Lock-In, Vertical Integration, and Investment: The Case of Eastern European Firms*

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Abstract

A key prediction of transaction cost economics (TCE) is that the presence of relationship-specific assets increases the likelihood of vertical integration whenever contracts are incomplete. I explore a firm-level data set on Eastern European and Central Asian firms, the BEEPS 2005 Survey provided by the EBRD and World Bank, to test this prediction. I measure lock-in by supplier substitution, and find the TCE prediction confirmed in the data. Testing whether the determinants of vertical integration also drive investment decisions, I find that lock-in raises the probability to engage in R&D, but has no robust effect on investment in physical assets.

JEL classification: L14, L23, L25.

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1 Introduction

The path breaking work of Coase (1937) on the boundaries of the firm has inspired an extensive literature on the determinants of vertical integration. This literature has become known by the name of "transaction cost economics" (TCE), and is identified with the name of Oliver Williamson (1975, 1985, 1996).[1]

The starting point for the TCE approach is the following: When contracts are incomplete, and parties develop relationship-specific assets, then they face the hazard of ex post opportunistic behavior; each party may attempt to "hold up" the other to appropriate a larger share of the relationship-specific gains from trade, the so-called "quasi-rents". A central prediction of this theory is that higher levels of lock-in should make it more likely that the two parties integrate.

The empirical evidence on the TCE approach is encouraging, but scant (see the excellent overview by Chiappori and Salanié (2002)). The main reason for this is the lack of appropriate data. To my knowledge, none of the data sets used in the empirical literature on vertical integration was actually designed for this purpose. Rather, it was left to the ingenuity of researchers to find the right angle from which to look into a data set that was constructed to serve very different purposes. I will briefly review the main contributions in this literature.

The literature was initiated by Monteverde and Teece (1982), who studied the make or buy decision (i.e. internal versus external procurement) in the automobile industry, more specifically for 133 components used by GM and Ford in 1976. The authors argue that not all of these components require the same level of engineering specific knowledge. Rather components involving more specific knowledge also generate more hold-up risk, and are therefore more likely to be made in-house, while components requiring less specific knowledge can be procured externally.

Along similar lines, Masten (1984) investigates procurement decisions of a large aerospace company over 1,887 components. The key assumption is that the degree of component complexity also measures the difficulty of complete contracting. This variable and the degree to which the component was specialized to this aerospace firm were found to significantly affect the likelihood of vertical integration.

Joskow's (1985) paper is the first to take Williamson's taxonomy of asset specificity to the data. He studies the relationship between coal suppliers and electric plants that burn coal in the US for 1979. Some electric plants are "mine-mouth", meaning that they are located close to the coal mine that supplies them. Other plants are designed to burn a specific type of coal (but not necessarily

[1] see Whinston (2003) for a comparison of the TCE approach and the more recent Property Rights Theory proposed by Grossman and Hart (1986).

from a specific supplier). Among other things, Joskow finds that mine-mouth plants are more likely to be integrated with the corresponding coal mine.

More recently, Baker and Hubbard (2003, 2004) investigated how the adoption of different classes of on-board computers (OBCs) between 1987 and 1997 influenced whether shippers use their own trucks for hauls or contract with for-hire carriers. They argue that on-board computers essentially made driver care contractible, and should therefore lead to vertical separation, a prediction for which they find confirmation in their data.

Finally, McMillan and Woodruff (1999) use a survey of private firms in Vietnam to study the determinants of trade credit. They find that a firm tends to grant more trade credit to its customers when the latter have no alternative supplier, when the supplier has more information about the customer's reliability, and when the supplier belongs to a business or social network that makes information available and/or helps enforce sanctions.

In the present paper, I want to explore a data set that has not yet been analyzed in the empirical literature on vertical integration. This data set was collected in 27 Eastern European and Central Asian countries by the European Bank for Reconstruction and Development and the World Bank. The declared goal of this survey was to "advise governments on ways to change policies and practices that impose a burden on private firms and to develop new projects and programs that strengthen support for enterprise growth" (see introductory statement of the questionnaire 2005). The survey was administered three times, first in 1999, then in 2002, and again in 2005.

Of course, the data had to be prepared before it could be used to test the questions of interest. After some manipulations, I was able to carve out some 1,600 firms which all serve large domestic firms in their countries; about 25% of these firms are vertically integrated with their customer, while the remaining three quarters are vertically separated. Using a measure of supplier substitution to identify the presence of lock-in, I test the key prediction of TCE theory, namely that more lock-in should make vertical integration more likely. The data clearly support this prediction, even after controlling for firm size, age, industry and country characteristics.

Next, I study the impact of the determinants of vertical integration on the firms' investment in both physical and intangible assets. While investment in physical assets appears to be driven only by firm size (with larger firms being more likely to invest in this type of assets), the lock-in variable does seem to matter for the decision to engage in R&D, i.e. to create intangible assets. I find that lock-in, along with firm size, is the single most important factor in explaining the incidence of R&D, even after including controls such as firm age, industry and country characteristics, and government subsidies.

In the light of the insights of TCE theory, these results lend themselves to the following interpretation: To the extent that intangible assets are much more sensitive to hold-up than physical assets, it is not surprising that lock-in has a strong effect on investment in the former, but no robust and significant effect on the latter. This points to the empirical importance of contracting problems for the innovative process, and suggests that the resulting underinvestment may

be of very significant orders of magnitude.

The paper proceeds as follows: Section 2 describes the data, Section 3 presents the descriptive statistics, Section 4 discusses the regression results of various linear probit specifications, and Section 5 concludes.

2 The Data

The Business Environment and Enterprise Performance Survey (BEEPS) is a joint initiative of the European Bank for Reconstruction and Development (EBRD) and the World Bank Group. The survey was first undertaken in 1999 - 2000, when it was administered to approximately 4,000 enterprises in 26 countries of Central and Eastern Europe (CEE) (including Turkey) and the Commonwealth of Independent States (CIS). The aim of the survey was to investigate how enterprise restructuring behavior and performance were related to competitive pressure, the quality of the business environment, and the relationship between enterprises and the state.[2] The second round of the BEEPS took place in 2002 and covered about 6,500 enterprises in 27 countries (including Turkey but excluding Turkmenistan).

