MULTINATIONALITY, DIVERSIFICATION AND FIRM SIZE
AN EMPIRICAL ANALYSIS OF EUROPE'S LEADING FIRMS

by

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Abstract

Conventional explanations of diversification and multinationality both point to size/growth related motives and firm-specific intangible assets as the driving forces. However, previous empirical studies have rarely exploited this commonality by investigating multinationality and diversification jointly. Using a database of leading EU firms, we devise a typology of firm structures which distinguishes diversification at home and abroad. This provides the framework for a sequential probit model which focuses on the roles of firm size and product differentiation. Our results suggest that multinationality and diversification are complementary in the presence of product differentiation, indicating that specific assets are a public good within the firm. In other cases, size factors are more dominant: multinationality increases with the firm's *absolute size* in its home country (presumably because production abroad becomes more profitable relative to exporting); however, diversification also increases more with *market share* (perhaps as a means of escaping constraints on further growth). In these circumstances, multinationality may become a substitute for diversification, since the latter is no longer the only route to growth; but the reverse is not true, since diversification does not affect the relative profitability of foreign production.

JEL Classification: L1, L2.

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1. Introduction

Prevailing explanations of firm diversification and multinationality display striking similarities, both pointing to intangible firm-specific assets and constraints on growth in the firm's primary/home market as major causal factors. Yet, in spite of this commonality, the empirical literatures have remained largely independent. The present paper attempts to rectify this by examining these two dimensions of corporate structure simultaneously for a sample of leading firms in the European Union. The central idea is that, by distinguishing between a firms' foreign production in its primary and secondary, industries, we gain additional insights into the motives for multinationality, (and, equivalently, diversification). This opens up a series of questions, and we focus here on three: "Are diversification and multinationality substitute, or complementary strategies?"; "Do the typical empirical findings, that larger firms are more diversified and more multinational, derive from underlying causal forces, or are they merely the result of arithmetic identity-type relationships?"; and, more tentatively, "Is there a "typical" time path for corporate structure as firms grow?"

Section 2 briefly summarises the existing literature. Section 3 describes the database, and presents some descriptive facts on the sample relationships between aggregate firm size, multinationality and diversification. Section 4 shows that these aggregate descriptive statistics are a blunt tool for extracting underlying causal influences, and that disaggregation is necessary. As an alternative, section 5 introduces a typology of firm structure which distinguishes diversification abroad from diversification at home (i.e. separating multinationality in primary and secondary industries). Building on this, section 6 introduces a sequential probit model and tests it against the database. Section 7 concludes.

2. Brief review of the literature

The conventional literatures on why firms choose to be multinational or diversified are sufficiently well known as to require only a brief rehearsal here[1]. The multinational firm is often viewed as having some special advantage which is

[1] Two recent survey papers in the *Journal of Economic Perspectives* provide succinct summaries (Markusen, 1995, on multinationality, and Montgomery, 1994, on diversification).

commonly associated with product differentiation and/or technological know-how; and because of high transactions and agency costs, this is often best exploited in foreign markets by local production rather than by exporting or licensing (e.g. Dunning, 1981; Caves, 1996). Another recurring theme in the literature concerns the relative magnitudes of fixed and marginal costs when using different modes to serve a foreign market: at larger scales of output, multinationality is more profitable than exporting, as the gains from reduced transport costs and tariff jumping outweigh the fixed costs of setting up the foreign plant (e.g. Smith, 1987). Robust empirical support for these hypotheses is offered by positive correlations and regression coefficients between multinationality and firm size advertising and R&D expenditures (see Caves, pp. 7-13, for example). Very similar themes are evident in the diversification literature: technological spillovers and exploitation of brand names and advertising goodwill in adjacent industries are cited as major reasons for the multimarket firm (e.g. Scott, 1993). The role of firm size is even more firmly entrenched in this literature (originating from Penrose, 1959), although the emphasis is more on diversification as a means for managers to pursue growth objectives when faced with constraints in their primary industry.

Of course, it is unsurprising that the two literatures are parallel, since multinational operations may be seen merely as geographical diversification. What is more interesting is whether a *joint* analysis offers additional insights. Perhaps most obviously, if both diversification and multinationality are driven by the same intangible asset story, why are some firms multinational without being diversified, and vice-versa? (Is the asset a ”public good” within the firm, or is it in finite supply?). Why do some firms diversify (go multinational) only in their country of origin (core industry), while others are also diversified (multinational) in other countries (industries)? Similarly, if multinationality and diversification are both strategies for escaping constraints to growth, are they typically pursued simultaneously or sequentially, and, if the latter, is there a "typical" sequence?

Very few previous studies have considered questions such as these. Indeed, formal theoretical modelling of the coincidence of multinationality and diversification seems to have been almost non-existent in the literature. However, there is a handful of

empirical studies; and Caves (1996, pp. 21-2 and 59-60) summarises accurately as follows:

"Several authors investigated the relation between product-market diversification and foreign investment... The results are somewhat diverse and reflect differences in samples and measuring methods, but they are consistent with (a) short-run trade-off...Other studies that compare product-market and geographic (international) diversification levels achieved by firms of varying sizes and maturities usually find positive correlations: given time and resources, a firm can exploit opportunities for diversifying in both directions, and the sorts of proprietary assets that support foreign investment are the same ones associated with "related" diversification."

Broadly speaking then, multinationality and diversification are often found to be substitutes in the short-run, but not in the long-run. However, a number of these studies, especially those based on cross-section analysis of broad samples of firms, raise certain methodological worries. Pearce (1993) is particularly pertinent for our purposes: not only is his the most recent study of which we are aware, but also he employs a database quite similar to our own[2]. His central conclusions are:

"diversification and internationalisation occur together, in a manner that may often imply a direct causal relationship which is only effectively opposed by resource constraints at relatively high levels." (ibid. p.147)

and

"The results for tests of firm size as an independent variable...indicate that of the two broad routes to growth...it is geographical diversification...that is relatively more prevalent than industrial diversification." (ibid., p.150).

These comments are based on cross-firm OLS in which (i) a multinationality index is found to be a significantly positive determinant of a diversification index, and (ii) firm size is used as an explanatory variable to "explain" multinationality and diversification. We shall argue in section 4 that this sort of approach provides, at best, only a very blurred picture of the underlying mechanisms, and, at worst, it amounts to little more than estimating identities.

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[2] His sample comprises nearly 800 of the world's largest companies (although, many have to be excluded from the tests referred to here because of missing data on key variables, raising potential worries of sample selection bias). Moreover, his data are more aggregate than our own: he measures multinationality simply by the share of a firm's sales produced abroad, and diversification is only distinguished across broad two digit sectors.

3. The database and descriptive statistics

We employ an unusual new database on the corporate structures of a set of the leading (277) firms in the EU for 1987[3]. It includes information for each firm on its production[4] in each of up to 100 industries defined at the (NACE classification) 3-digit level, across the same 11 member states. However, it excludes firms' outputs outside manufacturing or the EU, and it relates to just a single year. The sample comprises all "leading" EU manufacturing firms, where a firm is defined as a "leader" if it is amongst the five largest producers (at the EU level) in at least one 3-digit manufacturing industry. For any firm meeting this criterion, data have been collected on the scale of its EU output in all industries in which it operates (including those in which it is not a leader). lts total EU production in each industry is also disaggregated into separate figures for each member state. Thus, for each firm, we observe a matrix, in which x_{jk} refers to the firm's output in industry j (=1...100) in country k (=1...11). Obviously, this sample is deliberately heavily biased towards larger firms: it comprises nearly all of the EU's very largest firms, (according to our calculations, 97 of the top 100), as well as all firms with some degree of market power in individual industries.

