

The Determinants of Location Choices by Pharmaceutical MNEs
in Europe^{*}
Preliminary Version

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Abstract: Historically the European pharmaceutical market has been highly segmented by national differences in regulations and standards. It therefore provides a natural market for exploring the continuing influence of the national market on plant location choice within the EU after the Single Market Programme. Using the conditional logit model, we examine separately the determinants of pharmaceutical multinational location choices for expanded production at both existing and new facilities. We find evidence of the effects of both the national market and country level agglomeration on both types of location choice, but to different degrees.

JEL Classification: F15, F23, R12

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1. Introduction

The scale of reduction in trade costs associated with the introduction of the Single Market Programme (SMP) in Europe has provided trade economists with an opportunity to use theory to predict what would happen as cross border barriers fell and to test ex post whether the evidence supported the theoretical predictions. So there have been innumerable studies that have explored how trade patterns have changed as non-tariff barriers were reduced, in the context of different types of models, e.g., gravity, imperfect competition, etc., and the roles of non-economics variables (culture, institutions, etc) in the extent of the adjustments.

The SMP also provides a natural environment in which to explore the predictions of the New Economic Geography (NEG) literature (Krugman, 1991, Venables, 1996, and Puga, 1999), which suggests that increasing returns to scale (IRS) industries will tend to agglomerate (dis-agglomerate) in certain regions/countries in response to changes in inter-country trade costs. The persistence of this trend in agglomeration depends on whether the benefits of agglomeration are offset by rising congestion costs, generating a compensating tendency for dispersion. NEG models predict contrasting location trends of IRS industries in Europe following the reduction in trade costs in the early 1990s, consequent on the Single Market Programme (SMP).¹

In addition, the SMP provides a setting for looking anew at location choices generally within the EU, as the reduction in trade costs should mean that local markets are now less significant for location choice. This is especially true in the case of producers who are looking at the whole of the EU market for their sales and whose products have high value of weight ratios, i.e., products with naturally high transportation costs. A range of studies of the investment patterns of Multinational Enterprises (MNEs) have been undertaken, building on a literature that goes back to Caves (1971) and Dunning (1971).² This literature began the practice of economists thinking about foreign direct investment at the enterprise level, a practice that has blossomed during the 1990s as access to enterprise level data has become possible.³

This paper takes a sector-specific approach to exploring location choice, and the link to the NEG models, by investigating the factors determining the location of both EU and non-EU pharmaceutical multinational enterprises (MNEs) in Europe. We

¹ This programme resulted in the gradual abolition of non-tariff barriers to trade between the member states of the European Union (EU) after 1992 and consequently led to a significant fall in EU trade-costs.

² See also Caves (1982).

³ For a recent overview, see Markusen (2002).

chose the pharmaceutical industry, as it is a recognised as a major IRS industry⁴ in Europe and one with substantive non-tariff barriers historically.⁵ We look at MNEs, since these such enterprises are known to respond to trade costs, such as those linked to the SMP in making location decisions (see Buckley and Artisien, 1988, Dunning, 1992, Dunning and Robson, 1988 and Young, 1992). We examine their location choices over the period from 1993 to 2004.⁶ In addition to exploring location choice in terms of where new firms have located, we examine where existing plants have expanded production relatively, since the latter is up to six times a more important channel of production relocation for MNEs.⁷ We look at these separately because the two kinds of choices may be motivated by different economic considerations

Following in the path of recent papers exploring enterprise level locational choice (e.g., Head and Thierry, 2004), we use a conditional logit model (CLM) to identify the factors determining the location choice of pharmaceutical MNEs. In contrast with earlier papers, we look at the influence of the *national* market on location choice rather than the *potential* market, together with other measures such as production costs, transactions costs, and corporate-tax rates.⁸ Within this framework, we explore whether the existing agglomeration of the pharmaceutical industry in 1993, measured in terms of plant numbers, has impacted on location choice. Given the strong upstream links with the chemical industry, we also look separately its impact on location choice. The firm-level data for our analysis come from the *Amadeus* business database and the geographic level of analysis is at the national level.⁹

Our results suggest that the local market continues to be a driver of MNE production where this is produced in existing plants. In other words, MNEs are

