INVESTMENT, CREDIT RATIONING, AND THE SOFT BUDGET CONSTRAINT: EVIDENCE FROM CZECH PANEL DATA

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Abstract—Strategic restructuring of firms through investment is key to a transition from plan to market. Using data on industrial firms in the Czech Republic during 1992–1998, we find that foreign-owned companies invest the most and cooperatives the least, that private firms do not invest more than state-owned ones, and that cooperatives and small firms are credit rationed. Given the large volume of nonperforming bank loans to firms and the high rate of investment of large state-owned and private firms, our findings also suggest that these firms operate under a soft budget constraint. Estimates of a dynamic model, together with the support for the neoclassical model, suggest that firms started to behave consistently with profit maximization.

I. Introduction

STUDIES of investment behavior have always occupied a pivotal place in western economics literature. On the demand side, much of the literature has focused on establishing the relative merits of the structural dynamic, Tobin's *Q*, neoclassical, and accelerator models of investment demand, for the most part assuming that the supply of investment finance is perfectly elastic. More recently, an important part of the literature has concentrated on the supply side, examining the effects of potential capital market imperfections on the investment behavior of firms.[1]

Investment studies also constituted a key area of comparative economics, in part because of Stalin's and other communist leaders' preoccupation with overtaking capitalist economies by massive capital formation.[2] The centrally planned economies indeed reported very high rates of investment during most of their existence, although in the Soviet bloc these rates declined somewhat in the 1980s as economic growth slowed down and popular demand for consumption goods became harder to ignore (EBRD, 1995). Moreover, the technological development of centrally planned economies increasingly lagged behind those of capitalist countries.[3]

As the transition to a market system started to unfold in the early 1990s, it became clear that the transition economies needed to invest heavily in order to modernize their obsolete capital stock and become competitive on world markets. The issue of how best to restructure and modernize the state-owned enterprises (SOEs) and privatized firms has been a focal point in the policy debate about optimal types of ownership and legal (corporate) structure of firms in the new market economies. Theoretical studies have focused on strategic or deep restructuring of firms in the presence of imperfect capital markets as a key to the transition process, and they recognized investment as a principal vehicle of this restructuring.[4] Yet, from the outset it was recognized that only productive investment would contribute to restructuring. If firms faced soft budget constraints (willingness of the government or some other institution to provide additional resources or otherwise bail them out),[5] investment might reflect a waste of resources as the firms used these funds for survival rather than restructuring. Indeed, there has been increasing concern that, while direct government subsidies have been dramatically reduced in a number of countries, indirect subsidies through the banking system continued for the (former) SOEs on a large scale. Hence, although between 1989 and 1992 direct government subsidies to firms as a share of GDP fell from 25% to 5% in the Czech and Slovak republics, 12% to 5% in Poland and 11% to 3% in Hungary,[6] these economies experienced banking crises in the 1990s as the new commercial banks continued to extend loans to poorly performing SOEs and the large privatized firms.[7] The problem arose partly because, under central planning, all capital allocation was performed by a single bank that combined the roles of a central bank and commercial bank. At the start of the transition, this monobank system was terminated and independent commercial banks were created, but the new banks had virtually no project appraisal capability, some suffered from corruption, and many were under pressure from government as well as an "old-boys network" to continue extending credit to existing client firms. During the same period, there were also signs that newly created firms faced expensive bank finance or

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[1] See, for example, Jorgenson (1971), Nickell (1977), Abel (1980), Abel and Blanchard (1986), Shapiro (1986), Fazzari, Hubbard, and Petersen (1988, 2000), Gertler (1988), Hayashi and Inoue (1991), Bond and Meghir (1994), Kaplan and Zingales (1997, 2000), Hubbard (1998), Oliner and Rudebusch (1992), and Chirinko, Fazzari, and Meyer (1999).

[2] See, for example, Thornton (1970), Desai (1976), Gomulka (1978, 1986), Greene and Levine (1978), Weitzman (1979, Brada and Hoffman (1985), and Terrell (1992, 1993).

[3] The embargo imposed in the 1980s by western countries on advanced technology exports to communist economies contributed to this technological gap.

[4] See, for example, Grosfeld and Roland (1997), Aghion, Blanchard, and Burgess (1994) and Blanchard (1997).

[5] See Kornai (1979, 1986, 1998) for the introduction and discussion of the concept of a soft budget constraint.

[6] See Gao and Schaffer (1998) and Basu, Estrin, and Svejnar (1999).

[7] In addition, Schaffer (1997) estimates that tax arrears of firms represented subsidies equal to 1% to 2% of GDP in the early 1990s.

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were denied access to bank loans altogether. (A comparative analysis of the Czech financial may be found in a special issue of the *Journal of Comparative Economics* (1997) and in EBRD (1998).)

In this paper, we analyze investment behavior using more than 83,500 quarterly observations from the population of about 4,000 medium and large industrial firms located in the Czech Republic during the 1992–1998 period. Our study is of special interest for five reasons.

First, our work constitutes one of the first firm-level analyses of investment behavior in the transition economies, and it focuses on one of the lead countries that serve as models for other countries that have launched their transitions later. Our findings are hence of broad interest in the context of the transition. Although a small number of earlier studies have provided valuable partial surveys of investment in the transition economies,[8] detailed analytical studies of the investment behavior of firms in these economies are only now being performed.[9] Our study stands out among these few studies because we combine several methodological approaches and use a longer (seven-year) panel of data. This allows us to capture better the process of new investment and allow for construction and gestation of capital.

Second, we provide evidence on the propensity to invest by ownership and legal status of firms, and how these propensities vary over time. As might be expected, we show that the foreign-owned companies invest the most and the (domestically owned) cooperatives the least. However, we find little support for the accepted wisdom that private firms invest more than state-owned ones. Moreover, the relative investment rate of the state-owned firms increased over time.

Third, we provide evidence on whether firms face credit rationing or a soft budget constraint and whether the degree of rationing or softness of the budget constraint varies with the firm's ownership and legal status. In doing so, we test one of the leading explanations of the sharp decline in investment and output during the early transition period: Calvo and Coricelli's (1994) credit crunch hypothesis. We reject this hypothesis as an overall explanation. In particular, we find that cooperatives and, to a lesser extent, smaller and medium-sized private firms were rationed in their access to credit, but the majority of firms, including the state-owned and larger privatized firms, were not. Moreover, for many of the latter firms, the availability of investment funds is negatively related to profitability. This availability of investment funds to the SOEs and larger privatized firms despite poor performance, together with their high rate of investment, complements the evidence that Czech banks accumulated a large amount of bad enterprise loans in the 1990s. Taken together, these findings provide strong evidence that many large firms have been operating with a soft budget constraint.[10]

Fourth, because a key turning point in the transition process occurs when firms start behaving like their western counterparts, we test whether the investment behavior of firms in our data set is consistent with profit maximization. In particular, we test if the demand side of investment reflects the neoclassical, accelerator, and structural dynamic models. We find the behavior of most types of firms to be consistent with profit maximization in both the static (neoclassical) and structural dynamic framework. In the static context, we are also able to check if the support for the profit-maximizing model grows over time, and we find that it does. Our analysis hence shows that, although smaller firms suffer from credit rationing and larger ones have (too) easy access to bank loans, in terms of the use of financial resources they all behave consistently with profit maximization.

Finally, our study is of methodological interest because we use a large panel of quarterly firm-level data. We are hence able to eliminate bias introduced by data selectivity and aggregation (see, for example, Abel and Blanchard (1986)), reduce measurement error, take into account heterogeneity across firms and over time (Bond & Meghir, 1994), and control for the seasonal variation in investment. This makes our work important in the context of the growing literature on transition as well as recent investment literature in general.

Overall, although our choice of the Czech Republic is linked to the availability of a unique data set, an important factor for studying this case is clearly the fact that, together with other countries in central Europe, the Czech Republic has been a pioneering transition economy. In the early 1990s, the Czech Republic abolished central planning and carried out rapid price liberalization, macroeconomic stabilization, and widespread privatization of state-owned firms. It was one of the most successful countries in the region in terms of macroeconomic stabilization, keeping relatively low inflation, budget deficit, and unemployment rate.[11] As

[8] See, for example, Belka et al. (1994), EBRD (1995), and Eickelpasch (1995).

[9] For the other studies, see Lízal (1999a), Anderson and Kegels (1997), and Prasnikar and Svejnar (1998).

[10] At a meeting in Paris in December 2000, the governor of the Czech National Bank announced that, in 1999a, full 32% of the total loan portfolio of the Czech banks was classified as substandard. He stated that "the problem has been most serious in large banks (with more than 40% of their loans being classified at the end of 1999) and small Czech-owned banks (more than 50% of their loans classified) . . . the public costs of the banking sector transformation have been estimated at over CZK 250 billion, or 14% of annual GDP (plus the as yet unknown public costs of the IPB [Investment and Postal Bank] case)." In late 2000, estimates of the cost of covering IPB losses were up to CZK 180 billion, or another 10% of the Czech Republic GDP.

[11] After price liberalization, the Czech Republic reduced inflation to about 10% throughout most of the 1990s, as compared to a more gradual reduction from about 20% to 10% in Hungary, 40% to 12% in Poland and 20% to 10% in Slovakia. During most years in the 1990s, the Czech government ran a 1% to 2% budget deficit, compared to a 5% to 8% deficit in Hungary, a 2% to 5% deficit in Poland and a 0% to 5% deficit in Slovakia. Finally, until the recession in the late 1990s, the Czech Republic maintained its unemployment rate below 5%, while the unemployment rate in the other three economies reached double digits. During the

TABLE 1.—INVESTMENT AND GDP GROWTH IN CENTRAL EUROPE

	Czech Republic		Hungary		Poland		Slovak Republic	
Year	%ΔGDP	I/GDP	%ΔGDP	I/GDP	%ΔGDP	I/GDP	%ΔGDP	I/GDP
1991	−11.6	0.22	−11.9	0.21	−7.0	0.15	−14.6	0.25
1992	−0.5	0.25	−3.1	0.19	2.6	0.12	−6.5	0.30
1993	0.1	0.28	−0.6	0.18	3.8	0.09	−3.7	0.28
1994	2.2	0.31	2.9	0.20	5.2	0.09	4.9	0.28
1995	5.9	0.34	1.5	0.18	7.0	0.10	6.7	0.31
1996	4.8	0.38	1.3	0.19	6.1	0.11	6.2	0.42
1997	−1.0	0.37	4.6	0.20	6.9	0.12	6.2	0.44
1998	−2.2	0.31	4.9	0.21	4.8	0.14	4.1	0.44
1999	−0.2	0.30	4.5	0.20	4.1	0.14	1.9	0.36

% ΔGDP stands for the annual percentage change in real GDP. Comparable methodology is used across countries. Investment includes tangible and intangible fixed assets (except for the Czech Republic, where it includes only tangible fixed assets). With the exception of Poland, all investment data are for the entire economy, including estimates for entities not directly monitored by the statistical offices. In Poland, investment reflects entities with more than twenty (fifty in industry) employees. Data for Hungarian 1998 and 1999 investment share is preliminary estimate.

Source: EBRD (Transition Report) and CESTAT (Statistical Bulletin of Czech, Hungarian, Polish, Slovak, and Slovenian Statistical Offices), various issues.

may be seen from table 1, the Czech Republic, like the other economies in central Europe, suffered a significant GDP decline in the first phase of the transition, followed by a recovery in the early-to-mid-1990s. Unlike the other central European economies, however, the Czech Republic experienced a recession from 1997 to 1999. As in Slovakia and Poland, the Czech investment rate fell during the economic decline of the early 1990s and rebounded thereafter. The 1997–1999 recession also brought about a significant decline in the Czech Republic's high rate of investment. However, during most of the 1990s, the Czech and Slovak investment rates were among the highest observed in the transition economies. Finally, like other transition economies, the Czech Republic experienced a severe banking crisis in the mid-to-late 1990s. The crisis stemmed form excessive lending to firms for nonviable investment projects, and it was exacerbated by an underdeveloped legal framework, weak enforcement of existing laws, and high reliance of firms on bank credit for capital. Hence, understanding investment behavior of the various types of firms in the Czech Republic is useful for gaining a broader understanding of the investment behavior and hence restructuring of firms in the transition economies in general.

