the capital stock to the equilibrium long-term level is not instant. The net investment is adjusted to a fraction of the desired level only:

$$I^N{}_t = K_t - K_{t-1} = \lambda\,(K^*{}_t - K^*{}_{t-1}) \qquad (1)$$

where subscript *t* stands for the *t*-th period, $I^N{}_t$ is the net investment, K_t is the actual capital stock, K^*_t is the desired capital stock, λ is a fixed constant such that $0 \leq \lambda < 1$, called the coefficient of adjustment. In Clark's original model, the coefficient of adjustment is equal to unity. However empirical tests showed no support for such a value (see Jorgenson, 1971).

Based on observations of firms' behaviour in the industrial sector, Clark (1917) postulated that the demand for new capital depends on the growth of sales of the finished product. The demand of capital increases when the demand of final good accelerates, thus the name of accelerator. The intuition behind Clark's (1917) model can be given some neoclassical theoretical foundations with the firm's maximisation framework. The demonstration is eased by specifying a Cobb-Douglas production function as in Jorgenson's neoclassical model (1963). The firm's objective to maximise its profits, calculated as revenues less costs, is as follows:

$$\text{Max} \quad p_t Q_t - c_t K_t - \omega_t X_t \tag{2}$$

subject to

$$Q_t = K_t^{\alpha} X_t^{1-\alpha} \tag{3}$$

$$K_t = K_{t-1} + I_t - \delta K_{t-1} \tag{4}$$

where Q_t is the output supply, X_t is the labour demand, p_t is the output price, c_t is the cost of capital, ω_t is the labour wage, α is the elasticity of output with respect to the capital such that $0 < \alpha < 1$, I_t denotes the gross investment and δ is the depreciation rate. Equation (3) represents the Cobb-Douglas production function and equation (4) gives the capital accumulation condition.

The first order condition with respect to the capital gives:

$$\frac{\partial Q_t}{\partial K_t} = \frac{c_t}{p_t}. \tag{5}$$

Combining equations (3) and (5) gives:

$$\alpha \frac{Q^*_t}{K^*_t} = \frac{c_t}{p_t} \tag{6}$$

with K^*_t the desired stock of capital and Q^*_t the desired output.

Equations (4), (5) and (6) allow to express the gross investment in term of the desired output:

$$I_t = \lambda\alpha\left(\frac{p_t}{c_t} Q^*_t - \frac{p_{t-1}}{c_{t-1}} Q^*_{t-1}\right) + \delta K_{t-1}. \tag{7}$$

The accelerator implicitly assumes that the ratio of the output price to the cost of capital is constant over time, and that the desired output Q* is the actual output Q. Therefore, the investment can be written as a relationship of the growth in output:

$$I_t = \varphi(Q_t - Q_{t-1}) + \delta K_{t-1} . \tag{8}$$

with $\varphi = \lambda\alpha \frac{p}{c}$, and c and p the constant cost of capital and output price, respectively.

In empirical studies, sales are frequently used instead of output, as data are usually more accurate about the former (Abel and Blanchard, 1988). In the present study, sales are also used. They are considered as a better proxy for farms' investment opportunities than output, since farms might use a non-negligible share of their output for household consumption.

2.2. Model of investment and financial constraints

The investment models exposed previously (accelerator, neoclassical, Tobin's *q* model) all assume that capital markets are perfectly functioning. Under this assumption, Modigliani and Miller (1958) stated that internal (retained profits) and external (loans) financing are perfect substitutes. Therefore in a perfect capital market world, internal funds availability should play no role on investment decisions. In reality however capital markets might be affected by imperfections, and some firms might face limited access to credit. Self-financing then becomes an important determinant of investment demand.