The present paper builds on data from the third round of the BEEPS, which is a cross-section of 9,655 enterprises in 27 transition economies: 16 from CEE (Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, FR Yugoslavia, FYROM, Hungary, Latvia, Lithuania, Poland, Romania, Slovak Republic, Slovenia and Turkey) and 11 from the CIS (Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Ukraine and Uzbekistan). Each country is represented by 200 - 300 firms, with the exception of the following countries, where larger samples were drawn: Poland (975 firms), Hungary, Russia, Turkey, Ukraine, Kazakhstan, and Romania (about 600 each).

According to the July 2005 survey report by Synovate, who implemented the survey on behalf of EBRD and World Bank, the BEEPS 2005 sample was designed to replicate the sample distribution of BEEPS 2002 to maintain comparability between the two data sets. In the BEEPS 2002 survey, the sectoral composition of the sample in terms of manufacturing (including agro-processing) versus services (including commerce) was determined by their relative contribution to GDP. Firms that operate in sectors subject to government price regulation and prudential supervision, such as banking, electric power, rail transport, and water and waste water, were excluded from the sample. Enterprises which began operations in 2002, 2003 and 2004 were excluded from the sample as well. As the main survey was conducted from 10th March through 20th April 2005, this means that each firm in the sample has a business history of at least three years.

In addition, the sample was required to meet the following minimum quotas:

[2] A detailed description of the questionnaire and the implementation of the 1999 survey can be found in Hellman et al. (2000).

- Size: At least 10% of the sample was to be in the small (2 - 49 employees) and 10% in the large (250 - 9,999) size categories. Firms with only one employee or more than 10,000 employees were excluded.
- Ownership: At least 10% of the firms were to have foreign control and 10% state control (where control means more than 50% shareholding)
- Exporters: At least 10% of the firms were to be exporters (exports 20% or more of total sales)
- Location: At least 10% of firms were to be in the category small city / countryside (population under 50,000 inhabitants)

The BEEPS sample also has a small panel dimension, because the BEEPS 2005 survey covers some 1,500 respondents who already participated in BEEPS 2002 and had agreed, at that time, to participate in future rounds of the BEEPS.

The survey was conducted by means of face-to-face interviews with top level firm managers or owners in site visits, and encompasses questions on the business environment (such as business regulation and taxation, law and order and the judiciary, and on infrastructure and financial services, administrative corruption, and state capture), and on firm performance, in particular on the growth of firms, including the decisions to invest and to innovate, and the growth of revenues and productivity.

3 Descriptive Statistics

Given the novelty of the data set in the empirical TCE literature, a careful descriptive analysis will help us to put our regression results in perspective. The full BEEPS 2005 sample size is 9,655 firms. For 9,587 of these firms, Question 4a of the questionnaire provides information on the nature of the largest shareholder, as shown in Table 1.

Table 1: Q4a - Firm's largest shareholder currently

	Frequency	Percent	Cumulative
1 Individual	6,102	63.65	63.65
2 Family	877	9.15	72.80
3 General public	86	0.90	73.69
4 Domestic company	492	5.13	78.83
5 Foreign company	531	5.54	84.36
6 Bank	7	0.07	84.44
7 Investment fund	40	0.42	84.85
8 Managers of the firm	221	2.31	87.16
9 Employees of the firm	223	2.33	89.49
10 Gov't or gov't agency	852	8.89	98.37
11 Other	156	1.63	100.00
Total	9,587	100.00	

Category 11 ("other") also includes those cases where firms do not have a single largest shareholder, but two or more largest shareholders of different type among the categories 1 through 10. Firms belonging to category 4 or 5, and those firms in category 11 having either a domestic or a foreign company among their largest shareholders, will be considered a "subsidiary" in the following. This is the case for 1,102 firms, or about 11% of the total sample.

Survey Question 9 allows us to shed light on the identity of the main customers on the domestic market with whom the firms in our sample have trade relationships. Firms are asked to report:

Table 2: Q9 - What percentage of your domestic sales are to:

1	Government or government agencies (excluding state-owned enterprises)
2	State owned or controlled enterprises
3	Multinationals located in your country (not including your parent company, if applicable)
4	Your firm's parent company or affiliated subsidiaries
5	Large private domestic firms (those with approx. 250+ workers) (not including your parent company, if applicable)
6	Small firms and individuals
7	Other

If a firm has significant sales to its own parent or affiliated subsidiaries (i.e. the firm reported at least 20% under category 4 of Q9), then I will call this firm a "vertically integrated (VI) firm". These are firms which operate along the same vertical chain as one of their owners; more precisely, they act as suppliers (i.e. are located upstream) to their parent or affiliated subsidiary. This is the case for 434 firms, or 5% of the total 9,327 firms who supplied information on Q9. Note that the set of VI firms does not coincide with that of "subsidiaries": Many subsidiaries (90%) do not supply their parent (they may either buy from their parent or have no sales relationship with this parent at all); and a number of VI firms (75%) are not categorized as subsidiaries, presumably because the parent they sell to is just one of their owners, but not the largest shareholder.

Q9 also allows us to identify a set of firms that act as suppliers to other large firms, but - unlike the VI firms - are independent from their customers in terms of ownership. I will define a firm as "vertically separated (VS)" if it is not a "subsidiary", it does not have any sales under category 4 of Q9, and does not export, and at least 20% of its (domestic) sales are to either multinationals or large private domestic firms (categories 3 and 5 in Question 9). These firms will represent the counterparts to the VI firms defined above. There are 1,198 firms satisfying these criteria, accounting for 13% of the full sample of 9,327 firms who answered Q9.

