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Abstract:
The intangible asset theory of foreign direct investment holds that firms expand abroad to garner additional returns to intangible assets such as proprietary process or product technology or a strong reputation. I explore Norwegian manufacturing data for evidence that foreign owners are realizing returns to intangible assets. Foreign owners of Norwegian manufacturing establishments are clustered in industries that rely on such assets and, within narrowly-defined industries, differ from their domestic counterparts by being larger and using physical and human capital more intensively. My finding that foreign-owned establishments are approximately 2% more productive than their domestic counterparts is suspect evidence for the intangible assets theory because it relies crucially on the accuracy of the estimate of the scale elasticity, and such estimates are subject to well-known omitted variables and errors-in-variables biases. I show how the foreign ownership advantage varies with alternative assumptions about economies of scale, and find that under reasonable assumptions about scale economies it disappears. I conclude that foreign-owned establishments are larger and more productive, but cannot yet sort out the relationships between size, foreign-ownership, and productivity. I find that those establishments acquired by foreigners tend to be of average productivity and above-average size, but find no evidence that acquisition leads to a productivity improvement. In addition, I find that aggregating rented and owned capital in a capital services measure does not significantly affect the productivity comparison.

Correspondence: Margaret J. Simpson, Statistics Norway, Research Department,
P.O.Box 8131 Dep., 0033 Oslo. **E-mail:** msi@ssb.no

1. Introduction

Foreign-owned firms play a substantial role in the Norwegian economy and, as in other industrialized countries, have increased their presence over the past 15 years. The percentage of Norwegian manufacturing workers employed at establishments under non-Norwegian control increased from less than 7 percent in 1975 to more than 10 percent in 1989. As Europe proceeds towards greater integration and as Norway decides to what extent it will include itself in the process, the motivation for foreign direct investment and the behavior of foreign-owned firms become still more interesting issues to explore.

Although theories of foreign direct investment are still debated, international economists seem to have developed a consensus that firms expand abroad to further exploit intangible assets such as proprietary product or process technology or reputational capital. I search Norwegian manufacturing data for evidence that foreign owners are motivated by the prospect of additional returns to such assets. I conduct my search first by developing a broad overview of foreign control in Norwegian manufacturing, and then by comparing the characteristics and productivity performance of foreign-owned establishments with their domestically-owned counterparts.

Improvements in the availability of data and advances in empirical industrial organization have made comparisons of the productivity performance of domestic and foreign-owned firms a more promising source of information. I have access to comprehensive establishment-level data; since the industry-level predictions of the intangible asset hypothesis can be generated by other theories of multinational behavior, the ability to work at a micro-level is crucial. The data also allow me to construct and investigate various definitions of foreign control, and to control for the possibility that foreign-owned or acquired establishments may use owned and rented capital in different proportions. Recent developments in empirical industrial organization provide the means to explore the robustness of my results to different assumptions about technology, returns to scale and competition.

In the following section, I develop the implications of the intangible asset hypothesis for the productivity comparison between foreign and domestically-owned establishments. I also present an alternative to the intangible asset hypothesis that yields similar industry-level

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predictions but different micro-level productivity predictions. The discussion is not intended to provide a summary of the large literature on multinational behavior but, rather, to emphasize that more micro-level empirical examination of the intangible asset hypothesis is vital and that productivity comparisons are a useful contribution. In section 3, I present some preliminary exploration of the importance of foreign control of Norwegian manufacturing establishments. I use information on foreign holdings of equity in Norwegian firms to explore definitions of foreign control. I find that foreign owners usually have either a majority stake or too small a stake to confer any control, comforting information if one is faced with having to decide whether a 10%, 20%, or 50% stake is "large enough" to establish control. More secure given this knowledge, I choose a definition and provide an overview of foreign control in Norwegian manufacturing. In section 4, I focus on comparing the characteristics and performance of domestic and foreign-controlled establishments. In section 4.1, I examine the size of foreign-controlled establishments relative to their domestically-controlled counterparts, and the intensity with which they use physical and human capital. In sections 4.2 and 4.3, I present the productivity model and discuss two measurement problems, the aggregation of owned and rented capital, and transfer pricing, that may bias the productivity comparisons. Section 4.3 contains the results of the productivity comparisons, and an exploratory probit analysis of whether productivity and size affect the probability of being acquired by foreigners. Section 5 concludes with suggestions for future research.

2. Foreign Control and Productivity Performance

Most economists who study foreign direct investment (FDI) describe it as an attempt to extend corporate control as part of international corporate strategy and not as an attempt to shift capital between countries.[1] In particular, a consensus seems to have developed around the view that multinationals expand predominantly to exploit the returns to an intangible asset, such as proprietary technology or reputational capital, in the face of failures in markets for technology and information. Indeed, trade theorists have begun to incorporate these ideas in both static and dynamic settings.[2]

The "intangible assets" explanation of FDI is appealing partially because it seems to be confirmed by simple observation -multinationals tend to cluster in industries that rely heavily on investments in research and development (R&D) and marketing. Things are not so simple, of course, since there are alternatives to the intangible asset explanation that predict the same industries as targets of multinationals. In this section, I discuss the implications of the intangible asset view for the productivity comparison between foreign and domestically-owned establishments. To emphasize that productivity comparisons may be useful and that micro-level data are vital if we are to discriminate between theories of FDI , I also discuss an alternative explanation of multinational expansion that yields the same industry-level predictions as the intangible assets theory but predicts that foreign-owned firms need not be, on average, more productive than domestically-owned firms.

Consider potential foreign and domestic owners bidding for an existing establishment.[3] If the potential owners' objectives are to maximize expected profits, then foreign firms will outbid domestic firms if they expect future returns to be larger under their control or if they face a lower cost of capital. The intangible asset explanation of foreign direct investment takes as given that it is more costly for foreign firms to establish and operate in a market than domestic firms, and asserts that if foreign firms are willing to outbid domestic firms despite these higher costs it is because they expect higher returns. Foreign control yields higher returns because the foreign firm possesses assets, such as superior product technology,

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[1] Graham and Krugman (1991, p.36).

[2] See, e.g., Helpman (1984), Markusen (1984), Brainard (1993), and Grossman and Helpman (1992).

[3] I follow Graham and Krugman, op.cit., in employing this construct.

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superior marketing, distribution or organizational skills, or an established reputation, that provide an advantage over domestic rivals. The foreign firm must also perceive an "internalization advantage" to direct investment, that is, a reason it is better to exploit the asset within the boundaries of the firm rather than by licensing to a host-country firm. The internalization advantage may spring from imperfections in the markets for technology or information. Finally, the foreign firm must perceive a locational advantage, such as the existence of tariffs, transportation costs, or an advantage to being close to market, that make direct investment preferable to trade. For my purposes, the important prediction of the "intangible asset" hypothesis is that the asset is expected to generate lower costs or higher revenues for foreign-owned firms that should be observable as higher average revenue productivity. If "the asset" is a greater than average ability to innovate, or put innovations into practice, this should be reflected in better than average productivity growth.

Foreign firms may also outbid domestic firms if they face a lower cost of capital. Froot and Stein (1991) suggest that asymmetrical information may lead to FDI by creating differences in the cost of capital. If lenders have imperfect information about borrower types, borrower actions, project qualities or outcomes, the agency costs of external financing cause internal financing to be less costly. In this setting, foreign firms may be willing to engage in projects with lower expected productivity performance than would domestic firms if they have a relatively abundant supply of internally-generated funds that allows them to finance the projects at lower cost than domestic firms. Changes in firms' wealth generated by factors such as exchange rate changes will produce changes in the demand for foreign investment. Interestingly, agency costs should be highest in the technology and information-intensive industries in which the intangible asset hypothesis would predict that foreign direct investment would be important. Lenders are likely to find obtaining or verifying information most costly where, for instance, technology is changing rapidly or the influence of reputation or advertising makes demand difficult to predict. They will be less able to collateralize debt when borrowers' assets are primarily intangible and firm-specific. And moral hazard problems will be exacerbated when it is difficult to determine whether, say, lagging in a technology race is due to chance or to insufficient effort on the borrower's part.

Unfortunately, much of the empirical support for the intangible asset hypothesis relies on industry-level comparisons. Horst (1972) and Caves (1974), for example, find a positive relationship between the extent of multinational presence in an industry and industry

advertising and R&D intensity. Dunning (1973) and others find that multinationals tend to be more profitable and productive than other firms.[4] More recently, empirical tests have been done with firm-level data. Grubaugh (1987) uses linear probability and logit models and finds that, controlling for industry, the probability of firm becoming multinational increases with R&D expenditures and diversification. This lends support to the intangible assets hypothesis.

Harris and Ravenscraft (1991) and Morck and Yeung (1992) use disaggregate stock market data and an event study approach to test hypotheses about motives for cross-border acquisitions. Harris and Ravenscraft find that wealth gains to target firms tend to be larger for cross-border acquisitions in R&D intensive industries; they also find a significant role for the exchange rate and hence, support for Froot and Stein. They do not find a significant interaction between industry R&D intensity and the exchange rate. Morck and Yeung find that wealth gains are larger for acquiring firms with larger R&D expenditures. They control for industry effects and firm size and, hence, provide somewhat stronger evidence for the intangible asset theory.

