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ABSTRACT

The nature of the relationship between how international a company is (multinationality) and its performance has been studied for over forty years with conflicting results. This paper discusses how multinationality has been measured and builds on the emerging position that a value chain approach may be the best way forward by developing a new measure for multinationality.

A proof of concept for the new measure is presented based on a survey of 242 UK based manufacturing companies, which shows how different parts of the value chain respond differently to outsourcing and offshoring, potentially explaining the contradictory results in the multinationality literature to date.

Keywords: multinationality, performance, value chain

1. **Introduction**

A key hypothesis within the international business literature is that companies with a higher level of multinationality, essentially those operating in a greater number of countries, will have higher performance (Grant 1987; Gomes and Ramaswamy 1999; Verbeke et al. 2009). The roots of this work stretch back to the 1960s and earlier, as the study of modern multinationals, especially in the United States, began with an associated concern for the impact these multinationals were having on country sovereignty (Vernon 1971). If a general relationship could be shown for companies going international this would have important consequences for managers and for national policymakers. However, the myriad of studies to date have produced conflicting results.

Initially it appeared that researchers believed in a simple, linear, and positive relationship between multinationality and performance (Grant 1987) that was applicable in all instances. During this time period (essentially up to the 1980s) such a relationship might have existed based on the types of companies that were able to internationalise and the international trade conditions of the period. However, as the most recent wave of globalisation took hold, the simple models began to break as the companies in the international domain became more diverse. Now the problems with the specifications of the measures for multinationality and their use in analysis came to the fore, as they did not allow for anything other than a linear relationship between multinationality and performance (Sullivan 1994). New measures and new models have emerged, with the S-curve the current dominant model for the relationship between the level of internationalisation and performance (Contractor et al. 2003; Thomas and Eden 2004; Contractor 2007). However, problems with the measures remain, as they do not appear to measure the true international footprint of companies instead focusing on single measures such as foreign sales. Until a reliable measure for multinationality is developed, which can be used across sectors and countries, it is unlikely that the contradictory results will stop appearing and the field will not be able to move forward.

But why would a value chain approach provide a better measure of multinationality than the others proposed to date? The debate on the appropriate structure of measures in the M-P literature has begun to advocate taking a value chain approach for multinationality. As Verbeke and Brugman (2009: P.268) argue "… if one wishes to determine the degree of multinationality of 'operations', these could be defined in terms of any part of the value chain, including R&D, procurement, logistics, administration, production, marketing or sales." By assessing the level to which companies have placed the different elements of the value chain outside of their home country, it should be possible to get a more fine grained understanding of the positives and negatives of internationalising, as each activity on a company by company basis will have different levels of importance and linkage to the company. In essence, the non-linear nature of the relationship between multinationality and performance is likely to be based on the different impacts on the company of geographically dispersing different elements of the value chain.

2. Measuring multinationality

The concept of multinationality is at first glance relatively simple – the extent to which a company operates beyond its home country borders. However, there is no existing standard approach to measuring multinationality and many different perspectives have been put forward on how it should be approached. As Dunning (1973: p.292) warns "… it is worth emphasizing that identifying and measuring activities of [multinaltional enterprises] is not as straightforward as it may appear to be."

Beyond the definition of the term itself, there are also different phrases used to refer to multinationality by different research streams. The most common alternative to multinationality is degree of internationalisation (DOI) (for example see (Sullivan 1994) or (Pangarkar 2008)). A third term used is internationalisation (Bell et al. 2003), and this appears to be a more general term which is applied to companies having any type and level of activity in more than one country. Which of the terms is used depends on which research area each study comes from, as the international business literature seems to have little cross over with studies of global production networks, and both have had little interaction with economic history.

Another complication in defining multinationality is the connection between outsourcing and offshoring. These terms are themselves confused in the political debate over whether companies should be allowed to move significant operations overseas without restriction, especially in the United States (Levy 2005; Mankiw and Swagel 2006). While multinationality captures the structure of the company across different geographies, outsourcing and offshoring are the dynamic moments of change as activities are respectively placed outside of the company or moved from the home country to another country. Some commentators see outsourcing and offshoring as equivalent, missing the ownership and geographic dimensions that both contain.

How have previous studies measured what they term 'multinationality'? Prior work has used one of three approaches to measuring multinationality - single measures, multiple measures, or a multidimensional index.

The most common measure for multinationality through the 1970s, 1980s and 1990s is the ratio of foreign sales to total sales (FSTS). For example, in looking at the M-P relationship for British manufacturing companies, Grant (1987) uses the sales revenue of overseas operating subsidiaries as a proportion of total firm sales. Interestingly, reflecting what he and other researchers of the time may have wished to measure, Grant referred to this measure as a company's overseas production ratio.

