INVESTMENT AND CONTRACT ENFORCEMENT IN TRANSITION: EVIDENCE FROM HUNGARY*

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Working paper 2003/3

http://www.prgleuven.be

Abstract: Contract enforcement problems are a significant constraint on investment and growth, especially so in developing and transition economies. Evidence on these effects is mostly limited to case studies. This paper analyses the impact of contractual breaches on capital investment, using a unique dataset of Hungarian agricultural enterprises who contract production to processing firms. Contract breaches, under the form of delayed payments for supplied products, have a significant negative effect on investment at the primary production level. They occur more when the expected benefits from breaching are larger, e.g. when the price of capital is high, and when expected costs are lower, due to poor external contract enforcement or lower private enforcement capital.

Keywords: investments, contract enforcement, transition, payment delay, Hungary

* The authors thank Marno Verbeek and Geert Dhaene for discussions on the econometrics. We are also grateful to Erik Mathijs, Bart Minten and participants in seminars in Leuven, Zaragoza and Ljubljana for comments on an earlier draft of the paper. We are particularly indebted to Hamish Gow for many discussions. The data used in this paper were collected in a survey financed by the European Commission under its ACE Programme, and implemented by the Central Statistical Office of Hungary (CSO) in collaboration with the Budapest University of Economic Sciences (T. Ferenzi), the Katholieke Universiteit Leuven (E. Mathijs and H. Gow), and the University of Athens (A. Sarris). The usual disclaimers apply.

The paper is also published as LICOS Discussion paper 127/2003.

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I. INTRODUCTION

The importance of contract enforcement mechanisms in economic development is the subject of a growing literature [Johnson, McMillan, and Woodruff, 1999; McMillan and Woodruff, 1999; World Bank, 2002]. Within this field, Williamson [1975] and Klein, Crawford, and Alchian [1978] were the first to emphasise and elaborate the importance of the hold-up problem, i.e. when one party in a contract *ex post* exploits contractual imperfections to extract quasi-rents after the other party has sunk contract-specific investments, for the analysis of business institutions and practices. The growing interest in the subject was, subsequently, marked with important contributions to the literature by Williamson [1983, 1985], Milgrom and Roberts [1992], Shelanski and Klein [1995], Klein [1996], etc.

While there is much argumentation on the importance of contractual breaches and hold-ups, there is relatively little representative statistical evidence on the effect of hold-ups for firm investment and growth. Existing evidence is mostly limited to case studies due to the difficulty of obtaining consistent data on contracting cost, asset specificity, transaction complexity etc. [Shelanski and Klein, 1995]. Most of the statistical research on contracting has focused on the determinants of contract choice rather than on factors explaining contractual breaching and the importance of the latter for economic activity [Allen and Lueck, 1992; 1999; Leffler and Rucker, 1991]. Among the few existing exceptions are two influential studies by Johnson *et al.*, [1999] and McMillan and Woodruff, [1999] which analyse factors affecting contract enforcement in several transition countries.

In this paper we use a unique dataset of more than 300 agricultural enterprises that contracted sales to food processing companies in Hungary in 1997 to econometrically estimate the impact of hold-ups on capital investment in these enterprises. In addition, we identify conditions under which firms can be more susceptible to hold-up behaviour.

The paper is organised as follows: the next section discusses the importance of hold-up problems in transition; section 3 presents the empirical model and the estimation approach; section 4 describes the data and variable specifications; section 5 discusses the results; and section 6 concludes.

II. HOLD-UPS AND TRANSITION

Hold-ups and contract enforcement problems in general are believed to be very important in transition economies, contributing to output falls in early transition and constraining investment and growth [Gow and Swinnen, 2001]. These problems result from the institutional reforms associated with the transition process.

Under the Communist regime, production and processing were centrally planned and vertically integrated through the central command system. Many industries were composed of large state-owned firms, usually one per sector and in certain cases operating on both sides of the market. This allowed for resource allocation decisions as well as production and target prices to be centrally planned and set. The central authority provided contract enforcement and transacting parties faced a zero probability of being held-up.

Reforms caused several institutional changes, leading to important breaches of contracts. First, economic reforms split the vertically integrated chains into autonomous enterprises. The subsequent privatisation and restructuring of these entities created many independent enterprises. Second, the previous legal system, or the central planning authority, was no longer able to enforce the contractual terms and a new legal enforcement mechanism was absent or ineffective. Third, the transacting parties had no previous experience with hold-ups and producers continued making relationship-specific investments[1]. Fourth, macroeconomic reforms and liberalisation policies caused dramatic changes in both nominal and relative prices. Coupled with reforms of the banking system and the cut in government subsidies, these brought about severe financial distress for all firms thereby effectively reducing the capital costs of breaching the contract.

It is not difficult to imagine that following these reform-related shocks important infringements on business contracts were observed. Often, hold-up behaviour took the form of delays in payments for product deliveries (or wages)[2]. For example, Gorton, Buckwell, and Davidova [2000] find that, in 1998, late payments were the single most important obstacle to company growth in the Czech Republic and Slovenia, while this factor was ranked third out of 12 possible causes in Hungary. The payment delays effectively provided processors (or

[1] Specific investment is considered to be a major cause for the occurrence of hold-ups. See further for an explanation.