⁴ The pharmaceutical industry is the fifth largest industry in the European Union in terms of manufacturing value added (3.5 per cent, 2003 figure, EFPIA 2005). The IRS derives from its capital and R&D-intensity – it accounted for about 17 per cent of total EU business R&D expenditures (2003 figures, EFPIA 2005)

⁵ As pointed out in Cecchini Report (Cecchini et al., 1988), “..., *the sector (Pharmaceuticals) is highly regulated, with two areas of regulation (market registration and price controls) ... Admission of new products to national markets is subject to registration procedures to ... All EC countries have measures to control public expenditure on pharmaceuticals.* (pp.66-67)”. For a further discussion of the regulation of the European pharmaceutical industry, see Burstall (1990), Burstall et al. (1999), Gambardella et al. (2000), Danzon and Chao (2000) and Abraham and Smith (2003).

⁶ The choice of starting date is influenced by data considerations, but arguably it could well have been at least 1993 before the influence of the SMP would have taken effect.

⁷ Firm-level data used in our study show that the change in pharmaceutical production in existing firms was roughly six times that of new firms during the period from 1993 to 2004, where new firm is defined as a firm being established after 1993 and its production value in 2003 is used for comparison.

⁸ In related work we are also looking at potential market using the Harris (1954) definition.

⁹ Ongoing work is exploring how the analysis can be taken to sub-national level.

continuing to expand where the local markets are large. This contrasts with the location of production of new firms, where the impact of the local market, while positive in the base model, is not as robust to the inclusion of other variables, especially the agglomeration variables. The same result arises for corporate tax rates, which have a consistently negative effect on location choice for expansion by existing plants but the negative effect in the base model for new firms is not robust. In the case of new firms, proximity to Belgium (the distribution centre for European pharmaceuticals) and the familiarity with particular countries (as measured by having plants already in those countries) are important drivers.

This research contributes to the location-choice literature in two ways. It is, to our knowledge, the first completed study of multi-country location choices, measured in terms of output expansion, of multi-country MNEs.¹⁰ Secondly, it explores location choice using a carefully compiled data set, which has identified the specific links between the complex network of plants in the pharmaceutical industry in Europe, covering both EU and non-EU plants.

The paper is organized as follows. Section 2 gives a brief (and as yet incomplete) account of the location choice and NEG literatures in which this research is situated. As background to the plant level analysis, it also reviews some of the related empirical studies that have looked at industrial location in the context of European integration. Section 3 discusses the empirical methodologies and data used. Section 4 presents and discusses the results for the location choice of expansion and new-firm creation. In section 5, the paper is summarized and conclusions drawn.

2. Related Literature

The growth of economic regionalism in the past decade has increased interest in just what happens when countries come together in customs-union type arrangements. A major focus of that interest lies in what it does to the location of production, as between the customs union and the rest of the world and within the customs union itself. It is not surprising then that we saw in the 1990s the growth of the new economic geography literature, and a resurgence of interest in studying just what determines the location of production (see Fujita et al, 1999). In the European context, these issues were seen as important in trying to ascertain whether production would

¹⁰ Raymond Mataloni in his 2007 working paper studies the location choice of production expansion of US multinationals in Europe.

become more centralised, at the expense of a declining periphery (see Braunerhjelm et al, 2000). In this brief review, we start by looking at the New Economic Geography (NEG) literature, in terms of its predictions and the empirical evidence for Europe in relation to its patterns of location production. We then look at the location choice literature that underpins the precise approach we take in the subsequent analysis.

The NEG models, such as Krugman (1991), Venables (1996) and Puga (1999), aim to explain the geographic distribution of economic activities, which rely on the assumption that manufacturing industry exhibits increasing returns to scale and that there are benefits if these firms agglomerate. Krugman (1991) uses a two-region framework with IRS in production to demonstrate that, under the assumption of free movement of capital and workers between two regions, market size-production linkages will cause all manufacturing firms and workers to agglomerate in one region (called “core”) at the expense of the other region, which becomes a “periphery”. Venables (1996) suggests that input-output linkages in manufacturing can explain why manufacturing firms agglomerate together, even without invoking the assumption of inter-regional mobility of labour. Puga (1999) presents a model based on Krugman’s Core-Periphery model, into which he incorporates Venables-type input-output linkages. This model demonstrates the agglomeration processes of manufacturing sector across two regions under assumptions that manufacturing workers are either inter-regionally mobile or immobile.