II. Data and Basic Statistical Findings

The Czech Statistical Office (CSO) collected the data set we use. It covers all industrial firms employing more than 25 people in the 1992–1994 and 1997–1998 periods, and all industrial firms with more than one hundred employees in 1995 and 1996. The 1998 data come from a preliminary file and do not include all firms with fewer than one hundred employees.[12] The data were collected in quarterly or monthly intervals, depending on the size of the enterprise and the reported variables. We have combined the monthly and quarterly data so as to maximize the number of quarterly observations. In our analysis, we use data on total gross investment because this indicator is consistent with most existing studies of investment in the market economies and because we do not have much information on individual components of investment.[13]

Although the CSO is very professional, the data set contained some inconsistencies.[14] We have therefore performed a number of consistency checks.[15] In imposing these consistency criteria, approximately 10% of the observations were dropped, leaving us with a data set of approximately 83,500 quarterly observations.[16] In terms of the total number of firms (and quarterly observations) used in regressions, our data set covers 1,867 firms (6,947 quarterly observations) in the 1992–1993 subpanel, 2,315 firms (7,570 quarterly observations) in the 1993–1944 subpanel, 1,922 firms (6,991 quarterly observations) in the 1994–1995 subpanel, 1,969 firms (7,349 quarterly observations) in the

1996–2000 recession, the Czech unemployment rate peaked at 9.8% in January 2000.

[12] In 1995 and 1996, the Czech Statistical office temporarily changed its methodology and collected data only for firms with one hundred or more employees.

[13] For firms with investment of more than one million Czech Crowns (about $30,000), we have the investment figure subdivided into tangible and intangible components. The share of intangible investment is relatively small, averaging 2.4% in 1993 and 1994, and rising to 3.9% in 1995.

[14] The CSO is regarded as one of the most professional statistical offices in the former Soviet bloc.

[15] These checks are similar to those used by Lízal, Singer, and Svejnar (2001) and Lízal (1999b). They are based on logical and economic limits and definitions: firm's capital at the start and end of each quarter should be positive; the average labor force in a given quarter should be more than twenty employees; investment should be nonnegative (there were no negative values of investment reported in our data set); production should be positive; depreciation should be positive and less than the total capital value; investment should be smaller than the end-of-the-period capital stock; average wage should be higher than 2,000 Crowns/month (minimum wage in 1992); sales should be nonnegative; and one-year-lagged production, sales, and labor should be nonnegative or missing. We note that, due to historical factors, the Czech accounting system belongs to the Continental family of accounting systems. It is similar to (although not identical with) the system of international accounting standards. Our checks of variable definitions indicate that the relevant data are adequate for our analytical purposes. Data on capital stock are unavailable for 1992, and we thus use the 1992 data only for estimations that do not require the capital stock variable. Finally, it should be noted that the consistency checks revealed that data quality was improving slightly over the 1992–1998 period.

[16] One large firm that met the nine criteria reported a 90% drop in output during the third quarter of 1993. This deviation affected the summary statistics (see, for example, the large coefficient and standard deviation in 1993:Q3 investment-production in table 3) and some regression estimates. We have therefore eliminated this observation from the data set.

TABLE 2.—NUMBER OF FIRM-LEVEL OBSERVATIONS BY FIRM OWNERSHIP AND LEGAL FORM

Legal Form	Ownership						
	Private	State	Cooper.	Foreign	Mixed	Other	Total
Joint-Stock Company	9091	12170	0	2218	5226	93	28798
State Enterprise (SOE)	0	7154	0	0	0	20	7174
Limited Liability (Ltd.)	28697	616	9	5995	652	88	36057
Cooperative	4	0	5461	0	0	0	5465
Individual	5355	0	0	4	0	7	5366
Other	280	31	3	356	4	10	679
Total	43427	19971	5473	8568	5882	218	83539

The shaded cells denote the major ownership/legal form categories of firms that we analyze. All other types of firms are placed in the Other/Other (other ownership/other legal from) category. Firms with unknown ownership and/or legal form are also included in the Other/Other group.

1995–1996 subpanel, 1,861 firms (6,975 quarterly observations) in the 1996–1997 subpanel, and 1,799 firms (6,651 quarterly observations) in the 1997–1998 subpanel.

As may be seen in table 2, our data contain important information about the ownership and legal status (form) of the firms. Unfortunately, we cannot exploit this information in a panel format because changes in the legal status and frequently also ownership resulted in changed identification numbers of firms. We identify firms by their identification numbers, and changes in the legal status or ownership are from our standpoint indistinguishable from the births of new firms, breakups and spinoffs, or mergers.[17] Although the inability to track the evolution of ownership and legal form over time imposes limits on our analysis, we are nevertheless able to exploit the ownership and legal form information in a number of ways.

The CSO classified firms into ownership categories by majority ownership. Hence, a firm is (for instance) classified as being privately owned if it is more than 50% privately owned. When none of the types of owners (private owners, cooperative members, state, or foreign owners) have a majority stake, the firm is classified as having mixed ownership.

The legal status reflects the particular type of corporate governance and legal obligations associated with each form of registration. It also captures the relative financial and bureaucratic ease of establishing a given type of firm. Understanding the legal (corporate) status is important because different countries placed different emphasis on privatization and corporatization of state-owned firms during the transition. For instance, whereas the Czech Republic and Russia focused on rapid privatization, Poland stressed early corporatization and slower privatization of state-owned firms. The relative merits of these different approaches continue to be debated.

In the Czech Republic, as in other central European countries, individual, cooperative, and limited-liability categories tend to contain smaller firms that were started with relatively low initial capital base. In contrast, joint-stock companies tend to be larger in size. The state-owned and mixed-ownership firms each have a similar average firm size in both the limited liability and joint-stock legal status. Finally, state-owned/state enterprises tend to be relatively small, averaging less than one-half of the employees of other state-owned firms.[18] Corporate governance in smaller firms is relatively straightforward as ownership and management usually overlap. In state-controlled firms, the government appoints and controls managers, whereas in private firms the decisions are made by the largest shareholder(s). Finally, in cooperatives, the managers are elected by all coop members.

From table 2, it is clear that in terms of the number of quarterly observations, the most important ownership-legal status category is that of privately owned/limited-liability companies (28,697 observations). It is followed by state-owned/joint-stock companies (12,170), privately owned/joint-stock companies (9,091), state-owned/state enterprises (7,154), foreign-owned/limited-liability companies (5,995), cooperatively owned/cooperatives (5,461), privately owned/individual businesses (5,355), mixed ownership/joint-stock companies (5,226), and foreign-owned/joint-stock companies (2,218). These nine categories, plus mixed-ownership/limited liability firms (652), state-owned/limited-liability companies (616), and "other firms" category constitute the twelve types of firms whose investment behavior we analyze.

Tables A1 and A2 in the appendix give the evolution over time of the numbers of observations in the legal status and ownership categories, respectively. Taking into account the fact that firms with fewer than one hundred employees were excluded from the data set in 1995, 1996, and, to some extent, also in 1998, we see from table A1 that there was an expected decrease in the number and share of state enterprises and an increase in the number and share of limited liability, individual, and joint-stock companies. The number of cooperatives appears to have stayed steady or declined slightly between the early 1990s and 1998. In terms of ownership, the data in table A2 complement the picture by showing that the number and share of state-owned firms declined between the early and late 1990s, while the number and share of foreign, mixed, and domestic privately owned firms increased. The number of cooperatives again appears

[17] Changes in firm size that do not induce changes in the identification number are controlled for by including the capital stock as a scaling variable.

[18] Detailed descriptive tables may be obtained from the authors upon request.

to have held steady or declined slightly between the early 1990s and 1998.

The distribution of observations across industries, not reported in a tabular form, is quite broad, with 15% of observations being in the food industry, 13% in the machinery industry, 12% in the metal product industry, 7% in the furniture industry, and 6% in the processing of nonmetallic minerals and textile industries. Each of the remaining industry groups has less than 5% of all observations.

The summary statistics of the most-relevant variables are presented in tables 3 and 4. As may be seen from table 3, investment-production and investment-labor ratios show an increase over time, although the pattern is not as steady as in the aggregate data in table 1. The discrepancy is brought about by the fact that small firms are excluded from our microdata in 1995, 1996, and, to some extent, also in 1998, and by the fact that the aggregate investment figures in table 1 contain significant infrastructure investment carried out by the government. The data in table 3 also show a seasonal pattern with a fourth-quarter peak, reflecting an end-of-the-year investment spree.[19] It is interesting that the communist-era phenomenon of "spending funds before the year's end" is reflected in the investment behavior of firms well into the transition.[20]

Profit is defined as all revenues minus accrued costs. The data in table 3 show that average profits were positive in all years during the 1992–1998 period. There was also substantial quarterly and annual variation in average profits during this period, as was the variance of profits across firms in each quarter. In an opposite pattern to investment, there was a downward trend in profits across quarters in all years during the 1993–1998 period, with profit reaching negative values in the last quarter of 1993 and 1995–1998. Overall, the post-1992 transition has not been associated with declining profits, as may have been the case in the 1989–1992 period (Blanchard, 1997, pp. 64–66). This finding, together with the consideration of the appropriateness and availability of data, has led us to use profit as a measure of the firm's availability of internal funds for investment.

In panels A through C of table 4, we present for each of the thirteen ownership-legal status categories of firms the annual evolution of the propensity to invest, as captured by the investment-capital, investment-labor, and investment-production ratio, respectively. The foreign-owned/limited-liability and joint-stock companies are a rapidly growing group of firms, and they record some of the highest values of the three ratios in most years. These two findings based on microevidence make us argue that foreign-owned firms are a major conduit of investment and innovations into the transition economies such as the Czech Republic. The domestic privately-owned/joint-stock companies are not far behind the foreign-owned companies, however, and they dominate the foreign-owned/limited-liability companies on some of the investment indicators in several years. Moreover, although the state-owned/joint-stock companies (the second-most numerous group of firms) do not record high investment-capital ratios, they rank fifth out of thirteen on investment-labor in most years and move from the sixth to third place in investment-production between 1992 and 1998. Similarly, the state-owned/limited-liability companies register some of the highest investment-production ratios in the early-to-mid-1990s, while ranking relatively low in terms of investment-capital. The low investment-capital ratio found in state-owned firms may hence indicate that these firms continue to report in their accounting books the value of capital from the centrally planned period, rather than writing some of it off as obsolete and unproductive. In contrast, the privately owned/limited-liability firms (the single-most numerous category of firms) and individually registered firms rank high in terms of investment-capital but low in the other two indicators, suggesting that these smaller private firms operate with a small (recorded) capital stock and do not invest heavily relative to their output and employment. Finally, cooperatives and state-owned/state enterprises record the lowest investment ratios for all indicators in virtually every year.[21]

The statistics reported in tables 4A through 4C hence indicate that foreign companies generally tend to invest the most and cooperatives the least. The behavioral difference between the private and state-owned firms is more complex. Private firms clearly invest more than the state-owned ones relative to their recorded capital stock and the private joint-stock companies (the large private firms) also tend to invest a bit more than the state-owned/joint-stock companies on all three criteria. However, in the early-to-mid-1990s, state-owned/limited-liability companies dominated all domestic private firms in terms of the investment-production ratio, and throughout the 1990s the most-numerous private/limited-liability companies and the private individually registered firms tended to invest relatively little per output and per worker. The widely accepted Polish survey findings by Belka et al. (1994), indicating that during transition investment is high in the new private firms and low in the state-owned enterprises, is hence not supported by our large Czech data set. Finally, it must be noted that some of the highest investment ratios are recorded in the mixed-ownership and "other" categories of firms.

III. The Estimating Framework

We estimate several equations that allow us to explore the issues mentioned in the introduction and also permit us to

[19] The seasonal pattern is much more pronounced in net investment than in depreciation, as shown by Lízal and Svejnar (2001).