[2] Interestingly, Johnson *et al*., [1999] and McMillan and Woddruff [1999] use the portion of the bill paid after delivery as an indicator of trade credit, and hence an opposite indicator of contract enforcement than delayed payments in our analysis. This difference in interpretation is likely due to the difference in the nature of the exchange relationships studied. In their analysis contracting is mostly between manufacturing companies and their customers, and paying part of the bill after the products have been delivered can be interpreted as trade costumer credit. In our analysis, contracting is between (smaller) farms and (larger) food processors, whereby payment delays by processors – beyond the schedules in the contract – reflect involuntary rent extraction from farms instead of trade credit. Interestingly, in related studies we find that once successful contract enforcement institutions develop, similar forms of trade credit as those found by Johnson *et al*., [1999] and McMillan and Woddruff [1999] emerge between farms and food processors but with the food processing company providing trade credit to the farms, e.g. under the form of pre-payment of inputs and investment loans [Dries and Swinnen, 2002; Gow *et al*., 2000; Foster, 1999].

employers) with interest free loans from suppliers. With high inflation, the rent extraction was significant.

The hold-ups caused additional financial distress and worsened the already severe cash flow and profitability problems in the affected firms. Both partners to the contract suffered the consequences. As the suppliers recognised the possibility for continued hold-ups, they became reluctant to invest in activities involving high asset-specificity (or company-specificity). As a result the supplies to the downstream firms declined both in terms of quantity and in quality, with obvious negative effects on the downstream producers.

In general, the occurrence of hold-ups can affect firm investment in two ways: (a) directly, via the effect of a hold-up on a firm's cash flow and (b) indirectly, via the recognition of a hold-up potential. Concerns on the above may lead to sub-optimal investment as risk-averse firms, fearing that their investments will leave them vulnerable, refuse to make the efficient investment. Such concerns are especially due in transition countries where a combination of high litigation costs, ineffective contract law, poor third party verifiability, and the potential loss of the only suitable trading partner make the use of legal dispute mechanisms not viable. Even with risk-neutral transactors, however, the presence of possible hold-up behaviour, following unanticipated changes in market conditions, will entail costs as real resources are devoted to the attempt to improve post-transaction bargaining positions in the event of a hold-up contingency occurring. In general, less specific investment will be made to avoid being "locked in" [Klein *et al.*, 1978][3]. Agents reduce investments or move resources to sectors with lower asset specificity requirements.

[3] Almost all investments are partially liable to sunken costs due to a loss in the value of the assets when used outside the specific setting or relationship. The sorts of assets that are most problematic, however, are specific assets, i.e., "durable investments that are undertaken in support of particular transactions, the opportunity cost of which investments is much lower in best alternative uses or by alternative users should the original

In the rest of this paper we estimate the relationship between firms' capital investments and the incidence of hold-ups. Moreover, we analyse to what extent this relationship is affected by the characteristics of the firms and the nature of activities they are involved in, for example, by whether the firms are contracting sales to locally operating foreign businesses, by the extent to which they are expected to commit resources specific to a particular marketing contract, by the quality of the legal enforcement of contracts, the level of interest rates for loans, by whether the firms are restructured state companies or new (start-up) businesses, and by the level of their assets and liquidity.

III. THE EMPIRICAL MODEL

The empirical specification is an augmented liquidity-based model of investment demand [Samuel, 1996; Fazzari, Hubbard, and Petersen, 1988]. The main equation is of the following form:

$$
\begin{aligned}
& Y_{1i}^{*} = Y_{2i} y_{1} + X_{1i}' b_{1} + u_{1i} \qquad u_{1i} \approx NID(0, s_{u}^{2}) \\
& Y_{1i} = Y_{1i}^{*} \quad if \;\; Y_{1i}^{*} > 0 \\
& Y_{1i} = 0 \quad if \;\; Y_{1i}^{*} \leq 0
\end{aligned}
\tag{1.1}
$$

for $i = 1, ..., H$.

where Y_{1i} represents the observed and Y_{1i}^{*} the desired level of investment for firm i. Y_{1i} is censored at zero defined on the basis of the continuous latent Y_{1i}^{*}. $X_{1i}' = (1, x_{1i1}, x_{1i2}, ..., x_{1im})$ is a *1xM* vector of weakly exogenous variables explaining investment. u_{1i} is an i.i.d. standard

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transaction be prematurely terminated [Williamson, 1985]". Asset specificity creates quasi rents to be appropriated. For instance, there may be many potential suppliers of a particular asset to a particular user but once the investment in the asset is made, even with free competition for entry to the market, the asset is so specialised to the particular user (or more accurately the costs of making it available to others are so high) that quasi rents are created [Klein *et al.*, 1978].

normal error term with zero mean and constant variance and, y_1 and the vector $b_1 = (b_{10}, b_{11}, b_{12}, ..., b_{1m})'$ are estimable coefficients.

Y_{2i} is the hold-up variable of unknown exogeneity properties. With exogenous Y_{2i}, the familiar tobit model can be estimated by Maximum Likelihood (ML). If Y_{2i} is endogenous, the tobit estimator for equation (1.1) is inconsistent. In this case, a more appropriate estimation technique is the Two Stage Conditional Maximum Likelihood (TSCML). Smith and Blundell [1986] show this method to yield consistent estimators for the simultaneous tobit model[4]. Vella [1993] considered the case of a simultaneous equation model with a primary equation for an uncensored dependent variable on censored endogenous regressors.

Following TSCML, an auxiliary reduced-form equation for Y_{2i} is estimated in addition to the investment equation (1.1). This takes the following form:

$$
\begin{aligned}
& Y_{2i}^{*} = X_i' m_2 + v_{2i}, \qquad v_{2i} \approx NID(0, s_v^{\,2}) \\
& Y_{2i} = 1 \quad if \quad Y_{2i}^{*} \le g_1 \\
& Y_{2i} = 2 \quad if \quad g_1 < Y_{2i}^{*} < g_2 \\
& Y_{2i} = 3 \quad if \quad Y_{2i}^{*} > g_2
\end{aligned}
\tag{1.2}
$$

for $i = 1, ..., H$.

where Y_{2i} is an observable whose values follow a logical ordering (i.e., 0, 1, 2) representing the responses from firm managers to the question of whether their enterprises have experienced unimportant, fairly important, or important delayed payments for delivered products[5]. Y_{2i}^{*} is an

[4] In the Smith-Blundell model, the main equation regresses a censored dependent variable on explanators including a continuous (uncensored) endogenous regressor, for which a reduced form equation is provided.