For each firm, an aggregate index of diversification[5] is estimated using Berry's (1975) traditional measure, and multinationality is defined in an analogous way:

$$D = 1 - \Sigma_j (x_{j.})^2 / (x_{..})^2 \qquad (1)$$

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[3] This database was first assembled as part of a wide ranging study on the competitive process, and its consequences for the structure of industries and firms in European Union (EU) manufacturing, and is fully discussed in Davies, Lyons et al (1996). The main source of information was company reports, supplemented by business directories and national production censuses. Considerable care, based on the knowledge of economists from the relevant country, was taken in grouping together all firms under the same ultimate ownership (the accounts of all subsidiaries and associates in which share ownership was at least 50% were consolidated). The 100 industries account for 99% of total EU manufacturing output, and the 313 firms in the original database account for about one third of this. The EU is defined here as the 12 member states in 1987, with Belgium and Luxembourg amalgamated. In the present paper, we exclude 36 firms from the original database which are subsidiaries of non-EU owned parents. For these firms in particular, non-EU operations are clearly of central importance to their corporate structures.

[4] Throughout the paper, "production" is used as shorthand for "sales by country of origin". Obviously, the term is slightly imprecise in that it ignores changes in stocks of finished products. On the other hand, we prefer not to refer to "sales" in order to avoid the implication that the data refer to sales by country of destination, which would be quite inappropriate when measuring multinational production.

[5] Throughout this paper "diversified" refers to multi-industry operations and will therefore include vertical operations.

$$M = 1 - \Sigma_k (x_{.k})^2 / (x_{..})^2 \qquad (2)$$

These indices have familiar properties[6]: a firm specialized in a single industry scores D = 0, while one spreading its output equally across N industries records D = (N-1)/N, tending to unity as N becomes large; similarly, a firm which operates in a single country records M = 0, while one having equal sized operations in S countries has M = (S-1)/S.

Table 1 - Multinationality and Diversification: Descriptive Statistics

Firm numbers and sample means

	Specialised			Diversified			Total		
		Mean Values			Mean Values			Mean Values	
	no.	D	M	no.	D	M	no.	D	M
Uninational	80	0	0.00	81	0.53	0.01	161	0.27	0.00
Multinationa l	16	0	0.34	100	0.58	0.36	116	0.50	0.35
Total	96	0	0.05	181	0.55	0.21	277	0.37	0.15

Nearly three-quarters of the firms are either diversified and/or multinational (Table 1)[7], with diversification being more common: two-thirds of firms are diversified, whilst only two-fifths are multinational[8]. At first sight, there are no obvious signs that

[6] Our preference for these particular indices merely reflects the widespread acceptance of Berry's D index in the existing literature. We are not sure whether M has ever been used in this way before - most previous studies appear not to have had access to such complete and disaggregated data - but it is perfectly appropriate for present purposes.

[7] We define a firm as diversified (multinational) only if its D(M) value exceeds 0.095. This effectively ignores "trivially small" amounts of diversification/multinationality which may be the result of measurement error. Our main datasources are company reports which are not always careful, when describing smaller subsidiaries, to define industry of production precisely, or to distinguish foreign production from merely selling operations. This critical value is not very exclusive: it corresponds to a hypothetical firm operating in two industries (countries), of which the main industry (country) accounts for 95% of the total.

[8] The typical *extent* of diversification is also higher than typical multinationality: 41% of the total output of all sample firms is produced outside their primary industries, whilst only 18% is produced outside their home countries. This is reinforced by the sample means for D and M reported in the Table (0.37 and 0.15); however, the latter comparison is sensitive, of course, to the greater *scope* for diversification as measured here - the NACE classification identifies 100 industries, whilst we consider only 11 countries.

the two strategies are either substitutes or complementary. The number of firms that are **both** diversified and multinational (100) is almost identical to the number opting for **only one** of the two strategies (97). Moreover, amongst the diversified set, there is no significant difference in the mean value of D between those which are also multinational and those which are not (0.58 and 0.53); similarly, the mean value of M for multinational firms does not differ significantly between those which are, or are not, also diversified. Regression analysis (not shown in the table) tends to confirm the conventional findings about firm size, multinationality, diversification relationships: D and M are both positively correlated with aggregate firm size (r = .27 and .28 respectively), and are themselves significantly positively correlated (r = .32).

4. Indices of Diversification and Multinationality: Identity Relationships

Whatever the scene-setting value of statistics such as these, we believe that they are quite inappropriate as tests of *behavioural* hypotheses. Since some of the previous studies mentioned above draw substantive conclusions from similar regression/correlation analysis, a brief justification of this view is called for.

Consider first the **relationship to aggregate firm size**. If diversification and/or multinationality are used by firms to overcome constraints on growth in their primary industry and home country, then they are best thought of as routes to growth - the means by which larger size is attained. It is misleading to impute a *causal* relationship flowing from large size to diversification or multinationality. The Appendix formalises this argument by deriving two accounting identities. In product space, firm size and diversification are related by:

$$FMSIZE = MS * IS * (1-D)^{-1} \qquad (3)$$

where FMSIZE is the firm's aggregate size, MS is its "typical" market share, IS the "typical" size of industry in which it operates, and D is as defined above[9]. Thus firms may be large either because they achieve large market shares, and/or because they

[9] As shown in the Appendix, the decompositions employ Herfindahl-type indices to represent "typical" values - this is necessarily the case, given that we use Herfindahl based indices for M and D. Alternatively, had we used, say, Entropy indices for M and D, then CS, NATS, MS and IS would need to be re-defined similarly.

operate in larger industries, and/or because they operate across a large number of industries. Holding MS and IS constant, there is a simple proportionate relationship between FMSIZE and D. For example, a firm operating on equal scales in ND industries, in each of which it has a market share of 10% of a total market size of 100, will have an aggregate size of 10*ND. The equivalent decomposition in geographic space is:

$$FMSIZE = CS * NATS * (1-M)^{-1} \quad (4)$$

where CS is the firm's "typical" share of aggregate country size, NATS is the size of the "typical" country in which it operates, and M is as defined above.

Turning to the **relationship between diversification and multinationality**, a distinction should be made between the firm's *aggregate* diversification and its diversification within individual countries (or, equivalently, between its aggregate multinationality and multinationality in individual industries). An extreme example of where they will differ radically is a vertically integrated MNE, which locates its entire output of industry A in country 1, and its entire output in industry B in country 2: this firm is both multinational and diversified in aggregate, whilst being completely specialised within each country, uninational in each industry.

Making this distinction, it can be seen that acts of diversification will typically also affect the firm's index of overall multinationality. This is most obvious where the firm diversifies abroad - simultaneously affecting both M and D - but, home diversification, by raising the proportion of the firm's aggregate output produced at home, will also tend depress its aggregate M value. In the Appendix, we formalise by deriving the following:

$$D = d + \{(1-d).(M-m)/(1-m)\} \quad (5)$$

where d and m are "typical" within-country diversification and within-industry multinationality. Thus, aggregate diversification may be more/less than weighted average diversification within individual countries, depending on the precise pattern of multinationality within industries. In the above case of the vertical MNE, of size 100 in industry A in country 1 and 100 in B in 2, d = 0, but D = 0.5 since M = 0.5 and m = 0.