There are obvious reasons for using a measure such as FSTS, the most important being data availability. Using company accounts as the source of data for such studies, the split of sales between different geographic regions would have been immediately obvious. However, is measuring diversity of where a company is selling a good indicator of the company's international dispersion? Dunning (1973) makes an interesting distinction between multinational producing enterprises and multinational trading enterprises.

In the first case, the company has activities such as production in more than one country, whereas in the second the company has trading or sales activities in more than one country. This goes to the heart of the problem with the FSTS measure of multinationality. While a company might have sales activities in many countries, either through exporting or by having a sales operation in a country, this says very little to nothing about the rest of the company's activities unless the various activities of the company are highly correlated in locational terms, i.e. a company with sales operations in a country routinely also has production and other activities in that country. This is generally not the case, as companies have broken their value chains and dispersed various activities around the world (Gereffi et al. 2005) and so the FSTS measure of multinationality is a weak proxy at best.

Sullivan (1994) provides a clear overview of the measures used both for multinationality and for performance in 17 papers published studying the M-P relationship between 1971 and 1990 (including those listed by (Grant 1987)). While arguing that the methods used to ensure the companies studied are representative and diverse, and that the measures of performance are robust, Sullivan (1994: p.327) notes that "… glaring in its consistency is the inevitable use of Foreign Sales as a Percentage of Total Sales (FSTS) as the sole estimator of [multinationality]; each of the seventeen studies designated this ratio as the independent variable."

In their broad review of measures of multinationality from 1960 to 1992, Annavarjula and Beldona (2000) argue that much of the literature on the M-P link is misleading, as it does not have a precise concept for multinationality. They first clarify the definition of multinationality to be "… the extent to which firms operate internationally by investing in assets and/or controlling activities outside their home country" (Annavarjula and Beldona 2000: p.49). Even from this moment of clarification, it is obvious how weak foreign sales as a percentage of total sales or other single point measures like this are as a measure of multinationality.

Annavarjula and Beldona (2000) go on to separate out three levels of multinationality - operations, ownership, and orientation – which need to be clarified to have a fuller definition of multinationality. The first, operations, refers to whether a company has 'value activities' in other countries. Such value activities could be sourcing of physical or intellectual inputs from overseas, the location of production activities overseas, or the placing of sales and/or servicing outside of the home country. The second, ownership, refers to the extent to which the company owns value activities abroad, as well as the extent to which the company itself is owned by foreign entities (i.e. through shareholding). The third and final level of multinationality is the orientation or intent of the company. This describes whether the company is extending or replicating its strategy from its home country, or whether it takes a whole world approach to strategy and decision making.

This listing of different value activities and the introduction of ownership shows how the field is moving towards a value chain approach, without quite achieving full coverage of the value chain. This could be due to unwritten assumptions about which activities of a company can and should be separated from each other and dispersed across a number of countries. For example, research has traditionally been thought of

as a home country activity, and this is a position which has only recently been changing (Dunning and Lundan 2009).

Even though there have been a number of waves of studies on the M-P relationship, and clear moments when the field became introspective regarding the nature of the measures used, studies continue to use those structures which have been heavily critiqued and also continue to provide insufficient detail to recreate the measures used. For example, in their recent study on geographic diversification and performance for UK multinationals Driffield, Du et al. (2008) appear to use a combined index for multinationality, as they present it as a vector as they build their regression model, and then report it in the analysis as a single item 'degree of multinationality'. A close reading of the paper would suggest that their measure is based on the number of countries in which the company operates, and as such is a single item count measure. However, the measure is never explicitly defined and so is a salutary example of both using a single point measure and not describing that measure clearly.

Some of these continued weaknesses can be explained by different research streams not interacting between supply chain analysis, multinationality, and internationalisation. However, much is either down to the preferences of the researchers or what they feel is possible given their methods and access to data. As Glaum and Oesterle (2007: p.311) note "In practice, however, researchers are often confronted with a lack of appropriate data. For this reason, despite the above mentioned problems the majority of studies rely on one-dimensional measures, mostly on the ratio of a firm's foreign sales to total sales." Or as Dunning (1973: p.292) comments "In practice, the matter is often settled by the data available and the economist has to cut his coat according to the cloth given him, or obtained by himself!"