When the capital market is not perfectly functioning, there exists a cost differential between external and internal resources. This differential arises from the information asymmetry in a principal-agent framework. The principal – the lender, lacks information about the agent – the borrowing firm, leading to adverse selection or moral hazard (Besley, 1994). The information asymmetry might relate to the firms' characteristics that reveal their creditworthiness, that is to say their probability to repay the loan. This gives rise to the adverse selection problem, where the lender needs to sort out "good" borrowers from "bad" borrowers. The use of screening devices such as pledging collateral helps to mitigate the problem (Hoff and Stiglitz, 1990). The lack of information might also apply to the managers' actions once the loan has been attributed. Managers might make use of the loan for riskier projects or non-productive purposes. This leads to the moral hazard problem, and lenders need to monitor the agents' actions. To cover the screening and monitoring costs, lenders add a premium in the interest rate or require additional fees. For firms facing these additional costs, as well as the costs of bringing up some collateral, the opportunity cost of internal finance is less than the cost of external funds. Hence they might not apply for loans, and cover their investment expenditures with self-financing only. Other firms, although applying, might be denied credit if their collateral is not sufficient. Partial or total credit rationing would therefore also imply to resort to internal resources.

Therefore investment decisions of some firms should be determined by the availability of internal resources when the credit market is affected by information asymmetries. To test this hypothesis, the method suggested by Fazzari et *al.* (1988) in their cornerstone paper is to include an additional determinant in the investment equation, that proxies the firm's internal resources. They propose the following investment equation augmented by a liquidity variable:

$$\frac{I_{it}}{K_{it-1}} = \beta_0 + \beta_1 \frac{Z_{it}}{K_{it-1}} + \beta_2 \frac{L_{it-1}}{K_{it-1}} + \varepsilon_{it} \tag{9}$$

where subscript *i* refers to the *i*-th farm and subscript *t* refers to the *t*-th period; β_0, β_1 and β_2 are parameters to be estimated; Z_{it} is a vector of investment opportunities proposed by a specific investment model (change in output or sales / user cost of capital and prices / Tobin's *q*); L_{it-1} is a liquidity variable representing the firm's internal funds; $\in_{it}$ is an error term.

A positive and significant parameter attached to the liquidity variable (β_2) would indicate that for some firms the investment demand is sensitive to the availability of internal resources. This finding would reveal that these firms face a constraint on the capital market (in terms of rationing or of high application costs) and therefore would provide evidence of capital market imperfections. Identifying those firms that are severely constrained is an important step for policy recommendations. Fazzari et *al.* (1988) propose to *a priori* classify firms in two groups with respect to a variable that is thought to discriminate in terms of financial constraint. Such variables are frequently the firms' size or indebtedness structure (e.g. Budina *et al*., 2000), but the choice should be done according to the specific context. For example Lizal and Svejnar (2002), in their study of Czech firms in transition, use the legal form (state, private or co-operative firms) as they expect some differential in credit access between the forms. Equation (9) is then estimated for both groups of firms, and a statistically significant difference between the coefficient β_2 for both groups allows to identify highly constrained firms as those with the higher coefficient.

Fazzari *et al.* (1988) method has been widely applied to the industrial sector, but applications to the farming sector are scant. In developed countries, two main studies can be listed. Bierlen and Featherstone (1998) used this method on a panel of Kansas farms over the period 1976-