5. A Typology for Corporate Structure

In other words, *aggregate* indices of M, D and FMSIZE are jointly determined, and disaggregation is essential if we are to isolate underlying causal relationships. In fact, for the purposes of this paper, a straightforward approach turns out to be quite sufficient. We identify for each firm a primary industry and home country[10], and estimate its multinationality in the former and diversification in the latter, M_P and D_H. The remainder of the firm's operations are measured by R, the proportion of production outside the primary industry and home country: R is a crude (but sufficient for what is to follow) measure of both diversification outside the home country and multinationality outside the primary industry.

Using these three statistics, we distinguish the eight broad classes of corporate structure depicted in the 2*2 matrices shown in Figure 1[11]. The first three classes refer to firms which are not *both* multinational and diversified: **Class I** are specialist (i.e. non-diversified) uninational firms; **Class II** are specialised multinationals; and **Class III** are diversified uninationals. Of course, these firms have already been identified in Table 1[12].

The other five classes refer to different types of **diversified-multinationals**:

Class IV are specialised at home and uninational in their primary industry, but produce in a secondary industry abroad (e.g. a purely vertical multinational).

Class V are multinational, but only in their primary industry, and diversified, but only in their home country.

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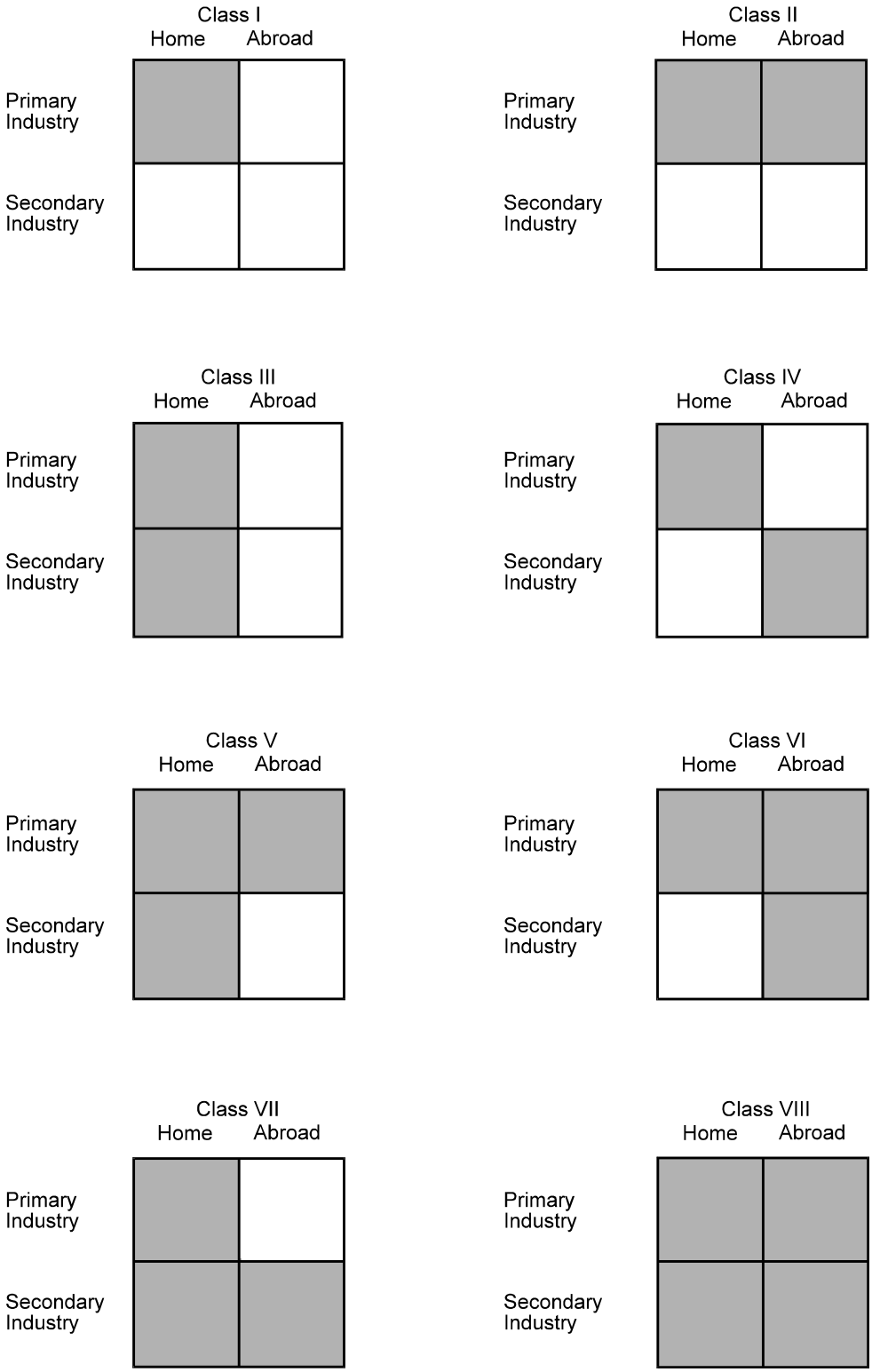
[10] "Home country" is always identified as the country of origin: all but 11 of the firms produce more than half of their total EU output in their home country. "Primary industry" refers to the industry accounting for the largest proportion of the firm's total EU output: 194 firms produce more than half of their output in their main industry. However, for 74, the main industry accounts for 25-50% of total output, and for 9, it accounts for only 15-25%. In some cases then, there is an ambiguity in definition, and, as will be seen, this does introduce a certain arbitrariness in the classification of a few firms in the current sample.

[11] It has been pointed out to us that this matrix is reminiscent of the Ansoff matrix (1965) which may be familiar to readers conversant with the corporate strategy literature. As far as we know, that matrix has never been used in empirical applications such as this.

[12] There is one minor difference because we classify firms as uninational or specialist if they record trivially low values (less than 0.095) for M or D. In Table 1, this criterion is applied to aggregate values, but in Table 2 it is applied to M_P and D_H. This shifts four more firms into the "diversified multinational" classification in Table 2.

Figure 1 - A Typology of Corporate Structures



Class VI are specialised at home, but produce abroad in both primary and secondary industries.

Class VII are diversified at home, but multinational only in secondary industries.

Class VIII are diversified both at home and abroad, i.e. multinational in both primary and secondary industries.

Table 2 - A Typology of Corporate Structure

Class	Number of firms	Mean Size (mn.ecus)	Mean Values M	D	D_H	Number for which $D<D_H$
I	80	570	0.0	0.0	0.0	n.a.
II	14	2642	0.34	0.0	0.0	n.a.
III	79	1846	0.0	0.52	0.52	0
Diversified MNE of which:	104	3671	0.35	0.57	0.57	65
IV	1	771	0.23	0.18	0.0	0
V	48	2981	0.28	0.45	0.49	48
VI	1	4724	0.75	0.68	0.0	0
VII	9	1849	0.24	0.69	0.63	0
VIII	45	4812	0.44	0.69	0.67	17
All Firms	277	2203	0.15	0.37	0.37	65

Note: A firm is considered to be diversified at home only if $D_H>0.095$; multinational in its primary industry only if $M_P>0.095$; and diversified abroad if $R>0.05$ (see footnote 7).