2.1 A value chain approach

As discussed, previous multinationality studies have either used single item measures (usually ratio based) for the dispersion of a given activity (such as sales) or have used count based measures to indicate the number of countries that a company is operating in. Neither approach appears to capture well whether core activities of the company have actually moved outside of the boundary of the company, either in the company's home country or overseas. As Verbeke et al. comment (2009: p.151) "… M is usually assumed implicitly to result from a bundle of homogeneous resource allocation commitments to expansion in foreign markets … This homogenous bundle is then supposed to have a straightforward impact on P, whereby only the level (e.g. the share of foreign assets in total assets), rather than the substance (e.g. the actual function and location of these foreign assets, and their linkages with assets located elsewhere) …" Without looking deeper into the actual activities that are being offshored it is unlikely that multinationality studies can make any progress.

Since the 1980s the concept of the value chain became more prevalent in describing the activities of a company (Porter 1985) with companies being "… a collection of discrete, but interrelated, economic activities such as products being assembled, salespeople making sales visits, and orders being processed" (Porter 1991: p.102).

Porter's original statement of the value chain has evolved, with influence from the concept of value-added in economics, to have a more linear sense that extends beyond the immediate operational concerns of the company. This gives the value chain a more extended scope in time and reach from research through to end of life management for a product. As Kaplinsky's definition (2000: p.121) states "The value chain describes the full range of activities which are required to bring a product or service from conception , through the intermediate phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final consumers, and final disposal after use." This is a definite change from the framework originally proposed by Porter, excluding some of the company infrastructural items and blending in a longer time horizon.

Taking the modern interpretation of the value chain, how might we construct a new measure of multinationality? The value chain framework that this work will use is rooted in the original Porter framework, but extended in the sense of Kaplinsky to allow for the inclusion of research and other activities. Such a picture was developed by Livesey (2006) when discussing the definition of high value manufacturing and is shown in figure 1.

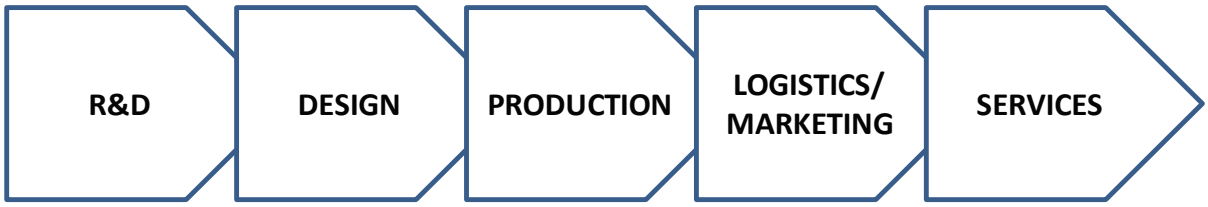

Figure 1 – the value chain as adapted by Livesey (2006)

This definition has a number of advantages to the original framework proposed by Porter for this type of work, as it simplifies some of the complexity surrounding the value chain and works at a slightly higher level of aggregation to include activities such as research and design thought to be very important to growth for many of the companies based in a developed economy such as the UK.

2.2 Ownership and multinationality

The lack of a discussion on ownership in the M-P literature means that activities outsourced from the company are not included in existing measures of multinationality. A company has to own the activity for it to count in most measures used to this point. This would appear to ignore a similar set of potential impacts on company performance, for example the cultural diversity of suppliers could have a strong impact on performance, or the distance and time to resupply for partners in far removed locations. It also speaks to a continuing confusion in the language used around offshoring and outsourcing. The two terms are distinct but have been confused, leading some writers to push them together to refer to offshore outsourcing for those activities that a company has placed outside of its boundary and outside of its home country (see for example Mankiw and Swagel (2006) and their discussion on the politics of offshore outsourcing in the United States).

To clarify the terms, Gregory et al. (2003) develop a simple two by two matrix, using ownership and location as the two axes, as shown in figure 2.