Klette (1991) uses, as do I, the census of Norwegian manufacturing establishments to compare the productivity performance of establishments with different ownership characteristics.[5] He finds that foreign ownership does not affect an establishment's productivity growth rate. Moreover, Klette finds that, controlling for a change in ownership, changes from foreign to domestic (and from domestic to foreign) ownership slightly worsen productivity levels in the three years following the control change. Although this seems to be evidence against the intangible asset hypothesis, the number of observations representing acquired establishments may be too few, or a three year adjustment period may be too short, to pick up an effect of foreign ownership on the level of productivity. Klette was interested in a wide range of factors that may influence productivity and productivity growth, so the question of whether the presence of intangible assets can be detecting by comparing the productivity performance of foreign and domestically-controlled establishments remains to be examined in greater detail.

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[4] Caves (1982) surveys much of the earlier empirical literature on multinationals.

[5] Note that although the theories of FDI discussed in this section are theories of firm behavior, I will be using establishment-level data. As a result, I will be concerned about the pricing of inputs and outputs transferred between establishments within the firm. I return to this issue in section 4.3.

3. Extent of Foreign Control in Norwegian Manufacturing

3.1. Defining Foreign Control

Since it is not obvious how large a share of equity is needed to exert control of a firm, or what equity shares signify the intent to exert control, different institutions and researchers use different working definitions of foreign control. The U.S. Department of Commerce and the OECD recognize a foreign investment as "direct," and involving control, when a single foreign investor owns 10% or more of the equity. Certainly, though, a single large shareholder may not exercise control although it owns 10% or more of equity, and less than 10% may be sufficient to exercise some control. Others use different definitions; when ownership is concentrated in the hands of a single foreign owner, the threshold percentage used to define foreign control usually ranges from 10 to 25%, with a tendency to the lower end of the range. When enterprises have several foreign owners, the threshold percentage is usually at least 50 and may be closer to 100%.[6]

Statistics Norway conducts an annual near-census of Norwegian enterprises with equity that is owned, wholly or in part, by foreigners. The resulting data, described in more detail in Appendix A, provide information on the face value of equity, the share of equity held by the single largest foreign owner, the share of equity held by all foreign owners, and the distribution of foreign-owned equity among nationality groups.[7] They allow a degree of flexibility in defining a proxy for foreign control and, as I will show, suggest that the potential for misclassifying firms as foreign-controlled when they are not, and vice versa, is fairly limited.[8]

Figure 1 represents the distribution of foreign ownership of Norwegian manufacturing establishments, conditional on there being some recorded foreign ownership.[9] It illustrates that ownership shares are often either majority shares and clearly intended to establish

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[6] See Liansheng (1992).

[7] See NOS (several years), *Credit Market Statistics: Foreign Assets and Liabilities*, for summary statistics and some additional documentation.

[8] Graham and Krugman (1991) and Steckler and Stevens (1991) discuss the identification of foreign-controlled firms, and argue that the Commerce/OECD definition works well in practice because ownership stakes are usually either very large, clearly indicating control, or very small. This is precisely what I find for the Norwegian data.

[9] Note that the data represented in figures 1 and 2 are organized at the establishment level.

control, or are too small to confer any control. Thresholds from 10% to 50% and even higher will, to a large extent, identify the same set of establishments as foreign-owned. The picture looks much the same if the focus is on the total equity share of all foreign owners. Interestingly, although throughout my sample period (1974-1989) Norway maintained a concession law that required foreign owners to undergo examination to obtain a concession if their equity stake was to exceed 20%, the requirement seems to have little effect; there is no noticeable concentration just below 20%.[10]
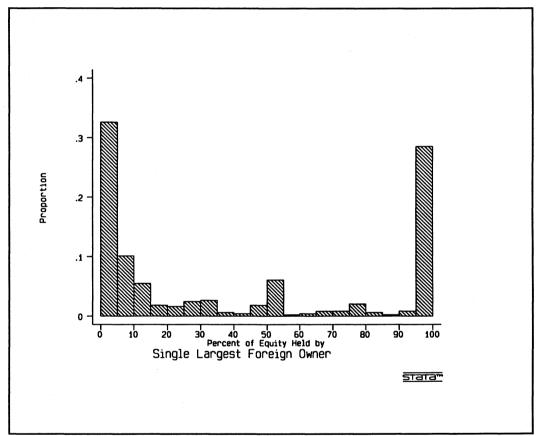

Figure 1. Distribution of the Equity Stake of the Single Largest Foreign Owner, 1980

In this paper, I concentrate on the share of equity held by the single largest shareholder since that seems to provide the smallest scope for misclassification; I will use the terms "foreign-owned" or "foreign-controlled" when the share held by the largest single foreign owner is large enough that it appears to indicate control. I have used three thresholds to explore the sensitivity of results to changes in this definition. Since the choice of a 10, 20 or 50%

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[10] In 1989 the law was altered such that a concession is required only if the foreign ownership share is to exceed one third of total equity.

threshold does not change the classification of most firms (and does not change results significantly), I present results for the 10% threshold in the body of the paper.[11]

Although the choice of definition of a foreign acquisition may be a more sensitive matter, most increases in foreign ownership are either small or a jump to majority ownership. Noticing the concentration of ownership at 8% of total equity (pictured in figure 2), I defined a foreign acquisition as a jump from less than 8% of equity held by the largest foreign shareholder to more than 10, 20 or 50%. Since results were not sensitive to the choice between these three definitions, I present results for the 10% threshold.
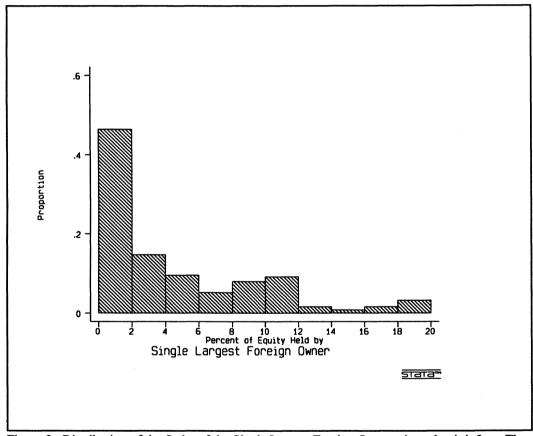

Figure 2. Distribution of the Stake of the Single Largest Foreign Owner given that it is Less Than or Equal to 20 Percent, 1980

[11] Demsetz and Lehn (1985) suggest ownership is likely to be less concentrated the larger the firm, since a given share is obtained only at a higher price and since owners may be risk averse. This negative relationship between size and ownership concentration is apparent in the credit market data. Ownership may be less concentrated in regulated industries, since regulators provide subsidized monitoring for shareholders. Ownership may be more concentrated the noisier firms' environments, since rapid change under, say, conditions of rapidly changing technology will make monitoring of managers more difficult and the payoff to owners maintaining tight control higher. While I have not looked for all these relationships in the data, they suggest a theoretical reason for focusing on the 10% threshold instead of on higher thresholds, since using higher thresholds may result in a selection of foreign-owned firms that overrepresents small and/or rapidly growing foreign firms.

3.2. An Overview of Foreign Control of Norwegian Manufacturing

I linked the information on foreign ownership to information from Statistics Norway's annual census of manufacturing establishments for 1974-89.[12] This allows me to develop a picture of foreign control of Norwegian manufacturing establishments, how that picture has changed over time, and how it varies across industries.[13]

Table 1 presents the fraction of establishments controlled by foreign owners and the fraction of all manufacturing workers employed in foreign-controlled establishments in 1980. As one reads Table 1 from left to right, the definition of foreign control becomes more inclusive. Using the 10% threshold, foreign owners controlled just over 3.5 % of manufacturing establishments and employed nearly 8.5 % of manufacturing workers.

Table 1. Share of Manufacturing Establishments and Employment Controlled by Foreign Owners, 1980

	Largest Foreign Owner Holds ≥ 50% of Equity	Largest Foreign Owner Holds ≥ 20% of Equity	Largest Foreign Owner Holds ≥ 10% of Equity
% of Establishments	2.50	3.09	3.54
Total Establishments		7995	
% of Employment	6.19	7.81	8.49
Total Manuf. Employment		3479704	

Table 2 describes the increase in foreign control over time, where the 10% threshold is the indicator.[14] Table 3 describes the pattern, in 1980 and 1989, of foreign control across industries. Foreign ownership is concentrated in the manufacture of chemicals, chemical and petroleum products, petroleum refining, and in the primary metals and electrical equipment industries. While the importance of petroleum to the Norwegian economy makes the pattern of foreign ownership in Norway special, the chemical and electrical equipment industries are certainly associated with a reliance on R&D and other intangible assets.

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[12] See Halvorsen et al. (1991) for documentation. NOS (several years), *Manufacturing Statistics*, reports some summary statistics.

[13] In the summary statistics that follow, establishments identified as engaged in auxiliary activities and hence reporting no own production have already been removed from the sample.