In fact, only two of the five diversified multinational classes, V and VIII, are quantitatively important for this particular sample (Table 2)[13]. Indeed, there are only 11 firms in classes IV, VI and VII, and an examination of the firms concerned suggests that, for some at least, there may be classificational ambiguities. Classes IV and VI each include only one firm - in both cases from the same small member state, Belgium - and since both have significant foreign operations in adjacent member states, the notion of a

[13] This is not to deny, that, say, vertical MNEs might be a more common occurrence were we to widen our canvas to include operations outside the EU, notably the developing world.

home country is less meaningful in these cases. The nine firms in class VII are a heterogeneous grouping and some could very easily switch to other classes with only marginal changes in structure[14].

In the next section, this typology provides the framework for formal model-building, but, first, we draw out its implications for the accounting relationships between aggregate multinationality, diversification and firm size. Consider first, **the purely arithmetic influence of multinationality on diversification** (or vice-versa). One way of quantifying this is to examine how multinationality affects the firm's aggregate diversification relative to diversification in its home country. In a simple 2*2 world, straightforward arithmetic shows that, for Classes IV, VI and VII, multinationality in a secondary industry must always increase aggregate diversification, whilst for Class V, multinationality confined to the primary industry must always reduce it. Only for Class VIII is the arithmetic effect arnbiguous, depending on the relative magnitudes in the 4 cells. In this sample, the deflationary effect dominates if measured by firm numbers (65 of the 104 diversified-multinationals have $D_H > D$). This reflects the balance of two counteracting effects: while Class V is far more frequent than Classes IV, VI and VII, *within* Class VIII, more often than not, multinationality tends to increase aggregate diversification. As can be seen, the former effect dominates the latter.

However, when judged by the overall sample means, the two effects exactly balance: mean D and D_H are both 0.57 for the 104 firms concerned. This is because many Class V firms are only moderately multinational in their primary industry.

Second, abstracting from the three very small classes (IV, VI and VII), and momentarily ignoring Class II, there is a tendency **for mean size of firm to increase as we move up through the four main classes**. Class III firms are significantly larger than Class I; Class V are significantly larger than III, and Class VIII are significantly larger than Class V. This is consistent with a stylised story, in which a firm first diversifies at home before then going multinational in its primary industry, and finally

[14] Two are conglomerates with large operations outside manufacturing, and one is a UK firm with traditionally strong interests in Ireland (Guinness): for these three firms, our classification scheme is arguably too simplistic. Similarly, three firms have only small foreign production (between 5 and 9%), and they are close to being classified in Class III.

diversifying abroad (i.e. a sequence of I → III → V → VIII). Each step increases the firm's aggregate size, and this gives rise to positive (albeit non-linear) correlations between M, D and FMSIZE. It is not so much that greater size facilitates multinationality and diversification, but rather that these strategies lead to larger size.

Of course this is only a stylisation, and one which is clearly inapplicable to the 14 Class II firms who have gone multinational without being diversified. Note also that their mean size is not significantly smaller than Class V, and so, for these firms at least, a Class II structure may not be an intermediate stage on the way to Class VIII. Until a time dimension is added to the database, the question of a "typical" time path must largely remain speculation; however, these magnitudes do tend to confirm our earlier argument that size will almost inevitably rise with diversification and multinationality, even without direct causality.

6. A Behavioural Model

We now turn to a formal model designed to avoid these arithmetic accounting relationships. We use a sequential framework, which builds from the typology by distinguishing diversification at home and abroad, and by employing disaggregated measures of size. We make the implicit assumption that firms do not typically choose to diversify abroad before diversifying at home, or go multinational in secondary before primary industries. (In effect, we ignore Classes IV, VI and VII).

Stage 1: the initial decisions on home diversification and primary multinationality (a) the role of size

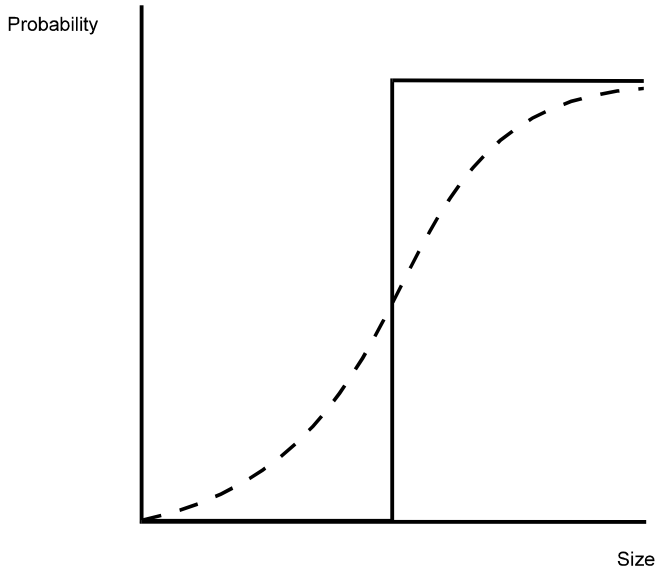
Consider first the firm's decisions on whether or not to diversify at home, and whether or not to go multinational in its primary industry. For **home diversification**, suppose that the probability a firm will be diversified in its home country is given by the probability that its **size in its home country primary industry**, $\mathbf{SIZE_{PH}}$, exceeds some **critical** level, $SIZE_D^*$:

$$P\{D_H>0\} = P\{SIZE_{PH} > SIZE_D^*\} \qquad (6)$$

A special case of this would be where firms choose to diversify at home, once their primary industry market share exceeds some threshold, say λ%, i.e. $SIZE_D^* =$

λ*$INDSIZE_{PH}$, where **$INDSIZE_{PH}$ is the size of the home country primary industry**. In that case, for firms in a given industry, the probability curve would be a simple step function, as shown in figure 2. Alternatively, when observed, as here, across a pooled sample of industries, critical size would have a distribution which merely mirrors that of industry sizes in the sample.

Figure 2



More generally, however, we would expect the threshold market share to vary both between industries, and between firms within industries, depending on the motives of managers, market structure, etc. Furthermore, size effects need not be confined exclusively to market shares; absolute size may also be important, for example, in determining the gains from diversification due to economies of scope and demand spillovers. Thus, $SIZE_D$* will vary across firms according to a vector of firm and industry-level characteristics, including industry size. Therefore, critical size is defined as a random variable, with mean μ_D and variance σ^2_D, and the step function generalises to the dotted sigmoid curve shown in figure 2, which is merely the cumulated $SIZE_D$* distribution. The magnitude of σ^2_D will then reflect the relative strength of these other

characteristics as determinants of diversification; where their effects dominate that of firm size, σ^2_D will be "large" and the curve relatively flat.

Multinationality in primary industry is modelled identically:

$$P\{M_P > 0\} = P\{SIZE_{PH} > SIZE_M^*\} \quad (7)$$

where $SIZE_M^*$ is another random variable, denoting a "critical" level of size for going multinational, with mean μ_M and variance σ^2_M.