1992, with a Tobin's *q* investment model. They found that the variable discriminating the most between constrained and unconstrained farms was the debt level, with higher indebted farms being more constrained. Benjamin and Phimister (2002) also used Tobin's *q* approach as well as a model accounting for adjustment costs, to study the impact of financial constraints on farms in France and in the United Kingdom through the period 1987-1992. The authors confirmed Bierlen and Featherstone's findings about indebtedness, but their results also suggested that farms mainly tenanted faced constraint while farms mainly owned did not. Surprisingly few studies have been undertaken on countries where capital markets are strongly suspected to be imperfectly functioning. In Eastern Europe, a few recent papers have been devoted to the industrial sector. Budina *et al*. (2000) applied Fazzari *et al.* (1988) method to Bulgarian firms over the period 1993-1995 with the help of an accelerator model. Lizal and Svejnar (2002) studied the role of liquidity on investment of Czech firms through 1992-1998 with an accelerator and an adjustment costs model. Konings *et al*. (2003) also investigated the issue for Czech firms, as well as for Rumanian, Bulgarian and Polish firms over the period 1994-1999 with the accelerator approach but did not classify firms. No application of Fazzari *et al.* (1988) method on the CEECs farming sector can be listed, with the exception of Chayka and Koshelev (2003). The authors applied the accelerator model augmented by a liquidity variable to a sample of Russian farms over the period 1999-2001 and concluded from their estimations that small farms, crop farms and highly indebted farms were the most constrained. The studies by Petrick (2002) and the World Bank (2001) are also worth to be mentioned although they do not constitute applications of Fazzari *et al*. (1988) method. Petrick used a household model and provided evidence that liquidity had an effect on investment undertaken by Polish farmers between 1997 and 1999. In the World Bank's study about Polish households, total income was found to be a significant positive determinant of the probability of having undertaken farm investment in 1999. The interpretation was that the households were forced to resort to self-financing due to financial-market constraints.

Studying the impact of liquidity on farm investment is of particular interest in transition countries where agricultural credit allocation, similarly to industrial credit allocation, was once centrally-planned, and where the newly-emerged rural capital markets might still be affected by imperfections. Applying Fazzari *et al.* (1988) method on a sample of Polish farms will therefore add to the rare existing literature studying the potential financial constraints facing farms in the CEECs.

3. Data and methodology

3.1. Dataset

The data used are extracted from the 1996-2000 database of the Polish Institute of Food and Agricultural Economics (IERiGZ). This institute conducts an annual survey over about 1,000 farms located in various parts of Poland. The survey covers only individual farms, that are the prevailing form in Poland due to historical reasons as mentioned earlier. In the IERiGZ survey the same farms appear every year, except if they disappear or merge. In such cases, new farms are added to the survey. For the present study, those farms that were surveyed in each of the five years were selected. This resulted in a balanced panel sample of 914 farms.

One drawback of the database is that it is not representative of the farm population in Poland in terms of farm size. It is biased towards larger farms, for the reason that the IERiGZ sample includes only those farms that have a bookkeeping. Therefore, only a couple of small farms are surveyed, despite accounting for the larger share of farms in Poland. Table 1 below gives evidence of the size bias in the sample used here. The figures are for the year 2000, but the same bias is noticed in the previous years.

Table 1: Share of farms according to their size in 2000, in Poland and in the sample used here

	Small farms			Medium farms		Large farms	
	1-2 ha	2-5 ha	5-7 ha	7-10 ha	10-15 ha	15-50 ha	>50 ha
Sample used (%)	1	10	9	13	19	35	13
Poland [a] (%)	24	32	24		10	10	

[a] National figures given by GUS (2001).

Half of the farms in the sample used here are large farms (over 15 hectares), while in Poland half of the population actually consists of very small farms (between 1 and 5 hectares). However, studying the investment behaviour of large farms only is justified on the ground that they mainly will be the ones having to compete with their Western counterparts, once the enlargement has taken place.

The five years survey allows to study four years of investment (1996-1997, 1997-1998, 1998-1999, 1999-2000) and thus the pooled sample used for estimation includes 3656 observations.

3.2. Methodology

Model specification

The two investment demand equations to be estimated are the following:

- standard accelerator model

$$\frac{I_{it}}{K_{it-1}} = \beta_0 + \beta_1 \frac{\Delta S_{it}}{K_{it-1}} + \mu_i + \pi_t + \varepsilon_{it} \tag{10}$$

- accelerator model with financial constraint

$$\frac{I_{it}}{K_{it-1}} = \beta_0 + \beta_1 \frac{\Delta S_{it}}{K_{it-1}} + \beta_2 \frac{CF_{it-1}}{K_{it-1}} + \mu_i + \pi_t + \varepsilon_{it} \tag{11}$$

where

subscript *i* refers to the *i*-th farm and subscript *t* refers to the *t*-th period;