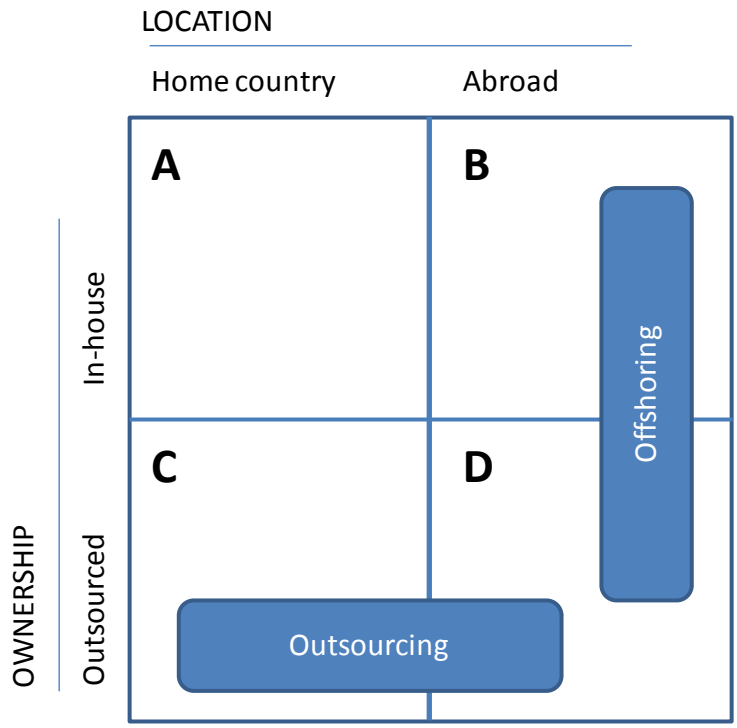

Figure 2 – clarifying the terms outsourcing, offshoring and multinationality

Using the diagram we can position each of the different activities of a company, for example production and sales, within one box or across any number. If a company has all of its activities in boxes A and B it is vertically integrated, i.e. it does not outsource any of its activities. In contrast, a company with its activities in boxes C and D will have outsourced its activities, potentially becoming a virtual producer with simple a coordinating headquarters function. The political debate on offshoring in the United States tends to focus on box D exclusively, which technically should be referred to as offshore outsourcing, when a company both outsources and sends that activity abroad (Cerruti 2008) in contrast to box C which is local sourcing.
A company with any activities in boxes B or D in the broadest sense are multinational, but reviewing the definitions used for multinationality it is unclear whether the various approaches wish to only discuss box B or if they are willing to include box D. For this work, the broad sense of multinationality will be used, whereby companies having in-house or outsourced activities outside of their home country will count towards their level of multinationality.

2.3 A new measure for multinationality

For each activity in the value chain we can then ask which of the four categories from figure 2 does the company use and to what extent. The final measure of multinationality is the reported footprints for research, design, and production for each company, using a simple share of total activity (i.e. sharing 100%) across the four categories defined by the matrix of location and ownership – in-house UK, outsourced UK, in-house abroad, and outsourced abroad (figure 3).

Company	In-house UK	Outsourced UK	In-house Abroad	Outsourced Abroad
R&D				
Design				
Production				

Figure 3 – multinationality measure based on the value chain location and ownership

These then can be put together to give measures of outsourcing and offshoring for each activity. For example, the level of production outsourcing (% production outsourced) is the sum of the percentage of production outsourced in the UK plus the percentage outsourced abroad. Similarly, the level of production offshoring (% production abroad) is the sum of the percentage of in-house production outside of the UK plus the percentage of production outsourced outside of the UK.

3. Proof of concept for the value chain approach

In order to test whether this approach moves the field forward a proof of concept survey was completed based on responses from UK based manufacturing firms. The survey is not an attempt to provide a general form of the M-P relationship rather its purpose is to show that different activities will have different responses to outsourcing and offshoring which impact performance. It should be noted that this approach does not automatically presuppose a positive relationship between high levels of multinationality and strong performance. Rather it implies that performance in a relative sense will be based on whether the company's configuration of activities is well suited to its strategic context relative to its competitors at a given point in time. The strategic context for a company will change and so those who are well adapted to current conditions may not be well situated in the future.

The approach taken was to investigate the relationship between the individual footprint responses for production, design, and research, to a performance measure based on two hypotheses –

- Hypothesis one – measuring the dispersion (both in terms of ownership and location) of different activities along the value chain will provide a stronger explanation of company performance than previous studies of multinationality and performance.
- Hypothesis two – different parts of the value chain will have different impacts (i.e. some positive and some negative) on company performance as they are offshored or outsourced.

As noted above a major critique of previous M-P studies is that they use measures which are not directly related to asset dispersion. If the value chain approach provides a better method for measuring multinationality and there is a link to performance, then there should be a clear and statistically significant link between the elements of the measure and company performance and secondly, the explanatory power (in statistical terms the adjusted R^2 of any regression analysis) should be greater than that of previous studies linking multinationality and performance.

The main driver behind taking a value chain approach is to allow for different activities to have different impacts on performance as they are outsourced or offshored. If the value chain approach is an improvement we should see varied and different impacts for the various elements of the value chain on company performance when they are offshored or outsourced. While the core arguments for previous analysis showing varied results have been based on an under specification of the terms used in the analysis, essentially non-linear terms not being included in the regression models, this work argues that the measures of multinationality themselves did not reflect the heterogeneous activities that could be geographically dispersed and would potentially impact in different ways on company performance.