Despite differences in the mechanisms employed to explain industrial agglomeration, all NEG models imply that how the industry agglomerates is closely connected with trade costs between regions (e.g., transportation costs, tariffs, non-tariff barriers, customs efficiency, etc.) and the degree of labour mobility between regions. Generally, these models generate two different patterns of relationship between industrial agglomeration and trade costs, depending on their assumption of labour mobility. Krugman’s model shows that manufacturing industry locates in both regions when trade costs are above a critical point and below that point the industry agglomerates in one region. Venables and Puga’s models show that manufacturing industry distributes evenly across regions when trade costs are high. However, in their models, in contrast to Krugman, as trade costs decrease, their models indicate that industry first agglomerates in one region, but then disperses as trade costs become very low.

The differences in predictions of NEG models are also reflected in the mixed evidence of industrial agglomeration found in related empirical studies at sector level in the EU, based on data related to the period prior to the Single Market. Using data on 11 European countries and 18 industries (including the chemical industry) between 1980 and 1990, Brülhart and Torstensson (1996) found that indices of IRS are positively correlated with the locational Gini coefficients, suggesting that industries with higher levels of IRS are more concentrated in selected European countries. Noting the significant non-tariff barriers between EU countries, they suggest that IRS industries will become more concentrated after 1990 if non-tariff barriers cease to hinder free trade. Amiti (1998, 1999) found similar results - during the period between 1968 and 1990, industries (including the pharmaceutical industry) characterized by high-scale economies and high proportions of intermediate goods in production showed an increase in geographical concentration across EU-12 countries. In contrast, using the Gini coefficient of concentration, Midelfart-Knarvik et al. (2002) found diverse trends of concentration across industries, with a very slow process of dispersion in geographic distribution for manufacturing sectors overall from the 1970s to the 1990s.¹¹

Turning to the more recent period, Aiginger and Davies (2004) and Aiginger and Pfaffermayr (2004) examined the geographic concentration of industries in the EU for the period up to 1998. They found, for the post-1992 period, industrial concentration declined across 14 EU countries. They suggest this evidence is consistent with the Venables-Puga model, namely, decreasing trade costs lead to locational dispersion.

Alongside the development of the NEG literature has been the literature that grew naturally out of Caves (1971) and Dunning (1971), who focused on MNEs as business entities, in contrast to previous literatures which modelled foreign direct investment in a more sectoral way. As that literature developed, MNEs were seen as locating to get close to markets (*market-driven*), in order to strengthen market position and reduce trade costs, or locating so as to reduce production costs (*cost-driven*), so that they can source more cheaply for the home market.¹² The former is associated with the organisation of the MNEs activities on a *horizontal* basis, whereas the latter is seen as

¹¹ Specifically, in the case of the medium and high IRS industries (including the drugs and medicines industry), they find a diminishing trend in the geographic concentration in central European countries before 1990.

¹² In the context of imperfect competition and increasing returns, Dunning stressed the ownership advantages that MNEs took account of in globalising their production.

being more *vertical* in its focus. This matter links particularly to the agglomeration literature, as the presence of existing industry is seen as a source of potential for spillovers, etc. More recently, the increasing fragmentation of global production and the growth of export platforms (see Ekholm et al, 2007) have indicated that the motives of MNEs are more complex than had previously been assumed. In practice they often involve a hybrid of both horizontal and vertical drivers. These arise because MNEs operate in a range of product areas and operate across multiple rather than just two countries. Recent literature is seeking to address this – see, for example, Baltagi, Egger and Pfaffermayr (2007). This is highly relevant to the pharmaceutical industry where individual plants are likely to be producing both for local markets (possibly both national and EU) as well as for global markets.¹³ It also points to the important interactions between trade patterns and MNE locations, echoing Vernon’s product cycle approach again.

A growing literature is focusing on the modelling of MNEs’ location choice explicitly, with the discrete-choice model as their main tool. Related studies include Head et al. (1995), which is one of early studies addressing the industrial level agglomeration’s impact on foreign firms’ location decisions; Head and Mayer (2004), primarily looking at the market potential’s effect on the Japanese MNEs’ location choice in the EU; Barrios et al. (2002) looking at the effects of agglomeration and policy incentives to MNEs and Devereux and Griffith (1998) stressing the effect of corporate tax rate. Our analysis follows the same method of this location-choice literature.