[20] A more detailed examination indicates that the cyclical nature of investment is systematically reflected in the behavior of joint-stock companies of all ownership types and, to a lesser extent, of state-owned/state enterprise and foreign-owned/limited-liability firms.

[21] It should be noticed that a large number of small firms (especially private/limited-liability and, in a lesser extent, private/individual businesses) did not report capital (see tables 4A and 4B). This is because the forms that smaller firms were required to fill out for the CSO focused on variables related to the income statement rather than the balance sheets.

TABLE 3.—MEANS, STANDARD DEVIATIONS, AND NUMBERS OF QUARTERLY OBSERVATIONS OF THE PRINCIPAL VARIABLES

	Inv./Capital	Inv./Prod.	Inv./Lab.	Profit	Labor	Investm.	Prod.	Capital
1992/Q1	0.014	0.140	9.3	6337	653	4975	77524	559905
	(0.034)	(1.656)	(73.1)	(35855)	(1899)	(21544)	(269293)	(2490146)
	[727]	[2018]	[2018]	[2018]	[2018]	[2018]	[2018]	[728]
1992/Q2	0.019	0.167	11.3	5779	569	6160	71796	539167
	(0.049)	(2.264)	(63.7)	(29100)	(1714)	(28426)	(260696)	(2442947)
	[719]	[2305]	[2305]	[2305]	[2305]	[2305]	[2305]	[719]
1992/Q3	0.020	0.149	11.6	4524	540	6062	63127	528921
	(0.091)	(0.966)	(51.5)	(28758)	(1645)	(32202)	(235927)	(2413873)
	[745]	[2413]	[2413]	[2413]	[2413]	[2413]	[2413]	[745]
1992/Q4	0.035	0.197	18.3	5684	484	10251	67834	509865
	(0.111)	(1.143)	(62.3)	(75347)	(1516)	(54632)	(259059)	(2346213)
	[736]	[2548]	[2548]	[2548]	[2548]	[2548]	[2548]	[736]
1993/Q1	0.057	0.079	7.7	5025	531	4717	71284	371088
	(0.775)	(0.273)	(29.2)	(39474)	(1625)	(32206)	(276324)	(1628198)
	[2319]	[2321]	[2318]	[2318]	[2318]	[2321]	[2321]	[2319]
1993/Q2	0.118	0.146	12.2	3719	474	6559	66645	328661
	(1.841)	(1.637)	(45.3)	(27107)	(1463)	(33746)	(274414)	(1505538)
	[2624]	[2624]	[2624]	[2624]	[2624]	[2624]	[2624]	[2624]
1993/Q3	0.103	0.165	11.8	1953	453	6511	57370	321219
	(1.409)	(1.780)	(43.1)	(33458)	(1403)	(38268)	(225152)	(1482040)
	[2714]	[2714]	[2713]	[2713]	[2713]	[2714]	[2714]	[2714]
1993/Q4	0.155	0.181	18.4	−3024	414	9217	61449	289762
	(1.914)	(1.218)	(59.8)	(39238)	(1303)	(56872)	(266118)	(1408122)
	[2825]	[2827]	[2824]	[2824]	[2824]	[2827]	[2827]	[2825]
1994/Q1	0.070	0.137	11.6	5150	347	3488	53893	281997
	(0.813)	(1.675)	(94.1)	(29256)	(1087)	(20776)	(228914)	(1432938)
	[3499]	[3503]	[3495]	[3495]	[3495]	[3503]	[3503]	[3499]
1994/Q2	0.067	0.105	14.1	4432	337	5624	58161	274200
	(0.488)	(0.513)	(48.9)	(30953)	(1056)	(40069)	(270944)	(1341419)
	[3596]	[3599]	[3595]	[3595]	[3595]	[3599]	[3599]	[3596]
1994/Q3	0.072	0.108	13.9	3392	332	5672	52641	274121
	(0.981)	(0.456)	(47.7)	(34164)	(1032)	(45049)	(216243)	(1341158)
	[3634]	[3636]	[3633]	[3633]	[3633]	[3636]	[3636]	[3634]
1994/Q4	0.134	0.190	23.6	1271	313	8315	56365	258243
	(1.263)	(1.366)	(98.3)	(29556)	(991)	(66671)	(221359)	(1297227)
	[3846]	[3849]	[3844]	[3844]	[3844]	[3849]	[3849]	[3846]
1995/Q1	0.037	0.161	12.5	5752	516	6070	89731	451553
	(0.230)	(2.893)	(52.4)	(47867)	(1260)	(28393)	(317440)	(1770985)
	[2117]	[2117]	[2117]	[2117]	[2117]	[2117]	[2117]	[2117]
1995/Q2	0.051	0.128	16.0	4986	505	8335	95449	447173
	(0.304)	(0.866)	(48.3)	(34653)	(1237)	(37889)	(341655)	(1769675)
	[2150]	[2150]	[2150]	[2150]	[2150]	[2150]	[2150]	[2150]
1995/Q3	0.041	0.127	15.2	3136	501	8857	85535	448239
	(0.181)	(0.666)	(41.8)	(41489)	(1224)	(48161)	(296572)	(1812700)
	[2148]	[2148]	[2148]	[2148]	[2148]	[2148]	[2148]	[2148]
1995/Q4	0.085	0.157	24.0	−1637	499	14472	103634	455185
	(0.549)	(0.514)	(61.2)	(35154)	(1212)	(66702)	(386065)	(1796648)
	[2152]	[2152]	[2152]	[2152]	[2152]	[2152]	[2152]	[2152]
1996/Q1	0.042	0.074	12.3	5978	491	7172	110981	472241
	(0.456)	(0.312)	(37.3)	(41854)	(1187)	(33138)	(413775)	(1894208)
	[2169]	[2169]	[2169]	[2169]	[2169]	[2169]	[2169]	[2169]
1996/Q2	0.064	0.103	19.0	3435	483	12401	114792	472699
	(0.520)	(0.525)	(69.7)	(32327)	(1180)	(79131)	(417202)	(1892272)
	[2177]	[2177]	[2177]	[2177]	[2177]	[2177]	[2177]	[2177]
1996/Q3	0.104	0.118	19.2	946	474	12279	104168	466544
	(2.067)	(0.805)	(59.4)	(37750)	(1160)	(107420)	(360790)	(1834646)
	[2180]	[2180]	[2180]	[2180]	[2180]	[2180]	[2180]	[2180]
1996/Q4	0.072	0.152	27.0	−4850	469	16997	118928	477815
	(0.423)	(0.951)	(74.6)	(50014)	(1151)	(87768)	(415584)	(1906272)
	[2172]	[2172]	[2172]	[2172]	[2172]	[2172]	[2172]	[2172]
1997/Q1	0.030	0.098	11.8	4165	208	3199	47918	531098
	(0.184)	(1.077)	(56.5)	(34911)	(720)	(22855)	(291868)	(2064342)
	[1896]	[5708]	[5623]	[2054]	[5623]	[5708]	[5708]	[1896]
1997/Q2	0.058	0.101	15.0	5770	200	4295	54033	279171
	(0.201)	(0.848)	(50.3)	(44793)	(697)	(38622)	(341041)	(1083281)
	[2021]	[5849]	[5773]	[2035]	[5773]	[5849]	[5849]	[2021]
1997/Q3	0.068	0.113	16.7	2887	200	4748	53530	281805
	(0.220)	(0.828)	(65.3)	(43077)	(693)	(37662)	(333722)	(1113805)
	[2052]	[5856]	[5778]	[2062]	[5778]	[5856]	[5856]	[2052]

TABLE 3.—*CONTINUED*

	Inv./Capital	Inv./Prod.	Inv./Lab.	Profit	Labor	Investm.	Prod.	Capital
1998/Q1	0.058	0.065	16.7	13111	453	10365	166251	306743
	(0.421)	(0.214)	(49.8)	(110878)	(1092)	(71311)	(786826)	(1158120)
	[1872]	[2205]	[2205]	[2205]	[2205]	[2205]	[2205]	[1872]
1998/Q2	0.058	0.073	21.9	6623	455	14796	166796	395351
	(0.245)	(0.189)	(67.0)	(52878)	(1092)	(104167)	(785015)	(3076007)
	[2167]	[2171]	[2171]	[2171]	[2171]	[2171]	[2171]	[2167]
1998/Q3	0.060	0.083	22.2	3936	451	14866	153501	399330
	(0.279)	(0.248)	(80.9)	(68175)	(1082)	(104122)	(693473)	(3100550)
	[2171]	[2173]	[2173]	[2173]	[2173]	[2173]	[2173]	[2171]
1998/Q4	0.088	0.120	37.7	−2019	452	27536	173375	412321
	(0.382)	(0.604)	(154.8)	(75062)	(1079)	(241179)	(766146)	(3174196)
	[2132]	[2132]	[2132]	[2132]	[2132]	[2132]	[2132]	[2132]
Total	0.075	0.126	16.8	3326	384	8046	78877	370325
	(0.919)	(1.124)	(67.2)	(46659)	(1160)	(66978)	(383870)	(1832438)
	[61600]	[83539]	[83185]	[68471]	[83185]	[83539]	[83539]	[61601]

Standard deviations in parentheses and number of quarterly observations in brackets. Investment/labor, profit, investment, production, and capital are in thousands of Crowns.

compare our results to those obtained for western economies. On the demand side, we use two specifications. The first one corresponds to the basic neoclassical and accelerator models of investment demand (Jorgenson, 1971). These models are internally consistent and have been widely used in the western context. They allow us to check if the behavior of firms in the transition is consistent with the profit maximization hypothesis inherent in these models. The models are based on somewhat restrictive assumptions about input substitutability (the accelerator model) or speed of adjustment (the neoclassical model), however, and we therefore also estimate an Euler equation that is derived explicitly from a dynamic structural model of investment demand. The Euler equation enables us to assess whether the firms display behavior that is consistent with dynamic profit maximization.[22]

On the supply side, we use a specification that allows us to test whether the firm's availability of internal and external funds affects its investment decisions. In particular, our discussion of imperfections in the newly established banking sector and the possible presence of a soft budget constraint make us hypothesize that the cooperatives and individually owned or limited-liability companies, which tend to be smaller and many of which are newly formed, could be expected to be more rationed in their access to financial resources than the joint-stock companies that tend to be large and well established, or the foreign-owned firms that can obtain investment financing from other countries. Moreover, we expect that current and privatized state-owned enterprises may display behavior that is consistent with a soft budget constraint.

In terms of actual specification, on the demand side we start with the accelerator and neoclassical models, as developed and used by Koyck (1954), Jorgenson (1966), Kopcke (1985), and others. The capital accumulation constraint is given by

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

where K_t is the current period capital stock,

$$I_t = I_t^{\text{Gross}} = I_t^{\text{Net}} + I_t^{\text{Replacement}}, \text{ and hence}$$

$$I_t^{\text{Net}} = I_t - \delta K_{t-1}.$$

Denoting output by Y_t and the optimal level of capital by K_t^*, the flexible accelerator (Koyck) model assumes that each period a proportion λ of the gap $K_t - K_t^*$ between the actual and optimal level of capital is closed. The model further assumes that $K_t^* = \mu Y_t$ and net investment is hence given by $I_t^{\text{Net}} = \lambda(K_t^* - K_{t-1}) = \lambda\mu Y_t - \lambda K_{t-1}$, implying that the actual level of capital may be expressed as $K_t = \lambda\mu Y_t + (1 - \lambda) K_{t-1}$. Substituting this expression into the equations for K_{t-1}, K_{t-2}, . . . , one obtains

$$K_t = \mu[\lambda Y_t + \lambda(1 - \lambda) Y_{t-1} + \lambda(1 - \lambda)^2 Y_{t-2} + \lambda(1 - \lambda)^3 Y_{t-3} + \dots], \quad (1)$$

which yields the corresponding net investment equation in first differences:

$$I_t^{\text{Net}} = K_t - K_{t-1} = \Delta K_t = \mu[\lambda \Delta Y_t + \lambda(1 - \lambda)\Delta Y_{t-1} + \lambda(1 - \lambda)^2 \Delta Y_{t-2} + \lambda(1 - \lambda)^3 \Delta Y_{t-3} + \dots].$$

We can substitute back into the gross investment relationship to obtain

$$I_t = K_t - (1 - \delta) K_{t-1} = \lambda\mu Y_t + (\delta - \lambda) K_{t-1}. \quad (2)$$

Although it is possible to proceed further in rearranging equation (2), the resulting specification tends to suffer from

[22] This is a rather strict test because even in western empirical applications the model has often encountered problems of convergence or generated counterintuitive parameter values (Bond & Meghir, 1994). However, the model represents an appealing alternative to empirical specifications relying on Tobin's *Q* because financial markets are not yet efficient, and adequate data for constructing the values of *Q* hence do not exist in the transition economies.