[5] Note that both the frequency and size of the delayed payments can be important for cash flows and the profitability of the enterprise. To take account of the level and frequency of payment delays that the firms have experienced during 1997, the survey asked managers to rank how important a constraint have delayed payments been for their firms. There is a potential for endogeneity as the size and importance of the hold-ups may partially reflect the size of investment, especially investment in specific assets.

underlying latent variable driving the choice between alternatives in Y_{2i}. X_i' is a *1xK* vector of observations on variables maintained as weakly exogenous, such that $X_i' = (X_{1i}', X_{2i}')$, with X_{2i}' containing exogenous regressors pertinent to equation (1.2) so as to allow the system's identification. v_{2i} is an i.i.d. standard normal error term, and the g -s are unknown "threshold" parameters characterising the boundary values defining the range of the observable Y_{2i}. Finally, $m_2 = (m_{20}, m_{21}, m_{22}, ..., m_{2k})'$ is a vector of estimable coefficients.

Following Smith-Blundell-Vella, the conditional model for (1.1) – (1.2) is derived (see Annex for the derivation). Then, estimates of the unobserved heterogeneity responsible for the endogeneity bias are included as an additional explanatory regressor in the primary equation (1.1). These are obtained as the "generalised residuals", in the Cox and Snell [1968] sense, from the reduced form equation (1.2). Finally, a test on the significance of the additional residual term appearing as explanatory is a test for Y_{2i}'s exogeneity in the investment equation.

Given the above procedure, one can rewrite the main equation in (1.1) as:

$$
\begin{aligned}
&Y_{1i}^* = y_1 Y_{2i} + X_{1i}' b_1 + aE(v_{2i} | Y_{2i}) + e_{1i} \\
&Y_{1i}^* = y_1 Y_{2i} + X_{1i}' b_1 + a\tilde{v}_{2i}(.) + e_{1i}, \\
&Y_{1i} = Y_{1i}^* \qquad if\ Y_{1i}^* > 0 \\
&Y_{1i} = 0 \qquad otherwise
\end{aligned}
\tag{1.3}
$$

where $\tilde{v}_{2i}(.)$ denotes the generalised residual from equation (1.2) and e_{1i} is a zero mean error, which is uncorrelated with the regressors by construction. Provided that e_{1i} is normally distributed, the TSCML is then computed in two steps. Initially, the vector m_2 of coefficients in the reduced-form equation (1.2) is estimated as an ordered probit model by ML. Then, $\hat{m}_2$ are used to calculate estimates of the generalised residuals, $\hat{\tilde{v}}_{2i}(.)$, by making use of results in

Gourieroux, Monforst, Renault and Trognon [1987] who show that the best prediction for the error term is the score with respect to the intercept. Second, the tobit estimation of the equation for Y_{1i} with $\hat{\hat{v}}_{2i}(.)$ appearing as an additional explanatory variable provides consistent estimates for the coefficients in equation (1.3). The additional regressor, $\hat{\hat{v}}_{2i}(.)$, captures the dependence between the error terms in equation (1.1) and (1.2). As a result, a sufficient condition for Y_{2i} being weakly exogenous is $s_{uv} = 0$. Thus the tobit estimator for a in the estimated conditional model provides the required test of $H_0 : a = 0$. If $a = 0$ and provided that e_{1i} is normal, then TSCML is consistent and asymptotically efficient since Y_{2i} and u_{1i} are independent so that Y_{2i} may be treated as exogenous.

In the above approach, the assumption on the distribution of e_{1i} is critical for estimating equation (1.3) by TSCML. Note that the empirical model (1.1) – (1.2) includes two endogenous variables: one censored dependent variable in (1.1) and one endogenous regressor, which is distributed as an ordered discrete variable. Thus, our model combines together those considered by Smith and Blundell [1986], and Vella [1993]. Obviously, this introduces additional complexity in the estimation process.

In our model, the error distribution for e_{1i} will be unknown, often non-normal [Vella, 1993]. It is well recognised that tobit estimates are not robust to misspecifications of the error distribution. However, note that the distribution of the test statistic under the null hypothesis of no-endogeneity is normal as the non-normality induced by the inclusion of the generalised residual in the investment equation disappears. Therefore, for testing purposes, the TSCML is a valid method.

In the next section, we first proceed with a tobit estimation of (1.1) assuming that Y_{2i} is exogenous to investment. Then we extend the model allowing for the endogeneity of Y_{2i} using the TSCML procedure to estimate (1.3) and making use of the usual normality conditions under the null. We also tested for the exogeneity of the hold-ups' variable by estimating our model using a censored quantile regression model (CQR), also known as least absolute deviation (LAD) model, while estimating the variance-covariance matrix of the parameter estimates by bootstrap re-sampling techniques. However, though robust to distributional assumptions, such a semi-parametric method was quite inefficient resulting in important losses in precision. Most variables were insignificant while the sign and magnitude of the estimated coefficients was very similar to those obtained by TSCML. Given that the results we obtained were not informative they have not been reported in here[6].

IV. VARIABLES AND DATA

The empirical analysis uses data from a 1998 survey of Hungarian agricultural enterprises. The survey randomly selected a sample of 367 enterprises, which were surveyed as representative for the country for year 1997. The enterprises include a variety of organisational forms such as cooperatives, partnerships, limited liability and shareholding companies. From this original sample, a sub-sample of 318 farms involved in contracts with food processing companies was drawn. The analysis in this paper is based on this sub-sample of contracting enterprises.