3. Empirical Methods and Data

3.1 General Approach

Since we are interested both in the factors influencing the location of MNE pharmaceutical production in Europe and whether previous agglomeration at country level is influencing that choice, we explore the agglomeration issue in the context of the location choice framework. We do this using a discrete-choice framework in

¹³ The Pfizer plant in Ireland became the early global producer of Viagra, selling virtually all of its output outside Ireland, and a large volume of it back to the US, as well as to the EU and other European countries. The scale of the production was such as to have a dramatic impact on Irish trade figures for several years.

which MNEs make investment decisions regarding the country (ies) in which to expand their existing production capacity, or in which country (ies) to build new production facilities. The probability of a country being chosen as a location is determined by how attractive the country is to an MNE in terms of observable characteristics.

Of interest to us is whether the home market, which was the driver of location choice before the SMP, continues to be an important driver of location choice since 1993. Furthermore we wish to test whether the findings in other papers (e.g., the negative effect of corporate taxes) are reflected in this particular industry, which is characterised by high sunk costs. We also wish to explore the impact of agglomeration factors and if these are similar to expanding as well as for new firms. If agglomeration factors are strong, we expect the previous agglomeration of pharmaceutical production in one country to be a factor in influencing location choice. If the agglomeration trend is decreasing (increasing), countries with larger portion of past pharmaceutical production become less (more) favourable to MNEs. Consequently the probability of such countries being chosen by MNEs to invest will be lower (higher). So, for example, if we find the previous agglomeration having a positive effect on location choice, our result will support the predictions of the Krugman model and early phase of the Venerable/Puga model.

We use the conditional logit model (CLM), which has been used widely in exploring the FDI location-choices in the US and the EU.¹⁴ However, before exploring the micro data on MNEs, we look briefly at the aggregate data on European pharmaceuticals for the period 1993-2002 to establish the overall pattern of concentration/dispersion over that timeframe.

3.2 Aggregate Concentration Patterns in European Pharmaceuticals, 1993-2002.

Trade costs within the EU fell dramatically following the introduction of the Single Market Programme, which effectively abolished non-tariff barriers (NTBs) within the EU with effect from 1993. In the context of decreasing trade costs, NEG models predict that the agglomeration level of industries in the European Union can either be strengthened or be weakened. Because the NTBs were particularly important

¹⁴ Bartik (1985), Friedman et al. (1992), Woodward (1992), Head et al. (1995), Head et al. (1999), Barrios et al. (2002), Basile et al. (2003), Disdier and Mayer (2004), Head and Mayer (2004), Hogenbirk and Narula (2004) and Békés (2005).

in the pharmaceutical industry, and this industry features high increasing returns to scale, it provides an interesting industry in which to explore the predictions of the NEG models. We look at the real trend of agglomeration of the whole European pharmaceutical industry over the past decade.¹⁵ The Location-Gini coefficient and the Ellison-Glaeser (E-G) index¹⁶ are used to measure the geographic concentration (agglomeration)¹⁷ of production of the pharmaceutical industry in 14 European Union countries between 1993 and 2002.¹⁸ The concentration measures used are based on the employment level and gross output data from the OECD STructural ANalysis (STAN) database.¹⁹

Both Gini coefficient measures in Figure 1 indicate that the pharmaceutical industry is exhibiting a dispersion trend over this period. This finding is consistent with that in Midelfart-Knarvik et al. (2002), who use the same concentration measure and database to measure dispersion trends in the same industry before the 1990's. The E-G indices in Figure 2 show conflicting agglomeration trends, with the gross output index dispersing until the middle of the time period and then it became more concentrated, while the employment index shows a continuously dispersion trend.²⁰

While the balance of the evidence is in favour of dispersion rather than concentration, i.e., Venables/Puga rather than Krugman, there are clearly other factors which influence the pattern of agglomeration over this period, in addition to the falling trade costs. To explore this systematically we use discrete-choice models and firm-level data, using the level of industrial concentration to test whether that agglomeration positively or negatively affects individual firm location choice.

¹⁵ Data do not allow us to look at MNEs separately but these account for most of the change over the period.