[14] The increases in the numbers of foreign-controlled establishments from 1975-77 and 1985-87, which do not show up as noticeable increases in employment under foreign control, may be due to increases in the coverage of small enterprises in the survey of foreign ownership. Communication with Leiv Ryalen, Section for Finance and Credit Market Statistics, Statistics Norway, March 14, 1994.

Table 2. Foreign Control of Norwegian Manufacturing Establishments, 1974-89. (Using the 10% Foreign Ownership Threshold)

Year	Employment at Plants under Foreign Control (%)	Total Employment	Plants under Foreign Control (%)	Total Plants
1974	7.3	362450	2.3	8413
1975	6.9	360428	2.4	8503
1976	6.8	359559	2.2	8414
1977	8.9	359874	2.9	8300
1978	9.5	354394	3.3	8114
1979	9.7	350106	3.5	8133
1980	8.5	347974	3.5	7995
1981	8.4	341902	3.5	7936
1982	8.3	330186	3.5	7727
1983	8.5	306741	3.7	7218
1984	9.1	302338	4.0	7141
1985	9.6	302516	3.9	7136
1986	10.4	302442	4.5	6994
1987	9.8	301093	4.7	6936
1988	9.5	282025	4.7	6615
1989	10.2	265069	4.9	6507

Table 3. Industrial Distribution of Foreign Control of Norwegian Manufacturing Enterprises, 1980 & 1989 (Using the 10% Foreign Ownership Threshold)

Industry Group	ISIC Code	Fraction of 1980 Employment at Plants under Foreign Control (Total Empl.)	Fraction of 1989 Employment at Plants under Foreign Control (Total Empl.)
Food, Beverages	31	4.0 (54564)	7.6 (48189)
Textiles, Apparel	32	2.8 (20842)	6.5 (9166)
Wood, Furniture	33	2.9 (30888)	2.1 (22528)
Printing, Publ.	34	5.1 (49012)	5.4 (41605)
Industrial Chem.	351	15.2 (9403)	10.4 (7327)
Other Chemicals	352	13.7 (7413)	16.6 (5020)
Petroleum Refining	353	57.4 (794)	38.1 (1211)
Petroleum Products	354	14.9 (1599)	14.4 (771)
Rubber Products	355	0.0 (1982)	74.0 (1257)
Plastic Products	356	9.3 (6752)	11.9 (5674)
Stone, Clay, Glass	36	4.4 (11641)	20.9 (8323)
Primary Metals	37	15.3 (26408)	13.7 (18012)
Metal Products	381	4.4 (24725)	11.5 (20976)
Machinery	382	8.3 (31568)	8.6 (32361)
Electrical Equip.	383	51.4 (20970)	28.1 (16199)
Transport Equip.	384	1.2 (45028)	8.8 (22554)
Instruments	385	1.0 (1297)	10.1 (1619)
Other Manufacturing	39	2.0 (3088)	3.8 (2277)

4. Performance of Foreign-Owned Establishments in Norway

4.1. Characterizing Foreign-Owned Establishments

I selected a smaller panel of establishments to characterize differences between and compare productivity performance of foreign-owned and acquired establishments with their domestically-owned counterparts. Since the bulk of foreign ownership has been in the chemical, petroleum, primary metals and machinery industries, I look at establishments that list as their principal activity the production of goods in ISIC groups 35-38 (see table 3).[15]

Table 4 lists some characteristics of what I will call the "productivity panel." Only establishments with more than five employees were included. Observations that were missing values for the necessary input and output variables were eliminated, as were observations with value-added per unit of labor and value-added per unit of capital more than three times the interquartile range beyond the first or third quartile. Since I examine the productivity records of establishments before and after control changes, I included only establishments in continuous operation. Establishments that close and reopen years later comprise less than 2% of the population. Establishments listed as providing auxiliary services had already been removed from the larger sample used in section 3. The result is an unbalanced panel of establishments in ISIC groups 35-38, including those that open or close during the period.

Table 4. Characteristics of the "Productivity Panel"

Item	
Cohorts	1974-1989
Number of Observations	33359
Number of Establishments	3851
Number of Establishments, 1974	1903
Foreign	97
Number of Establishments, 1980	2065
Foreign	136
Number of Establishments, 1989	2165
Foreign	180
Number of Foreign Acquisitions, 1975-89	
10% threshold	197
20% threshold	162
50% threshold	130

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[15] Klette (1991) uses data on establishments in ISIC group 38 from 1976-1985.

Tables 5a & b report summary information about the foreign and domestically-owned establishments in the panel, by two to three-digit ISIC for 1975 and 1989. Foreign-owned establishments are, on average, larger than their domestically-owned counterparts and, in most industries, more capital-intensive. The census distinguished between production and white-collar workers through 1982, so I use the early data to describe the mix of labor used by foreign and domestically-owned establishments. In this sample, foreign-owned establishments tend to use more white-collar labor, and tend to make higher payments to both labor classes.

Table 5a. Mean Size, Capital/Labor Ratios and Labor Mix in Domestic and Foreign-Owned Establishments, 1975

Industry	Value Added/ Establishment		Employees/ Establishment		Capital/[a] Employee	
	Dom.	For.	Dom.	For.	Dom.	For.
35	9164	23414	82	104	258	563
	(31236)	(50409)	(204)	(130)	(179)	(840)
36	5268	4898	49	62	220	298
	(13510)	(2772)	(88)	(43)	(173)	(61)
37	33021	91439	254	667	264	375
	(53165)	(95987)	(451)	(533)	(170)	(145)
381	3692	9023	45	104	139	200
	(6762)	(9839)	(75)	(99)	(97)	(85)
382	5943	9580	64	121	133	130
	(13994)	(9489)	(135)	(144)	(94)	(87)
383	7043	31713	81	295	115	151
	(17035)	(51495)	(154)	(454)	(111)	(87)
384	9478	2908	110	29	105	189
	(22913)	(3299)	(245)	(29)	(69)	(121)
385	1977	--	30	--	75	--
	(1794)		(28)		(57)	

Note: Table 5a continues on the next page.

	White Collar Compensation[b]		Production Compensation			Fraction of Prod. Workers		Number of Plants	
	Dom.	For.	Dom.	For.		Dom.	For.	Dom.	For.
35	61	72	46	52		.75	.64	258	30
	(16)	(19)	(13)	(13)		(.16)	(.16)		
36	58	64	48	46		.82	.79	199	4
	(21)	(13)	(9)	(5)		(.11)	(.11)		
37	70	73	52	56		.82	.78	76	10
	(11)	(11)	(8)	(4)		(.09)	(.06)		
381	60	68	48	52		.83	.76	481	12
	(20)	(17)	(10)	(17)		(.11)	(.11)		
382	61	66	53	55		.81	.80	308	18
	(18)	(13)	(11)	(10)		(.13)	(.15)		
383	64	69	47	47		.75	.69	134	23
	(15)	(11)	(10)	(9)		(.17)	(.19)		
384	62	62	51	51		.86	.87	381	4
	(18)	(2)	(10)	(4)		(.10)	(.11)		
385	62	--	49	--		.80	--	24	--
	(16)		(10)			(.13)			

Notes: Standard deviations in parentheses. Nominal values represent N.kr.1000.

[a] The fire insurance values used to construct the capital stock measure have been smoothed using a perpetual inventory method.

[b] Compensation is measured as total salary divided by the number of workers.

Table 5b. Mean Size and Capital/Labor Ratios in Domestic and Foreign-Owned Establishments, 1989

Industry	Value Added/ Establishment		Employees/ Establishment		Capital/ Employee		Number of Plants	
	Dom.	For.	Dom.	For.	Dom.	For.	Dom.	For.
35	21255 (66083)	56215 (123450)	63 (142)	92 (130)	1247 (1498)	2404 (2754)	255	38
36	9909 (19667)	28470 (33359)	32 (48)	82 (81)	1235 (1301)	1378 (861)	183	20
37	129362 (221743)	198364 (279226)	235 (283)	259 (296)	1909 (1199)	2261 (1135)	60	9
381	6045 (9845)	18251 (24088)	27 (41)	72 (88)	526 (435)	998 (1110)	593	30
382	20309 (54251)	19741 (27740)	76 0(206)	65 (83)	527 (406)	480 (398)	340	35
383	14006 (24290)	40015 (54827)	49 (70)	123 (173)	551 (554)	906 (996)	183	32
384	13509 (27074)	38951 (39727)	56 (101)	146 (151)	565 (508)	830 (465)	333	13
385	7442 (9360)	11279 (13140)	27 (30)	27 (22)	390 (331)	479 (106)	38	3

Notes: Standard deviations in parentheses. Nominal values represent 1000 N.kr.

Table 6 explores whether the fairly dramatic differences between foreign and domestically-owned establishments described in tables 5a & b are largely explained by industry and establishment size. That is, I investigate first whether multinationals tend to locate in those subsectors of the broad industry categories used above that are characterized by large plants, higher capital per worker and greater use of human capital. Then I investigate whether, controlling for industry, differences in capital per worker and use of human capital are explained by size differences.