These hypotheses are tested econometrically using a bivariate probit model, with two zero-one dependent variables regressed against the logarithms of $SIZE_{PH}$ and $INDSIZE_{PH}$. Four implications follow from this specification. First, because size is measured by the firm's operations in its home country primary industry, and given the simple binary nature of the dependent variable, there is little danger of a reverse causality. Second, the use of probit analysis, with firm size logged, makes the implicit assumption that critical size is lognormally distributed[15]. Although there is no theoretical necessity for any particular distribution, the lognormal is a very plausible candidate: critical size is clearly non-negative and if it is the product of a large number of independent influences, then the multiplicative form of the central limit theorem offers a reasonable genesis for the lognormal. Third, **bivariate** probit analysis acknowledges that $SIZE_D^*$ and $SIZE_M^*$ may be correlated across firms; if so, it will offer an efficiency gain over estimating the two equations separately. Fourth, $INDSIZE_{PH}$ and $SIZE_{PH}$ are included as separate regressors, without restrictions to allow for the likelihood that there is an *absolute* firm size, as well as a market share, effect.

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[15] If critical size is lognormal, then using the notation of Aitchison and Brown (1957), $SIZE_D^*$ is $\Lambda(\mu_D, \sigma^2_D)$, and $P\{D_H > 0\} = N\{(\log SIZE_{PH} - \mu_D)/ \sigma_D |0,1\}$. This is a linear relation between the normal equivalent deviate of the probability and $\log SIZE_{PH}$, as in a standard probit model, with an intercept term of $-\mu_D/\sigma_D$ and a slope of $1/\sigma_D$.

Table 3 - Probit (Logit) Analysis of the Probability of Diversification/ Multinationality

1. Basic Model, Bivariate Probit

	Const	$SIZE_{HP}$	$INDSIZE_{HP}$
$P\{M_P > 0\}$	-1.921***	0.279***	-0.002
	(0.489)	(0.063)	(0.039)
$P\{M_H > 0\}$	-0.541	0.249***	-0.106**
	(0.482)	(0.057)	(0.042)
LL =	-307, rho = 0.540		

2. Product Differentiation, Bivariate Probit

	NON-DIFF*			DIFF*		
	Const	$SIZE_{HP}$	$INDSIZE_{HP}$	Const	$SIZE_{HP}$	$INDSIZE_{HP}$
$P\{M_P > 0\}$	-2.145***	0.285***		-0.900	0.160*	
	(0.621)	(0.105)		(0.583)	(0.086)	
$P\{M_H > 0\}$	-1.006	0.378***	-0.149***	-0.622	0.153*	0.062
	(0.657)	(0.101)	(0.046)	(0.857)	(0.091)	(0.094)
LL =	-297, rho = 0.524					

3. Distinguishing Classes, Multinomial Logit

	NON-DIFF*			DIFF*	
	Const	$SIZE_{HP}$	$INDSIZE_{HP}$	Const	$SIZE_{HP}$
Class II	-5.088**	0.740**	-0.118	-2.918	0.246
	(2.526)	(0.372)	(0.168)	(2.195)	(0.328)
Class III	-1.780	0.718***	-0.366***	-0.859	0.150
	(1.336)	(0.212)	(0.103)	(1.331)	(0.207)
Classes	-4.215***	0.948***	-0.216**	-1.371	0.346*
V & VIII	(1.535)	(0.233)	(0.105)	(1.192)	(0.183)
LL =	-293				

Wald Tests

(i) DIFF v NON-DIFF		(ii) Inter Class	NON-DIFF(3)	DIFF(2)
Equation	22.51*** (9)	II v III	23.8***	9.8***
Class II	2.36 (3)	II v/VIII	15.7***	26.4***
Class III	13.57*** (3)	III v/VIII	5.2	11.4***
Class V/VIII	10.22** (3)			

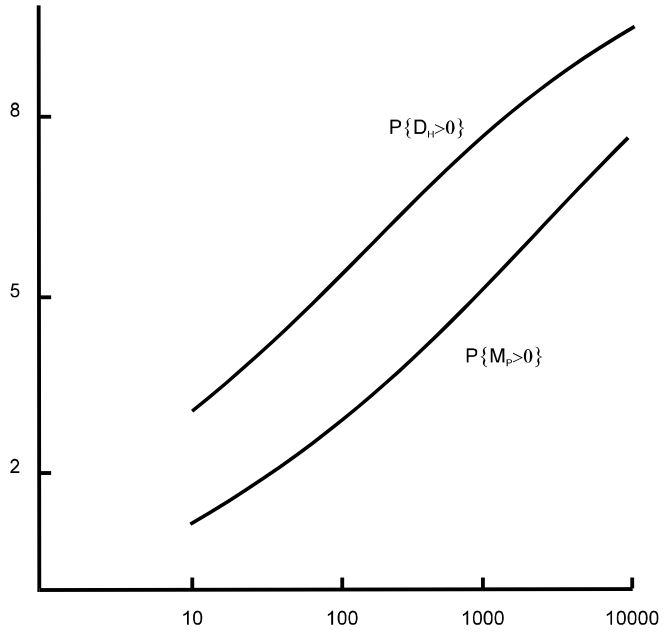
4. Diversification Abroad, Univariate Probit

	Const	$SIZE_{HP}$	
Class VIII	-2.188***	0.288***	
v Class V	(0.871)	(0.115)	LL = -61

$SIZE_{HP}$ and $INDSIZE_{HP}$ are logged; N = 266, but, for (4), n=93; significance levels: *10%, **5%; *** 1%.

Equation (1) in table 3 confirms a significantly positive role for SIZEPH for both diversification and multinationality. Industry size has the expected negative (and significant) effect on diversification, but it is insignificant for multinationality: for multinationality, it is the firm's absolute size alone which matters, but, for diversification, there appears to be both market share and absolute size effects at work16. The coefficient on SIZEPH does not differ significantly between the two equations, but the intercept does, implying that the mean of the critical size distribution is lower for diversification than for multinationality. This is reflected by figure 3, in which the implied probability curve for home diversification against SIZEPH (evaluated at sample mean values for INDSIZEPH) is always higher than that for primary multinationality. Finally, the estimated correlation between the residuals of the two equations is +0.542, implying, in turn, a positive correlation between the two critical sizes: on balance, multinationality and diversification are complementary strategies in a sense to be discussed more fully below17.

Figure 3



[16] The restriction of (absolute) equality in the coefficients on $SIZE_{PH}$ and $INDSIZE_{PH}$ in the diversification equation is rejected at the 5 % level.

[17] The efficiency gain from estimating the two equations jointly in bivariate probit analysis is revealed by comparing the log-likelihood for (1) with the sums of the ratios when estimating the equations separately: -307 against -153 (+) -179 = -332.