Unfortunately, there is no question in the BEEPS about *supplier* details corresponding to Q9, so that it is not possible to identify the "downstream" analogues to our VI and VS firms, i.e. those firms who *buy* from their parent (or from some major domestic or foreign firm they are independent from in

terms of ownership). Likewise, for those firms whose sales are not confined to the domestic market, i.e. who *export* part or all of their output, we do not have any customer information analogous to that of Q9. However, some 57% of all VI firms do not export at all, and only 13% have more than half of their sales on the export market. Among the non-VI firms, a staggering 75% does not have any exports, and less than 8% have more than half of their sales on the export market. Thus, concentrating our analysis on those firms which only serve the domestic market does not seem too restrictive.

To summarize, our sample now includes 1,632 firms, all of which have at least 20% of their sales with large firms on the domestic market. Out of these 1,632 "upstream" firms, 434 firms (or 27%) are vertically integrated with their main customer, while the remaining 1,198 (or 73%) are vertically separated. Among the vertically integrated suppliers, 62 firms (or 14%) have a domestic parent, 46 firms (or 11%) have a foreign parent, and the remaining 326 firms (or 75%) have a parent firm who is not the largest shareholder (and hence not captured by Q4a). Figure 1 illustrates the vertical structures for the different types of firms in our final sample.

<INSERT FIGURE 1 HERE>

We can now compare the two groups - vertically integrated and separated - with respect to standard firm characteristics like size, age, mode of establishment, and industry. The numbers reported in the figures below sometimes rely on a smaller sample because of missing values in an indicator of interest; the underlying sample size for each group is indicated in the legend of each figure (in brackets).

Figure 2 shows the distribution of annual sales for both vertically integrated and separated firms. The BEEPS Survey does not report exact sales figures, but assigns each firm to one of 13 sales categories for which figure 2 gives the upper bound on the x-axis. We see that the sales distribution of the vertically integrated firms (black bars) is clearly to the right of that for the separated firms (grey bars): integrated firms tend to be larger than separated ones. Mean sales for the VI firms are about 3.6m USD, while VS firms have about 1.2m USD, i.e. one third of the VI sales on average.

<INSERT FIGURE 2 HERE>

This pattern is confirmed if we measure firm size by the number of full-time employees rather than by sales. This variable only encompasses three size categories (small, medium, large), but it is a useful complement to the sales variable, because it is available for all firms, while only two thirds of our sample also reported sales figures. Figure 3 shows that three quarters of the separated firms have less than 50 full-time employees, while only half of the integrated firms fall into this category. The pattern is reversed for large firms: 16% of the vertically integrated firms have more than 250 full-time employees, while only 4% of the vertically separated firms reach this size.

<INSERT FIGURE 3 HERE>

Regarding firm age, there is no clear pattern that distinguishes integrated from separated firms. Figure 4 shows that more than 80% of all firms in the sample were established after 1989, with an almost even distribution across the years 1990 to 2001.[3] For clarity, the graph was truncated from the left at 1970, but the year of establishment is available for all firms, including those established before 1970 (accounting for less than 8% of our sample).

<INSERT FIGURE 4 HERE>

As for the way in which the company was established, Figure 5 illustrates that vertically separated firms are more likely to be established as originally private firms, while vertically integrated firms are more frequently created through privatization, as private subsidiaries of formerly state-owned firms, or as joint ventures with foreign partners.

<INSERT FIGURE 5 HERE>

Regarding firm location, figure 6 demonstrates that vertical separation is particularly dominant in Kazakhstan, Romania, Hungary, Ukraine, and Poland, while vertical integration is more frequent almost everywhere else.

<INSERT FIGURE 6 HERE>

Finally, let us consider the sector composition of our sample. A firm is assigned to a particular sector if it reports more than 50% of its sales in this sector. If a firm does not have more than 50% of its sales in any single sector, it is assigned to the category "diversified" (10 firms, or 0.6%, of our full sample). Figure 7 shows that vertically separated firms are somewhat overrepresented in construction and wholesale/retail trade, while integrated firms are relatively more frequent in manufacturing and mining; in the remaining sectors (transport, real estate, and hotels & restaurants), the shares are very similar.

<INSERT FIGURE 7 HERE>

The BEEPS questionnaire provides a rich set of information on each firm that goes well beyond the standard characteristics discussed above. For the sake of brevity, let me just summarize the most important ones. Regarding the scope of firm activity, when asked whether they compete in the local market or in the national market (i.e. the whole country), roughly two thirds of both groups (vertically integrated and separated) reported to compete on the national market. The skill composition of the firms' labor force seems to be comparable as well (roughly 50% of the labor force are high-skill in both groups). I also find that vertically integrated firms appear to grow at about the same rate as the separated firms (on average 21% sales growth over the last three years).

[3] Recall that firms established after 2001 were excluded from the BEEPS sample.

In contrast, there seem to be important differences regarding technology adoption. When asked whether the firm acquired new production technology over the last 36 months, almost half of the integrated firms, and only 38% of the separated firms, answered in the affirmative. Interestingly, only 5% of the VI firms who introduced a new technology transferred this technology from their parent (11 out of 202 firms). For the vast majority of technology adopters (roughly two thirds in both groups) the new technology is embodied in new machinery and equipment that they acquired.

This leads us to our final point, namely investment in physical and intangible assets. I define a firm as engaging in R&D (and hence investing in intangible assets) if it has non-zero expenditures on R&D. As Figure 8 shows, the share of firms engaging in R&D is much higher among medium-sized and large firms, and there is a noticeable gap between integrated and separated firms.

<INSERT FIGURE 8 HERE>

This pattern is not present in the expenditure on physical assets (new buildings, machinery and equipment). Figure 9 shows that for each size category, the share of firms spending on physical assets is much higher than that for R&D. Size still seems to matter (though less so than it does for R&D), but compared to the gaps in R&D expenditure, the differences between integrated and separated firms are small. Among the large firms, separated firms are even more (not less) likely to invest in physical assets that integrated firms.