The entries in table 6 were calculated by performing variants of the following regression:

$$\ln(\text{CHAR}) = \alpha + \beta(\text{FOWN10})$$

where CHAR is the value of the characteristic for the establishment, normalized by the median for its industry/year or industry/year/size class cell, and FOWN10 is the foreign

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ownership dummy variable, defined using the 10% threshold. The coefficient β, then, represents the percentage by which the foreign-owned establishment differs from its domestically-owned counterpart, and conventional t-statistics can be used to test the statistical significance of the differences.

Table 6. Are Differences Between Foreign and Domestically-Owned Establishments Explained by Industry and Size?

Characteristic	3-Digit ISIC/ Year Cells	5-Digit ISIC/ Year Cells	5-Digit ISIC/ Year/Size Class Cells
Value-Added	.793 ** (.029)	.586 ** (.028)	.202 ** (.016)
Employees	.663 ** (.026)	.499 ** (.025)	-.--
Capital/[a] Employee	.242 ** (.018)	.141 ** (.016)	.112 ** (.014)
White Collar[b] Wage (1974-82)	.107 ** (.008)	.090 ** (.008)	.075 ** (.007)
Production Wage (1974-82)	.056 ** (.007)	.053 ** (.006)	.047 ** (.006)
Fraction of Production Workers (1974-82)	-.067 ** (.007)	-.060 ** (.007)	-.040** (.007)
n	33359	33359	33359
n(1974-82)	18346	18346	18346

Note: Heteroskedasticity-corrected standard errors are in parentheses.
* Significant at the 5% level.
** Significant at the 1 % level.
[a]The fire insurance values used to construct the capital stock measure have been smoothed using a perpetual inventory method.
[b] Due to missing values, 16541 observations are used in the white collar wage regression, and 17971 in the production wage regression.

I present a sequence of results using successively finer cells. The first column of table 6 compares foreign-owned establishments with domestically-owned establishments in the same 3-digit ISIC group and year. There are large, significant differences in size, capital per worker, compensation per hour, and the mix of production and white collar labor. By controlling at the 5-digit ISIC level, the regressions shown in the second column restrict the comparisons to establishments engaged in more similar production. Although the differences

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between foreign and domestically-owned establishments diminish, as expected, establishments with foreign owners are still distinctly different. Even within 5-digit ISIC categories, foreign-owned establishments are more capital and human capital intensive. Finding that, foreign-owned establishments are still different after tightening industry categories suggests the intangible assets hypothesis; foreign-owned establishments seem not only to be clustered in particular niches but to be unique within their niches.

The final column of table 6 controls for the effect of firm size. This is an attempt to further tighten the comparison to establishments engaged in similar types of activities and to account for the likelihood that domestic owners control most young, small establishments that, because of their age, may be quite different from more mature establishments. I divide establishments into four different size categories: less than 50 employees, 50 to 99 employees, 100 to 149 employees, and more than 150 employees.[16] Again, although differences between foreign and domestic establishments diminish as the reference group is tightened, large differences remain; foreign-owned establishments have approximately 11% more capital per worker and pay production workers nearly 5% more, for instance.[17]

4.2. Comparing Productivity Performance

Sections 3.2 and 4.1 provide some tentative support for the intangible assets theory. Foreign ownership does tend to be concentrated in industries that rely on investments in R&D and marketing, and foreign-owned establishments appear to be unique even within fairly tightly-defined niches. In the remainder of the paper, I search establishments' productivity performance for confirmation that foreign-owned firms are reaping the rewards to intangible assets. In this section, I present the basic production function framework within which foreign and domestically-owned establishments are compared. In section 4.3, I investigate how the measurement of capital and intermediate input may affect the comparison and, in section 4.4, present the results.

Assume that all firms in an industry have technology that, at time t, can be described by the

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[16] Since size class is defined over the number of employees, I do not calculate the comparison of the number of employees per establishment in column 3 of table 6.

[17] I use the same method to compare growth rates of sales and inputs for foreign-owned and domestically-owned establishments and find no significant differences.

production function $Q_{it} = A_{it}F_t(X_{it})$, where Q_{it} represents the output of firm i, X_{it} represents a vector of inputs, F_t is the production function for all firms in the industry at time t, and A_{it} is the productivity term.

Recent advances in methods of estimating production functions allow me to compare productivity between foreign and domestically-owned firms without having to make restrictive assumptions about competition, returns to scale, and the functional form of the production function. I follow Klette (1993) closely; his model, which infers the marginal productivities of variable factors from the first-order conditions of an optimizing firm, also allows for differences in the quality of inputs used by different firms.

Klette describes how the production function can be expressed as logarithmic deviations from a reference point, using a version of the mean value theorem. This approximation allows me to avoid making restrictive assumptions about functional form and has the considerable advantage of being appropriate even when there are large differences in the values of outputs and inputs, as is usually true for cross-sectional comparisons between firms or establishments and as is true for my "productivity" panel. I follow Klette in choosing the industry/year median combination of inputs and output as reference point.

The production function expressed in terms of logarithmic deviations is:

$$\hat{q}_{it} = \hat{a}_{it} + \sum_j \bar{\alpha}_{it}^j \hat{x}_{it}^j, \qquad j = l, m, k \qquad (1)$$

where lower-case letters with hats represent logarithmic deviations from industry/year medians, the inputs j are identified as labor (l), intermediate inputs (m), and capital (k), and α_{it}^j is the jth input elasticity for firm i in period t.

The input elasticities are estimated by two methods. The first-order conditions from the profit-maximization problem of a firm that is a price-taker in input markets imply that the input elasticity for each factor can be approximated by the product of the ratio of price to

marginal cost (call this the markup) and the factor's share in total revenue.[18] Utilizing the first-order conditions yields:

$$\hat{q}_{it} = \hat{a}_{it} + \mu_{it} \sum_{j} \bar{s}_{it}^{j} \hat{x}_{it}^{j}, \quad j = l, m, k$$

(2)

where μ_{it} represents the markup and s_{it}^{j}, the cost share for input j.

At this point, one can estimate the products of markup and cost shares directly or introduce information about the cost shares, leaving only the markup to estimate. Using the cost share information requires the additional assumptions of profit-maximization and price-taking in input markets by firms, but it provides a method of introducing a degree of heterogeneity of technologies between establishments. Previous work with similar production data demonstrates that such heterogeneity is pervasive; the summary information presented in section 4.1 reveals important differences between the foreign and domestically-controlled establishments in my sample.[19] Allowing the elasticities to vary across establishments and time also allows for some differences in the quality of inputs used. However, introducing the cost share information may introduce additional measurement error.

The cost shares should be evaluated at an internal point between the reference point, the median input/output combination for that industry in year t, and the input/output combination for establishment i in year t. The bar above the s_{it}^{j} signifies that the cost share is evaluated at this internal point. I follow Klette in using, as an approximation, the average of the establishment's share and the median industry/time share.

I follow much of the literature in assuming that capital should be treated differently than labor and intermediate input because it is likely to be fixed in the short run. I estimate capital's share residually, first by imposing the assumption of constant returns to scale:

(3)

$$\hat{q}_{it} - \hat{k}_{it} = \hat{a}_{it} + \mu_{it} [\bar{s}_{it}^{l} (\hat{l}_{it} - \hat{k}_{it}) + \bar{s}_{it}^{m} (\hat{m}_{it} - \hat{k}_{it})].$$

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[18] See Hall (1990) or Klette (1993).

[19] Cf. Griliches and Mairesse (1991).

In addition, I relax the assumption of constant returns to scale by applying Klette's method of estimating markups and scale economies simultaneously:

$$\hat{q}_{it} - \hat{k}_{it} = \hat{a}_{it} + \mu_{it}[\bar{s}_{it}^l(\hat{l}_{it} - \hat{k}_{it}) + \bar{s}_{it}^m(\hat{m}_{it} - \hat{k}_{it})] + (\sigma_t - 1)\hat{k}_{it} \qquad (4)$$

where σ_{it} represents the elasticity of scale.

To estimate (4), I must impose restrictions on μ_{it} and σ_{it}. I assume the markup, or the elasticity, is common within each of the eight industry categories and that there is a single, common elasticity of scale. The variable definitions, in large part, rely on previous work with these data by Griliches and Ringstad (1971) and Klette (1993). Revenue is defined as gross production value, net of sales taxes and subsidies. The labor input is represented by the number of personhours. Since only blue collar personhours are reported prior to and including 1982, total personhours are estimated using the information on blue collar hours and information on total wage costs for white and blue collar workers. After 1982, only the total number of personhours is reported, and this is used to represent labor input.[20] Since I am concerned about how the definitions of capital services and intermediate input affect the comparison between foreign and domestically-owned firms, I discuss the two in detail in section 4.3.

The productivity term, a_{it}, is assumed to include foreign-ownership related factors that are represented by a variable that takes the value one if the equity share of the largest foreign owner is 10% or more, and zero otherwise. Unfortunately, there is good reason to expect that a_{it}, the disturbance of the production function, contains other components that are correlated with the regressors. Marschak and Andrews (1944) suggested that, because producers' knowledge of their relative productivities would be used in choosing input quantities, the use of ordinary least squares (OLS) would lead to "simultaneous equations bias." This problem is referred to as a "transmission bias" in the productivity literature, and will tend to bias estimates of input and scale elasticities upwards.