3.1 What performance measure to use?

In deciding on which performance measures to use in this analysis there is a balance to be struck between measures which will provide a link to the outcomes that we wish to investigate for the company and whether that data is accessible. There is little point in specifying a measure of performance that is not routinely reported, so it is not available in company accounts, or one that companies do not understand and so would not be able to provide via an interview or survey. This encourages us to use an existing and well known measure for performance.

Existing financial measures include return on assets (ROA), return on sales (ROS), and profit margin amongst others. The measure used in this analysis was profit margin, which is the profit for a given year divided by turnover multiplied by 100. This measure will be used due to the availability of the measure via company accounts (and via the FAME database as our source of reported accounts) but also as it is the simplest financial measure we could ask for the components of from the companies and calculate it as a reported value. In this way we may be able to cross-check the reported values (secondary) with those provided by the companies (primary) and ensure that we have realistic measures of company profitability.

3.2 Data collection

The data for this analysis was collected through an online survey using the Qualtrics platform. Companies were contacted via two organisations – the Engineering Employers Federation (EEF) and the Regional Development Agencies (RDA) manufacturing leads. Each company contact was sent an email explaining the purpose of the survey and inviting them to participate. In both cases the same definitional boundaries were used, in order to ensure that we were collecting data samples that could be used together in analysis, and the collection windows were overlapped, so that there was no time distortion in the two sample responses. As stated above, we were primarily interested in manufacturing companies and so company invitations were filtered on the companies' primary standard industrial classification (SIC) code where available. Based on SIC 2003 we restricted invitations to companies with two-digit SIC codes between 15 and 37, which is the defined boundary for manufacturing companies in the classification. However, as not all companies' SIC codes were available and companies can report multiple SIC codes, there was a possibility that some of the companies contacted will be outside of this boundary.

As a second filter, and to attempt to have a common level of response from the companies, invitations were only sent to senior managers within the companies contacted. This meant in practice sending invitations to named contacts for whom the partner organisations had titles in their company contact databases and restricting this to managers with titles including Chief Operating Officer (CEO), Chief Operating Officer (COO), Chief Technology Officer (CTO), or Director of any kind.

The total return for the survey was 313 responses, which is an overall response rate of 4.6%, with 42% of responses coming from the EEF panel and 58% of the responses coming from the RDA panel. This response rate is low and it is thought that the complexity of the questionnaire may have contributed to non-response, and that the timing of data collection during such volatile economic conditions may have also

have had a negative impact on responses. However, this is a significant dataset which is felt is broadly representative of manufacturing companies based in the UK.

However, not all of these responses were useable in analysis for a number of reasons, such as inconsistency in the responses or incomplete returns. The data was further cleaned as outlined in appendix one with a final set of 242 companies used in the analysis.

On completion of the data collection windows, the two datasets were collated and brought into one sample. As a test of whether the samples were significantly different a 2-tailed t-test was used to test for significant differences in profit margin. The test indicates that based on profit margin, while the EEF sample has a higher mean profit margin (M=10.3) than the RDA based sample (M=6.0), there is no statistical difference between the samples (t=0.833, p=0.406). Therefore for the analysis we can consider the two samples combined as a single sample.

4. Analysis

The expectation for M-P studies is that the explanatory power of the model will be low - "… considering the small number of variables included in the equations as compared to the vast number of factors which influence firm profitability, low R^2s are to be expected" (Grant 1987: p.83). This is a key point for this work, as if the measure based on the value chain does not show a significant improvement in the variance of the performance measures used hypothesis one will not be upheld.

Ordinary least square (OLS) regressions were carried out for the following four models –

- Model 1: Control variables only (i.e. age, industry, etc.) in order to show the level of explained variance for the controls before any other effects are included.
- Model 2: Control variables plus measures of outsourcing, in order to test whether placing activities outside of the boundary of the firm is linked to performance regardless of location.
- Model 3: Control variables plus measures of offshoring, in order to test whether placing activities outside of the home country is linked to performance, irrespective of ownership of the activities.
- Model 4: Control variables plus measures of outsourcing and offshoring, in order to test whether both ownership and location of activities is linked to performance.

The control variables that were used in the analysis are outlined in table 1.