The full empirical specification of the system described in equations in (1.1) and (1.2) is as follows:

[6] These results can be provided by the authors, on request. The model was estimated at the 80th quantile with 250 bootstrap sampling replications. A sensitivity analysis by performing the estimation also at the 70th, 75th, and 85th quantiles showed quite similar results.

$$INV = f(DPAY, LEG, FDI, LIQ, LAND, COL, INTR, INTSUB, GUAR, ORG, SUC, MATR, MART^2, SPEC, PRCINF, MARK, BUY)$$

$$DPAY = g(LEG, FDI, LIQ, LAND, COL, INTR, INTSUB, GUAR, ORG, SUC, MATR, MATR^2, SPEC, PRCINF, MARK, BUY)$$

where INV ($=Y_1$), is the flow of *gross capital investment* during 1997 normalised by the stock of the gross capital assets at the beginning of the period, CAP[7]. This normalisation controls for the effects of size and reduces the problem of remaining outliers, heteroskedasticity, and sample heterogeneity. Information on replacement investment is unavailable. However, as standard in the literature, this paper assumes that replacement investment is proportional to capital stock implying a geometric mortality distribution for investment goods [see, Chirinko, 1993; Jorgenson, 1971]. As such, given the normalisation rule and the cross-sectional nature of the data, the effect of replacement capital is just a scaling constant. Other financial variables are also scaled by the stock of fixed capital at the beginning of the period.

As mentioned already, the dependent variable in the second equation, $DPAY$ ($=Y_2$) is a discrete variable taking the values 0, 1 and 2 whenever firms responded that *delayed payments* for delivered products have been unimportant, fairly important, or important, respectively. As explained in the introduction, delayed payments are a very significant form of hold-ups in transition countries, and particularly so for agricultural enterprises delivering to food processing companies.

LEG is an indicator of the quality of the *court enforcement* of contracts. The variable takes values of 0, 1, and 2 measuring whether the firms find the ineffective legal enforcement of

[7] This is a standard normalisation rule found in the literature [see, Kaplan and Zingales, 1997; Lamont, 1997; Chirinko and Schaller, 1995; Fazzari and Petersen, 1993; Whited, 1992; Hoshi, Kashyap, and Scharfstein, 1991; Fazzari *et al.*, 1988].

contracts to have been an unimportant, moderately important, or important constraint for their business activities.

FDI is a dummy (0/1) for whether the firms have *contracted any sales to foreign firms.* Case studies suggest that foreign firms may be less likely to infringe on contracts through delayed payments for several reasons including less capital constraints and reputation incentives [Gow and Swinnen, 2001].

LIQ is the *quick liquidity position* of the firm measured by the stock of working capital at the beginning of the period, normalised by gross capital assets lagged one period.

LAND is the rental value of total agricultural land cultivated in 1996 (including arable land, orchards, vineyards, pastures, forests, etc.) deflated by the stock of gross fixed capital for the same period. It can be interpreted as a proxy for firm's *expectations of future output conditions and investment opportunities*. Like in Hoshi *et al.*, [1991] and Hubbard and Kashyap [1991], controlling for such expectations ensures that these effects are not captured by the liquidity variable[8]. Finally, note that *LAND* only marginally overlaps with *COL* as 94 percent of cultivated land in the surveyed enterprises was leased.

COL is a proxy for the firm's *access to external resources* measured as the level of collaterised assets (agricultural and other real estate, livestock, machinery, purchased products) at the beginning of the period deflated by the stock of capital (lagged one period)[9]. Following

[8] See, Hoshi *et al.* [1991] for a discussion of the rationale for including a proxy for output in addition to a variable for financial constraints.

[9] Real estate collateral does not include agricultural land as most of the land cultivated by the enterprises in our sample is leased.

Gertler and Rose [1991], this measure together with that for liquidity might also be interpreted as indicators of the firm's net worth position.

Three variables account for factors that affect the cost of capital, including government policies, and hence are likely to affect investment demand. The *interest rate* (*INTR*) refers to firms' average interest charges for loans. An indicator for *interest subsidies* (*INTSUB*) is 0, 1, and 2 according to the extent to which the firms have benefited from such measures as not importantly, moderately, and importantly, respectively. A dummy variable for *credit guarantees* (*GUAR*) is 1 for firms receiving such government support during 1997 and 0 otherwise.

Four variables are included to capture exogenous firm characteristics, which might explain cross-firm variations in investment behaviour. These are *organisation* (*ORG*), information on whether the firm was established as a successor to previous production organisations or a start-up business (*SUC*), experience or *maturity* (*MATR*), and *specialisation* (*SPEC*). A squared term for the *MATR* variable was also included to consider the possibility of a quadratic effect on investment. *ORG* is specified as 0 if the firm is a cooperative and 1 if it is organised as a limited partnership, a limited liability, or a joint-stock company. *SUC* is 0 if the firm is a start-up and 1 if it is a successor organisation to a former collective or state enterprise. *MATR* is the natural logarithm of the number of years that the firm has been operating plus one. Finally, based on the share of crop to total sales, *SPEC* categorises the enterprises as 2 for crop firms (crop sales 70 - 100 percent of total sales), 1 for mixed (30 - 70 percent), and 0 livestock (0 - 30 percent). Besides controlling for additional heterogeneity, the specialisation index might

capture possible industry/activity-specific differences in capital-intensity requirements within the farming sector[10].

PRCINF is intended to capture market imperfections, i.e., noise and uncertainties inherent in the marketplace that might have a bearing on the investment behaviour of firm. It takes the values of 0, 1 and 2 indicating whether firms report the *lack of price information* as an unimportant, moderate, or important constraint.