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[20] The labor variable is "quality-weighted", then, only through 1982, with the weight assigned to white-collar personhours equal to the establishment's average white-collar relative to average blue-collar wage.

The usual first response to the transmission problem, suggested by Mundlak and Hoch (1965), is to include a fixed firm effect. This also controls for omitted but fixed or slowly changing differences between firms that may bias the OLS estimates, an advantage in most cases. In my case, the advantage may be a disadvantage. Although foreign ownership is only one source of fixed differences between firms, employing the fixed effects eliminates all between-firm variation. After controlling for the fixed effects, identifying an effect of foreign ownership on the level of productivity relies on those few firms that change ownership status during the period.

There are other potential sources of bias. Approximating the cost shares, as was discussed above, and ordinary measurement errors introduce the possibility of "errors-in-variables" bias. Klette and Griliches (1992) show that using deflated sales or, equivalently, sales normalized by industry/year medians as proxies for output may introduce an additional source of bias. A firm-specific productivity advance may well cause a firm to lower price and expand output. If firms have some ability to set price, using normalized or deflated sales will underestimate the growth of output and hence underestimate the scale coefficient.[21] All of these problems will tend to bias the estimate of the scale coefficient downwards.[22]

I take the following approach to the problem of estimating the foreign ownership effect in the face of these potential pitfalls. First, I estimate the production function without fixed effects but with an attempt to control for several possible sources of fixed differences between firms or, in my case, establishments. I include dummies to control for the establishment's region, whether the establishment is the main, secondary, or sole facility of the firm, and whether the firm is organized as a corporation, partnership, single-owner firm, etc.

Second, I include the fixed effects dummies to explore how fruitful it is likely to be to implement some of the techniques that have been suggested to control for these sources of bias. After including fixed effects, one could proceed to instrumental variable estimation to control for "errors-in-variables" and "transmission" problems. In addition, Klette and

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[21] Klette (1993) also discusses this on pg. 35.

[22] The comparison between domestic and foreign-controlled establishments may also be affected by a selection bias. If foreign ownership or multiplant production allow more flexibility to close plants with inferior productivity, high productivity establishments may be overrepresented among foreign-owned establishments. Since early results of research on exit behavior by Klette and Mathiassen (1994, forthcoming) indicate that exit probabilities are not greater for foreign-owned establishments, I do not attempt to correct for this potential source of bias.

Griliches (1992) suggest reduced-form specifications to control for the problems involved with using deflated or normalized sales instead of output. Much econometric technique could be loaded on the problem; the question is whether the 197 establishments that change from domestic to foreign status can bear the weight of all the technique. In the fixed effects specification, two variables are included to capture a foreign ownership effect; the first takes the value one if the establishment has changed from domestic to foreign ownership status within the last one to three years and zero otherwise and, since organizational changes may take time to implement, the second takes the value one if the establishment changed to foreign status four or more years prior.

Finally, I adopt a pragmatic approach. I use the experience of Klette and others, with these and similar data, to specify a range of reasonable markups and scale coefficients. I then impose different assumptions on the production function and estimate foreign ownership effects under this range of assumptions.

4.3 Two Measurement Issues: Rented Capital and Transfer Pricing

Although constructing input variables by weighting and aggregating different types of labor, intermediate inputs and capital is typical in productivity research, I am concerned with two instances in which aggregating, or rather aggregating with potentially incorrect weights, may seriously bias the comparison between foreign and domestically-owned establishments. In this section I discuss the implications of the possibility that foreign and domestically-owned establishments may use rented and owned capital in different proportions, and of the possibility that foreign-owned establishments engage in "transfer pricing," the internal pricing of inputs or outputs transferred between the establishment and foreign affiliates at incorrect prices to lower reported profits and taxes. I can use the productivity framework to quantify the extent to which I have discounted rental capital. Although the problem of transfer pricing is conceptually the same, the data do not exist to allow me to quantify the premia or discounts attached to transferred inputs and outputs.

I construct an estimate of capital services that aggregates rental costs of capital and the fire insurance values of plant and equipment, weighted by depreciation rates and rates of return to

capital.[23] In particular, I use the following aggregation:

$$(5)$$

$$K_{it} = R_{it} + (0.07 + \delta^m) V_{it}^m + (0.07 + \delta^b) V_{it}^b$$

where R_{it} represents rental costs of buildings and machinery, δ^m (=0.06) and δ^b (=0.02) are depreciation rates for machinery and buildings obtained from the Norwegian National Accounts, and V_{it}^m and V_{it}^b are fire insurance values for machinery and buildings at the year's end. The rate of return to capital that I have assumed, 0.07, is the discount rate used for public investment in Norway and is within the range of estimates of the return to capital that are found in productivity studies. Although these assumptions are subject to debate, I discuss below how I explore their validity.

While using the cost share information and estimating capital's contribution residually allows the shadow price of capital to vary across establishments and time, the aggregation of the two types of capital may artificially fix weights. This may be a concern if foreign and domestically-owned establishments tend to use the two types of capital in different proportions or if, at the time of acquisition, establishments tend to shift from one type to another (perhaps merely for accounting reasons). Although the data do not reveal important differences between foreign and domestically-owned establishments in the choice of rented and owned capital, there are frequent changes at the time of acquisition.

To explore the importance of this issue, I include a variable in the production function to capture any "premium" (or discount) of rented over owned capital that was not captured in the capital aggregate.[24] To see this, represent the capital services aggregate as:

$$(6)$$

$$K_{it} = R_{it} + V_{it}$$

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[23] To reduce noise and avoid discarding the many observations that are missing values for fire insurance values, fire insurance values of plant and machinery have been smoothed using a perpetual inventory method. Since I am concerned that establishments that are acquired may, for accounting purposes, switch between owned and rented capital, I break the smoothing at the year of acquisition. This is only an issue for the few establishments that are acquired by foreign owners.

[24] This type of exploration was done by Griliches and Ringstad (1971), p.28.

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where R_{it} represents all rented capital and V_{it} all services from owned buildings and machinery. Assume the true weighting of the rented and owned components of capital services is:

$$K_{it}^* = (1+\eta)R_{it} + V_{it}$$

$$= K_{it} + \eta R_{it} \tag{7}$$

$$= K_{it}(1 + \eta(\frac{R_{it}}{K_{it}})).$$

Since the production function is in log deviations, the use of K_{it} instead of K_{it}^* implies that the deviation of $\ln(1 + \eta(R_{it}/K_{it})$ has been omitted from the specification, where η is the premium or discount associated with rented capital. This is potentially important here where the fraction of capital services that is rented may be correlated with ownership. Expressing (7) in log deviations and taking advantage of the fact that, since η is not likely to be large and R_{it}/K_{it} cannot be greater than 1, $\ln(1+\eta(R_{it}/K_{it}))$ can be approximated by $\eta(R_{it}/K_{it})$, yields:

$$\hat{k}_{it}^* = \hat{k}_{it} + \eta(\frac{\hat{R}_{it}}{K_{it}}). \tag{8}$$

This suggests including the deviation of R_{it}/K_{it} from its industry/year median in the production function to investigate the effect of the capital aggregation on the comparison between foreign and domestically-owned firms.

The intermediate input variable is also an aggregate, with prices as weights. Some intermediate inputs, including management or marketing services, may be produced within the firm but outside of the establishment. In the case of foreign-owned establishments, some inputs may be produced by parents or affiliates outside of Norway. If these inputs are priced correctly in the data, the location of production is irrelevant. The census values inputs produced outside of the establishment but within Norway at cost. Establishments are asked to value management and other inputs obtained from a foreign parent or affiliate at market prices.[25] Similarly, output sold to foreign affiliates is to be valued at market prices.

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[25] Communication with J. Stensrud, Section for Industry and Trade Statistics, Statistics Norway.

If establishments find it easier to report internal accounting prices than to estimate market prices, and if transfer prices differ systematically from market prices, my foreign ownership comparisons will be affected. A foreign-owned establishment may appear less productive than it actually is if transfer prices are manipulated to avoid Norwegian taxes. An establishment may appear more productive than it is if transfer prices are used by a parent in a higher tax country, say, to reduce taxable income at home by shifting income to Norway. If shipments to and from foreign affiliates were recorded separately in the census, this issue could be approached in the same way as the issue of aggregating rented and owned capital; one could use the information to estimate the missing premia or discounts on transferred inputs or outputs. Unfortunately, the Norwegian manufacturing census distinguishes only shipments to and from domestic affiliates, so I am unable to control in this way for the transfer pricing problem. There were, however, large shifts in the relation between the Norwegian and the OECD average corporate tax rates over the period which may help to detect whether significant manipulation of transfer prices has occurred. In the 1970s, the Norwegian corporate tax rate was significantly lower than the OECD average. By 1985, however, it had risen to more than two times the OECD average and remained relatively high through the decade.[26] Although for now I simply split the sample to look for differences in results between 1974-82 and 1983-89, this is clearly an area in which I plan further exploration.