<INSERT FIGURE 9 HERE>

4 Regression Results

Let us start with the determinants for the decision to vertically integrate. The BEEPS data set offers a good measure for the presence of lock-in. Question 11 asks: "If you were to raise your prices of your main product line or main line of services 10% above their current level in the domestic market (after allowing for any inflation) which of the following would best describe the result assuming that your competitors maintained their current prices?" Table 3 shows the possible answers to this question:

Table 3: Q11 - Possible answers

Our customers would continue to buy from us:	
(i) in the same quantities as now	1
(ii) but at slightly lower quantities	2
(iii) but at much lower quantities	3
Many of our customers would buy from our competitors instead	4

Some readers may find this question reminiscent of a SSNIP test, a standard tool in antitrust litigation to determine a firm's relevant geographic and product market: The application of the SSNIP test involves interviewing consumers

regarding buying decisions and determining whether a hypothetical monopolist or cartel could profit from a price increase of 5% for at least one year (assuming that "the terms of sale of all other products are held constant"). If a sufficient number of buyers are likely to switch to alternative products and the lost sales would make such price increase unprofitable, then the hypothetical market should not be considered a relevant market for the basis of litigation or regulation.

In a very similar spirit, question 11 asks firms about the likely reaction of their customers to a 10% price increase not matched by any of their competitors. If supplier substitution is possible, then the answer should be 4, and so the customers of this particular firm cannot be considered as locked in to their current supplier. If the answer is instead 1, 2, or 3, then customers clearly do not have any alternative source for their supplies. I define the dummy variable "lock-in" to be 1 whenever Question 11 was answered by either 1, 2, or 3, while lock-in is zero for answer 4.

In our sample, lock-in is 1 for a total of 1,180 firms, or 72%. If lock-in is such a pervasive phenomenon, it may seem surprising that only about a quarter of all firms are vertically integrated. But of course, TCE also elucidates the downside of integration in the form of rising agency costs: the larger the organization, the more tasks have to be delegated to managers and their subordinates, whose individual interests cannot always be aligned with those of the firm as a whole.

Therefore, I include two different measures for agency cost (more precisely: monitoring cost) into the regression analysis:

(i) The average number of days over the last 12 months that it took from the time the firms imported supplies arrived in their point of entry (e.g. port, airport) until the time the firm could claim them from customs (Question 16a). Sluggish customs clearance can cause interruptions in production and hence delays in delivery to own customers. For customers, it is then difficult to distinguish between supplier failure and *force majeure*.

(ii) The percentage of the value of products the establishment shipped over the last 12 months which was lost while in transit due to breakage, spoilage or theft (Question 26a): similar to the reasoning above, such losses in transit make outcomes noisier so that inference about agent's efforts becomes harder (from the customer's point of view).

Table 4 shows the results of various probit specifications, estimating the impact of lock-in and agency costs on the probability of a firm being vertically integrated with its customer.

Table 4: Integrated or Separated?

Dependent variable: Firm is vertically integrated with customer				
	Probit 1	Probit 2	Probit 3	Probit 4
Lock-in	0.331***	0.249***	0.238***	0.176*
	(0.0827)	(0.0857)	(0.0870)	(0.0928)
Customs	0.008	-0.004	-0.007	-0.004
	(0.0096)	(0.0104)	(0.0105)	(0.0113)
Transit loss	0.005	0.007*	0.007*	0.005
	(0.0040)	(0.0041)	(0.0041)	(0.0045)
Size		0.451***	0.459***	0.505***
		(0.0597)	(0.0607)	(0.0644)
Year		-0.012***	-0.011***	-0.009***
		(0.0027)	(0.0027)	(0.0029)
Constant	Yes	Yes	Yes	Yes
Industry (8)	No	No	Yes	Yes
Country (26)	No	No	No	Yes
# of obs.	1,434	1,432	1,432	1,430
Pseudo R^2	0.0119	0.0778	0.0893	0.1629

*/**/*** means significant at the 10/5/1 percent level.
Numbers in brackets are standard errors.

We see that the lock-in coefficient is positive and significant in all specifications. The coefficient diminishes somewhat as we control for firm size (measured by the number of full-time employees underlying figure 3), and firm age (measured by the year of establishment). We see that the larger, and the older, a firm is, the more likely it is to be vertically integrated. These relations continue to hold as we include industry and country controls. Thus, our results are perfectly in line with the predictions of the TCE theory: lock-in is a major determinant in the decision to integrate vertically. Interestingly, the two measures for agency cost do not come out significant at conventional levels.

Modern theories of firm organization explain the decision to integrate as maximizing joint surplus (of buyer and seller) in anticipation of the investment levels that each ownership structure (integrated or separated) gives rise to.[4] Thus, in the reduced form of such an investment model, the factors that determine the integration decision also explain the investment decision.

Table 5 shows estimation results for both investment measures provided by the BEEPS, i.e. (i) expenditure on R&D, and (ii) expenditure on physical assets.

[4] see Whinston (2003) for a comprehensive and yet tractable linear-quadratic model of buyer integration under both self- and cross-investment and bilateral hold-up.

Table 5: Does the firm invest in R&D? in physical assets?

Dependent variable:	(i) R&D Expenditure		(ii) Physical Assets	
	Probit 5	Probit 6	Probit 7	Probit 8
Lock-in	0.445***	0.314**	0.230**	0.141
	(0.1204)	(0.1400)	(0.1071)	(0.1220)
Customs	0.017	0.004	0.013	0.003
	(0.0123)	(0.0153)	(0.0142)	(0.0170)
Transit loss	-0.001	-0.003	-0.003	-0.006
	(0.0061)	(0.0077)	(0.0066)	(0.0068)
Size		0.767***		0.514***
		(0.1031)		(0.1191)
Year		-0.0004		0.001
		(0.0042)		(0.0050)
Subsidized		0.028		0.114
		(0.2193)		(0.2662)
Constant	Yes	Yes	Yes	Yes
Industry FE (8)	No	Yes	No	Yes
Country FE (26)	No	Yes	No	Yes
# of obs.	812	809	877	856
Pseudo-R^2	0.0215	0.2330	0.0072	0.1351

*/**/*** means significant at the 10/5/1 percent level.
Numbers in brackets are standard errors.