K_{it-1} is the stock of capital, that includes all tangible fixed assets such as buildings, machinery and tools, standing timber and permanent crops, breeding livestock and soil melioration; the normalisation by this scalar controls for size effects;

I_{it} denotes the gross investment, calculated as the change in capital stock (net investment) plus the depreciation [1]:

$$I_t = K_t - K_{t-1} + \delta K_{t-1} \tag{12}$$

with δ the depreciation rate (the values of K in period *t* were deflated by the input price index based in 1996);

ΔS_{it} stands for the change in output sales (in value) between period *t-1* and period *t* and is the proxy for opportunities of investment (the values in period *t* were deflated by the output price index based in 1996);

CF_{it-1}, the cash flow, is the proxy for liquidity and is defined as the sum of revenues from output sales and other incomes (off-farm income, pension, subsidies), less variable costs,

[1] Farmers might also invest in new land but the database is not sufficiently detailed to allow to distinguish between land purchased and land inherited. Therefore only investment into capital outside land is considered here.

labour costs, land rent and interest; it represents the cash available to the farm at the end of period *t-1* for purchasing new capital during period *t*;

$\in_{it}$ is the remaining disturbance, β_0, β_1 and are β_2 are parameters to be estimated;

μ_i represents an unobserved individual effect and π_t an unobserved time effect.

Individual effects are likely to arise in panel data estimation. These effects account for specific farm characteristics that are time-invariant, e.g. farmers' gender. Time effects might also play a role. They include events that happened in a particular year and affected all farms, such as a price increase. Testing for the presence of effects can be done by the Breusch and Pagan test that uses a Lagrange multiplier statistic based on the Ordinary Least Squares (OLS) residuals. Under the null hypothesis of absence of effects H_0: $\hat{\sigma}_\mu{}^2 = 0$ and $\hat{\sigma}_\pi{}^2 = 0$, the statistic follows a Chi-square distribution with two degrees of freedom (Baltagi, 2001). Effects can be assumed to be fixed, and in this case the model can be estimated with OLS on Within-group specification (deviation from individual means over time). If the effects are assumed to be random, Generalised Least Squares (GLS) estimation is applied. Testing for fixed *versus* random effects can be done with the Hausman test. The underlying idea is to test whether both estimators, the OLS and the GLS, are significantly different. Under the hypothesis of fixed effects, the GLS estimator is not consistent. The statistic to compute is the following (Baltagi, 2001):

$$m = \left(\hat{\beta}_{OLS} - \hat{\beta}_{GLS}\right)' \left(\mathrm{Var}(\hat{\beta}_{OLS}) - \mathrm{Var}(\hat{\beta}_{GLS})\right)^{-1} \left(\hat{\beta}_{OLS} - \hat{\beta}_{GLS}\right). \tag{13}$$

Under the null hypothesis that effects are random this statistic follows a Chi-squared distribution with the number of regressors as the degrees of freedom.

Classification

Differentiating between high or less constrained farms is done by splitting farms into two groups according to a characteristic that potentially discriminates on the rural credit market. Equation (11) is then estimated for both groups. A significant difference between the coefficient β_2 of the first group and the one of the second group allows to conclude that both types of farms face different constraints. The group of farms for which the coefficient is the higher is then identified as the one experiencing the most severe constraint. Testing whether the coefficients are significantly different can be done with a Chow test. The restricted model is given by equation (11), while the unrestricted model allows for varying cash flow coefficients. The null hypothesis is the statistical equality of the cash flow coefficients estimated for respectively the first group of farms and the second group.[2]

Based on the existing literature about credit problems experienced by Polish farmers, several variables will be tested as possible characteristics distinguishing between constrained and unconstrained farms. Characteristics of the farms in the first year of the survey (1996) will be used. The mean of the variables considered will be taken as the value for separating the farms into two groups.