Variable	Details
Age	The age of each of the companies was calculated as 2010 – year of incorporation. It is expected that companies who are older may have greater experience in managing the complexity of outsourcing and offshoring.
Volume	This is the five point scale for volume, from 1 for high volume producer to 5 for one-off/low volume producer.
Price	This is the five point scale for price dependence, from 1 for highly price sensitive to 5 for not price sensitive.
Technology Level	This is the four point scale for the complexity of the production processes reported by the companies from 1 for low levels of automation and traditional techniques of production to 4 for high levels of automation and cutting edge production techniques.
Industry	In order to control for industry effects, such as capital intensity or strongly varying product cycles, the regressions include dummies for the sectors included. Therefore, there are 11 sector dummies labelled SIC1 to SIC11 to control for the 12 SIC code groups that are created in this manner.

Table 1 – control variables used in the analysis

4.1 Results for UK based companies

This section presents the results for linking multinationality and performance for all companies in the sample regardless of whether they were a subsidiary or not. A check of the level of correlation between the key predictor variables was carried out (Pearson's correlation) for the whole sample and only one of the pairs had a high level of correlation, that being the percentage of research abroad and the percentage of design abroad ($r=0.873$, $p<0.001$). This indicates that there may be some multicollinearity in the sample and so the variance inflation factors (VIFs) were checked for each of the analyses presented below. The VIFs for the percentage of research abroad and percentage of design abroad were consistently above 4 but never above 10, seen to be the critical level for a variable having a negative impact on a regression such as this (O'Brien 2007). In order to ensure that the regression was not impaired by multicollinearity, the percentage of design abroad was excluded from the analysis, as it was one of the two variables with worrying levels for variance inflation and its removal affected the sample size the least.

Table 2 below shows the results of the regression for the whole sample. As expected, and in line with most previous studies, the adjusted R^2 for each of the models is relatively low, indicating that the amount of variance explained by the included variables is not high. However, the value of the adjusted R^2 for models three and four is more than double that of the control variables alone (model one), indicating that there is a significant effect for including the measures of offshoring and the model does have some explanatory power. All of the models are statistically significant, although models three and four are stronger (i.e. are significant at the $p < 0.01$ level compared to model one ($p < 0.05$) and model two which is significant only at the $p < 0.1$ level).

Across all four models, neither age, volume or price dependence appear to be significant factors for performance as none of these variables are significant even at the $p < 0.1$ level. However, the technology level of the company and whether the company is a subsidiary are strongly linked to performance. The self reported technology level of the companies is significant ($p < 0.01$ for models one, three and four, $p < 0.05$ for model two) and appears to show a decrease of approximately 11 points in profit margin for each scale point increase in the technology level of the production processes used. This would mean a 33 point drop in profit margin, all else being equal, for a company with a company with the latest cutting edge technologies as compared to very low levels of automation and traditional methods of production. This could be explained by the levels of investment required to develop and use such advanced techniques, leading to short term lower profitability. It will be important to look at how companies respond over longer periods of time once they have established themselves at different technology levels for production.

Independent variables	Model 1 Controls	Model 2 Outsourcing	Model 3 Offshoring	Model 4 Outsourcing and Offshoring
Age	0.047 (0.568)	0.054 (0.647)	0.047 (0.585)	0.058 (0.723)
Volume	1.798 (0.654)	1.663 (0.598)	1.422 (0.537)	1.115 (0.418)
Price	4.737 (1.321)	4.422 (1.185)	4.224 (1.214)	4.313 (1.190)
Technology level	-10.718 (-2.617)***	-10.568 (-2.548)**	-11.514 (-2.908)***	-11.170 (-2.801)***
UK Owned	-16.786 (-2.357)**	-17.667 (-2.411)**	-34.673 (-4.086)***	-37.213 (4.249)***
% production out		0.106 (0.729)		0.188 (1.248)
% design out		-0.055 (-0.040)		0.022 (0.134)
% research out		-0.008 (-0.329)		-0.122 (-0.643)
% production abroad			-0.203 (-1.624)	-0.266 (-1.905)*
% research abroad			-0.370 (-3.061)***	-0.363 (-2.881)***
R2	0.144	0.147	0.216	0.226
Adj. R2	0.062	0.048	0.131	0.126
F-statistic	1.757**	1.489*	2.531***	2.256***

Note: *** p<0.01, **p<0.05, *p<0.10

Table 2 – regression for profit margin, whole sample (N = 184, Durbin-Watson = 2.179)

Interestingly, none of the outsourcing variables are significantly linked to profit margin, indicating no difference in profit margin across the sample and the variety of outsourcing intensities for the companies responding to the survey. Offshoring of production is statistically significant at the lowest level ($p < 0.1$) in model four, but not in model three. However, the offshoring of research is strongly linked to profit margin in both model three and model four. From this analysis for this sample, an increase of one percentage point in research offshoring is linked to a drop in profit margin of 0.36, i.e. a 10% increase in research offshoring

would be linked to a drop in profit margin of 3.6. In order to have as large an impact as a single point increase in the technology level of the company, there would need to be an increase in production offshoring of approximately 30%.