We see that lock-in significantly raises the probability of engaging in R&D, while the two agency cost measures do not seem to matter for R&D. The coefficient on the lock-in variable remains highly significant even after controlling for firm size, age, industry, country and for receiving subsidies.[5] Surprisingly, neither subsidy status nor firm age come out significantly in explaining R&D participation. As for investment in physical assets, we see that the lock-in variable is no longer significant once we add the standard controls. The only significant explanatory variable is firm size.

In view of TCE theory, the interpretation to give to this result is as follows: The assets created through R&D tend to be more relationship-specific than physical assets such as new buildings, machinery and equipment. First of all, intangible assets are probably more difficult to describe ex ante (i.e. before the R&D was carried out), and hence to contract upon, than physical assets. Second, physical assets are likely to have a higher salvage value than the assets created by R&D, i.e. they can more easily be resold or commercialized in some other way outside the trade relationship. Thus, to the extent that investment in physical assets is less vulnerable to hold-up, we should expect lock-in to matter more for investment in intangible assets than in physical assets. This points

[5] The BEEPS provides detailed information on the source of the subsidies, i.e. whether they are from the national government, EU sources, regional/local governments or any other sources. I aggregated this information into a dummy variable called "subsidized" which is equal to 1 whenever a firm receives any subsidies at all, no matter from which source. This is the case for 101 firms, or 6% of our sample.

to the empirical importance of contracting problems for the innovative process, which may be of very significant orders of magnitude.

5 Conclusion

The purpose of this paper was to tap a new dataset, the BEEPS 2005 Survey carried out by the European Bank for Reconstruction and Development and the World Bank, for the empirical analysis of TCE theory. Based on some 1,600 firms located in 27 Eastern European and Central Asian countries, I test the key prediction of TCE theory, namely that more lock-in should make vertical integration more likely. This prediction is very clearly borne out in the data: The presence of lock-in significantly raises the probability of vertical integration between supplier and customer.

TCE theory also suggests that the hazard of hold-up can lead to underinvestment if firms cannot write complete contracts. Taking this prediction to the data, I test to what extent the determinants of vertical integration also affect the firms' investment in both physical and intangible assets. While investment in physical assets appears to be driven only by firm size (with larger firms being more likely to invest in physical assets), the TCE variables do seem to matter for the decision to engage in R&D, i.e. to create intangible assets. I find that lock-in, along with firm size, are the two most important factors in explaining the R&D decision across firms, even after controlling for industry and country characteristics, firm age and subsidy status.

The interpretation I give to these results is that, to the extent that intangible assets are much more sensitive to hold-up than physical assets, it is not surprising that lock-in has a strong effect on investment in the former, but no robust and significant effect on the latter. This points to the empirical importance of contracting problems for the innovative process, and suggests that the resulting underinvestment may be of very significant orders of magnitude.

References

[1] Baker, George P., and Thomas N. Hubbard (2003): "Make Versus Buy in Trucking: Asset Ownership, Job Design, and Information," *American Economic Review*, 93(3): 551-572.

[2] Baker, George P., and Thomas N. Hubbard (2004): "Contractibility And Asset Ownership: On-board Computers And Governance In U.S. Trucking," *Quarterly Journal of Economics*, 119(4): 1443-1479.

[3] Chiappori, Pierre André, and Bernard Salanié (2002): "Testing Contract Theory: A Survey of Some Recent Work," CESifo Working Paper No. 738, June 2002.

[4] Coase, Ronald H. (1937): "The Nature of the Firm," *Economica*, New Series, 4(16): 386-405.

[5] Grossman, Sanford J., and Oliver D. Hart (1986): "The Costs and Benefits of Ownership: A Theory of Vertical Integration," *Journal of Political Economy*, 94: 691 - 719.

[6] Joskow, Paul L. (1985): "Vertical Integration and Long-Term Contracts: The Case of Coal-Burning Electric Generation Plants," *Journal of Law, Economics, and Organization* 1: 33-80.

[7] Hellman, Joel S., Geraint Jones, Daniel Kaufmann, and Mark Schankerman (2000): "Measuring Governance, Corruption, and State Capture: How Firms and Bureaucrats Shape the Business Environment in Transition Economies," World Bank Policy Research Working Paper 2312, April 2000.

[8] Masten, Scott E. (1984): "The Organization of Production: Evidence from the Aerospace Industry," *Journal of Law and Economics* 27(2): 403-417.

[9] McMillan, John, and Christopher Woodruff (1999): "Interfirm Relationships And Informal Credit In Vietnam," *The Quarterly Journal of Economics*, 114(4): 1285-1320.

[10] Monteverde, Kirk, and David J. Teece (1982): "Supplier Switching Costs and Vertical Integration in the Automobile Industry," *Bell Journal of Economics* 13(1): 206 - 213.

[11] Whinston, Michael D. (2003): "On the Transaction Cost Determinants of Vertical Integration," *Journal of Law, Economics, and Organization* 19(1): 1-23.

[12] Williamson, Oliver (1975): "Markets and Hierarchies: Analysis and Antitrust Implications," The Free Press.

[13] Williamson, Oliver (1985): "The Economic Institutions of Capitalism: Firms, Markets, Relational Contracting," The Free Press.

[14] Williamson, Oliver (1996): "The Mechanisms of Governance," Oxford University Press.