4.4 A Foreign Ownership Effect on Productivity?

Table 7 presents the results of two sets of estimates of the productivity equation without fixed effects. In the regressions presented in the top panel, elasticities are estimated directly, without the use of cost share information; in the bottom panel, cost share information is incorporated. In each panel, I present a sequence of regressions intended to successively relax assumptions and test the input definitions. Separate labor and intermediate input elasticities, or markups, are estimated for each of the eight ISIC industries. All variables are measured as deviations from industry/year medians and dummy variables are included to control for regional differences in productivity, differences related to the legal organization of the firm (corporation, single owner, etc.), and differences related to the establishment's

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[26] Bachtler et al. (1991) report that while in 1975 the Norwegian corporate tax rate was 38 percent of the OECD average, by 1985 it had risen to 2.1 times the average. It remained high throughout the 1980s, falling sharply in recent years. Of course, the relation of the Norwegian to the OECD average corporate tax rate provides only a partial picture of firms' incentives to manipulate transfer prices.

position in the firm (sole, main, or secondary facility). All regressions are estimated using ordinary least squares.

Although the basic message of table 7 is that foreign-owned establishments appear to have a productivity advantage of approximately 1.5 to 2.5 percent over their domestic counterparts, foreign-owned establishments are also larger than domestically-owned establishments, and the relation between size, ownership and productivity is yet to be unraveled. The estimated productivity advantage of foreign-owned establishments survives different specifications, is unaffected by the definition of the capital variable, and holds for a subset of larger establishments. It also survives a large shift in Norway's corporate tax rate relative to the OECD average that should represent a large shift in incentives to manipulate transfer prices to reduce taxes. However, the magnitude of the estimated "foreign-ownership effect" depends critically on the estimate of the scale elasticity, an issue to which I return below.

Table 7. Estimates of Prodution Function Without Fixed Effects

	(1) CRS	(2) Relax CRS	(3) Test K Mix	(4) >=50 Employees	(5) 1974-82	(6) 1983-89
Estimated Elasticities[a]						
scale		-.007 **	-.005 **	-.006 *	-.006 **	-.002
		(.001)	(.001)	(.003)	(.002)	(.002)
fraction of			.099 **	.108 **	.099 **	.093 **
capital rented			(.006)	(.012)	(.008)	(.009)
fown10	.013 **	.016 **	.015 **	.015 *	.011	.015 *
	(.005)	(.005)	(.005)	(.007)	(.007)	(.007)
n	33352	33352	33352	9850	18343	15009
R^2	.900	.900	.901	.912	.902	.905
RMSE	.204	.204	.203	.187	.201	.200
Cost-Share Specification						
μ_{35}	1.12 **	1.12 **	1.12 **	1.15 **	1.11 **	1.12 **
	(.005)	(.005)	(.005)	(.011)	(.007)	(.009)
μ_{36}	1.04 **	1.04 **	1.05 **	1.12 **	1.06 **	1.03 **
	(.046)	(.047)	(.048)	(.012)	(.066)	(.068)
μ_{37}	1.10 **	1.11 **	1.10 **	1.11 **	1.11 **	1.10 **
	(.010)	(.010)	(.010)	(.015)	(.013)	(.015)
μ_{381}	1.08 **	1.09 **	1.08 **	1.08 **	1.08 **	1.09 **
	(.006)	(.006)	(.006)	(.008)	(.011)	(.005)
μ_{382}	1.07 **	1.07 **	1.07 **	1.09 **	1.07 **	1.06 **
	(.005)	(.005)	(.005)	(.009)	(.006)	(.008)
μ_{383}	1.06 **	1.06 **	1.06 **	1.07 **	1.05 **	1.06 **
	(.007)	(.007)	(.007)	(.014)	(.011)	(.009)
μ_{384}	1.04 **	1.05 **	1.04 **	1.04 **	1.05 **	1.04 **
	(.003)	(.004)	(.003)	(.005)	(.005)	(.005)
μ_{385}	1.04 **	1.05 **	1.04 **	1.12 **	1.08 **	.987 **
	(.028)	(.028)	(.027)	(.026)	(.024)	(.051)
scale		.004 **	.005 **	.020 **	.001	.010 **
		(.001)	(.001)	(.002)	(.002)	(.002)
fraction of			.079 **	.105 **	.078 **	.078 **
capital rented			(.005)	(.010)	(.008)	(.007)
fown10	.023 **	.021 **	.020 **	.028 **	.024 **	.015 **
	(.004)	(.004)	(.004)	(.005)	(.006)	(.006)
n	33352	33352	33352	9850	18343	15009
R^2	.927	.927	.928	.935	.927	.930
RMSE	.175	.174	.174	.160	.174	.172

Note: Heteroskedasticity-corrected standard errors in parentheses.
* Significant at the 5% level.
** Significant at the 1% level.
a. The estimates of the elasticities are omitted to simplify the presentation, as are the parameter estimates for the control variables. Dummy variables control for establishment's region, position within firm, and the legal organization of the firm.

First, consider the results in the top panel. In column 1, the assumption of constant returns to scale is imposed. The foreign ownership effect is significant and indicates that foreign-owned establishments are approximately 1.3% more productive than their domestically-owned counterparts. When the constant returns to scale assumption is relaxed, shown in column 2, I find slight diseconomies of scale. Since foreign establishments tend to be larger than their domestic counterparts, the foreign ownership effect increases slightly. Column 3 reveals that although rented capital is considerably undervalued in the aggregation I use, the use of incorrect weights does not significantly affect the estimate of the foreign ownership effect.[27] Column 4 examines the effect of excluding small establishments, which are more likely to be young and to be domestically-owned. This restriction, as well, has little effect. I return to the discusssion of columns 5 and 6 below.

Introducing the cost share information, shown in the bottom panel of table 7, improves the fit of the production functions. The ability to allow for differences in technology and in input quality, the advantage of the cost share approach, almost doubles the foreign ownership effect. I find that foreign-owned establishments have a productivity advantage of more than 2% over their domestic counterparts.[28] In this case, relaxing the constant returns to scale assumption yields slight economies of scale. This, in turn, causes the foreign ownership effect to decline slightly. This response and the response to relaxing the assumption of constant returns to scale in the estimated coefficient regression in the top panel highlight that, all else equal, when the estimated magnitude of the scale elasticity increases, the foreign ownership decreases, and vice versa.

Column 3 of the bottom panel reveals, again, that aggregating owned and rental capital has little effect on the estimate of the foreign ownership effect. In column 4, removing small establishments causes the scale parameter, markups and foreign ownership effect to increase. The finding of greater scale economies for the larger establishments is, admittedly, strange; it

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[27] The coefficient of the capital mix variable estimates the product of the elasticity of capital and η, the omitted premium on rented capital from (8) on pg.25. For illustration, assume the elasticity of capital equals .15 (this is consistent with findings from other productivity studies); given this, the capital mix parameter estimates of .08 to .10 imply that η ranges from .53 to .67. These results indicate either that rental capital is internally priced by firms at a significant discount or that the rate of return to owned capital is much less than I assumed in my aggregation.

[28] For perspective, consider that Holmøy et al. (1993) estimated that, from 1971-1990, annual total factor productivity growth in export-oriented Norwegian manufacturing was 1.9% and, in import-competing manufacturing, was 1.2%. Foreign-owned establishments have, roughly, better than a year's advantage over domestically-owned establishments.

is, however, confirmed by similar results in Klette (1993).[29] The increase in the foreign ownership effect is also surprising; if anything, I expected the foreign ownership effect to shrink when the comparison was restricted to larger, more similar establishments.

Columns 5 and 6 contain the results of splitting the sample into two periods, 1974-82 and 1983-1989, to examine the stability of the estimated coefficients over time. There are at least two important differences between the periods to consider: one involving the corporate tax rate and foreign firms' incentives to use transfer prices to shift profits out of Norway, and the other in the definition of the labor variable. Since the corporate tax rate in Norway relative to the OECD average increased dramatically between the 1970s and the 1980s, incentives to shift profits out of Norway by manipulating transfer prices should have increased from the earlier to the later period. If firms do manipulate transfer prices, and all else equal, this should show up as a decline in the productivity advantage of foreign-owned establishments from the early to the late period.

The other change to consider is in the definition of the labor variable. Through 1982, labor is to some extent "quality-weighted", since white-collar labor is assigned a weight equal to its average wage relative to the blue-collar average. From 1983, labor is simply the unweighted sum of blue and white-collar personhours. Since foreign-owned establishments tend to use a larger proportion of white-collar labor than their domestic counterparts, the underestimate of labor input in the later period is more severe for the foreign-owned establishments. They should, as a result, appear relatively more productive. This problem is ameliorated in the cost share formulation, since the labor elasticity of foreign-owned establishments will reflect their greater expenditure on labor quality.