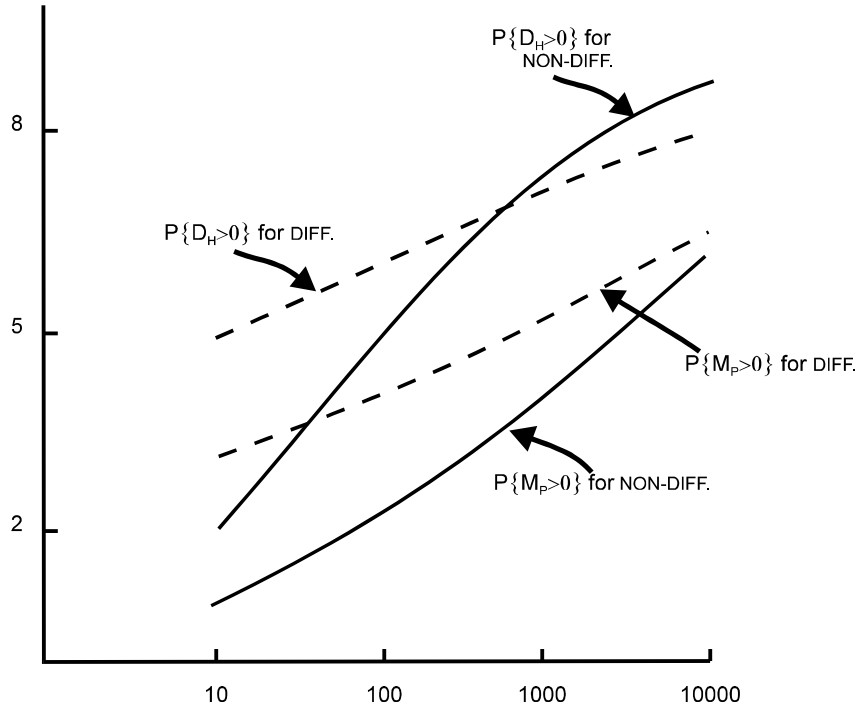
(b) the role of specific assets

Obviously, this model can be enriched, given available data, by specifying some of the other determinants of critical size. Of particular interest is the role of **firm specific assets**, especially those associated with product differentiation, and as revealed by high advertising and R&D outlays. Unfortunately, comparable firm-level data on these and other variables are currently unavailable, and so we proceed in an indirect way. Using industry-level data, we have constructed a binary dummy variable, **DIFF**, which takes the value 1 if the **firm's primary industry is typically characterised by "high" levels of advertising and/or R&D expenditures**. Thus, DIFF should be interpreted as an indicator of the intrinsic nature of the firm's main industry, rather than as a proxy for how much the firm spends. The implication is that the classification is not country - or time - specific, and that leaders in such industries must inevitably possess some specific asset[18].

The hypothesis is that the parameters of the critical size distributions will differ between DIFF and NON-DIFF firms. The expectation is that firm-specific assets make each strategy more likely, at any firm size, thus mean critical size should be lower for DIFF firms; expectations are less clearcut for the variance, but, if firm size becomes relatively less important where specific assets are pronounced, then it will be higher for DIFF firms.

[18] DIFF is constructed from Italian and UK data on R&D and advertising spends (see Davies, Lyons, et al. 1996). One other implication of the binary form of this variable is that it minimises the likelihood of simultaneity with both diversification and multinationality.

Figure 4



Equation (2) reports the result of re-estimating the bivariate model separately for DIFF and NON-DIFF firms[19]. The log-likelihood is reduced from 307 to 297 and the appropriate Wald tests allow us to reject the hypothesis that the coefficients are the same for DIFF and NON-DIFF - both for the equation as a whole (19.1), and for the diversification and multinational components individually (10.6 and 9.1 respectively). The implied point estimates of the parameters of critical size confirm expectations: DIFF reduces the mean but increases the variance, making both multinationality and diversification more likely at most firm sizes, as well as diluting the strength of the firm size effect. In fact, as shown in Figure 4, although both probability curves are shifted upwards by DIFF, in the case of diversification, the larger variance means that the probability is actually slightly lower, but still very high, at very large firm sizes.

[19] $INDSIZE_{HP}$ continues to be completely insignificant in the multinationality equation and is excluded from the equation reported in the table.

Stage 2: interaction between primary multinationality and home diversification

So far, the model is silent, *theoretically*, on the relationship between the two initial decisions, although, *econometrically*, the rho values in equations (1) and (2) imply that there is a connection, in that there is a positive correlation between the residuals in the component equations. This suggests, in turn, a positive correlation between $SIZE_M$* and $SIZE_D$*; and, in this sense, we can define the two strategies as **complementary**. Of course, this statistical association is open to various interpretations, and it does not necessarily imply causality. For example, it might merely reflect a tendency for firms to have similar "tastes" for multinationality and diversification. One reason might be that managers with preferences for empire building and growth maximising see both strategies as potential (not mutually exclusive) avenues for securing their objectives. Similarly, (and perhaps more convincingly), firms may possess specific assets which can be exploited equally in both geographic and product spaces. However, there might also be a more causal explanation: where a firm has already gone multinational, this may then facilitate diversification (or vice-versa). In terms of the model, the critical size with respect to one strategy may change, as and when, the firm follows the other strategy. Without a time dimension to the data, we can not discriminate decisively between these alternatives, but can pursue this question a little further by reintroducing the typology as follows.

Equation (3) in the Table takes disaggregation one step further by distinguishing multinational firms that are also diversified from those that are not. In other words, there are now three groups of firm - Classes II, III, and V amalgamated with VIII[20] - to compare with the default, Class I. This is an obvious extension of the bivariate model, but we are unable to use the obvious econometric extension, multivariate probit, in the absence of any available computer programme[21]. Fortunately, multinomial logit is a good second best, given the close similarity of the logistic and normal distributions.

---

[20] Because we continue to focus only on primary industry multinationality and home diversification, there is no distinction between Class V and Class VIII firms at this stage.

[21] As Greene, 1993, p. 663, explains, "The practical *obstacle to such an extension is the evaluation of higher order multivariate normal integrals*".

Figure 5 (a) NON-DIFF.

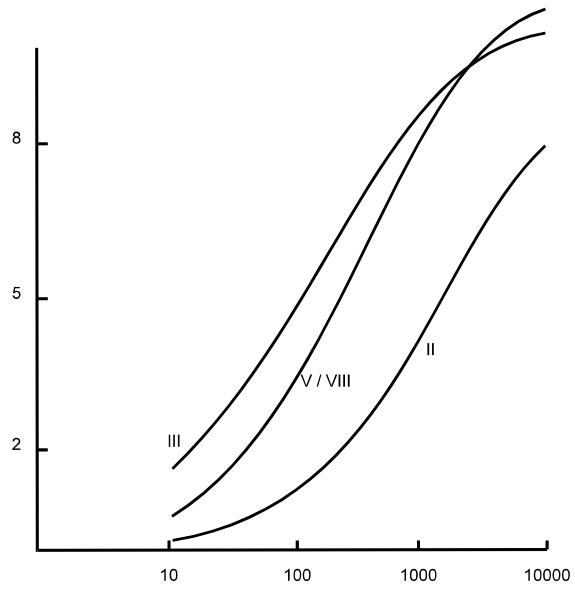


Figure 5 (b) DIFF.