6 Appendix: Figures

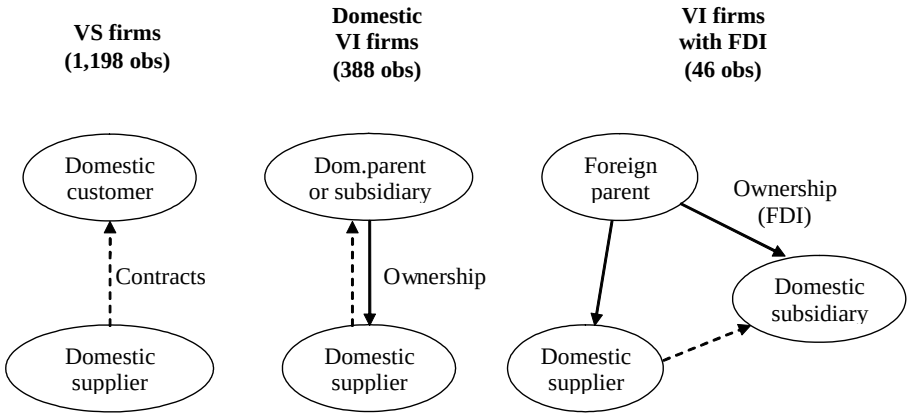

Figure 1: Vertical chain structure of firms in the final sample (solid arrows: ownership, hatched arrows: sales)

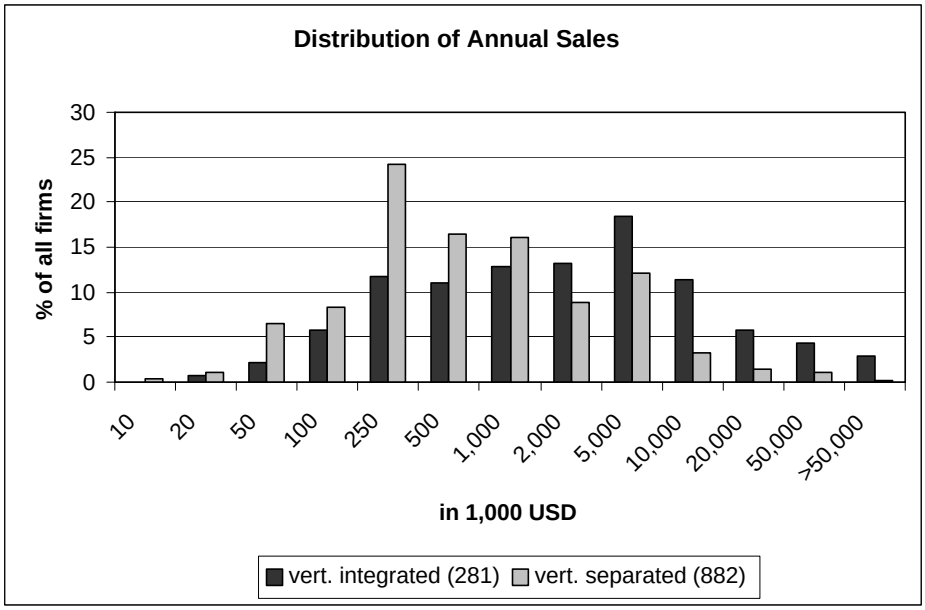

Figure 2: Distribution of annual sales for vertically integrated and separated firms

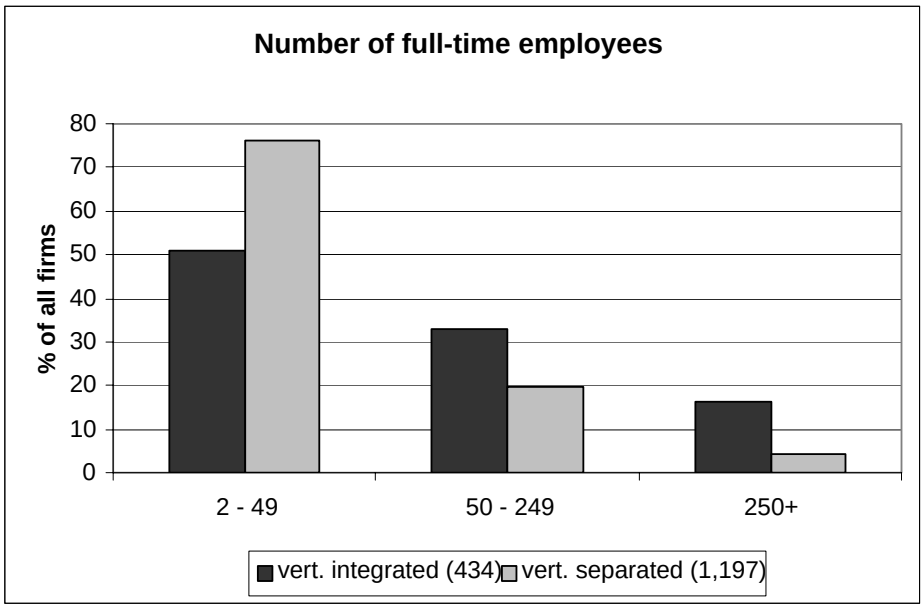

Figure 3: Size distribution of vertically integrated and separated firms as measured by number of full-time employees

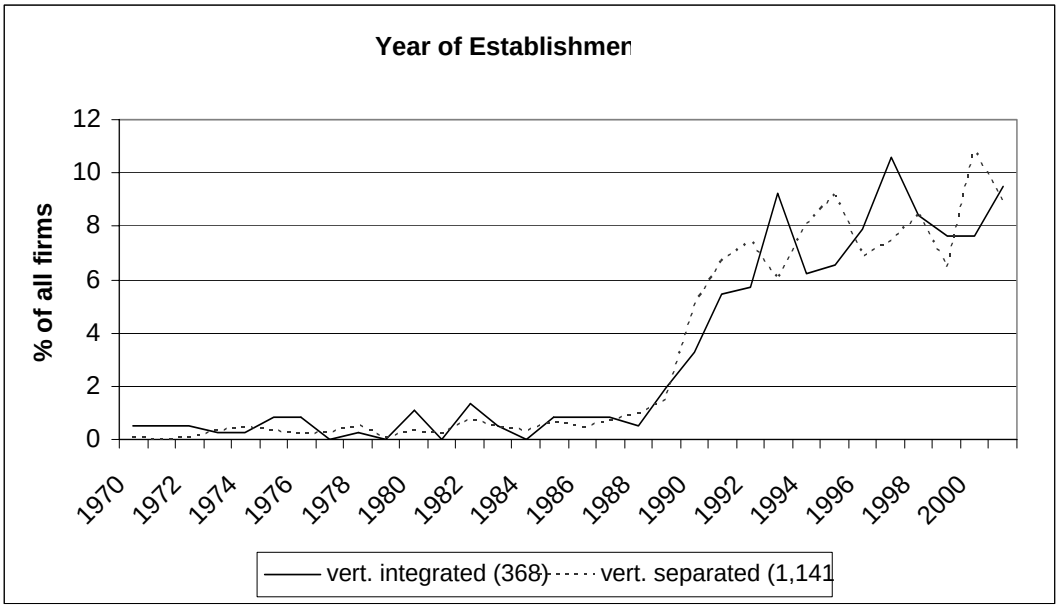

Figure 4: Distribution of integrated and separated firms by year of establishment