TABLE 4A.—MEANS, STANDARD DEVIATIONS, AND NUMBER OF OBSERVATIONS OF INVESTMENT PER CAPITAL BY TYPE OF FIRM IN 1992–1998

	State/ J. Stock	Private/ J. Stock	State/ SOE	Private/ Ltd.	Coop	Private/ Individ.	State/ Ltd.	Foreign/ J. Stock	Foreign/ Ltd.	Mixed/ J. Stock	Mixed/ Ltd.	Other	Total
1992	0.021	0.144	0.015	·	0.031	·	·	0.079	0.192	0.104	·	·	0.022
	(0.034)	(0.337)	(0.039)	(·)	(0.120)	(·)	(·)	(0.135)	(0.245)	(0.322)	(·)	(·)	(0.078)
	[619]	[28]	[1704]	[0]	[524]	[0]	[0]	[20]	[14]	[18]	[0]	[0]	[2927]
1993	0.034	0.083	0.012	0.252	0.024	0.166	0.032	0.185	0.291	0.022	0.665	0.029	0.110
	(0.262)	(0.483)	(0.028)	(2.842)	(0.063)	(1.527)	(0.086)	(0.739)	(1.263)	(0.071)	(2.583)	(0.060)	(1.576)
	[2516]	[331]	[2395]	[2906]	[984]	[508]	[90]	[141]	[358]	[123]	[53]	[77]	[10482]
1994	0.019	0.055	0.009	0.150	0.024	0.089	0.033	0.049	0.167	0.025	0.108	0.076	0.087
	(0.054)	(0.201)	(0.030)	(1.450)	(0.147)	(0.431)	(0.106)	(0.077)	(0.685)	(0.066)	(0.546)	(0.265)	(0.938)
	[3225]	[870]	[1186]	[5758]	[1026]	[695]	[126]	[243]	[881]	[272]	[99]	[194]	[14575]
1995	0.021	0.062	0.009	0.085	0.018	0.050	0.043	0.040	0.168	0.023	0.112	0.112	0.053
	(0.067)	(0.378)	(0.024)	(0.474)	(0.033)	(0.096)	(0.144)	(0.089)	(0.832)	(0.088)	(0.295)	(0.229)	(0.347)
	[2859]	[836]	[479]	[2539]	[590]	[138]	[100]	[190]	[432]	[231]	[91]	[82]	[8567]
1996	0.015	0.053	0.010	0.124	0.021	0.055	0.035	0.044	0.165	0.021	0.046	0.112	0.071
	(0.029)	(0.325)	(0.030)	(1.947)	(0.082)	(0.155)	(0.063)	(0.170)	(1.012)	(0.076)	(0.119)	(0.582)	(1.111)
	[416]	[1575]	[295]	[2593]	[534]	[123]	[80]	[420]	[649]	[1841]	[84]	[88]	[8698]
1997	0.033	0.042	0.024	0.080	0.031	0.155	0.038	0.049	0.138	0.039	0.093	0.111	0.063
	(0.081)	(0.108)	(0.068)	(0.271)	(0.066)	(0.606)	(0.061)	(0.086)	(0.324)	(0.172)	(0.213)	(0.398)	(0.220)
	[303]	[1993]	[165]	[2314]	[446]	[139]	[73]	[481]	[699]	[1226]	[84]	[86]	[8009]
1998	0.038	0.042	0.031	0.083	0.031	0.123	0.056	0.065	0.141	0.039	0.092	0.054	0.066
	(0.091)	(0.107)	(0.103)	(0.442)	(0.061)	(0.604)	(0.081)	(0.149)	(0.633)	(0.141)	(0.173)	(0.128)	(0.336)
	[267]	[2262]	[118]	[2243]	[424]	[190]	[59]	[489]	[886]	[1200]	[84]	[120]	[8342]
Total	0.024	0.050	0.013	0.136	0.025	0.114	0.038	0.061	0.167	0.031	0.152	0.080	0.075
	(1.140)	(0.239)	(0.036)	(1.594)	(0.096)	(0.896)	(0.098)	(0.234)	(0.779)	(0.125)	(0.908)	(0.313)	(0.919)
	[10205]	[7895]	[6342]	[18353]	[4528]	[1793]	[528]	[1984]	[3919]	[4911]	[495]	[647]	[61600]

autocorrelated error terms.[23] We hence use equations (1) and (2). Because this specification requires the adjustment process to be a distributed lag (and hence the coefficients to decline according to a geometric pattern), we follow the literature and relax this restriction. In particular, we build on equations (1) and (2) by experimenting with specific numbers of lagged terms of output without imposing restrictions on their coefficients:

$$I_t = k + \Sigma b_i Y_{t-i} + cK_{t-1} + e_t \quad i = 0, 1, 2, \ldots, m, \tag{3}$$

where k is a constant, e is the error term, and equation (3) may also be viewed as a special case of Jorgenson's rational lag function.

In a neoclassical model, we arrive at equation such as (3) by assuming that the firm maximizes a profit function, $\pi_t = p_t Y_t - w_t L_t - c_t K_t$, subject to a neoclassical production function $Y_t = f(K_t, L_t)$, where capital K_t and labor L_t are substitutable, p is the output price, w is the wage, and c is the user cost of capital. The maximization results in the standard first-order conditions equating the marginal product of labor to the wage and the marginal product of capital to its user cost. This approach requires one to specify the production function and define the user cost of capital. Depending on the production function, a general form of the estimating investment equation is of the form

$$I_t = k + \Sigma b_i (p/c)_{t-i} Y_{t-i} - \Sigma d_i (p/c)_{t-i} Y_{t-i-1} + \delta K_{t-1} + e_t \quad i = 0, 1, 2, \ldots m.$$

If one considers a one-period investment ordering (investment requiring one period to be fully installed) in the context of a Cobb-Douglas production function $Y = K^{\theta} L^{1-\theta}$, one obtains $\theta (Y_t/K_t) = c_t/p_t$ and $K_t^* = \theta (p/c)_t Y_t$. The net investment is then given by

$$I_t^{\text{net}} = \Delta K_t^* = \theta (p/c)_t (Y_t - Y_{t-1}) = \theta (p/c)_t Y_t - \theta (p/c)_t Y_{t-1},$$

and gross investment is given by an equation that is of the same form as equation (3):

$$I_t = \Sigma g_i \theta (p/c)_{t-i} Y_{t-i} + \delta K_{t-1} + e_t, \quad i = 0, 1, 2, \ldots m, \tag{3'}$$

[23] Note that, because equation (2) holds also for $t - 1$, it follows that

$$I_{t-1} = K_{t-1} - (1 - \delta) K_{t-2} = \lambda\mu Y_{t-1} + (\delta - \lambda) K_{t-2}$$

and, by multiplying each side by $(1 - \delta)$ and subtracting the resulting equation from (2), one obtains

$$I_t - (I - \delta) I_{t-1} = \lambda\mu Y_t - (1 - \delta)\lambda\mu Y_{t-1} + (\delta - \lambda) K_{t-1} - (1 - \delta)(\delta - \lambda) K_{t-2}.$$

This equation may in turn be rewritten as

$$I_t - (1 - \delta) I_{t-1} = \lambda\mu Y_t - (1 - \delta)\lambda\mu Y_{t-1} + (\delta - \lambda) I_{t-1},$$

because $I_t = K_t - (1 - \delta) K_{t-1}$ implies that $I_{t-1} = K_{t-1} - (1 - \delta) K_{t-2}$. Rearranging and collecting the I_{t-1} terms yields

$$I_t = \lambda\mu Y_t - (1 - \delta)\lambda\mu Y_{t-1} + (1 - \lambda) I_{t-1}.$$

The advantage of this resulting investment equation is that it does not require data on capital stock. However, because it contains lagged dependent variable and the error process tends to be correlated, the inconsistency problem in OLS arises.

TABLE 4B.—MEANS, STANDARD DEVIATIONS, AND NUMBER OF OBSERVATIONS OF INVESTMENT PER LABOR BY TYPE OF FIRM IN 1992–1998

	State/ J. Stock	Private/ J. Stock	State/ SOE	Private/ Ltd.	Coop	Private/ Individ.	State/ Ltd.	Foreign/ J. Stock	Foreign/ Ltd.	Mixed/ J. Stock	Mixed/ Ltd.	Other	Total
1992	17.1	25.6	10.9	10.2	3.7	8.2	2.9	50.6	22.9	14.3	21.1	9.9	12.9
	(68.0)	(120.3)	(34.8)	(74.6)	(12.0)	(30.9)	(7.8)	(156.3)	(88.2)	(38.5)	(69.3)	(20.7)	(62.7)
	[2490]	[292]	[2393]	[2079]	[959]	[393]	[78]	[124]	[261]	[117]	[34]	[64]	[9284]
1993	17.4	27.2	9.9	8.8	4.2	7.4	18.8	50.5	29.9	13.3	35.7	10.7	12.8
	(47.6)	(100.5)	(27.4)	(32.4)	(11.1)	(16.9)	(69.6)	(142.8)	(105.7)	(41.0)	(84.5)	(22.4)	(46.5)
	[2516]	[331]	[2395]	[2906]	[984]	[508]	[90]	[141]	[358]	[123]	[53]	[74]	[10479]
1994	17.4	31.1	7.0	12.7	4.7	13.3	13.5	38.8	38.2	15.7	10.5	19.4	16.0
	(48.6)	(190.1)	(25.8)	(69.5)	(11.3)	(47.6)	(66.5)	(59.7)	(119.7)	(34.2)	(25.4)	(49.5)	(76.5)
	[3225]	[870]	[1186]	[5758]	[1026]	[695]	[126]	[243]	[881]	[272]	[99]	[186]	[14567]
1995	18.6	27.4	8.1	9.8	5.8	7.3	21	44.2	39.4	17.3	7.5	46.2	17.0
	(41.2)	(93.4)	(21.0)	(33.4)	(12.0)	(21.2)	(80.4)	(77.6)	(86.7)	(66.6)	(18.7)	(86.4)	(51.6)
	[2859]	[836]	[479]	[2539]	[590]	[138]	[100]	[190]	[432]	[231]	[91]	[82]	[8567]
1996	16.3	21.0	14.2	11.5	5.4	8.6	31.5	50.8	37.0	21.6	4.2	32.8	19.4
	(44.0)	(64.7)	(89.9)	(52.4)	(12.2)	(21.5)	(105.8)	(88.2)	(94.1)	(53.2)	(7.0)	(75.9)	(62.1)
	[416]	[1575]	[295]	[2593]	[534]	[123]	[80]	[420]	[649]	[1841]	[84]	[88]	[8698]
1997	20.0	22.0	14.7	12.5	5.3	12.6	15.6	43.2	32.7	17.5	8.3	23.0	16.9
	(71.9)	(75.0)	(63.1)	(52.7)	(14.3)	(51.4)	(32.1)	(81.8)	(106.8)	(34.6)	(22.0)	(56.9)	(63.5)
	[392]	[2817]	[280]	[10355]	[927]	[3147]	[81]	[605]	[2459]	[1395]	[200]	[251]	[22909]
1998	26.3	25.4	10.7	10.9	5.9	9.4	13.9	54.8	40.6	36.3	9.9	19.8	24.5
	(63.3)	(123.9)	(19.4)	(39.3)	(13.2)	(17.0)	(23.7)	(117.0)	(87.8)	(139)	(24.4)	(31.8)	(96.6)
	[272]	[2370]	[124]	[2321]	[431]	[208]	[61]	[495]	[934]	[1247]	[87]	[131]	[8681]
Total	17.9	24.4	10.0	11.5	4.8	11.5	16.8	47.7	35.1	23.2	11.1	22.9	16.8
	(52.6)	(107.5)	(35.9)	(54.5)	(12.3)	(45.1)	(65.8)	(99.6)	(102.7)	(79.4)	(35.6)	(54.9)	(67.2)
	[12170]	[9091]	[7152]	[28551]	[5451]	[5212]	[616]	[2218]	[5974]	[5226]	[648]	[876]	[83185]

where $\Sigma g_i = 1$ ($i = 0, 1, 2, \ldots m$), if no investment orders were canceled.