¹⁶ The Location-Gini coefficient is defined as the area between the Lorenz curve and 45 degree line in a space where s_i , the pharmaceutical production share of country i in the data set that under investigation, is cumulated on the Y-axis and the number of countries cumulated on the X-axis with equal interval of width $1/N$. Countries are ranked by s_i . The E-G index (Ellison and Glaeser, 1997) is regarded as superior as it takes into account the part of geographic concentration which is caused by the size distribution at plant, or in our case, firm level.

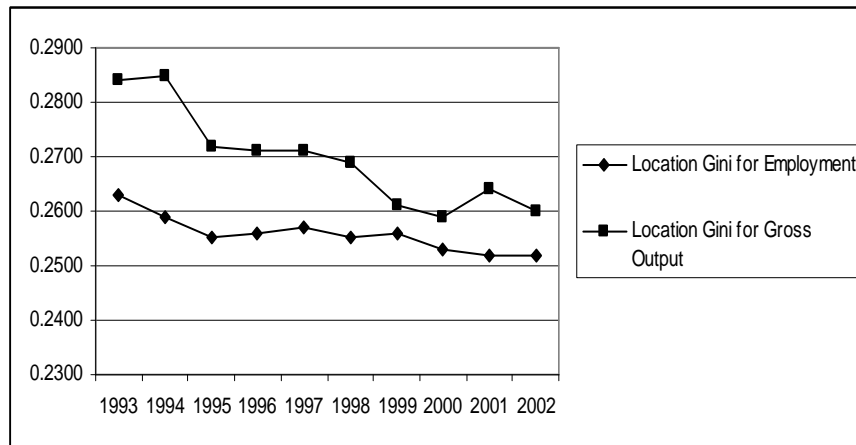
¹⁷ The terms concentration and agglomeration are used interchangeably in this paper and both refer to the distribution pattern of industry production in given geographic area (countries in this paper).

¹⁸ Due to data availability, we can only calculate the Gini coefficients and the E-G indices for 14 European countries from 1993 to 2002. These countries are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden, and the UK.

¹⁹ Both employment and output are used – neither is perfect: the former may be biased due to productivity differences across countries, while the latter may be biased due to price difference across countries.

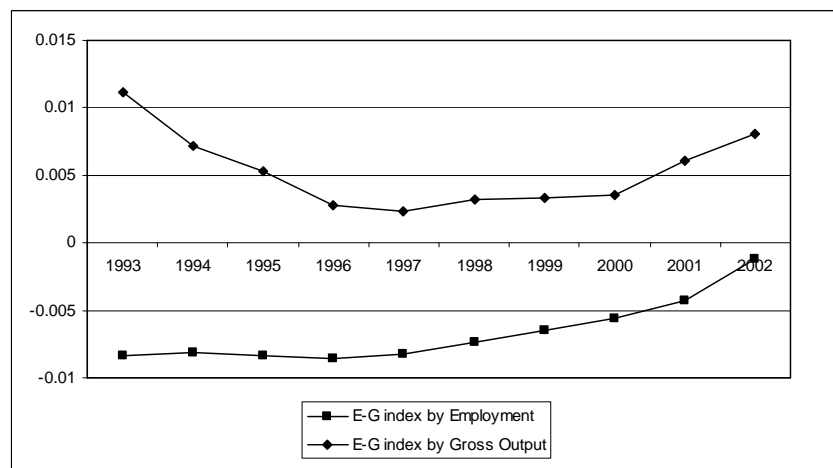
²⁰ The index approaching (deviating from) 0 means more (less) dispersion.

Figure 1: Location-Gini Coefficients of Pharmaceutical Production for Selected European Countries



Source: (OECD STAN Data, EU14, excl. Luxembourg.)

Figure 2: E-G Indices of Pharmaceutical Production for Selected European Countries



Source: (OECD STAN Data, EU14, excl. Luxembourg.)

3.3 Data Description

Our study is focused on the location choices of MNEs taking place between 1993 and 2004 in the pharmaceutical industry²¹ in EU15 countries (excluding Luxembourg).²² We include all MNE subsidiaries, irrespective of the parent nationality. Two types of location choices are considered. The first type is the choice of location

²¹ The pharmaceutical industry is defined according to NACE Rev.1.1 industry code at 3-digit level. The 3-digit NACE code for the pharmaceutical industry is 244 and two 4-digit codes are assigned to its sub-industries: 2441 (manufacture of basic pharmaceutical products) or 2442 (manufacture of pharmaceutical preparation).