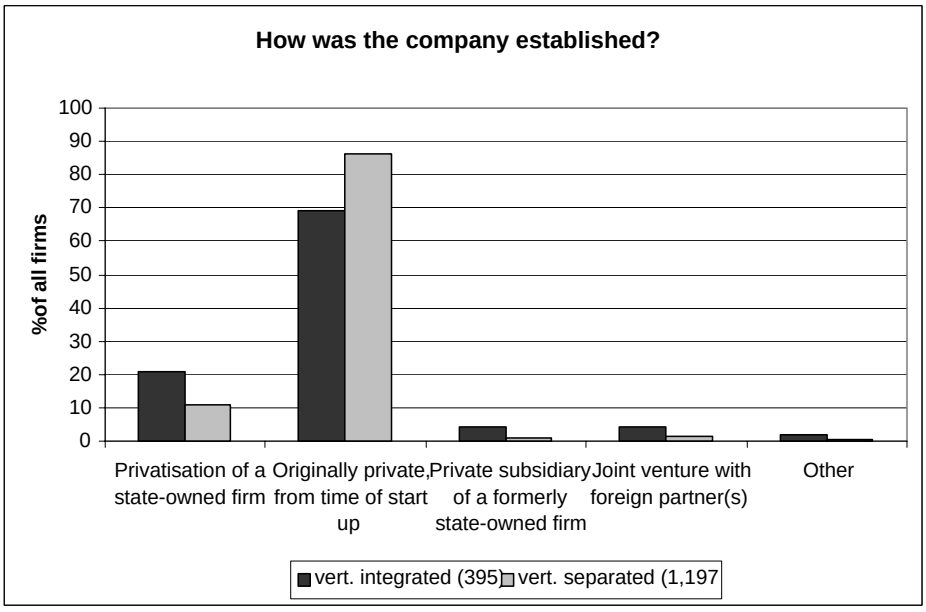

Figure 5: Distribution of firms according to the way in which the company was established