Collateral is the first criterion taken into consideration by banks during an application process. For example the World Bank (2001) reports from its survey on 2,000 Polish households in 1999 that the mean loan-to-value ratio over the sample was 0.80 for loans from BGŻ. The lack of collateral might imply rationing but might also discourage farmers. For example Petrick and Latruffe (2003) studied the determinants of borrowing costs (interest rate plus other transaction costs) of 313 Polish farms between 1997 and 1999. They found that farms with lower collateral faced higher costs. Two collateral variables will be tested here, one relating to the land asset and the other to the machinery and buildings assets. The first variable is the share of own land in the total land used. The second is the tangibility of the farm, that is to say the share of tangible assets (outside land) in total assets. Size and farm performance constitute the second group of variables that might discriminate between constrained and unconstrained farms. Banks prefer large-scale operating farms, that have a high turnover, even for subsidised credit (Józwiak, 2001). These farms are also more likely to face low information costs because they can spread the costs over a large loan volume. Land size and the degree of market integration (calculated as the share of sales in total output) will be used here. Social characteristics are another set of potentially discriminating variables. Low educated and aged farmers are less likely to apply because they might face higher information costs than others (e.g. Petrick and Latruffe, 2003). Moreover banks might reject their application or add a risk premium because their risk of defaulting is considered greater. The level of education and the age of the farmers will be used here. Off-farm income will also be used. This characteristic might play the role of collateral. For example the World Bank's

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[2] The statistic to compute for the Chow test is $\left(\dfrac{\mathrm{SSE}\,r-\mathrm{SSE}\,ur}{\mathrm{DF}\,r-\mathrm{DF}\,ur}\right)/\left(\dfrac{\mathrm{SSE}\,ur}{\mathrm{DF}\,ur}\right)$, where SSE denotes the sum of squared errors, DF denotes the degrees of freedom, and *r* and *ur* stand respectively for restricted and unrestricted model. Under the null hypothesis the statistic is distributed as $\mathrm{F}\left(\mathrm{DF}\,r-\mathrm{DF}\,ur\,,\mathrm{DF}\,ur\right)$.

(2001) study reported that one of the main reason for not applying for a loan in 1999 was an unstable income. As noted by Petrick and Latruffe (2003) off-farm employment can have an opposite impact, as it might mean part-time farming and therefore greater risk of default.

Reputation is also an important determinant of credit access. Farms that have been borrowers in the past (and that have not defaulted) have lower chance to be denied from credit in the future than new applicants. They would also face lower information costs, as for example their collateral has already been evaluated. This intuition is confirmed by Petrick (2002). A Probit model based on a survey of direct questions to farmers about credit rationing between 1997 and 1999 enabled him to conclude that farmers having rescheduled a loan in the past were more likely to be rationed. However taking this characteristic as potential discriminating variable in the present study implies that a value *prior* to the study is used, for example in 1995. These data are not available, but in order to test the hypothesis of reputation, the panel will be shortened to the period 1997-2000 and the debt to assets ratio (zero or strictly positive) in 1996 will be used as the differentiating variable. The reputation hypothesis therefore expects that farms with zero debts in a certain year are identified as financially constrained in the next years. An opposite result however might be found. The interpretation would be that banks deny credit to farms that are already highly indebted, as found by Bierlen and Featherstone (1998) and by Benjamin and Phimister (2002).

3.3. Descriptive statistics

Table 2 below reports the number of farms that have invested and the average level of gross investment and gross investment to capital ratio per farm for each year and for the whole period 1996-2000.