The neoclassical and accelerator models embedded in equations (3) and (3′) are usually operationalized by relating a firm's investment-capital ratio to its output-capital ratio:[24]

$$\frac{I_t}{K_{t-1}} = \alpha + \sum_{k=1}^{m} \gamma_k \frac{Y_{t-k}}{K_{t-1}} + \epsilon_t, \tag{4}$$

where the interpretation of γ's depends on whether the underlying theory refers to the neoclassical or accelerator models and m is the number of lags. In our empirical work, we also control for the ratio of output price to user cost of capital ratio by including firm-specific fixed effects and time dummy variables and by estimating the equation separately for the different categories of firms.

Equation (4) reflects the firm's demand for investment, and it implicitly assumes that the supply of investment funds is perfectly elastic. In accounting for the possibility that the firm faces transaction costs or restrictions in obtaining external financing, the usual approach in the investment literature is to augment this type of equation by one or more cash flow variables such as profit. Because Czech firms were required to pay for internally financed investment from retained profits and our data set contains information on profit for most firms in most of the time periods, we examine the link of investment to this variable. In the studies of advanced market economies, a positive coefficient on profit (cash flow) is usually interpreted as an indication that firms are credit rationed because, in a perfect capital market, the firm and lender would be indifferent between internal and external financing and the coefficient on profit would hence be zero.

We note that, in the transition context, the inclusion of the profit variable as a regressor allows one also to test the soft budget constraint hypothesis. In particular, because firms have used bank credit extensively as their principal and almost exclusive form of external financing, a zero coefficient on profit signals that firms have access to bank credit for investment irrespective of their profitability, which as we saw earlier ranges from highly positive to highly negative. In the presence of high investment rates and rapid accumulation of nonperforming enterprise loans by the banks, this nondiscriminatory supply of bank funds to firms signals the presence of a soft budget constraint for the poorly performing firms. We also formulate a stronger version of the soft budget constraint hypothesis, namely that the coefficient on profit is negative. This strong version reflects the case wherein poorly performing firms get a better access to bank loans and invest more, ceteris paribus, than profitable firms.[25]

During some quarters we are missing either profit, capital, or investment data for some of the firms and, because our final specification requires at least five quarters of

[24] Note that the usual assumption on the form of heteroskedasticity of e_t leads to scaling with the reciprocal of capital. We therefore use ϵ_t to denote the transformed residuals.

[25] For another possible manifestation of the soft budget constraint, namely in the form of higher wages, see Prasnikar and Svejnar (1998). The particular form of the soft budget constraint hence depends on institutional environments.

TABLE 4C.—MEANS, STANDARD DEVIATIONS, AND NUMBER OF OBSERVATIONS OF INVESTMENT PER PRODUCTION BY TYPE OF FIRM IN 1992–1998

	State/ J. Stock	Private/ J. Stock	State/ SOE	Private/ Ltd.	Coop	Private/ Individ.	State/ Ltd.	Foreign/ J. Stock	Foreign/ Ltd.	Mixed/ J. Stock	Mixed/ Ltd.	Other	Total
1992	0.176	0.272	0.144	0.124	0.080	0.077	0.029	1.354	0.236	0.403	0.651	0.091	0.165
	(1.004)	(1.935)	(0.744)	(1.582)	(0.308)	(0.309)	(0.072)	(9.548)	(0.791)	(2.532)	(3.200)	(0.315)	(1.572)
	[2490]	[292]	[2393]	[2079]	[959]	[393]	[78]	[124]	[261]	[117]	[34]	[64]	[9284]
1993	0.139	0.158	0.221	0.097	0.079	0.074	0.144	0.260	0.289	0.075	0.350	0.184	0.145
	(0.404)	(0.420)	(2.747)	(0.437)	(0.255)	(0.205)	(0.419)	(0.694)	(1.346)	(0.219)	(0.908)	(0.472)	(1.381)
	[2516]	[331]	[2395]	[2906]	[984]	[508]	[90]	[141]	[358]	[123]	[53]	[81]	[10486]
1994	0.132	0.223	0.055	0.127	0.075	0.153	0.25	0.171	0.275	0.103	0.085	0.15	0.136
	(0.985)	(1.466)	(0.170)	(1.397)	(0.318)	(0.788)	(2.163)	(0.322)	(1.179)	(0.245)	(0.201)	(0.395)	(1.133)
	[3225]	[870]	[1186]	[5758]	[1026]	[695]	[126]	[243]	[881]	[272]	[99]	[206]	[14587]
1995	0.196	0.177	0.072	0.086	0.082	0.057	0.211	0.168	0.242	0.094	0.048	0.278	0.143
	(2.606)	(0.524)	(0.298)	(0.473)	(0.185)	(0.178)	(1.142)	(0.333)	(0.890)	(0.291)	(0.081)	(0.640)	(1.560)
	[2859]	[836]	[479]	[2539]	[590]	[138]	[100]	[190]	[432]	[231]	[91]	[82]	[8567]
1996	0.107	0.143	0.233	0.061	0.066	0.064	0.164	0.151	0.165	0.128	0.033	0.103	0.112
	(0.300)	(1.075)	(2.386)	(0.212)	(0.147)	(0.144)	(0.672)	(0.279)	(0.422)	(0.420)	(0.063)	(0.167)	(0.694)
	[416]	[1575]	[295]	[2593]	[534]	[123]	[80]	[420]	[649]	[1841]	[84]	[88]	[8698]
1997	0.096	0.100	0.506	0.085	0.063	0.129	0.06	0.139	0.162	0.100	0.068	0.192	0.109
	(0.254)	(0.433)	(3.132)	(0.847)	(0.367)	(1.226)	(0.123)	(0.593)	(0.662)	(0.374)	(0.204)	(0.915)	(0.872)
	[392]	[2817]	[282]	[10501]	[937]	[3290]	[81]	[605]	[2480]	[1395]	[204]	[252]	[23236]
1998	0.133	0.082	0.053	0.047	0.053	0.083	0.048	0.134	0.139	0.108	0.040	0.093	0.085
	(0.391)	(0.240)	(0.101)	(0.131)	(0.108)	(0.419)	(0.079)	(0.304)	(0.273)	(0.747)	(0.091)	(0.291)	(0.355)
	[272]	[2370]	[124]	[2321]	[431]	[208]	[61]	[495]	[934]	[1247]	[87]	[131]	[8681]
Total	0.156	0.129	0.166	0.092	0.073	0.118	0.144	0.222	0.192	0.118	0.113	0.159	0.126
	(1.449)	(0.795)	(1.830)	(0.938)	(0.278)	(1.012)	(1.12)	(2.306)	(0.782)	(0.62)	(0.793)	(0.591)	(1.124)
	[12170]	[9091]	[7154]	[28697]	[5461]	[5355]	[616]	[2218]	[5995]	[5226]	[652]	[904]	[83539]

Standard errors in parentheses, and number of observations in brackets.

consecutive presence in the data, the set of firms on which we run the investment equation is hence somewhat smaller than the original one. To control for possible selection bias stemming from this switch to a smaller data set, we first run a Heckman-type probit equation, predicting the probability of the firm being included in the sample on the basis of output, profit, industry dummy variables, and firm type variables. The resulting inverse Mills ratio is included as an explanatory variable in the investment equation:

$$\frac{I_{i,t}}{K_{i,t-1}} = \alpha + \sum_{k=1}^{m}\left(\beta_k \frac{\Pi_{i,t-k}}{K_{i,t-1}} + \gamma_k \frac{Y_{i,t-k}}{K_{i,t-1}}\right) + \mu M_{i,t} + \psi^T X_{i,t} + \epsilon_{i,t}, \tag{5}$$

where Π denotes gross profit, M the inverse Mills ratio from the probit estimation, and X a set of quarterly (and in the case of longer panels also annual) dummy variables. Naturally, β's and γ's are the parameters of our main interest, with vector Ψ and μ being other parameters to be estimated. We have run pretests with varying numbers of lags. Because we have quarterly data, we have focused on models with the number of lags equal to or greater than four. The results for four or more lags are similar, and we hence report findings based on $m = 4$.[26] To control for firm-specific heterogeneity, we estimate equation (5) using a fixed-effects (mean deviation or within group) specification. As is customary in the literature, we assume that the lagged values of the regressors are exogenous.

As mentioned earlier, we also estimate an investment equation that corresponds to a structural model of dynamic optimization by firms in the presence of adjustment costs:

$$\frac{I_{i,t}}{K_{i,t}} = \alpha + \varphi_1 \frac{I_{i,t-1}}{K_{i,t-1}} + \varphi_2\left(\frac{I_{i,t-k}}{K_{i,t-1}}\right)^2 + \varphi_3\left(\frac{Y_{i,t-1} - w_{i,t-1}L_{i,t-1}}{K_{i,t-1}}\right) + \psi^T X_{i,t} + \epsilon_{i,t}, \tag{6}$$

where w denotes the wage, L is employment, and φ's are parameters. Because models such as the one in equation (6) have a lagged dependent variable as a regressor and need a substantial time dimension for convergence (Bond and Meghir, 1994), we estimate equation (6) on the deviations from the mean using the whole panel. We use the first and second powers of the deviations from the mean of the twice-lagged labor-capital ratio, the wage interacted with the labor-capital ratio, the output per worker minus the wage interacted with the labor-capital ratio, and the output-capital ratio as instruments for the right-side variables.[27]

[26] We have also estimated equations with a four-quarter difference specification and found the results to be similar to those obtained with four quarterly lags. However, the four-quarter difference specification by construction shortens our panel by an additional four periods and is more demanding on the completeness of the firm presence in the time dimension.

[27] The Euler equation models require a large time dimension to converge to consistent estimates even if the number of firms is large because, in the presence of aggregate shocks, the error term contains a prediction error that averages to zero over time but not over firms. This need for a long timespan is a major problem in empirical studies of investment because there are usually fewer than twenty time observations. We have only seven-year data, and the high seasonality of quarterly observations effectively wipes out the advantage of longer time dimension of the panel. (Lízal (1999b) examines the effects of such seasonality in a simpler setup

TABLE 5.—FIXED-EFFECT ESTIMATES OF INVESTMENT EQUATION (5) FOR 1992–1998

	Ownership/Legal Form Category												
	All	State/ J. Stock	Private/ J. Stock	State/ SOE	Private/ Ltd.	Coop.	Private/ Individ.	State/ Ltd.	Foreign/ J. Stock	Foreign/ Ltd.	Mixed/ J. Stock	Mixed/ Ltd.	Other
$\Sigma\gamma_k$	0.010***	0.065***	0.008***	0.013***	0.014***	0.027***	0.572***	0.016**	0.128***	0.026***	0.050***	−0.003	0.040***
	(0.001)	(0.003)	(0.001)	(0.002)	(0.001)	(0.003)	(0.018)	(0.007)	(0.024)	(0.004)	(0.002)	(0.002)	(0.008)
$\Sigma\beta_k$	0.019***	0.063***	−0.007	−0.002	0.051***	0.052***	−0.808***	−0.060	0.104	0.062**	−0.001	−0.015	0.127***
	(0.003)	(0.010)	(0.011)	(0.012)	(0.008)	(0.015)	(0.127)	(0.114)	(0.088)	(0.028)	(0.014)	(0.013)	(0.021)
P-value	0.000	0.000	0.000	0.000	0.000	0.017	0.000	0.076	0.000	0.004	0.948	0.003	0.000
Adj. R^2	0.118	0.291	0.166	0.097	0.180	0.373	0.661	0.273	0.252	0.079	0.170	0.290	0.178
N/NF	42483/3805	7884/865	5751/699	3797/501	10899/1254	3635/255	971/159	373/35	1728/149	2372/265	4410/504	305/34	358/46

Standard errors in parentheses.
Values for 1992 are used for lagged values of regressors only.
*** = significant at 1% level
** = significant at 5% level
* = significant at 10% level
N = number of quarterly observations
NF = number of firms
P-value = *p*-value of the Hausman test of equality of fixed-effect and random-effect estimates.