MARK indicates the extent to which firms, on signing a sales contract, commit to deliver their products at contracted buyers' processing facilities, i.e., buyers do not come to collect the produce at the farm-gate. The variable is discrete (0, 1, 2), based on whether firms report that the above is seldom, not so often, or often the case. This information reflects the distribution of costs associated with the delivery of produce, i.e., transportation, transaction and other costs associated with the exchange, and hence the distribution of private enforcement capital between the farm producers and the food processors[11]. This ultimately contributes to specificities related to the particular contractual relationship.

Finally, *BUY* is a discrete variable (0, 1, 2) used as an indicator of search costs measuring whether firms find it more difficult, the same, or easier to *locate a buyer compared to 1993*. This variable together with *MARK* defined above, are intended to capture transaction specificities in business relations.

[10] It could be argued that the specialisation index is endogenous, since it is based on the total volume of realised sales, as reported at the end of 1997. However, it turns out that the specialisation index is invariably insignificant for investment and regressions run with and without this variable yield almost identical results.

[11] The private enforcement capital is a combination of the reputation capital and the present value of the rents, which accrue to the non-salvageable relationship-specific investment provided by each party to a contract (Klein, 1996).

All variables contained in the vector X'_{1i} and appearing as exogenous to the *INV* equation in the simultaneous system are maintained as weakly exogenous to *DPAY* as well. Variables for firm's internal liquidity, level of collateral and total land cultivated in 1996 are exogenous because of reflecting beginning-of-period information. Variables reflecting firm characteristics and the effect of market imperfections on their activity are also exogenous in both equations because of representing past decisions and/or factors outside the firm's control. Further, assuming that contracting precedes any possible hold-up behaviour, the variable for whether firms sell to downstream businesses with foreign involvement is exogenous in relation to the hold-up's variable.

Note that because of the possibility of missing variables in equation (1.2) for the endogenous regressor, the estimated results for this equation indicate association but cannot be given any causality interpretation.

V. RESULTS

Table I reports results from the tobit estimation of equation (1.1) assuming *DPAY* is exogenous. Regression (1) shows that *DPAY* has a significantly negative effect on investment. Investments are significantly lower in firms where payment delays are an important problem. This result is robust to changes in the set of control variables (see further).

Other contract-related variables have the expect sign but are insignificant for investment. Neither the legal enforcement of contracts (*LEG*), nor foreign ownership of the processing facility (*FDI*) have an impact on investment. We return to these results and their interpretation later.

The liquidity variable (*LIQ*) is positively and significantly correlated with investment indicating that capital investment is higher the more liquid the firms. This result remains unchanged even with an orthogonalised measure of *LIQ* used instead of the original variable (see regression 2)[12].

The coefficient of (*LAND*) is also positive and significant: investment is higher in firms with a higher rental value of the land they use. Presumably, this reflects expectations of future output conditions and investment opportunities of these firms.

Interestingly, the variable for collateral (*COL*) is negatively correlated with investment. This result is counterintuitive at first. However, the negative sign here might reflect the fact that, with expensive external credit in a transition environment, firms may prefer to finance their investment internally, rather than through borrowing. In this case, only internally constrained firms would resort to external resources to finance their investment needs. As such, given that external finance is costly and other things being equal, investment levels of firms using collateral for loans may well be lower than those for the unconstrained firms.

To capture this effect, we include an interaction term for *COL* and a dummy for the liquidity position of the firm, *DLIQ*COL*. The liquidity dummy is specified as 1 if the firm has a level of internal liquidity above the sample average and 0 if it is below that average. The results from the model with the interaction term are presented in regression (3) in table I. The interaction term is positive and significant for investment. This implies that the negative relationship

[12] A .70 correlation coefficient between *LIQ* and *MARK* showed that the information contained in those variables is highly collinear within our cross-section. Therefore, the initial variables were orthogonalised with respect to each other and the model estimated with the new variables instead (regression 2). See notes at the bottom of table I for more details.

between the collaterised assets and higher levels of investments is primarily the case for firms with below average liquidity levels, and indeed reflects a preference for internal financing.

Variables for interest rates (*INTR*) and interest subsidies (*INTSUB*) also significantly affect investment. Higher interest rates reduce investments, while the incidence of subsidised rates of interest has a positive effect. In contrast, government loan guarantees (*GUAR*) have no impact on investment in the firms analysed in here.

The estimated impact of *ORG* and *SUC* in regression (1) indicates that commercial companies, *ceteris paribus*, are likely to invest significantly more than cooperatives, and that successor organisations invest more than start up (or so-called *de novo*) firms. However, there is a problematic correlation between *SUC* and *ORG* in regression (1). After correcting for this by orthogonalising both variables in regression (2), *SUC* loses its significance for investment, and the organisational structure remains the essential factor, with cooperative farms investing significantly less than commercial companies. This result is consistent with empirical evidence in Mathijs and Swinnen, [2001] who find that the organisational structure of cooperative farms induces differences in managerial behaviour, productivity and presumably investment compared to other forms of enterprises.

Other firm specific characteristics, such as the age (*MATR*), age squared, and specialisation (*SPEC*) have no impact on investment. Similarly, variables intended to capture uncertainties (*PRCINF*) and transaction specificities (*MARK*) and (*BUY*) show insignificant results. Note that regressions (1) to (3) show that *FDI*, *LEG*, *MARK* and *BUY* do not belong in the investment regression what encourages their use as instruments for *DPAY*. Results for other regressors in

the investment equation do not change when these variables are dropped as shown in regression (4).