²² They are Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden, and United Kingdom.

amongst existing high-performance subsidiaries at which production is to expand, where high-performance subsidiaries are defined as those with above-median rates of output growth. We look at these particular subsidiaries because it is to be expected that subsidiaries would expand at higher growth rates in the more attractive country locations. The second type is the choice of location for new start-up subsidiaries. We analyse these two types separately, because while they are both vehicles of production relocation, they reflect different considerations for MNEs in terms of country-level characteristics. In particular, expanding production in an existing subsidiary generally involves negligible sunk costs compared with starting up a new subsidiary.

Expanding and new MNE subsidiary firms are identified in, and their data are extracted from, a commercial dataset “*Amadeus*”, which contains accounts data on firms located in Europe.²³

The year 1993 is chosen to distinguish between the existing firms and new firms, so no pharmaceutical firm exists in both samples.²⁴ After applying certain size criteria²⁵, we initially find 725 existing subsidiaries, which were established before 1993. Further investigation allows us to identify 444 subsidiaries out of 725 that have complete production data in both 1995 and 2003, which are necessary for one to calculate the scale of production change. The ‘high-performance’ subset contains 222 subsidiaries in EU 15.²⁶ The “new-firm sample” contains the 129 new subsidiaries that were established between 1993 (inclusive) and 2004 in EU 15.²⁷

In Appendix 2, Tables A1 – A4 summarize the descriptive statistics and location distribution (by parent nationality) of the high-performance firms and new firms respectively.²⁸ Comparing mean and median values for the high-performance firms, we can see that the distribution of employees, turnover and fixed assets is skewed towards larger firms; the distribution of age is skewed to older firms; and the

²³ A brief description of the *Amadeus* database and details about how we identified our sample MNEs and their subsidiaries is set in Appendix 1.

²⁴ Moreover, since in the *Amadeus*, firms’ accounts from 1995 are better (in terms of completeness) than those in 1993, we calculate the growth rates of turnover of each existing pharmaceutical firm for the period between 1995 and 2003.

²⁵ Because data for small firms are generally poor in the *Amadeus*, we only choose those firms can meet at least one of the three size criteria: turnover greater than 12 million USD, or number of employees greater than 150, or total assets greater than 12 million USD.

²⁶ These firms were located in only 11 of the EU-15 countries: Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Portugal, Spain, Sweden, and UK.

²⁷ These new firms were established in only 11 of the EU-15 countries: Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Spain, Sweden, and UK.

²⁸ The MNE parent’s nationality is decided by headquarter’s location.

distribution of growth rates is skewed towards fast-growing firms. For the new firms, the same features can be observed, except in the case of age which is skewed towards younger firms.

Turning to the geographic distribution of firms, we see that France, Italy, Spain and UK account for the majority of high-performance firms during the period between 1995 and 2003, while France, Spain and UK account for the majority of new firms established. We also note that, relative to land and population size, both Belgium and Ireland account for a significant number of new firms. The relatively low representation of Germany in both samples may in part be due to the fact that German firms are underrepresented in the *Amadeus*.

3.4 Explanatory Variables and Empirical Models

Based on the location choice theory and on the NEG theories we construct three sets of explanatory variables: industry-specific (pharmaceutical) country-level variables, country level variables and firm-specific variables.²⁹

Industry-Specific Country-level Variables

Market Variables: Following the location choice literature, we choose the national consumption of drugs and medicines (million USD), as a variable to proxy national market size [*MKSIZE*] in each country. We want to test whether, after the implementation of SMP after 1993, the national market size still matters to MNEs looking for the place where to expand production or build up new facilities.

Pharmaceutical Labour Costs: To take account of national differences in production costs, labour costs per employee [*LCOST*] in the pharmaceutical industry in each country is derived from the OECD STAN database. Assuming that we can account for quality, we expect a negative sign on *LCOST*.

Agglomeration Variables: Following other studies³⁰, sets of absolute and relative measures are constructed. We use the number of foreign-owned firms in the

²⁹ In current work we are exploring the differences between home-country source variables, distinguishing between whether the parent is EU or non-EU.