Equation (6) is appealing because it provides evidence on the consistency of enterprise behavior during the transition with a model of profit maximization in the presence of cost of adjustment. As mentioned earlier, this is valuable because a key turning point in the transition occurs when the behavior of firms starts approximating that of a firm in a market economy. We use the investment setting to provide microeconometric evidence on this issue. In particular, omitting for simplicity the firm subscript i, equation (6) may be derived from the maximization of the present discounted value of firm's expected profits V_t as follows:[28]

$$V_t = E\left[\sum_{j=0}^{\infty} \xi_{t+j}\Pi_{t+j}\,\middle|\,\Omega_t\right], \tag{7}$$

subject to

$$\xi_{t+j} = \prod_{n=0}^{j-1} \frac{1}{1+r_{t+n}} \quad \forall\ j > 0, \qquad = 1 \quad j = 0, \tag{8}$$

$$\Pi_t = \Pi(K_t, L_t, I_t) = p_t Y(K_t, L_t, I_t) - w_t L_t - p_t^I I_t, \qquad Y(K_t, L_t, I_t) = F(K_t, L_t) - G(K_t, I_t), \tag{9}$$

and

$$G(K_t, I_t) = \frac{a}{2}\left(\frac{I_t}{K_t} - b\right)^2 K_t, \quad a, b \geq 0, \tag{10}$$

where the term $E[\cdot\,|\Omega_t]$ denotes the expectation conditional on all information available at the time t,

Π_t is the expected profit at time t,
ξ_{t+j} is the discount factor between period t and $t + j$ (assuming that payments are made at the beginning of each period),
r is the discount rate,
p is output price,
$F(\cdot\,,\cdot)$ is a strictly concave (unobservable) frontier production function,
$G(\cdot\,,\cdot)$ is a strictly convex (unobservable) cost of capital adjustment function,
$Y(\cdot\,,\cdot\,,\cdot) = F(\cdot\,,\cdot) - G(\cdot\,,\cdot)$ is the firm's observable production, and
a and b are parameters of the cost of the capital adjustment function.[29]

The term $p_t^I I_t$ is used instead of the usual "capital rental" on the assumption that investment is paid for at the time of purchase.

In this setting, the firm's optimal investment problem can be restated as a dynamic programming problem with a single-state variable K_t and single control variable I_t:[30]

$$V_t(K_{t-1}) = \max_{K_t I_t L_t} \{\Pi(K_t, I_t, L_t) + E[\xi_{t+1} V_{t+1}(K_t)|\Omega_t]\}. \tag{11}$$

Assuming that the production function $F(\cdot\,,\cdot)$ is homogeneous of degree 1 in labor and capital and that the firm has rational expectations, one can differentiate equation (11) with respect to the choice variables K_t, L_t, and I_t to obtain equation (6) after algebraic manipulations.[31]

for depreciation). As could be expected in this situation, when we perform the estimation separately for the major ownership-legal status groups, the estimates generate high standard errors and unreasonable mean values of parameters. The need for a larger cross-sectional dimension in the presence of a limited number of time observations has led us to estimate the Euler equation jointly on all observations, allowing the ownership-legal status effects to be captured as different intercepts in the fixed effect.

[28] See also Mátyás and Severstre (1992) or Bond and Meghir (1994) for related derivations.

[29] In the classical setup, the production function $F(\cdot\,,\cdot)$ and the adjustment cost function $G(\cdot\,,\cdot)$ are assumed to be additively separable.

[30] We assume that capital can be changed only through investment and the investment decision is made at the beginning of each period.

[31] In the present derivation, we assume that the labor input may be adjusted costlessly. This assumption may be relaxed with no influence on

IV. Empirical Estimates

In table 5, we present our overall estimates of equation (5), which allow us to capture the importance of the neoclassical-accelerator and the internal funds-soft budget constraint models. The estimates are based on 1992–1998 quarterly data for the twelve principal categories of firms, and the coefficients give the total effects of the four lagged output and profit variables.[32]

As may be seen from table 5, the sum of the coefficients on output is positive and statistically significant for all categories of firms except for the mixed/limited-liability group (34 firms), where the coefficient is −0.003 and statistically insignificant. As might be expected from these individual results, the overall regression using pooled data from all firms generates a positive and statistically significant coefficient on output as well. The sum of coefficients on profit is also positive in the overall regression based on pooled observations from all firms, but among the individual categories of firms it is positive and significant in only five of the twelve categories. All the remaining coefficient estimates are statistically insignificant, except for the coefficient on private/individual firms, which is negative and significant.

The estimates in table 5 hence indicate that the neoclassical-accelerator model, reflecting firm behavior that is consistent with profit maximization, receives a fairly uniform support from virtually all categories of firms. The credit-rationing hypothesis is supported by data from the three categories of mostly smaller firms (private/limited-liability companies, cooperatives, and foreign/limited-liability firms) and also from the category of state-owned/joint-stock firms. The finding that investment in smaller firms varies positively with firm's profit could be expected in an underdeveloped financial market in which smaller firms do not have easy access to bank capital and are unlikely to benefit from a soft budget constraint because they are not former state-owned firms. The positive coefficient on profit in the category of state-owned/joint-stock firms points to the absence of a soft budget constraint in these firms, but a more complex picture emerges as we address this issue with more-disaggregated data below. All except one of the remaining categories contain primarily larger firms and generate insignificant coefficients on profit—a finding that is consistent with a lack of credit rationing and the presence of a soft budget constraint. Following on our earlier discussion, the soft budget constraint is consistent with these findings if some firms encounter difficulties selling their output at a profit but receive bank loans even if they produce at a loss. If profitable firms in the same categories also have access to bank credit, one may find a positive coefficient on output (the firms produce and invest) and an insignificant coefficient on profit (banks provide investment funds irrespective of profitability). Finally, the negative profit coefficient in private/individual firms, although consistent with the strong soft budget constraint hypothesis, most likely stems from the fact that many of these firms are newly created entities whose investment occurs in the start-up stage in their life cycle when their profit is low or negative. We next examine these issues in more detail.

Our strategy is to generate first separate estimates for larger and smaller firms to see if investment behavior varies with size across the various categories of firms. We divide the firms into two groups: those with one hundred or more workers and those with fewer than one hundred workers. This division also allows us to take into account the fact that our data do not cover firms with fewer than one hundred workers in 1995, 1996, and, to some extent, in 1998. In particular, by generating estimates for firms with one hundred and more workers in all years, we can assess the impact of the aforementioned change in statistical coverage.

As may be seen from the top panel of table 6, the estimates of equation (5) for firms with one hundred and more workers are very similar to those obtained for all firms in table 5.[33] The corresponding coefficients have identical signs in all cases except for the profit coefficient in privately owned/individual firms, wherein firms with one hundred and more workers display a statistically insignificant coefficient, as compared to the negative coefficient found in the combined group of large and small firms. As might be expected, the negative and statistically significant coefficient is found in the smaller, privately owned/individual firms in the lower panel of table 6. Because these small firms tend to be more recent startups than their larger counterparts, the findings in table 6 suggest that it is the small (rather than both small and large) privately owned/individual firms that are observed during the startup stage of their life cycle when they invest heavily and their profit is low or negative. Interestingly, although both small and large cooperatives appear to be credit rationed, private and foreign limited-liability companies display credit rationing among only the larger firms. With these caveats in mind, we can conclude that the estimates based on all data are quite similar to those for larger firms.

Because investment behavior is likely to have undergone changes as the firms proceeded through the transition process, we have also estimated equation (5) separately for each year.[34] As may be seen from table 7, the separate annual estimates for 1993–1998 show considerable varia-

the core of our derivation. See, for example, Estrin and Svejnar (1993) for the derivation and estimation of a model with adjustment costs of labor.

[32] The 1992 data are used for lagged values of regressors. The underlying individual coefficients may be obtained from the authors upon request.

[33] In this estimation, we have left out the three categories of firms that have too few observations when divided into the two size groups: state-owned/limited-liability enterprises, mixed/limited-liability companies, and other firms.

[34] As in tables 5 and 6, in table 7 we report the total effects of output and profit. The individual coefficients for each of the lagged values of output and profit may be obtained from the authors upon request.

TABLE 6.—1992–1993 FIXED-EFFECT ESTIMATES OF INVESTMENT EQUATION (5) BY SIZE AND TYPE OF THE FIRM

	Large Firms (Labor ≥ 100 Employees)									
	All	State/ J. Stock	Private/ J. Stock	State/ SOE	Private/ Ltd.	Coop.	Private/ Individ.	Foreign/ J. Stock	Foreign/ Ltd.	Mixed/ J. Stock
$\Sigma\gamma_k$	0.007***	0.072***	0.009***	0.017***	0.015***	0.027***	0.060***	0.132***	0.027***	0.051***
	(0.000)	(0.003)	(0.001)	(0.002)	(0.002)	(0.004)	(0.011)	(0.025)	(0.005)	(0.002)
$\Sigma\beta_k$	0.039***	0.057***	−0.013	−0.016	0.081***	0.057***	−0.041	0.094	0.075**	0.032
	(0.003)	(0.011)	(0.012)	(0.016)	(0.011)	(0.020)	(0.034)	(0.092)	(0.037)	(0.025)
P-value	0.000	0.000	0.000	0.001	0.000	0.026	0.008	0.000	0.015	0.991
Adj. R^2	0.133	0.301	0.177	0.109	0.183	0.211	0.251	0.254	0.079	0.177
N/NF	36837/2974	7557/826	5479/671	3036/395	8497/842	2905/174	501/63	1651/140	2018/214	4237/486
	Small Firms (Labor < 100 Employees)									
	All	State/ J. Stock	Private/ J. Stock	State/ SOE	Private/ Ltd.	Coop.	Private/ Individ.	Foreign/ J. Stock	Foreign/ Ltd.	Mixed/ J. Stock
$\Sigma\gamma_k$	0.046***	0.003	0.022*	0.011	0.006**	0.024**	0.620***	0.048	0.017	0.033
	(0.003)	(0.010)	(0.012)	(0.008)	(0.003)	(0.010)	(0.024)	(0.055)	(0.011)	(0.039)
$\Sigma\beta_k$	−0.075***	0.011	0.072	0.002	0.005	0.096**	−1.014***	−0.187	0.015	−0.038
	(0.019)	(0.029)	(0.108)	(0.032)	(0.014)	(0.044)	(0.218)	(0.242)	(0.041)	(0.085)
P-value	0.000	0.000	1.000	0.218	0.027	0.158	0.000	0.000	0.667	0.902
Adj. R^2	−0.024	0.371	0.006	0.088	0.156	0.654	0.756	0.787	0.177	0.035
N/NF	5646/1412	327/89	272/89	761/182	2402/622	730/147	470/116	77/18	354/85	173/59

Standard errors in parentheses.
Values for 1992 are used for lagged values of regressors only.
*** = significant at 1% level
** = significant at 5% level
* = significant at 10% level
N = number of quarterly observations
NF = number of firms
P-value = *p*-value of the Hausman test of equality of fixed-effect and random-effect estimates.

tion in investment behavior over time.[35] Moreover, in examining the raw data, we have detected significant movements of firms across categories during certain years. As we show presently, it is essential to use this information in evaluating changes in the estimated coefficients over time.