As explained above, the results reported in table I would be biased and inconsistent were *DPAY* endogenous in the investment regression. Following the TSCML approach described in section 3, a reduced form equation for the hold-ups' variable is estimated by ordered probit. Results are reported in table II. Generalised residuals, i.e., the scores with respect to the intercept, are calculated from regression (7) and included as an additional explanatory variable in the investment equation. The investment model is then estimated as a normal tobit and results are reported in table III, regression (8).

In regression (8), the generalised residual has an estimated coefficient, which is statistically zero, indicating that *DPAY* is exogenous to investment. This implies that the findings reported in table I remain valid. A comparison of results in table III with those in table I shows that the main conclusions we have discussed earlier do not change. Contract breaches under the form of delayed payments have a significantly negative impact on investment. Furthermore, investment is significantly higher in commercial companies than in cooperatives, and in firms with access to subsidised interest rates for investment loans. Investment is higher for firms with relatively higher levels of liquidity, lower levels of collateralised assets, and a higher value of land used by the firm, for reasons explained above.

Moreover, the results of table II and III combined provide some interesting insights on the direct and indirect effect of certain variables on investment. The results in table II indicate that the likelihood of firms having experienced important delays in payments for delivered products is significantly associated with several variables, including the legal enforcement of contracts

(*LEG*), the origin of the firm (*SUC*), the level of collaterised assets (*COL*) and the proxy for transaction costs associated with marketing the produce (*MARK*).

The results indicate that problems with the legal enforcement of contracts might have an important, but indirect, impact on investment. Contract breaches under the form of delayed payments are positively associated with legal enforcement problems. Hence, while the legal enforcement has no direct impact on investment (see table I and III) there is a significant negative indirect impact through the contract breach problems, as can be derived from the significant coefficients of *LEG* in table II and *DPAY* in table III.

No significant impact of foreign ownership of the processing company on the likelihood of payment delays or on investment was found. An explanation for this result may be found in strong spillover effects from foreign investment in the food industry. Presumably, successful business strategies of foreign companies have been replicated by domestic processing companies, possibly to the extent that there are no longer any significant differences in their effects. For example, in a study of the Polish dairy sector, Dries and Swinnen [2002] find that in the mid 1990s foreign investors followed business strategies that were significantly different from those prevailing among domestic firms, including prompt payments and provision of a variety of services to their supplies. However, by 2001 these differences had disappeared as domestic companies replicated the successful strategies of foreign companies. As Hungary attracted FDI earlier and more extensively than Poland, the same effect may have occurred already by 1997 in Hungary – explaining the positive but insignificant effect of the *FDI* variable in the regressions.

Interestingly, the results for variables reflecting the costs of capital confirm our intuition. Higher commercial interest rates are positively associated with higher payment delays. With

higher cost of capital the incentives to extract quasi-rents from suppliers by implicitly lending from them at zero interest rates through payment delays increases. As expected, interest subsidies and government guarantees have no impact on such contract breaches.

The two stage estimation results indicate that while being a start-up firm or a successor of a collective or state firm does not have a direct impact on investment, there is potentially an indirect effect. Start up firms are less likely to face delayed payments than successor organisations, which indirectly leads to higher investments in new start up firms.

Finally, table II also indicates an important correlation of *MARK* with the incidence of delayed payments. The positive coefficient indicates that processing companies showing lower levels of private enforcement capital invested in exchanging and marketing the produce, i.e., firms that receive products at the processing plant rather than at the farm-gate, are more likely to hold up suppliers.

The results discussed in here are robust to changes in the set of information included in the form of right hand side variables as shown in regressions (6) and (7) when highly insignificant variables were excluded from the estimation.

VI. CONCLUSIONS

Most of the existing studies provide limited evidence on the significance of contractual breaches and hold-up behaviour for economic activity in transition firms. Research in the area has mostly been confined to case studies while little representative statistical evidence exists on the effect of hold-ups for firm investment and growth. This paper uses a unique dataset of 318

Hungarian contracting agricultural firms, surveyed in 1998, to study the relationship between firms' capital investments and the extent to which those were affected by the incidence of contract hold-ups.

Contract breaches under the form of delayed payments have a significant negative impact on firm investment. Our study shows that these payment delays are more important when the legal enforcement of contracts is problematic, lowering the costs of contract breach, and when the cost of capital is high, raising the benefits of contract breach. These factors therefore have a potential of indirectly affecting investment.

Commercial interest rates also directly affect investment by their standard impact on raising the cost of capital. For the same reason we find that access to interest rate subsidies has a positive effect on investment, but no effect on contractual breaches. We find no impact of loan guarantee programs on investment.

The study also confirms that firms with higher levels of liquidity invest more. Firms with more collateralised assets invest less, especially at low liquidity levels. At the same time firms with more collateral face less contract breaches under the form of payment delays.

There was no significant effect of whether the processing company was foreign or domestically owned, either directly on investment or indirectly through payment delays. This may reflect the fact that spillover effects of FDI to domestic companies have reduced differences in business strategies between them.

The organisational structure of the supplying firm affects investment both, directly and possibly indirectly. Commercial companies invest more than cooperatives, *ceteris paribus*. The origin of the firms does not directly affect investment, but new start up enterprises seem to be less affected by direct payments, and are thus indirectly associated with higher investments.

Whether firms commit to delivering the product themselves or whether the product is collected by the processor at the farm-gate, reflecting differences in the distribution of private enforcement capital in the form of commitment and exchange costs, affects the likelihood of hold-ups occurring. Delayed payments are significantly higher when the firms have to deliver the product at the processing facilities.

In summary, our results confirm that investment is affected by a variety of factors. Contractual breaches, in the case of this study under the form of delayed payments, have a significant negative effect on investment. Our study also shows that such contract breaches, with their negative effect on investment, are more likely to occur when the benefits of breaching the contract for the processor are larger because of a higher cost of capital, and when costs are lower, due to poor external contract enforcement or because of less private contract enforcement capital involved.