Table 2: Number of investor farms, level of investment per farm and investment to capital ratio per farm in the sample used

	1996-1997	1997-1998	1998-1999	1999-2000	4 years
Number of investor farms	904	901	884	909	3,598
Average level of investment (euros)	8,894	7,013	7,241	11,043	8,404
Average investment to capital ratio	0.171	0.117	0.111	0.160	0.136
Total number of farms	914	914	914	914	3,656

The calculation of the gross investment variable reveals that almost all farms in the sample have invested each year of the period studied. The absolute level of investment is relatively low in comparison to Western standard. For example in France the average investment (excluding land purchase) per farm in 2000 was 16,500 euros (Agreste, 2002) while it was 11,043 for this sample. However comparing the investment to capital ratios between both countries gives a different picture. In 2000 French farms had an average ratio of 0.131 while it was 0.160 for farms of the sample used here, suggesting that the latter invested more in relation to their existing capital than French farms did. Although these figures seem in contradiction with the abovementioned claim of low investment in Polish farms, it can be explained by the size bias of the sample described previously.

A few farms present a negative value of gross investment, that is to say they have experienced disinvestments (sales of equipment). The average absolute level of investment per farm declined between 1997 and 1999 but increased again in 2000, this period recording the highest average over the period. The number of farms that have invested is relatively stable over the period 1996-2000 (more than 900), except a drop in 1999 (884 farms). But this did not affect the average level of investment, which remains similar to the one in the preceding year (97-98). Studying the evolution of the growth of sales over time might help to explain the drop in the number of investors. Farms with positive change in sales account for about 60% in each year except in 1999 where the share is reduced to 51%. The similar pattern in the number of investors and the number of farmers presenting positive change of sales is a first indication that Polish farmers behave as profit maximisers. Finally a look at the cash flow of the sample's farms reveals that the level is very stable over the years (about 8,250 euros) and that almost all farms present a positive value.

4. Results

4.1. Estimation results for the whole sample

Table 3 below provides the results of the estimation of both equations (10) and (11) for the pooled sample. In the second column are presented the results from equation (10), i.e. the standard accelerator model. The third column reports the results from the accelerator model augmented with the liquidity variable, as defined by equation (11). The first row shows that the Breusch-Pagan test rejects the null hypothesis of absence of (individual and time) effects. The second row gives the result of the Hausman test, rejecting the null hypothesis of random effects. The next rows are therefore the results of estimation with fixed effects on the Within-group specification.

Table 3: Results of the fixed individual and time effects model estimation (Within-group) and Breusch-Pagan and Hausman tests; independent variable: Investment / Capital

	Standard accelerator model	Accelerator model with financing constraints
Breusch-Pagan test (Chi^2)	10,034.0 ***	9,134.4 ***
Hausman test (Chi^2)	55.4 ***	77.7 ***
Intercept (β_0)	0.131 ***	0.077 ***
Change in sales / Capital (β_1)	0.063 **	0.171 ***
Cash flow / Capital (β_2)		0.344 ***
R^2_{Within}	0.343	0.356
Significance of the model (Ftest)	1.56 ***	1.65 ***
Number of observations	3,656	3,656

*, **, ***: significance at 10%, 5%, 1% level

Both models are highly significant and all variables are highly significant. In both models, the coefficient for the change in sales is positive and significant, suggesting that, as expected, individual Polish farmers' behaviour is consistent with profit maximising. A growth of investment opportunities in terms of sales induces an increase in investment level. In the accelerator model with financing constraints, the coefficient for cash flow is significantly positive. Liquidity thus affects investment decisions of some farms in the sample, in the sense that their investment expenditures are constrained by the availability of self-financing. This reveals the presence of imperfections on the rural credit market in Poland during the period 1996-2000.

The total R-squares of the models are 0.463 for the standard accelerator model and 0.523 for the accelerator model with financing constraint [3]. A large part of the variability of the investment demand is therefore attributed to the growth in sales, and to a lesser extent to the liquidity availability.

4.2. Identification of severely constrained farms

Splitting farms according to all criteria listed previously reveal no significant differences between the cash flow coefficient of both groups, except for collateral characteristics. The hypothesis that large and commercial farms in Poland are less constrained than others is rejected by the data used here. Results also do not provide support for a discrimination in terms of age or education, of off-farm income or of reputation or high indebtedness.