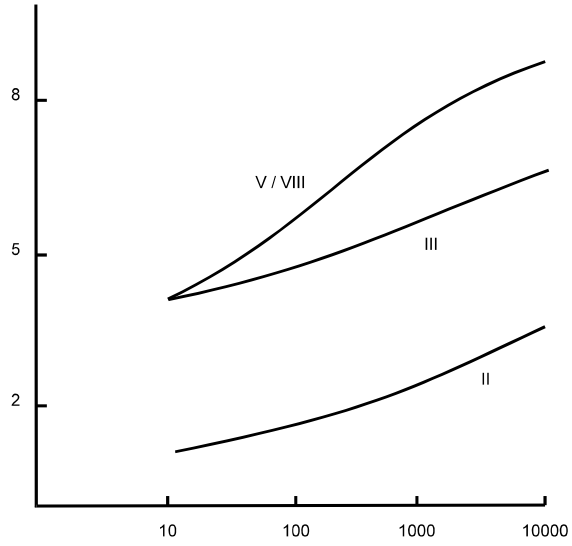


Figure 5 is a graphical representation of the results, separated into NON-DIFF and DIFF. Each curve refers to a bilateral comparison between the relevant class and the default (evaluated at mean values of $INDSIZE_{PH}$). In this case, there are two sets of Wald tests, one comparing DIFF and NON-DIFF, and the other making inter-class comparisons.

The DIFF v. NON-DIFF comparisons are straightforward and they largely confirm the bivariate probit results. As can be seen, the probability curves are generally far less sensitive to firm size where specific assets are more likely. Indeed, we can now see that it is only amongst the Class V/VIII firms (i.e. diversified/multinationals) that size has any significant influence at all for the DIFF group. The Wald tests confirm that the equations differ significantly between DIFF and NON-DIFF subgroups, both for the model as a whole, and for Classes III and V/VIII separately. On the other hand, the Class II curve does not differ significantly between DIFF and NON-DIFF, i.e. for firms that are only multinational, size is the only significant discriminator when compared with specialised uninational firms. Within the NON-DIFF sub-set, the results on size are also in line with those of the bivariate probit: for all three classes, firm size is always

significant when compared with the default, but industry size is only significant for diversification (Classes III and V/VIII).

However, the more interesting new insights concern the differences *between* classes. In order to interpret the appropriate Wald tests, consider first the meaning of each curve.

(i) Curve II compares firms that are solely multinational with those that are not multinational or diversified, and it therefore portrays **the probability of being multinational, conditional on not being diversified**

(ii) Curve III compares firms that are solely diversified with those that are not multinational or diversified, and it therefore portrays **the probability of being diversified, conditional on not being multinational**

(iii) Curve V/VIII compares firms that are both multinational and diversified with those that are neither. Here, the main interest lies not so much with straight comparison between Class V/VIII and the default, but more in comparisons with the two other curves. Thus, V/VIII relative to II compares firms that are multinational and diversified with those that are solely multinational, from which we can deduce the relative magnitudes of **the probability of being multinational, conditional on being diversified and the probability of being multinational, conditional on not being diversified**. Similarly, V/VIII relative to III reveals the relative magnitudes of **the probability of being diversified, conditional on being multinational and the probability of being diversified, conditional on not being multinational**.

Within the DIFF sub-set, the Wald tests show that the three curves differ significantly from each other: as shown by the figure, the probabilities of being solely diversified or solely multinational (particularly the latter) are typically quite low for DIFF firms. Comparing V/VIII with II and III, the conditional probability of being multinational is higher for diversified firms than for non-diversified firms and the conditional probability of being diversified is higher for multinational firms than for non-multinationals. In other words, where specific assets are likely to be important, if firms are multinational then they are also probably diversified, and vice-versa. This is consistent with the hypothesis of complementarity driven by specific assets which can be exploited both geographically and in product space - the specific asset is a public good within the firm.

Within the NON-DIFF sub-set, a visual comparison of the II and V/VIII curves shows that the conditional probability of being multinational is also higher for diversified firms than for non-diversified firms; and the Wald test confirms that the difference is strongly significant. Apparently then, complementarity continues to apply even when specific assets are less likely. On the other hand, a visual comparison of III with V/VIII suggests that the conditional probability of being diversified is *lower* for multinationals than for non-multinationals, except at extremely large firm sizes. This is the first evidence that multinationality and diversification may sometimes be substitutes. However, in this instance, the Wald test shows the difference to be only weakly significant, at slightly less than the 10% level. Nevertheless, there would appear to be a paradox. For NON-DIFF firms, the two strategies seem to be complements looked at from one direction, but not from the other (indeed, if anything, the weak evidence is that they are substitutes).

In fact, we believe that there is no paradox, and that the explanation lies in the different size-motives for multinationality and diversification. As we have just seen, for NON-DIFF firms, both strategies are largely driven by size considerations: diversification removes the constraint on growth otherwise imposed by a large primary industry market share, whilst, for multinationality, it is absolute size rather than market share which matters - once the firm achieves a certain size in its home country, multinationality becomes a viable alternative to exporting. But, if this is so, it follows that the growth incentive for diversification will be reduced *if the multinationality option has already been taken*, since expansion can now be effected geographically without recourse to diversification. On the other hand, the incentive for multinationality remains unchanged, *whether or not the firm is diversified* - the cost-effectiveness of foreign production relative to exporting in the primary industry is unaltered by diversification into other industries at home.

However, this alone can be only part of the story, since we have found that the probability of multinationality is *higher* (rather than no different) for diversified firms and that the probability of diversification is only *weakly significantly lower* for multinational firms. This might suggest that, after allowing for these differential size considerations, there is still an underlying residual complementarity in both cases. We can only speculate on why this might be, but one possibility is that some firm-specific

assets are not necessarily associated with high advertising and/or R&D spends, such as general managerial skills.

Stage 3: Foreign Diversification

We turn finally to foreign diversification (i.e. secondary multinationality), which we model quite simply in terms of the conditional probability that a firm will be diversified abroad, given that it is already diversified at home and multinational in its primary industry.

In terms of the typology, this amounts to a straight comparison of Class V with Class VIII[22], which can be modelled simply using univariate probit, allowing the parameters to differ between DIFF and NON-DIFF. However, in this case, $INDSIZE_{PH}$ is not included since a high home primary industry market share is not a constraint on growth for a firm already diversified at home and multinational in its primary industry. Similarly, $SIZE_{PH}$ is no longer an appropriate measure of firm size, and instead, we use $SIZE_{P\&H}$, **the firm's total output in its primary industry and its home country**, i.e. aggregate size exclusive of production in secondary industries.

Here, there is no significant evidence of a difference in the equation between DIFF and NON-DIFF firms, and the reported equation (4) in the Table is confined merely to examining the role of size. As can be seen, it is positively significant[23]. It appears that foreign diversification can be explained as an alternative avenue for expansion, once firms have diversified at home and gone multinational in their primary industry. However, we are reluctant to conclude that specific assets have no role to play in this "final" stage, since the majority of firms in **both** Classes V and VIII originate from DIFF industries, rendering this particular proxy especially imprecise in this stage.

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[22] In other words, we continue to ignore the 11 firms in Classes IV, VI and VII. As mentioned already, there are doubts about the robustness of the classification for some of these firms. In any event, they constitute too small a sub-sample to support econometric examination.

[23] We also experimented with three other size measures: $SIZE_{PH}$, the firm's size in its primary industry across all countries, and its total home country size. None achieved the same significance level as $SIZE_{P\&H}$; indeed, each attracts a negative sign when included alongside $SIZE_{P\&H}$.

7. Implications and Conclusions

The key premise of this paper is that, because diversification and multinationality are often inextricably linked, a joint investigation should provide deeper insights into their causes than can be gleaned from studying the two phenomena separately. Our database is in many ways ideal for this purpose: leading EU manufacturing firms display a variety of different corporate structures, and a large number are diversified both at home and abroad - precisely the conditions where multinationality and diversification are most obviously interdependent.