Annex: **Deriving the Conditional Model**

Consider the above two-equation simultaneous model again:

$$\begin{aligned} Y_{1i}^{*} &= Y_{2i} y_{1} + X_{1i}' b_{1} + u_{1i}, \\ Y_{2i}^{*} &= X_{i}' m_{2} + v_{2i}, \\ &for \quad i = 1,...,H. \end{aligned} \tag{A.1}$$

Assume u_{1i} and v_{2i} have a joint normal distribution with zero mean and finite positive definite covariance matrix:

$$\begin{bmatrix} u_{1i} \\ v_{2i} \end{bmatrix} \approx NID\left(0, \begin{pmatrix} s_{uu} & s_{uv} \\ s_{vu} & s_{vv} \end{pmatrix}\right) \tag{A.2}$$

Further, assume X_{i}', u_{1i}, v_{2i} are i.i.d and the parameters of the model are identified up to some normalisation. System (A.1) is written in its conditional form, by taking expectations with respect to Y_{2i}, as:

$$\begin{aligned} E\left(Y_{1i}^{*} \middle| Y_{2i}\right) &= y_{1} E\left(Y_{2i} \middle| Y_{2i}\right) + b_{1} E\left(X_{1i}' \middle| Y_{2i}\right) + E\left(u_{1i} \middle| Y_{2i}\right), \\ E\left(Y_{2i}^{*} \middle| Y_{2i}\right) &= m_{2} E\left(X_{i}' \middle| Y_{2i}\right) + E\left(v_{2i} \middle| Y_{2i}\right) \end{aligned} \tag{A.3}$$

The conditional error terms $E\left[u_{1i} \middle| Y_{2i}\right]$ and $E\left[v_{2i} \middle| Y_{2i}\right]$ (i.e., best predictions of u_{1i} and v_{2i} given Y_{2i}), are the generalised errors in the Cox and Snell [1968] sense. Denote those as $\tilde{u}_{1i}(.)$ and $\tilde{v}_{2i}(.)$. Rewriting $\tilde{u}_{1i}(.)$ in terms of $\tilde{v}_{2i}(.)$, the following expression can be obtained:

$$\begin{aligned} E\left(u_{1i} \middle| Y_{2i}\right) &= E\left(E\left(u_{1i} \middle| v_{2i}\right) \middle| Y_{2i}\right) = E\left(a v_{2i} \middle| Y_{21}\right) \\ &= aE\left(v_{2i} \middle| Y_{2i}\right) = s_{uv} s_{vv}^{-1} \tilde{v}_{2i}(.) \end{aligned} \tag{A.4}$$

where $a = s_{uv} \Big/ s_{vv}$.

Such expression is arrived at by using the assumption of joint normality between u_{1i} and v_{2i} and the law of iterated expectations. First, note that the law of the iterated expectations $E\left(u_{1i} \middle| Y_{2i}\right) = E\left(E\left(u_{1i} \middle| v_{2i}\right) \middle| Y_{2i}\right)$ is applicable since v_{2i} provides more information about the stochastic nature of u_{1i} than Y_{2i}, i.e., it provides as much information as the continuous latent Y_{2i}^{*}, while

the latter tells more than its ordered counterpart, Y_{2i} [13]. Second, due to u_{1i} and v_{2i} being jointly normal, the mean of the conditional probability distribution of u_{1i}, given v_{2i}, is a linear function of the latter, i.e., $E(u_{1i}|v_{2i}) = a_0 + a v_{2i}$ where $a_0 = t_u - t_v r_{uv} \frac{s_u}{s_v} = 0$ (i.e., t_u and t_v are zeroes as means of the marginal distribution of u_{1i} and v_{2i}, respectively) and $a = r_{uv} \frac{s_u}{s_v} = \frac{s_{uv}}{s_{vv}}$.

Accordingly, one can rewrite the main equation in (A.3) as:

$$
\begin{aligned}
& Y_{1i}^{*} = y_1 Y_{2i} + X_{1i}' b_1 + a E(v_{2i}|Y_{2i}) + e_{1i} \\
& Y_{1i}^{*} = y_1 Y_{2i} + X_{1i}' b_1 + a \tilde{v}_{2i}(.) + e_{1i}, \\
& Y_{1i} = Y_{1i}^{*} \qquad \textit{if } Y_{1i}^{*} > 0 \\
& Y_{1i} = 0 \qquad \textit{otherwise}
\end{aligned}
\tag{A.5}
$$

[13] Note that the observations in the vector of exogenous variables X_i' are fixed in repeated samples and m_2 is a vector of constants.

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Table I. Estimation of the Tobit Model for Capital Investment[a]