A significant difference however arises from the collateral characteristics, namely the share of own land and the tangibility, as shown on Tables 4 and 5 below. Mainly owned farms have a significantly lower cash flow coefficient than mainly tenanted farms. The effect of cash flow is also stronger for more tangible farms. The results suggest that the investment demand is more sensitive for farms that have few assets. This provides support for the existence of credit rationing by banks towards farms that are less collateralisable.

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[3] The share of the variability given by the Between-group estimation (averages over time), $R^2_{Between}$, and the share given by the Within-group estimation (R^2_{Within}) allow to compute the total explained variability (R^2_{Total}) as follows (for demonstration see for example Falconer *et al.*, 2000): $R^2_{Total} = R^2_{Between} + (1 - R^2_{Between})\ R^2_{Within}$.

Table 4: Results of the accelerator model with financial constraint for farms mainly tenanted (own land < 83.4%) and farms mainly owned (own land ≥ 83.4%)

	Farms mainly tenanted	Farms mainly owned
Intercept (β_0) Change in sales / Capital (β_1) Cash flow / Capital (β_2)	0.071 *** 0.134 *** 0.455 ***	0.084 *** 0.2461 *** 0.2462 ***
Test of significance of the difference in β_2 (F-test)	12.5 ***	
Number of observations	1,268	2,388
Average share of owned land (%)	56.8	97.6

*, **, ***: significance at 10%, 5%, 1% level

Table 5: Results of the accelerator model with financial constraint for farms with small tangibility (tangible assets < 86.6%) and farms with large tangibility (tangible assets ≥ 86.6%)

	Farms with small tangibility	Farms with large tangibility
Intercept (β_0) Change in sales / Capital (β_1) Cash flow / Capital (β_2)	0.081 *** 0.188 *** 0.410 ***	0.087 *** 0.108 ** 0.179 ***
Test of significance of the difference in β_2 (F-test)	22.8 ***	
Number of observations	1,668	1,988
Average tangibility (%)	79.4	90.9

*, **, ***: significance at 10%, 5%, 1% level

5. Conclusion

The impact of credit constraint on investment is of central importance in countries where capital markets are emerging or still imperfectly functioning, such as developing countries or countries in transition. In Poland in particular, debate about the functioning of the rural credit market is still topical. The objective of the paper was to test for the presence of market imperfections on the rural credit market in Poland during the second half of the transition decade, and to identify farms that were more likely to be constrained. Panel data of 914 individual farms over the period 1996-2000 were employed. An accelerator model augmented by a cash flow variable was used. Hypothesis of profit maximisation was confirmed by the data, as the results revealed that the propensity to invest depended on the opportunities of selling. The study provided evidence of imperfectly functioning rural credit market during the period studied, with the consequence that some farms faced credit rationing or high borrowing costs.

Results also revealed that the degree of financial constraint varied between farms, with farms presenting less collateral being more constrained. This finding confirms the conclusions from other studies on Polish farms (e.g. Petrick and Latruffe, 2003) and suggests that the adverse selection problem matters more than the moral hazard problem in Poland's farming sector. The discrimination in terms of collateral was also found by Benjamin and Phimister (2002) on their study of farms in France and in the United Kingdom during the period 1987-1992. Pledging collateral might therefore not be a specific feature of emerging capital markets. Nevertheless the present study identified the lack of collateral as one major impediment to investment of Polish farms during the period 1996-2000, which is in contradiction to the way the Polish government intervened on rural credit market during this period. Intervention should have focused on guaranteed credit rather than on subsidised credit. In a few months however Poland will be part of the European Union, and government intervention will disappear. Direct aids of the Common Agricultural Policy might help Polish farmers to self-finance their investment projects despite limited credit access.

Although the main objective of the paper was to give evidence of capital market imperfections presence, further research could also concentrate on the impact of interest rate on Polish farmers' investment decisions. The responsiveness of investment demand to interest rate is interesting to investigate, as subsidised loans will disappear after accession in 2004. The use of more complex models (neoclassical, Tobin's q) would be a means of investigation.

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