Two recurring results in the previous literatures are that diversification and multinationality are both more common in larger firms, and where specific assets are important. Our own results tend to confirm these "stylised facts", but with important qualifications and extensions. First, we have argued that positive correlation (or regression) coefficients linking aggregate firm size to diversification and/or multinationality are not conclusive evidence of causality. Rather, they are open to purely arithmetic identity-type explanations - unless multinational/diversificational expansion is a perfect substitute for home country operations in the core industry, it must necessarily entail an increase in the firm's aggregate size. For this reason, we have modelled the decision-making process as sequential, distinguishing home from foreign diversification, and primary from secondary multinationality. This leads to more refined formulations of the size hypotheses: for example, is *home* diversification related to the size of the firm in its home primary industry? Generally speaking, the significance of size remains robust to this sort of disaggregation, but some important qualifications now emerge. Some concern differences between the two strategies. Thus, whilst the probability of home diversification is found to depend on the firm's market share, as well as its absolute size in its home industry, the probability of primary multinationality depends only on the firm's absolute size in its home country primary industry. This is consistent with the hypothesis that firms turn to diversification as an alternative route to expansion, once their primary industry market share becomes large. On the other hand, primary multinationality is more likely to be activated once size exceeds some critical absolute level, and this is because foreign production becomes relatively more attractive (compared to exporting) once the scale of operations is sufficiently high to merit additional fixed costs abroad. Turning to *foreign* diversification (or, equivalently,

secondary industry multinationality), we find that size continues to be important, but, in this case, it is the firm's size aggregated across its primary industry in all countries and across all its industries in its home country. This is consistent with the hypothesis that foreign diversification is viewed as a further potential source of expansion.

Specific assets also play an important part in the story. More precisely, we find that, in general, home diversification and primary multinationality are both more likely where the firm originates from an industry characterised by high advertising and/or R&D. Our interpretation is that leading firms in this type of industry almost inevitably possess some specific asset associated with product differentiation. Interestingly, in these industries, the statistical significance of firm size measures is much reduced, suggesting that these strategies are motivated more by focused exploitation of a specific asset than by expansion *per se*.

Our most intriguing results concern the interplay between the two strategies. In most cases, home diversification and primary multinationality are found to be complementary, in that firms which are multinational in their core industry are also more likely to be diversified at home, and vice-versa. This is an unambiguous result for firms associated with differentiation, and the implication is that specific assets are typically a public good within the firm, if they can be exploited across countries, they can also typically support expansion in product space. Indeed, relatively few firms in this category opt for only one of the two strategies. However, where firms originate from industries in which specific assets and differentiation are less likely, while it remains true that diversified firms are more likely to be multinational than non-diversified firms, there is no evidence that multinationals are more likely to be diversified than non-multinationals (there is weakly significant evidence that the reverse is true). Our explanation is that the growth motivation for diversification is diluted once the firm has already chosen the multinational option, whilst the advantage of foreign production over exporting remains unaltered by home diversification.

Finally, we should acknowledge that this study is limited because the database is still at a fairly preliminary stage in its development. It is confined to a single year, with no information on firms' activities outside manufacturing or outside the EU. Obviously, this means we have measured multinationality and diversification more narrowly than is desirable, and it has also constrained our ability to pursue some hypotheses

satisfactorily. For example, patterns in the data are *suggestive* of a typical growth path, in which firms first diversify at home, then go multinational in their primary industry, and finally diversify abroad. Until a dynamic dimension is added to the database, this hypothesis must await more rigorous analysis.

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Appendix

Identity relationships between firm size, multinationality and diversification

Recall that FMSIZE denotes the firm's size ($x_{..}$) aggregated across all industries and countries, and its overall diversification and multinationality are defined as:

$$D = 1 - \Sigma_j (x_{j.})^2/(x_{..})^2 \quad (1)$$

$$M = 1 - \Sigma_k (x_{.k}) /(x_{..})^2 \quad (2)$$

(i) Decomposition of firm size in product space

Denote the firm's market share in industry j by $MS_j = x_{j.}/S_j$, where S_j denotes the aggregate size of industry j, and substitute into (1):

$$D = 1-\Sigma_j (MS_j)^2 S_j^2/(x_{..})^2 \quad (A1)$$

Next define its "typical" market share as the weighted average market share across industries:

$$MS = \Sigma_j MS_j(x_{j.}/x_{..}) \quad (A2)$$

and combine (A1) and (A2) to give

$$MS(1-D)^{-1} = x_{..}[\Sigma_j MS_j x_{j.}] / [\Sigma_j MS_j^2(S_j^2)] \quad (A3)$$

Next define an index of the typical size of industry[1] in which the firm operates as:

$$IS = \Sigma_j(w_{j.}S_j) \quad (A4)$$

where $w_j = (x_{j.}MS_j)/\Sigma(x_{j.}MS_j)$ (A5)

then $IS = \Sigma_j S_j x_{j.} MS_j/\Sigma(x_{j.}MS_j) = \Sigma_j S_j^2 MS_j^2/\Sigma(x_{j.}MS_j)$ (A6)

Substituting (A6) into (A3) and rearranging, it follows that:

$$FMSIZE = x_{..} = MS * IS * (1-D)^{-1} \quad (A7)$$

[1] Some comment is needed in interpreting the IS index. As can be seen, for firm i, it is a weighted average size of all the industries in which the firm operates. Since the weights depend on the size of the firm's presence in the industry times its market share, this index is firm specific. This means that industry j is given more weight in the index if the firm's operations in that industry are both important to the firm and significant in the industry.

(ii) Decomposition of firm size in geographic space

The analogous decomposition across countries is derived algebraically in an identical way, by merely replacing market share and industry size for industry j with country share (CS) and country size (NATS) for country k:

$$FMSIZE = x = CS * NATS * (1-M)^{-1} \quad (A8)$$

(iii) Relationship between multinationality and diversification

Denote the firm's diversification within country k by

$$D_k = 1 - \Sigma_j (x_{jk})^2 / (x_k)^2 \quad (A9)$$

and the "typical" (weighted average) value of this across countries as[2]

$$d = \Sigma_k v_k D_k \text{ where } v_k = x_k^2 / \Sigma x_k^2 \quad (A10)$$

Similarly, denote multinationality in j and typical multinationality by:

$$M_j = 1 - \Sigma_k (x_{jk})^2 / (x_j)^2 \quad (A11)$$

and

$$m = \Sigma_j w_j M_j \text{ where } w_j = x_j^2 / \Sigma x_j^2 \quad (A12)$$

First substituting (A9) into (A10) and (A11) and (A12) and then equating the two expressions yields:

$$(1-m)\, \Sigma_j x_j^2 = (1-d) \Sigma_k x_k^2 \quad (A13)$$

Then substituting in (1) and (2) gives:

$$(1-m)(1-D) = (1-d)(1-M) \quad (A14)$$

Finally, simple manipulation gives:

$$D = d + \{(1-d).(M-m)/(1-m)\} \quad (A15)$$

[2] Note that the unusual weighting structure in defining "typical" is dictated by the nature of Herfindahl type indices. The weights, so defined, sum to unity and attach relatively more importance to the larger industries (countries).

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