Sample Size: 318 firms

Dependent:	*Capital Investment*							
Regress. No[b]	(1)		(2)		(3)		(4)	
	Coeff.	*z-value*	*Coeff.*	*z-value*	*Coeff.*	*z-value*	*Coeff.*	*z-value*
Constant	94.17	(.71)	110.37	(.83)	109.21	(.83)	121.94	(.93)
DPAY	-13.60**	(2.25)	-13.60**	(2.25)	-12.93**	(2.11)	-13.17**	(2.34)
LEG	8.23	(1.06)	8.23	(1.06)	7.89	(1.01)	---	---
FDI	.45	(.05)	.45	(.05)	.70	(.08)	---	---
LIQ [c]	2.40***	(3.05)	2.02**	(2.46)	1.99**	(2.45)	2.06**	(2.55)
LAND	.11***	(2.98)	.11***	(2.98)	.11***	(2.97)	.11***	(2.95)
COL	-63.13**	(2.46)	-63.13**	(2.46)	-67.10***	(2.81)	-68.69***	(2.71)
DLIQ*COL	---	---	---	---	49.53***	(2.68)	45.08*	(1.85)
INTR	-.10**	(1.98)	-.10**	(1.98)	-.09*	(1.76)	-.08*	(1.91)
INTSUB	56.63***	(3.74)	56.63***	(3.74)	56.08***	(3.74)	55.85***	(3.85)
GUAR	3.07	(.39)	3.07	(.39)	2.74	(.35)	2.67	(.35)
ORG [c]	18.42***	(3.24)	7.38***	(3.24)	6.92***	(3.08)	6.34***	(2.91)
SUC [c]	24.80**	(1.92)	7.13	(1.27)	7.10	(1.27)	6.45	(1.15)
MATR	-106.76	(1.24)	-106.76	(1.24)	-105.61	(1.23)	-107.41	(1.29)
MATR (Sqr)	18.06	(1.46)	18.06	(1.46)	17.67	(1.43)	17.90	(1.53)
SPEC	9.79	(1.54)	9.79	(1.54)	9.35	(1.45)	9.93	(1.52)
PRCINF	-4.33	(.55)	-4.33	(.55)	-4.24	(.53)	-5.77	(.74)
MARK[c]	-3.59	(.92)	-2.61	(.92)	-2.99	(1.02)	---	---
BUY	1.72	(.30)	1.72	(.30)	2.52	(.45)	---	---
Wald chi2	319.72		319.72		366.35		292.14	
Prob > chi2	.00000		.00000		.00000		.00000	

[a] All regressions are reported with Huber/White/sandwich robust SEs adjusted for clustering on a regional (county) dummy.

[b] *** ,** and * denote significance at 1 percent, 5 percent and 10 percent, respectively.

[c] From regression (2) onwards, *MARK* has been orthogonalised with respect to *LIQ* and *ORG* with respect to *SUC* using a modified Gram-Schmidt procedure performed routinely by *STATA*. This was necessary as a correlation coefficient of .70 between the first two variables and -.50 between the last two is high, especially considering out cross-sectional framework.

Table II. Ordered Probit Estimation of the Hold-Ups' Variable[a]

Sample Size: 318 firms

Dependent:	*Delayed Payments*					
Regress. No [b]	(5)		(6)		(7)	
	Coeff.	*z-value*	*Coeff.*	*z-value*	*Coeff.*	*z-value*
LEG	.38**	(2.58)	.35***	(2.82)	.36***	(2.63)
FDI	-.20	(1.21)	-.19	(1.10)	-.20	(1.17)
LIQ [c]	-.02	(1.00)	-.03	(.97)	-.04	(1.01)
LAND [d]	-.0002	(.88)	---	---	---	---
COL	-.40*	(1.90)	-.46**	(2.13)	-.47**	(2.06)
DLIQ*COL	-3.18***	(2.70)	-3.02**	(2.16)	-2.96**	(2.51)
INTR	.001*	(1.79)	.002**	(2.26)	.001**	(2.13)
INTSUB	.14	(.57)	---	---	.15	(.59)
CGUAR	-.07	(.55)	---	---	-.07	(.60)
ORG [c]	.03	(.37)	---	---	.02	(.28)
SUC [c]	.17***	(2.74)	.17***	(2.61)	.18***	(2.79)
MATR	-.53	(.86)	---	---	-.57	(.92)
MATR (Sqr)	.06	(.52)	---	---	.07	(.61)
SPEC	.13	(1.62)	.11	(1.64)	.12	(1.63)
PRCINF	-.14	(.68)	-.12	(.63)	-.13	(.68)
MARK [c]	.44***	(3.94)	.42***	(4.12)	.43***	(4.13)
BUY	-.13	(1.39)	-.13	(1.47)	-.13	(1.43)
Wald chi2	301.35		244.14		299.07	
Prob > chi2	.00000		.00000		.00000	

[a] All regressions are reported with Huber/White/sandwich robust SEs adjusted for clustering on a regional (county) dummy.

[b] *** ,** and * denote significance at 1 percent, 5 percent and 10 percent, respectively.

[c] The variables *MARK*, *LIQ*, *ORG* and *SUC* used in here are the orthogonalised one. See notes in table I for details.

[d] *LAND* was excluded from regression (7) due to its coefficient being practically zero.

Table III. Two Stage Results for Capital Investment[a]

Sample Size: 318 firms

Dependent:	*Capital Investment*	
Regress. No[b]	(8)	
	Coefficients	*z-values*
Constant	133.38	(1.03)
DPAY	-22.91**	(2.19)
LIQ [c]	1.96**	(2.43)
LAND	.12***	(3.00)
COL	-71.62***	(2.94)
DLIQ*COL	35.68	(1.27)
INTR	-.06	(1.35)
INTSUB	55.03***	(3.83)
GUAR	2.58	(.34)
ORG [c]	5.99***	(2.86)
SUC [c]	7.26	(1.26)
MATR	-109.61	(1.33)
MATR (Sqr)	18.14	(1.56)
SPEC	10.10	(1.52)
PRCINF	-4.31	(.57)
Generalised Residual[d]	8.98	(1.14)
Wald chi2	303.61	
Prob > chi2	.00000	

[a] Regression is estimated with Huber/White/sandwich robust SEs adjusted for clustering on a county dummy.

[b] *** ,** and * denote significance at 1 percent, 5 percent and 10 percent, respectively.

[c] The variables *LIQ*, *ORG* and *SUC* used in here are the orthogonalised one. See notes in table I for details.

[d] Scores with respect to the intercept, i.e., the generalised residuals, are calculated from regression (7), in table II.