The regressions shown in columns 5 and 6 of the upper panel do not incorporate the cost share information. In this case, the foreign ownership effect increases, if anything, from the earlier to the later period. This may be due to the change in the definition of the labor variable. The regressions shown in columns 5 and 6 of the lower panel do use the cost share information, and indicate either a decline in the foreign ownership effect on productivity, or an increase in the transfer of profits from Norway to foreign affiliates in response to the increase in relative corporate tax rates from the 1970s to the 1980s. Note that a significant

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[29] Cf. Klette, op.cit., p.32.

foreign ownership effect is still evident in the later period - the foreign ownership effect survives an apparently large increase in incentives to transfer profits out of Norway.

Although the results of table 7 seem to provide strong evidence of a foreign ownership effect on productivity, it is clear that the accuracy of the estimate of the foreign ownership effect relies on the accuracy of the estimated elasticities and scale parameters. "Transmission," a potential source of upward bias in the estimates of input and scale elasticities, could bias the foreign ownership effect on productivity downwards. "Errors-in-variables" problems could bias estimates of input and scale elasticities downwards and the foreign ownership effect upwards.[30] As was discussed in section 4.2, the first remedy for the transmission problem (but not the errors-in-variables problem) is to turn to a fixed effects specification; I present the fixed effects results in table 9.

Before turning to the fixed effects results, I examine the productivity and size of those establishments acquired by foreign owners during the period. Table 8 reports the results of a probit regression of foreign acquisition on establishment size and relative productivity, as well as industry, year, region and type.[31] I estimate the following regression:

$$FACQ10_t = f(PROD_{t-2}, EMP_{t-2}, PROD_{t-2}^2, EMP_{t-2}^2, YR, I, REG, TYPE)$$

where $FACQ10_t$ is a dummy variable taking the value one if the establishment is acquired by foreign owners (defined using the 10% threshold) during period t and zero if not. $PROD_{t-2}$ is the productivity residual from a cost share production function regression like that described in column (2) of table 7, but without the foreign ownership term and control variables. It is lagged two years to represent the establishment's performance before entering the transition period around the acquisition.

EMP_{t-2} is the number of employees, included to represent size, and again lagged two periods. Squared values of the productivity and size variables are included to explore the possibility

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[30] Cf. Griliches (1986), pp.1476-85. Griliches (p.1480) points out that the errors-in-variables problem is likely to be more serious in the fixed effects specification, since eliminating much of the variance of the explanatory variables magnifies the noise-to-signal ratio.

[31] I compared the size, capital intensity and labor mix of foreign-acquired establishments relative to foreign-owned establishments, using the method that was used for table 6. Differences were not significant at conventional significance levels; if anything, though, acquired establishments are somewhat larger, and make less intensive use of physical and human capital, than foreign-owned establishments.

of nonlinear relationships. "YR" represents the set of time dummies, "I" the set of industry dummies, "REG" the set of dummies describing the region of Norway, and "TYPE" the set of dummies indicating whether the establishment is the main, secondary or sole facility of the firm.

The probit results indicate that an establishment's relative productivity is not a significant determinant of the probability of being acquired. I conducted a likelihood ratio test of the hypothesis that the coefficients of both productivity variables equal zero. The results are shown at the bottom of table 8a; the null hypothesis clearly cannot be rejected.[32] This is useful information. Since establishments acquired by foreigners are of average productivity, I can look for a foreign ownership effect by looking for foreign-owned establishments' deviation from average after acquisition. If we can convince ourselves that foreign-owned establishments are more productive than domestically-owned establishments, the results also imply that foreign owners are actually adding productivity-enhancing skills or technology and not simply acquiring more productive establishments.

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[32] Under the null hypothesis, the test statistic $-2(L_1-L_0)$, where L_1 is the log likelihood value from the model estimated under the constraint that the coefficients of the productivity variables equal 0, and L_0 is the log likelihood value from the unconstrained model, has a $\chi^2_{(K-1)}$ distribution.

Table 8a. Probit Results: Are More Productive
Establishments Acquired by Foreigners?

Variable	
PROD$_{-2}$	-.046
	(.177)
EMP$_{-2}$	.003 **
	(.000)
PROD$_{-2}^2$	.076
	(.466)
EMP$_{-2}^2$	-2.53e-06 **
	(6.18e-07)
1977	.439 **
	(.164)
1978	.293
	(.171)
1979	.175
	(.179)
1980	-.010
	(.196)
1981	.088
	(.186)
1982	.277
	(.172)
1983	.089
	(.186)
1984	.347 *
	(.169)
1985	.047
	(.192)
1986	.308
	(.171)
1987	.303
	(.172)
1988	.275
	(.174)
1989	.514 **
	(.162)
ISIC35	-.157
	(.231)
ISIC36	-.074
	(.235)
ISIC37	-.278
	(.260)
ISIC381	-.171
	(.228)
ISIC382	-.112
	(.229)
ISIC383	-.239
	(.241)
ISIC384	-.406
	(.239)
n	25206
Pseudo-R^2	.0574

Likelihood Ratio Test for Significance
of Productivity Variables
$\chi^2(2) = 0.09$
Prob $> \chi^2 = 0.9540$

Notes: The dummies for 1976 and ISIC385 are omitted.
Data for 1974 and 1975 are used for the lagged series.
Dummy variables (not shown) also control for region and
type of establishment.

Table 8b. Illustrative Foreign Acquistion Probabilities

Size Quantile (Number of Employees in parentheses)	Probability of Foreign Acquisition
Main Establishment of firm, in ISIC 383, located in Oslo, in 1980	
5 percent (7)	.004
10 percent (9)	.004
25 percent (13)	.004
50 percent (26)	.004
75 percent (67)	.005
90 percent (166)	.009
95 percent (326)	.015
99 percent (921)	.006
...in 1989	
50 percent (26)	.017

33

The probit results indicate that an establishment's relative productivity is not a significant determinant of the probability of being acquired. I conducted a likelihood ratio test of the hypothesis that the coefficients of both productivity variables equal zero. The results are shown at the bottom of table 8a; the null hypothesis clearly cannot be rejected. This is useful information. Since establishments acquired by foreigners are of average productivity, I can look for a foreign ownership effect by looking for foreign-owned establishments' deviation from average after acquisition. If we can convince ourselves that foreign-owned establishments are more productive than domestically-owned establishments, the results also imply that foreign owners are actually adding productivity-enhancing skills or technology and not simply acquiring more productive establishments.

The probability of acquisition increases with size to a point and then declines. To illustrate the relationship between size and acquisition probability, table 8b. converts the probit coefficients for the example case of a main facility of a multiplant firm, which is located in Oslo and operating at an average level of productivity (relative to the entire sample) in the electrical equipment industry in 1980.[33]

Table 9 contains estimates of the production function using the fixed effects specification. Control variables used in the production function regressions of table 7 are omitted; regional and other differences in productivity are assumed to be captured by the fixed establishment effect. The variable "acq13" is assigned a one if the establishment has been acquired by foreign owners within the last one to three years; "acq4on" is assigned a one if the establishment was acquired four or more years prior.

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[33] The estimated coefficients for the control variables not shown in table 8a are interesting even if somewhat tangential to the goals of this paper. If, for instance, the 26-person establishment that has a 0.4% probability in any year of being acquired by foreign owners were in mid to North Norway (Trondheim and north) instead of in Oslo, that probability would fall to 0.1%. If the 26-person establishment in Oslo were the sole instead of the main establishment in the firm, the acquisition probability would be 0.3%.

Table 9. Estimates of Production Function With Fixed Effects

	(1) CRS	(2) Relax CRS	(3) Capital Mix
Estimated Elasticities[a]			
scale		-.034 **	-.035 **
		(.004)	(.004)
fraction of			.080 **
capital rented			(.007)
acq13	-.008	-.010	-.011
	(.009)	(.009)	(.009)
acq4on	-.016	-.019	-.017
	(.011)	(.011)	(.011)
n	33352	33352	33352
R^2	.950	.950	.950
RMSE	.154	.154	.153
$F(2,df)^b$	1.13	1.65	1.38
	(29485)	(29484)	(29483)
p-value	0.324	0.193	0.253
Cost Share Specification			
μ_{35}	1.07 **	1.06 **	1.06 **
	(.007)	(.008)	(.009)
μ^{36}	1.01 **	.989 **	.995 **
	(.048)	(.050)	(.051)
μ_{37}	1.12 **	1.11 **	1.11 **
	(.012)	(.013)	(.013)
μ_{381}	1.06 **	1.05 **	1.05 **
	(.010)	(.011)	(.011)
μ_{382}	1.03 **	1.02 **	1.02 **
	(.008)	(.009)	(.009)
μ_{383}	1.08 **	1.07 **	1.07 **
	(.008)	(.009)	(.009)
μ_{384}	1.05 **	1.04 **	1.04 **
	(.005)	(.006)	(.006)
μ_{385}	1.00 **	.985 **	.980 **
	(.023)	(.023)	(.023)
scale		-.023 **	-.024 **
		(.006)	(.005)
fraction of			.058 **
capital rented			(.007)
acq13	-.003	-.005	-.005
	(.008)	(.008)	(.008)
acq4on	-.003	-.005	-.003
	(.010)	(.010)	(.010)
n	33352	33352	33352
R^2	.960	.960	.960
RMSE	.137	.137	.137
$F(2,df)^b$	0.08	0.19	0.19
	(29493)	(29492)	(29491)
p-value	0.919	0.825	0.827

Heteroskedasticity-corrected standard errors in parentheses.
* Significant at the 5% level.
** Significant at the 1% level.
[a] The estimates of the elasticities are omitted to simplify the presentation.
[b] Degrees of freedom in parentheses.