The overall regression (based on observations from all firms) in table 7 generates a positive coefficient on total output in all six years, whereas the effect of profit is negative in 1993 and 1996, statistically insignificant in 1994, and positive in 1995, 1997, and 1998. In the aggregate, production hence drove investment in each year, while profitability was negatively related or unrelated to investment in the early 1990s, and primarily positively related in the second half of the 1990s. In examining the coefficients in the individual categories of firms, one finds in table 7 (as in table 5) that there are more positive (statistically significant) coefficients on output than on profit. The data are also increasingly supportive of the neoclassical-accelerator model as the transition proceeds, in that the number of categories of firms with positive coefficients on output increases (almost but not quite monotonically) from three in 1993 to eight in 1998. In contrast, the number of categories of firms with a positive coefficient on profit varies between one and four and, although it increases over time, the pattern is not particularly strong. Hence, most coefficient estimates on profit are consistent with the soft budget constraint.

The support of the neoclassical-accelerator model also becomes evident when one notes that the categories of firms whose behavior is consistent with this model are the most numerous ones and increasingly so over time. Hence, although slightly more than 50% of firms belonged to the categories that conformed to this model in 1993 and 1994, by 1998 the proportion rose to almost 100%. The categories of firms whose coefficient estimates are consistent with the credit-rationing model account for about one-third of firms in each of the six years, and two-thirds of firms therefore have estimates that are consistent with the soft budget constraint hypothesis.

In examining the coefficients of individual categories of firms in table 7, we take into account year-to-year movements of ten or more firms across the ownership/legal status categories. There was no such movement between 1992 and 1993, and the 1993 estimates reflect the categorization of firms just before the first wave of large-scale privatization.[36] A particularly interesting finding for 1993 is that the estimated coefficients on profit for state-owned/joint-stock companies and state-owned/state enterprises are negative. This suggests that, in 1992–1993, these two largest groups

[35] In all sets of regressions, the 1992 data are used as lagged values of 1993 regressors.

[36] Czech mass privatization proceeded in several stages. Between 1990 and 1991, various properties valued between $2.5 billion and $4.2 billion were restituted to previous owners. Between 1991 and 1993, small firms were sold for about $1 billion in the so-called small-scale privatization program. The most important method by which most medium and large state-owned enterprises were privatized was the large-scale privatization program, which accounted for about $30 billion in asset value. To handle the large number of firms, the large-scale privatization program was divided into two waves, with the first wave occurring between 1992 and 1993 and the second wave between 1993 and 1995. The large-scale privatization program employed a variety of privatization methods, including direct sales and transfer of shares to the population at large.

TABLE 7.—ANNUAL FIXED-EFFECT ESTIMATES OF INVESTMENT EQUATION (5)

1993

	All	State/ J. Stock	Private/ J. Stock	State/ SOE	Private/ Ltd.	Coop.	Private/ Individ.	Foreign/ J. Stock	Foreign/ Ltd.	Mixed/ J. Stock
$\Sigma\gamma_k$	0.095***	0.113***	0.028	0.040**	−0.001	0.043	0.712***	0.706	−0.046*	0.199
	(0.005)	(0.010)	(0.022)	(0.015)	(0.006)	(0.029)	(0.029)	(0.875)	(0.025)	(0.132)
$\Sigma\beta_k$	−0.229***	−0.114*	−0.163	−0.150***	0.136***	0.153**	−1.138**	−0.239	−0.043	−0.432
	(0.030)	(0.062)	(0.404)	(0.042)	(0.041)	(0.060)	(0.475)	(2.870)	(0.083)	(0.291)
P-value	0.000	0.006	0.396	0.000	0.000	0.112	0.000	0.017	0.080	0.598
Adj. R^2	0.205	0.546	0.212	0.283	0.429	0.313	0.854	0.053	0.379	0.047
N/NF	6947/1867	2140/544	197/57	1787/457	1250/386	832/215	262/77	108/27	184/55	96/25

1994

	All	State/ J. Stock	Private/ J. Stock	State/ SOE	Private/ Ltd.	Coop.	Private/ Individ.	Foreign/ J. Stock	Foreign/ Ltd.	Mixed/ J. Stock
$\Sigma\gamma_k$	0.016***	0.000	0.025	0.000	0.016**	0.036***	0.310***	−0.018	0.228***	0.083
	(0.002)	(0.008)	(0.023)	(0.005)	(0.007)	(0.011)	(0.040)	(0.121)	(0.030)	(0.056)
$\Sigma\beta_k$	0.003	0.001	0.048	0.013	−0.057**	0.021	−0.351***	0.993**	0.114	−0.379**
	(0.013)	(0.020)	(0.242)	(0.025)	(0.028)	(0.054)	(0.092)	(0.394)	(0.080)	(0.165)
P-value	0.000	0.000	0.000	0.996	0.000	0.015	0.000	0.012	0.000	0.164
Adj. R^2	0.242	0.314	0.515	0.007	0.197	0.758	0.291	0.500	0.345	0.251
N/NF	7570/2315	2118/581	344/108	1006/317	2125/720	866/232	327/107	137/40	309/102	163/47

1995

	All	State/ J. Stock	Private/ J. Stock	State/ SOE	Private/ Ltd.	Coop.	Private/ Individ.	Foreign/ J. Stock	Foreign/ Ltd.	Mixed/ J. Stock
$\Sigma\gamma_k$	0.074***	0.064***	0.038*	0.011**	0.090***	−0.003	0.070	0.240***	−0.078	−0.023
	(0.006)	(0.009)	(0.019)	(0.005)	(0.009)	(0.021)	(0.044)	(0.070)	(0.211)	(0.018)
$\Sigma\beta_k$	0.065***	0.084**	0.028	0.019	0.055**	0.159*	0.020	−0.268	0.436	1.164**
	(0.015)	(0.042)	(0.078)	(0.036)	(0.023)	(0.086)	(0.113)	(0.216)	(0.610)	(0.463)
P-value	0.000	0.000	0.000	0.000	0.000	0.084	0.607	0.044	0.987	0.004
Adj. R^2	0.101	0.336	0.247	0.650	0.151	0.282	0.241	0.638	−0.004	0.072
N/NF	6991/1922	2695/700	554/159	463/128	1760/523	571/149	105/30	175/45	293/83	188/53

1996

	All	State/ J. Stock	Private/ J. Stock	State/ SOE	Private/ Ltd.	Coop.	Private/ Individ.	Foreign/ J. Stock	Foreign/ Ltd.	Mixed/ J. Stock
$\Sigma\gamma_k$	0.023***	0.059**	0.061***	0.104***	0.052***	0.024	0.225**	0.048	0.039**	0.058***
	(0.004)	(0.029)	(0.004)	(0.016)	(0.012)	(0.027)	(0.091)	(0.029)	(0.018)	(0.003)
$\Sigma\beta_k$	−0.070*	−0.190**	0.971***	−0.459***	0.011	0.032	0.688**	0.033	−0.045	−0.267***
	(0.036)	(0.093)	(0.056)	(0.131)	(0.084)	(0.248)	(0.320)	(0.230)	(0.056)	(0.060)
P-value	0.000	0.059	0.000	0.000	0.000	0.704	0.099	0.206	0.208	0.000
Adj. R^2	0.094	0.284	0.566	0.490	0.098	0.107	0.485	0.115	0.415	0.725
N/NF	7349/1969	392/103	1219/341	282/83	2076/576	526/133	94/26	391/101	414/111	1757/459

1997

	All	State/ J. Stock	Private/ J. Stock	State/ SOE	Private/ Ltd.	Coop.	Private/ Individ.	Foreign/ J. Stock	Foreign/ Ltd.	Mixed/ J. Stock
$\Sigma\gamma_k$	0.014***	0.051**	0.105***	0.024	0.017***	0.020	−0.029	0.037	0.026***	0.011
	(0.002)	(0.020)	(0.008)	(0.021)	(0.003)	(0.012)	(0.057)	(0.034)	(0.007)	(0.008)
$\Sigma\beta_k$	0.050***	0.063	−0.100**	0.113	0.050**	0.249***	−0.261	0.351**	0.330***	−0.025
	(0.011)	(0.060)	(0.043)	(0.082)	(0.022)	(0.086)	(0.283)	(0.141)	(0.063)	(0.072)
P-value	0.000	0.216	0.000	1.000	0.039	0.000	0.009	0.331	0.000	0.130
Adj. R^2	0.217	0.178	0.291	0.075	0.168	0.455	0.685	0.264	0.413	0.073
N/NF	6975/1861	297/76	1691/460	162/44	1913/522	440/112	70/19	462/118	543/147	1191/306

1998

	All	State/ J. Stock	Private/ J. Stock	State/ SOE	Private/ Ltd.	Coop.	Private/ Individ.	Foreign/ J. Stock	Foreign/ Ltd.	Mixed/ J. Stock
$\Sigma\gamma_k$	0.013***	0.051	0.014***	0.630***	0.013***	0.042***	0.029*	0.620***	0.013***	0.067***
	(0.001)	(0.042)	(0.003)	(0.131)	(0.004)	(0.012)	(0.016)	(0.061)	(0.004)	(0.005)
$\Sigma\beta_k$	0.027***	−0.050	−0.118***	0.694*	0.005	0.136*	0.017	−0.361	−0.020	0.056***
	(0.007)	(0.243)	(0.037)	(0.363)	(0.034)	(0.077)	(0.066)	(0.220)	(0.055)	(0.020)
P-value	0.000	0.636	0.000	0.006	0.019	0.579	0.448	0.000	0.000	0.000
Adj. R^2	0.169	0.141	0.194	0.190	0.066	0.380	0.407	0.399	0.541	0.331
N/NF	6651/1799	242/64	1746/475	97/28	1775/484	400/103	113/35	455/119	629/172	1015/271

Standard errors in parentheses.
Values for 1992 are used for lagged values of regressors only.
*** = significant at 1% level
** = significant at 5% level
* = significant at 10% level
N = number of quarterly observations
NF = number of firms
P-value = *p*-value of the Hausman test of equality of fixed-effect and random-effect estimates.

of firms (accounting for more than 50% of all industrial firms at the time) were operating under a strong version of the soft budget constraint in that investment was negatively related to profit.[37] The negative coefficient on profit changes to zero for these two categories of firms in 1994 and actually turns positive for state/joint ventures in 1995, before becoming again negative for both sets of firms in 1996.[38] This suggests that the nature of the credit constraint of the state-owned firms changed over time, showing little sign of being restrictive and some sign of being quite soft in at least two years.

In interpreting changes in the estimated coefficients over time, one must take into account the fact that, between 1993 and 1994, 68 firms moved out of the state-owned/joint-stock category of firms, with forty firms going to the private/joint-stock and 28 to the mixed/joint-stock category. Moreover, 140 firms moved from the category of state-owned/state enterprises to other categories that we cannot identify.[39] Overall, the number of firms in the private/joint-stock and mixed/joint-stock categories virtually doubled in 1994, primarily due to the influx of former state-owned firms. The fact that the estimated coefficient on profit for the mixed/joint-stock firms turns from being insignificant in 1993 to negative in 1994 hence suggest that the incoming firms were those that operated under the strong soft budget constraint and continued to do so a year later under mixed ownership. Hence, although some of the changes in coefficient estimates could signal moderation of state-owned banks in providing credit to unprofitable firms, some were brought about by the switch of firms across ownership/legal status categories.[40] In addition, it should be noted that the number of private/limited-liability companies almost doubled between 1993 and 1994, and the firms also registered a negative coefficient on profit in 1994. Some of the new firms may be the former state-owned/state enterprises operating under the strong version of the soft budget constraint, whereas others are newly created firms that invest heavily during the start-up period when profits are low or negative. Finally, the number of foreign/joint-stock companies increased by more than one-third between 1993 and 1994, and these firms display a positive 1994 coefficient on profit.

No firms moved across categories between 1994 and 1995 except for firms that moved from the state-owned/state enterprise category to other unidentifiable groups. During the 1994–1995 period, the Czech economy also achieved the most rapid rate of growth of GDP (6%) in all of the 1990s. In our 1995 estimates, we do not observe any significant negative profit coefficients, although the coefficients for private/joint-stock firms and state-owned/state enterprises are zero and hence consistent with the soft budget constraint. Interestingly, we find a positive coefficient on profit for state and mixed/joint-stock firms, as well as for private/limited-liability firms and cooperatives. With the economy booming and the Czech prime minister declaring the transition to be over, the banks may have hardened the budget constraint for some categories of firms.