The strongest effect on profit margin in this regression is whether a company is a subsidiary or not, especially in the last two models where the offshoring variables are included. Being UK owned appears to have a penalty of between 34 and 37 points for profit margin in models three and four. In both models the link is strong ($p < 0.01$) and the effect is negative. Given the strength of the effect for subsidiarity and the lack of other linkages, it raises the question as to whether the subsidiaries and non-subsidiaries can be considered to be similar entities, i.e. whether they can be analysed in the same sample.

4.2 Results for UK owned companies

This pattern in this analysis, with the significance of ownership of the company so strong, raises the question as to whether the companies which are subsidiaries of other companies can and should be included in the analysis linking performance and multinationality. The following section presents the analysis of the UK owned companies only, i.e. excluding subsidiaries, in order to understand the differences between the two groups.

A check of the level of correlation between the key predictor variables was carried out (Pearson's correlation) for the UK sample and only one of the pairs had a high level of correlation, that being the percentage of research abroad and the percentage of design abroad ($r=0.865$, $p<0.001$). A further check of the variance inflation factors (VIFs) indicated that the VIFs for research abroad and design abroad were high (above 5 in both cases) indicating a problem of multicollinearity between the two variables. Based on a higher number of retained samples and higher variance explained, the percentage of research abroad was retained in the analysis, while the percentage of design abroad was excluded.

The results of the regression analysis are summarised in table 3 and the first important point to note is that in models 3 and 4 there is a significant increase in the level of explained variance in profit margin. In models 1 and 2 the adjusted R^2 is very low, below 5% in both cases. However, in models 3 and 4 the level of the adjusted R^2 is significantly higher, approximately 30% in both cases. This is both a significant increase in the explained variance above that explained by the control variables and also a much higher level of adjusted R^2 than usually found in multinationality-performance studies. This is a key test of hypothesis one, which claimed that measuring the dispersion of different activities along the value chain would provide stronger explanations of company performance. With this level of explained variance, this does appear to be the case.

Independent variables	Model 1 Controls	Model 2 Outsourcing	Model 3 Offshoring	Model 4 Outsourcing and Offshoring
Age	0.034 (0.472)	-.050 (0.706)	0.006 (0.100)	0.022 (0.358)
Volume	-1.969 (-0.815)	-2.163 (-0.896)	-1.795 (-0.873)	-2.125 (-1.401)
Price	5.459 (1.875)*	5.228 (1.695)*	4.266 (1.710)*	4.607 (1.751)*
Technology level	-4.661 (-1.382)	-4.571 (-1.363)	-1.324 (-0.452)	-1.848 (-0.637)
% production out		0.235** (2.250)		0.269 (2.586)**
% design out		-0.046 (-0.341)		-0.032 (-0.281)
% research out		-0.006 (-0.032)		0.010 (0.066)
% production abroad			0.034 (0.294)	-0.103 (-1.179)
% research abroad			-1.211 (-5.485)***	-0.977 (-4.139)***
R2	0.144	0.187	0.392	0.433
Adj. R2	0.026	0.046	0.294	0.320
F-statistic	1.215	1.330	3.992***	3.853***

Table 3 – regression for profit margin against UK subsample (N = 116, Durbin-Watson = 2.124)

Of the control variables, only one is statistically significant in any of the models. The level of price sensitivity for the company is positively linked to profit margin, consistently at the $p < 0.1$ level across the four models, with a one point increase in the price scale linked to an increase of between 4.3 and 5.5 in profit margin. This would imply that as companies operate in a less price sensitive environment their profit margin increases.

Two of the value chain activities show some link to profit margin, one in terms of outsourcing and one in terms of offshoring. Firstly, the level of production outsourced appears to be positively linked to profit margin, both in model 2 and in model 4. The link is statistically strong in model 4, with $p < 0.05$, and an

effect size of an increase in profit margin of 0.27 for every one percentage point increase in the level of production outsourced. Secondly, the level of research placed abroad is strongly statistically linked to profit margin ($p < 0.01$) and with a relatively stronger effect size, as a one percent increase in the amount of research placed abroad appears to be linked to a fall in profit margin of approximately 1.