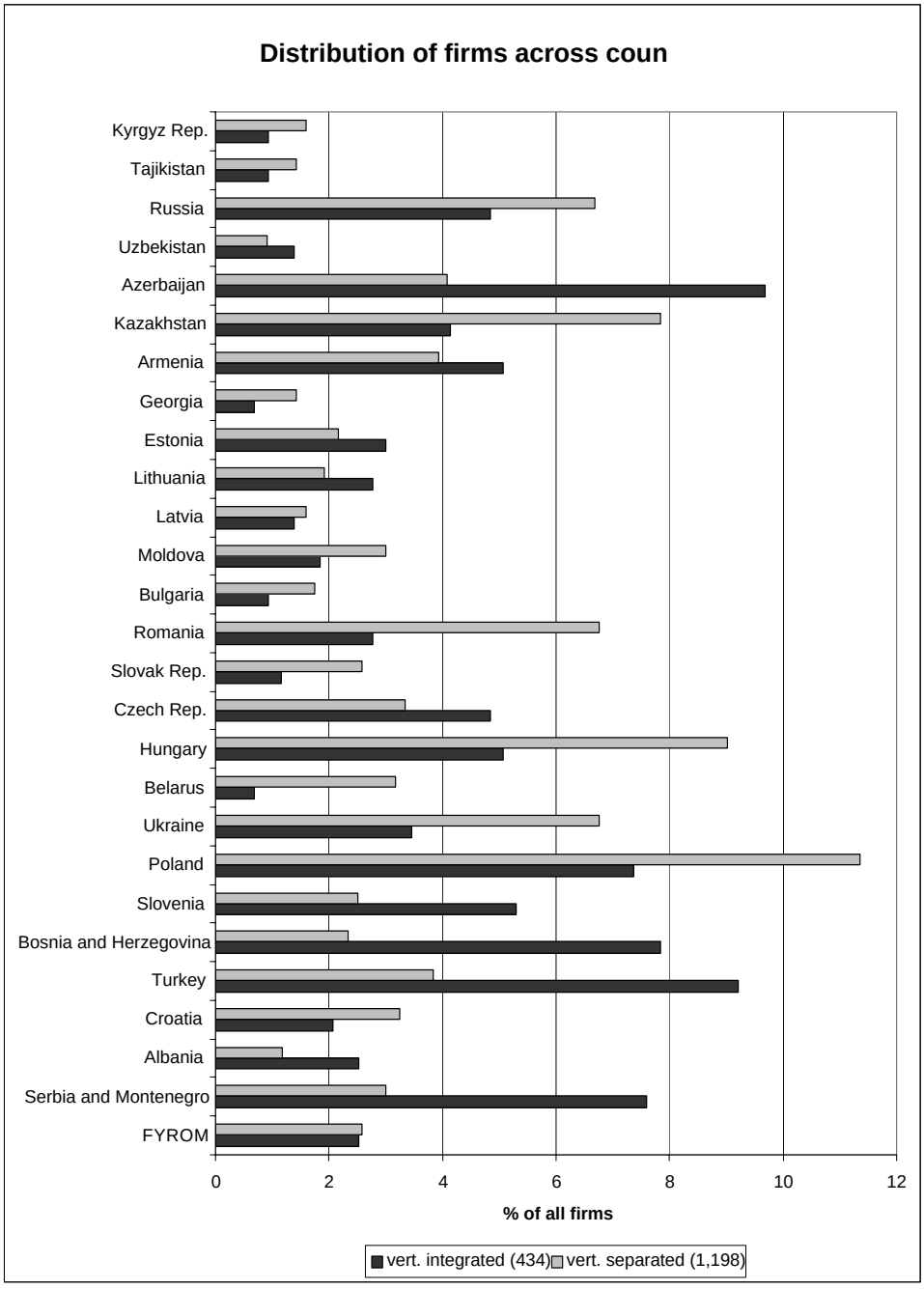

Figure 6: Distribution of integrated and separated firms across countries

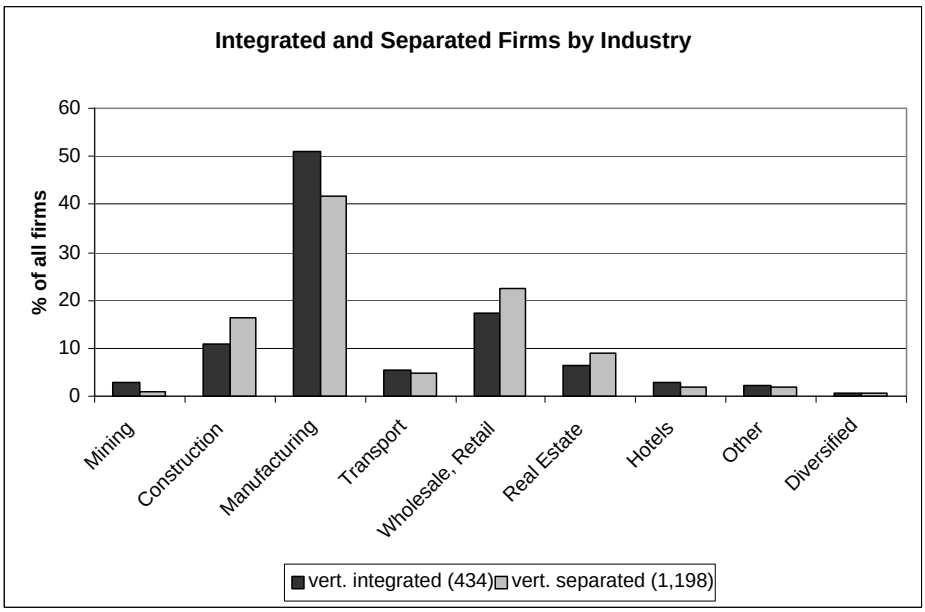

Figure 7: Distribution of vertically integrated and separated firms across industries

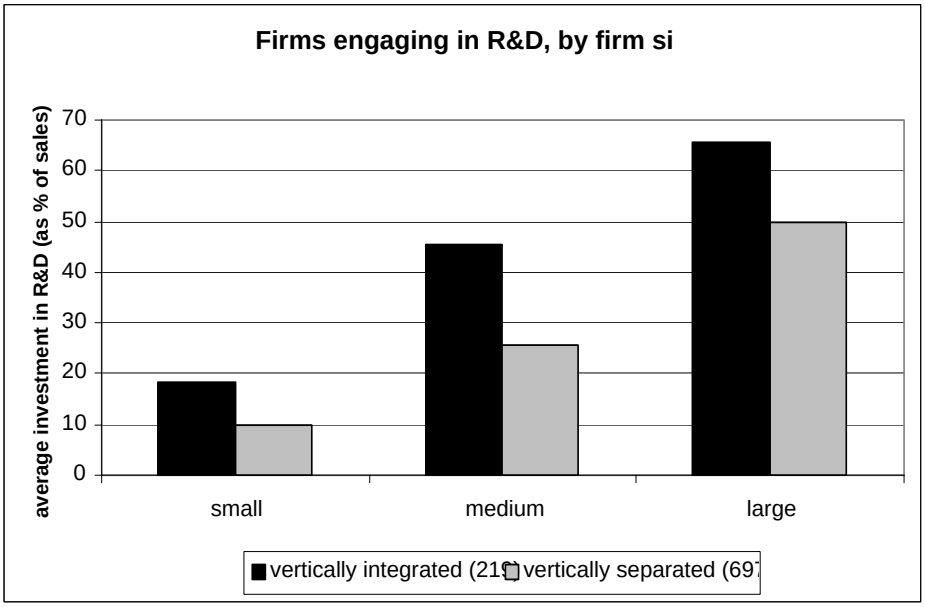

Figure 8: Share of firms engaging in R&D, by firm size

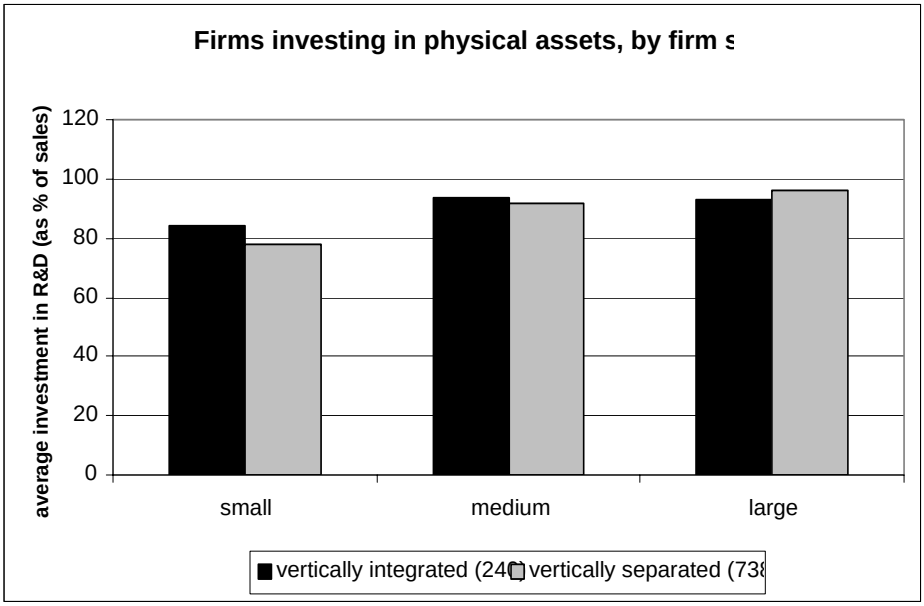

Figure 9: Share of integrated and separated firms investing in physical assets, by firm size