In 1996–1999, the Czech economy experienced an unexpected recession, and in 1996 the banks again relaxed the budget constraint for state-owned firms, in part under political pressure. With hundreds of firms moving from state to mixed and private ownership between 1995 and 1996, the estimates for 1996 in table 7 indicate that investment was again negatively related to profits in state and mixed/joint-stock companies, as well as in state-owned/state enterprises.[41] Between 1996 and 1997, more than 150 firms moved from state and mixed ownership to the private/joint-stock category, where the 1997 and 1998 coefficients on profit turned negative. It is likely that this switch to a strong soft budget constraint in the private/joint-stock firms in 1997–1998 reflected the sizable inflow of firms that operated under a strong soft budget constraint in their original categories of firms in 1996. At the same time, as the banking crisis developed in 1997–1998, cooperatives, and, to a lesser extent, also private/limited-liability companies appear to have operated under a credit crunch.

Overall, the disaggregated annual estimates in table 7 suggest that, during most of the 1993–1998 period, the current and former state-owned firms operated under a soft budget constraint. In contrast, cooperatives and, to a lesser extent, the private/limited-liability companies appear to have been credit rationed.

As the last step in our analysis of the soft budget constraints, we have checked various measures of the propensity to invest of profitable and unprofitable firms. We started by comparing annual data on the investment-capital, investment-output, and investment-labor ratios of firms with positive and negative annual profit. We found that the difference was statistically insignificant for all three measures in all years. Second, to eliminate the effect of outliers, we replicated these tests for trimmed samples, where we compared only profitable and loss-making firms that were within two standard deviations of their respective means. Again,

[37] As mentioned earlier, there is also a negative coefficient on profit in the case of private/individual firms. This is most likely associated with the heavy investment in the early phase of the life cycle of these firms when profit is low or negative.

[38] The state-owned firms became numerically relatively insignificant in 1997 and especially 1998.

[39] State enterprises were usually assigned a new identification number as they switched their legal status.

[40] Between 1993 and 1994, 33 firms also moved into the category of state-owned/joint-stock companies, with eighteen coming from the private/joint-stock and fifteen from the mixed/joint-stock category. The movement into state ownership could reflect a number of phenomena, including an increase in the firm's basic capital, with the state becoming a majority owner by contributing more than the other owner(s) of the firm. As mentioned, throughout the 1990s there was also a movement of firms from the state-owned/state enterprise category, much of which went to the state-owned/joint-stock company group. The reader can surmise this flow from the changes in the number of firms in these two categories over the years. However, because this switch was accompanied by a change in the firm's identification number, we cannot detect it directly.

[41] However, it was positive in private/joint-stock and (the few) private/individual firms.

TABLE 8.—ESTIMATES OF THE DYNAMIC MODEL WITH ADJUSTMENT COSTS, EQUATION (6)

Parameter	Estimate
φ_1	1.0208***
	(.0067)
φ_2	−.00021**
	(.00010)
φ_3	−.00014***
	(.00005)
μ	−.060**
	(.030)
Adj. R^2	.969
N	48226

*** = significant at 1% level
** = significant at 5% level
* = significant at 10% level

Estimates of the dynamic investment function are based on the entire sample. The specification includes the inverse Mills ratio (estimated parameter associated with it is denoted μ) to control for the possible selection bias. Model contained quarterly and ownership/legal form dummy variables to control for a possible shift across ownership/legal categories (parameter vector Ψ, none of the ownership/legal dummy coefficients was significant). Estimates are based on the deviations from the individual firm means. We have used labor/capital, product/capital, wage times labor/capital, product minus wage times labor/capital, and all dummy variables as instruments. All instruments except the dummy variables are in the form of first and second power of lagged values of the deviation from the individual means. The *p*-value of the *F*-test of overidentifying restrictions was 0.96.

we found the difference to be statistically insignificant for all three measures in all years. Third, to check if the difference in investment rates between profitable and loss-making firms reveals itself only over a period of several years, we took firms that were present in our sample for at least six years and we compared a six-year cumulative propensity to invest of firms that had positive total profit and those that had negative total profit over the six-year period. Having found no statistically significant differences among these two groups of firms, we then sharpened the test by comparing only the highly profitable and highly loss-making firms in this sample.[42] Although the highly profitable firms had somewhat higher mean investment rates than the loss-making firms, we again could not reject the hypothesis that the rates were the same.[43] Our findings hence indicate that the loss-making firms had long-term access to capital and on average were able to maintain investment rates that were comparable with those of profitable firms. This is strong complementary evidence that loss-making firms operated under soft budget constraints, and it is consistent with the observed lack of corporate bankruptcies in the Czech Republic in the 1990s.

Finally, in table 8, we present estimated coefficients of the dynamic structural model based on our entire sample of firms. The model includes quarterly and ownership/legal form dummy variables and the inverse Mills ratio. In view of the difficulties that are frequently encountered in estimating this type of a model, our estimates are very encouraging because the three structural coefficients—φ_1, φ_2, and φ_3—have the theoretically predicted signs and are statistically significant. In addition to providing support to the static neoclassical-accelerator model, the Czech data from the post-1992 phase of the transition hence suggest that, in terms of investment, the firms started behaving consistently with intertemporal profit maximization.

[42] The highly profitable firms were defined as those with cumulative capital-weighted profits greater than 1 (cumulative profits exceeded the value of capital), whereas the highly loss-making firms had cumulative capital weighted profits less than −1 (cumulative losses exceeded the value of capital).

[43] For example, the six-year investment-to-output ratios and corresponding standard errors were 0.08 (0.08) for the highly profitable firms and 0.06 (0.06) for the highly loss-making firms.

V. Conclusions

Strategic restructuring of firms is viewed as key to a successful transition from plan to market, with investment under a hard budget constraint being a principal form of this restructuring. In this paper, we have used the population of medium-sized and large industrial firms operating in the Czech Republic between 1992 and 1998 to analyze the investment behavior of firms with various types of ownership and legal (corporate) status. Ours is one of the first studies in this area, and it differs from other studies in that we (i) examine the validity of the main competing models of investment in the transition context, (ii) test for the presence of credit rationing and a soft budget constraint, (iii) assess whether investment behavior of firms changes as the transition proceeds and whether it varies with a firm's ownership and legal status, (iv) use quarterly rather than annual data in the presence of seasonal variation in investment, and (v) apply panel data and sample selection techniques to the firm-level data and thus eliminate aggregation and selectivity biases and control for heterogeneity across firms and over time.

A comparison of the investment-capital, investment-labor, and investment-production ratios across thirteen principal ownership/legal form categories of firms during 1992–1998 shows that (the relatively few) foreign-owned companies generally tend to invest the most and (the domestically owned) cooperatives the least. Privately owned/joint-stock companies tend to rank after the foreign-owned firms in terms of their propensity to invest, followed by state-owned/joint-stock companies. However, the general picture is complex, as some domestic firms dominate foreign ones for some criteria in some years, and some state-owned firms dominate privately or foreign-owned ones in some cases. In particular, by 1994 and 1995, state-owned/limited-liability companies dominated all domestic, private firms in terms of the investment-production ratio. Moreover, throughout 1992–1998, the privately-owned/limited-liability companies (the most numerous group of firms) and private individually owned firms tended to invest little relative to their output and employment. The findings from our large data set hence contrast with the widely accepted findings of the relatively small Polish survey (Belka et al., 1994), which suggested that investment during the transition was high in the new private firms and low in the state-owned enterprises.

Our econometric tests based on data from all firms indicate that overall investment behavior may be approximated by the neoclassical-accelerator model. Estimates for

individual types of firms in turn show that most firms behave consistently with this model, and, when we estimate on successive biennial subperiods of data, we find that the support for the neoclassical-accelerator model grows over time. More generally, our results are similar to those from western economies in that we find output to be an important determinant of investment and the investment behavior of firms in the Czech Republic to be consistent with both the static (neoclassical-accelerator) and dynamic models of a profit-maximizing firm.

The fact that we find a positive relationship between profit and investment in only cooperatives and to a lesser extent the smaller private firms supports the view that these firms encounter financing constraints. However, the lack of a strong positive link between profit and investment across the broad range of firms casts doubt on the validity of the Calvo-Coricelli hypothesis that stresses a positive relationship between credit rationing and aggregate investment and output. In fact, our results suggest that larger firms had virtually unlimited access to capital, and in many years it was the less profitable (more loss-making) state and former state-owned firms that received more bank credit and invested at a higher rate, ceteris paribus, than their more profitable counterparts. Taken together with the facts that the Czech banks accumulated a large portfolio of nonperforming loans, large firms had a high propensity to invest, and by the mid-to-late 1990s many of them reached the verge of bankruptcy, these findings suggest that throughout the 1990s many large firms operated under a soft budget constraint.

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TABLE A1.—NUMBER AND FREQUENCY DISTRIBUTION OF FIRMS BY LEGAL STATUS

Legal Form	1992	1993	1994	1995	1996	1997	1998	Total
Joint Stock Company	3036	3124	4633	4124	4256	5225	4400	28798
	[3.63]	[3.74]	[5.55]	[4.94]	[5.09]	[6.25]	[5.27]	[34.47]
State Enterprise (SOE)	2393	2395	1203	482	295	282	124	7174
	[2.86]	[2.87]	[1.44]	[0.58]	[0.35]	[0.34]	[0.15]	[8.59]
Limited Liability (Ltd.)	2459	3414	6920	3165	3410	13277	3412	36057
	[2.94]	[4.09]	[8.28]	[3.79]	[4.08]	[15.89]	[4.08]	[43.16]
Cooperative	959	984	1030	590	534	937	431	5465
	[1.15]	[1.18]	[1.23]	[0.71]	[0.64]	[1.12]	[0.52]	[6.54]
Individual	393	508	705	139	123	3290	208	5366
	[0.47]	[0.61]	[0.84]	[0.17]	[0.15]	[3.94]	[0.25]	[6.42]
Other	44	61	96	67	80	225	106	679
	[0.06]	[0.08]	[0.12]	[0.08]	[0.09]	[0.27]	[0.12]	[0.81]
Total	9284	10486	14587	8567	8698	23236	8681	83539
	[11.11]	[12.55]	[17.46]	[10.26]	[10.41]	[27.81]	[10.39]	[100.00]

Relative frequency in percentage is denoted in brackets.

TABLE A2.—NUMBER AND FREQUENCY DISTRIBUTION OF FIRMS BY OWNERSHIP

Ownership	1992	1993	1994	1995	1996	1997	1998	Total
Private	2795	3787	7376	3541	4326	16683	4919	43427
	[3.35]	[4.53]	[8.83]	[4.24]	[5.18]	[19.97]	[5.89]	[51.98]
State	4968	5012	4550	3438	791	755	457	19971
	[5.95]	[6.00]	[5.45]	[4.12]	[0.95]	[0.90]	[0.55]	[23.91]
Cooperative	964	990	1027	590	534	937	431	5473
	[1.15]	[1.19]	[1.23]	[0.71]	[0.64]	[1.12]	[0.52]	[6.55]
Foreign	390	505	1156	657	1114	3231	1515	8568
	[0.47]	[0.60]	[1.38]	[0.79]	[1.33]	[3.87]	[1.81]	[10.26]
Mixed	151	176	371	322	1925	1603	1334	5882
	[0.18]	[0.21]	[0.44]	[0.39]	[2.30]	[1.92]	[1.60]	[7.04]
Other	16	16	107	19	8	27	25	218
	[0.02]	[0.02]	[0.13]	[0.02]	[0.01]	[0.03]	[0.03]	[0.26]
Total	9284	10486	14587	8567	8698	23236	8681	83539
	[11.11]	[12.55]	[17.46]	[10.26]	[10.41]	[27.81]	[10.39]	[100.00]

Relative frequency in percentage is denoted in brackets.