This pattern of a positive relationship to production outsourcing and a negative relationship to research offshoring is a key test of hypothesis two, which claimed that different parts of the value chain would have different impacts on company performance as they were offshored or outsourced. However, the overall impact of these two effects, and whether this would describe an S-curve, would depend heavily on the sequencing of dispersion of the activities.

It is very important to note that the percentage of production abroad does not have a statistical linkage to profit margin for the UK subsample. This goes against previous work which from Grant (1987) through to Driffield et al. (2008) and others works from the position that production offshoring is positive for a company due to factors such as lower labour costs. For this analysis, whether the production is retained in-house or moved outside of the boundary of the firm is more important than whether it is sent overseas or not. If this pattern is supported in further work, this has significant implications both for companies and for government support to manufacturing companies. For companies, it means that the choice to move production outside of their home country may not provide expected benefits, while retention of production rather than using a specialised outsourcing partner may not support strategic goals for the company. In terms of government support to manufacturers, this may indicate that supporting the development of contract manufacturers within the home country may allow companies to achieve their strategic needs by outsourcing in country. This would reduce the offshoring of production activity, and potentially have a significant effect on the level of production retained in the national economy.

5. Conclusions

This paper has developed a new measure for multinationality based on estimates of outsourcing and offshoring across the value chain. This approach allows for differences in scale and directionality of impact for the varied elements of the value chain as they are offshored or outsourced, which provides a more realistic picture of what may happen to a company as it becomes international. This is important as while there may be a temporal element to whether a company is seeing positive impacts from internationalisation, there may also be differences based on what activity is being outsourced or offshored.

The proof of concept analysis indicates that for UK owned companies research and production respond differently to being moved outside of the boundary of the firm or the home country boundary. This is a first step in having more realistic measure of multinationality and in approaching a clear linkage between M and P. However, in further work a number of issues need to be addressed –

- A longitudinal study is required to allow for assessment of how these impacts play out over time, in line with the proposed S-curve for companies as they internationalise.
- Measures of performance need to be addressed so that there is commonality in what is used there also.

This paper has shown how a value chain approach to measuring multinationality can be constructed and also provides evidence that there are different effects for a company as they outsource or offshore different elements of the value chain. This is important for strategic managers, as they decide on the composition of their value chain, but also is very important for policy makers to understand that while companies may need to outsource production they may not necessarily need to offshore it, as long as a competent contract manufacturer is available in their home country. It is hoped that the measure developed for multinationality will serve as a prompt for a standard to emerge so that future studies of multinationality will be comparable.

APPENDIX ONE – Data cleaning

The following process was used to clean the data set and to ensure that spurious responses were rejected prior to the analysis.

1. Each return was checked to ensure that the sum of the responses for production, design and development, and research each individually summed to 100. This reduced the total responses from 313 to 291.
2. As turnover and profit margin are critical outcome variables, data for turnover, profit margin, number of employees and SIC code were sourced from the FAME database[i] to ensure the robustness of the outcome variables where possible. 121 of the 291 companies in the survey dataset were present in the FAME database and the latest available data was added to the dataset (earliest used was 2008).
3. The turnover per employee was calculated for each response and those with a turnover per employee greater than £1,000 were rechecked against the data from FAME (17 cases), while the other 16 cases were adjusted where it was obvious that there was a systematic error in the survey response (i.e. the respondee entered data in pounds as opposed to thousands of pounds as requested).
4. Two combined outcome variables were created (Turnover_Combined and ProfitMargin_Combined). The combined outcome variable is simply either the data for that variable from the FAME database, if available for the company in the last financial year (2008 at the earliest), or the survey response from the company. This maximises the number of companies for which there are outcome performance variables and ensures the largest possible sample for the regression analysis. Ninety companies of the 242 in the sample had reported profit margin for 2008 or more recently in the FAME database.
5. Companies with zero or non-reported turnover were removed from the dataset (this took the number of responses down from 291 to 242).

Variable	Average	Standard deviation
% production outsourced	17.32	26.06
% production offshored	14.81	26.60
% research outsourced	10.60	22.96
% research offshored	15.64	31.91
% design outsourced	11.66	23.77
% design offshored	14.70	28.37
M	14.6	24.0
Employees	271	776
Turnover	77,451(K)	469,793(K)

Table 4 – descriptive statistics for the whole sample

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Endnotes

[i] FAME is a commercial database which provides financial information for UK and Irish businesses. For further details please see http://www.bvdinfo.com/Products/Company-Information/National/FAME.aspx (last accessed September 20th 2010).