In all cases, the coefficients of the foreign ownership variables are negative, small and insignificant.[34] The fixed effects results lend no support to the hypothesis that foreign acquisition improves productivity. The F-tests listed below each of the regressions in table 9 refer to a test of the joint hypothesis that the coefficients of "acq13" and "acq4on" equal zero. None the tests support a rejection of the null hypothesis. There are, however, only 197 foreign acquisitions during the sample period, too few, perhaps, to be confident that this represents evidence against the intangible asset hypothesis. The limited number of establishments changing status during the period make it questionable that adding more complicated estimation techniques to control for various sources of bias would yield greater insights.

The estimated magnitudes of markups and scale coefficients that emerge from the fixed effects specification are lower than from the specification without fixed effects. If transmission were the only concern, this would imply that the estimates of the foreign ownership effect in table 7 are too low. But transmission is not the only concern, and the errors-in-variables bias is likely to be more severe in the fixed effects formulation. So comparing fixed effects with total regressions does not help determine the direction in which the foreign ownership coefficients of table 7 are biased.

One way to proceed is to make use of the experience of Klette and others to specify a range of reasonable assumptions about markups and scale elasticity, impose these different assumptions on the data, and map out a range of estimates of the foreign ownership effect. The results of such an exercise are presented in matrix form in table 10. I make two assumptions about competition. First, in column 1, I assume the price/marginal cost ratio equals one. Second, in column 2, I assume that the price/marginal cost ratio equals 1.20. This is at the high end of the estimates of the markup that I have obtained, and that have been obtained in extensive work with these data by Klette.

I make three assumptions about the elasticity of scale. First, in the top row of table 10, I assume that there are quite large diseconomies of scale, that the deviation from constant returns to scale equals -.10. This is at the low end of the range of estimates found by Klette (1993). In the middle row, I assume constant returns to scale, and in the bottom row, I

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[34] I split the sample into early and late periods to perform the fixed effects regressions as well. Doing so yielded no interesting differences.

assume that the deviation from constant returns to scale equals +.10. Klette and Griliches (1992) find such estimates of the scale elasticity from reduced forms that correct for the use of deflated sales instead of output. In each cell, I present only the estimate and (heteroskedasticity-corrected) standard errors of the foreign ownership coefficient from regressions that differ from the cost share regressions of table 7 only in that the assumptions about competition and scale have been imposed.

Table 10. Estimates of the Foreign Ownership Effect under Various Assumptions about Competition and Economies of Scale

Markup	$\mu=1$	$\mu=1.20$
Scale Coefficient		
$\sigma=.90$	.073 **	.072 **
$(\sigma-1)=-.10$	(.005)	(.006)
CRS	.023 **	.022 **
$\sigma=1$	(.004)	(.004)
$\sigma=1.10$	-.027 **	-.028 **
$(\sigma-1)=.10$	(.005)	(.005)

This table presents only the estimates and (heteroskedasticity-corrected) standard errors for the foreign ownership coefficient from 6 cost-share regressions like those presented in table 7.

When I impose constant returns to scale and perfect competition, the foreign ownership effect is around 2%, similar to the results of table 7 (in which estimates of scale elasticities do not deviate much from constant returns to scale.) Moving towards diseconomies of scale causes the foreign ownership to increase dramatically. Moving towards economies of scale quickly causes the foreign ownership effect to shrink and become negative.

Table 10 highlights the hazard of imposing constant returns to scale on the data to estimate the foreign ownership effect. Assuming constant returns to scale when, for instance, there are economies of scale, could lead to a false conclusion that foreign ownership provides a productivity advantage. Within the range of estimates of the scale elasticity that emerge from the literature, the foreign ownership effect takes a wide range of values.

5. Conclusions and Extensions

My results suggest caution in interpreting foreign-owned establishments' productivity advantage. Although I find that foreign-owned establishments are larger and more productive than their domestically-owned counterparts, the relationships between size, foreign ownership and productivity have not yet been unraveled. Until this is done, it is not convincing to argue that the productivity difference is evidence that foreign owners are motivated by the returns they reap from applying their intangible assets in Norway.

Over all, I find only mixed support for the intangible asset hypothesis. It does appear that foreign-owned establishments are unique even within tightly-defined industries. The probit analysis indicates that those establishments acquired by foreigners are of average productivity. If combined with convincing evidence that foreign-owned establishments were more productive, this could help strengthen the case for the intangible asset hypothesis. The fixed effects results do not suggest any productivity improvement as a result of foreign acquisition, but the number of establishments involved in a foreign acquisition during my sample period is small. Lengthening the time series as new cohorts of data become available will make the fixed effects regressions more informative.

The paper yields some practical guidance for future research. Adding the cost share information, and thereby allowing technology and input quality to vary across firms, increases the estimate of the foreign ownership effect. Aggregating owned with rented capital has little effect on the estimate of the foreign ownership effect. Although the foreign ownership effect appears to survive large shifts in incentives to manipulate transfer prices to shift profits out of Norway, this is clearly an area that requires additional investigation.

Statistics Norway collects and compiles other information that could shed light on the intangible assets hypothesis and, in particular, on the foreign ownership effect on productivity. Firm-level information on R&D exits from 1975, and firm-level information on advertising expenditures exists from 1986. Although these data measure only intangible asset investments within Norway and not investments by foreign parents and affiliates, incorporating information on intangible assets investments would control for some sources of productivity differences that I have not explained and further refine the estimates of the

foreign ownership effect. Comparing the expenditures on R&D and other intangibles made within Norway by similar domestic and foreign-owned enterprises would be interesting in its own right, since foreign owners are often charged with shifting such activities out of host countries.

The intangible assets theory leads one to expect that establishments owned by other Scandinavians will behave more like domestically-owned establishments than other foreign-owned establishments. Since languages are similar, distances not great, and legal/regulatory frameworks similar, the costs of entering the Norwegian market are not as great for these firms. To the extent that tax rates are more similar within Scandinavia than between Scandinavian and other countries, Scandinavian parent firms face less incentive to shift profits through the manipulation of transfer prices. Although the data do not identify the nationality of the single largest foreign owner, they do distribute total foreign equity holdings by nationality, so differences in the behavior of Scandinavian-owned and other foreign-owned establishments would be a fairly simple, and interesting, extension to explore.

Appendix A: Statistics on Foreign Ownership of Equity in Norwegian Enterprises - Statistics Norway's "SIFON-registers"

Since 1919, Statistics Norway has conducted an annual survey of all Norwegian enterprises or individuals known to hold foreign assets or liabilities. One of the outputs of this survey, the "SIFON-register", which was initiated in 1972, is a unique and relatively unexplored record of foreign ownership of equity in Norwegian enterprises. In principle, all Norwegian enterprises with foreign equityholders are surveyed. Although in practice some small enterprises with low levels of foreign ownership may be missed, these enterprises account for negligible amounts of employment or sales.[35] The register records only direct foreign ownership. If, for example, an enterprise is owned wholly or in part by a Norwegian subsidiary of a foreign firm, the "indirect", or once-removed, relationship between the enterprise and its foreign owners will not appear in the register. A recently introduced system offers the opportunity of recording indirect ownership relations from the 1990 cohort onward, but this opportunity has not yet been exploited.

The register identifies enterprises by a code that enables the data to be matched to manufacturing, accounting, and other information collected by Statistics Norway. It contains information on the total book value of equity in the enterprise at year's end and the percent of that equity held by the single largest foreign shareholder. It also lists the total value of equity held by foreigners, and distributes that value into 24 different nationality groups.[36,37]

When the survey indicates that foreign ownership of equity in the enterprise has changed, the register is updated, and the outdated record is saved in a historical file. Thus, although the register is not organized as a panel, one can construct a panel of observations for each enterprise in each year from the register's history. The file also identifies whether enterprises that disappear from the "SIFON-register" have been dissolved, merged, or no longer have significant foreign ownership.

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[35] Communication with Leiv Ryalen, Section for Finance and Credit Market Statistics, Statistics Norway, March 14, 1994. Increases in the coverage of the survey occurred from 1975-1977 and 1985-87. Currently, enterprises which have book value of equity greater than or equal to 50000 NOK are certainly covered, and many smaller enterprises are also covered.

[36] The information on total value of equity held by foreigners is the source of a foreign ownership variable reported in the manufacturing statistics. The variable takes the value 1 if the foreign ownership share equals or exceeds 50%,2 if the foreign ownership share equals or exceeds 20% but is less than 50%, and 0 if foreign ownership is less than 20%.

[37] From 1990, the "SIFON-register" also includes the market value of equity.

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