³⁰ Agglomeration forces are seen as playing an important role in location-choice studies by Bartik (1985), Head et al. (1995), Hogenbirk and Narula (2004) and Disdier and Mayer (2004).

pharmaceutical industry [*PHAR1*] in each country to measure the absolute agglomeration of this industry in each country. The foreign-owned firm is defined as the firm with foreign ownership of at least 25 per cent share. In addition to measuring the presence of foreign firms at country level, we also expect this variable to capture the country-level characteristics that were internalised in these location decisions made by foreign MNEs. As a robustness check, we also use the number of both domestic and foreign-owned firms, [*PHAR2*], in the pharmaceutical industry to measure agglomeration, where this variable is adjusted for certain size criteria.³¹ If there is an agglomeration process underway due to falling trade costs, the NEG models suggest that individual MNEs will follow that trend. Given the mixed results found in Section 3.2, we have no *a priori* sign for these variables. For relative measures, we use total manufacturing as a reference point in each case to create [*PHARSHR1*], [*PHARSHR2*]. These relative measures also have the additional advantage of being less likely to be correlated with the Market Size variable than the absolute measures of agglomeration.³²

Because some of the agglomeration effects linked to location choice focus on upstream/down-stream linkages, to take account of the possibility that the pharmaceutical industry may co-locate with the chemical industry, we include two corresponding chemical-industry agglomeration variables, namely, the number of foreign-owned firms [*CHEM1*] and that of domestic and foreign-owned large firms (with the same size criteria applied) [*CHEM2*], and a positive sign is expected.³³ The corresponding relative measures for the Chemical industry are created on the same basis as the Pharmaceutical sector variables as [*CHEMSHR1*] and [*CHEMSHR2*].

Generic Country-level Variables

Corporate Tax Rate: We use the effective average tax rate [*EATR*] generated by Devereux and Griffith (2003) to measure corporate tax rates. A negative effect on

³¹ To avoid including small firms, we only choose those firms can meet at least one of the three size criteria: turnover greater than 12 million USD, or number of employees greater than 150, or total assets greater than 12 million USD. The same size criteria are applied to the selection of existing firms in Section 3.3. If one takes into account all manufacturing firms in one country as a variable of agglomeration, this large number of firms inevitably captures the effects of other determinants which are considered by MNEs, therefore such variable will blur the identification of other determinants.

³² *PHARSHR1* is the share of firms in the pharmaceutical sector in that of all manufacturing sectors, where firms are constrained to foreign-owned with size criteria applied. *PHARSHR2* is defined in the similar way but firms are constrained to both domestic and foreign-owned.

³³ NEG theories strongly support such a positive sign since there is not perceived negative effect due to competition.

output expansion and new start-up can be expected, as shown in Devereux and Griffith (1998) for US MNEs' location choices in three European countries.

Geographic Variables: In the NEG theories, trade costs are conceived as a mixture of various factors that hinder the free movement of goods between countries, e.g., tariffs and quotas, non-tariff barriers, customs inefficiency, transportation costs, etc. It is not possible to find a simple variable that can take account of all these costs,³⁴ so we use the Euclidean distance to proxy transportation costs, where the distance measure [*DIST*] is that from each country's capital city to Brussels.³⁵ We expect that the larger is the distance from one country to Brussels, the higher the costs of accessing European market are for a manufacturer from this country and thus the lower the probability of this country being chosen.³⁶ Furthermore, since this analysis uses national market rather than potential market as a variable in the location choice equation, we anticipate that this variable will capture some of what is captured in a Harris-type potential market measure.

Following Bartik (1985), Woodward (1992) and Hogenbirk and Narula (2004), we also include land mass [*AREA*] in the specification for the new-firm sample in order to control for dart-board effects, i.e., the larger is the land mass of a country, the more new investments it can take if all other country-level characteristics are the same.

Infrastructure: In order to capture the quality of infrastructure within a country, which is likely to impact on production costs, we include a measure of motorway density (km per million inhabitants) which is derived from a combination of EUROSTAT and OECD data.

MNE-specific Country-level Variable

Familiarity: A familiarity variable [*FAM*] is generated for each firm in the new-firm sample. It equals 1 for a country if a new firm in that country has an MNE parent or sister subsidiary already located in that country.³⁷ Potentially, this indicator variable might capture an MNE's knowledge of a particular country's business

³⁴ We focus on distance only on the grounds that other trade costs have been reduced by the Single Market.

³⁵ Brussels is chosen because, according to an industry specialist consulted, it is seen by many leading pharmaceutical MNEs as the key distribution centre in Europe.

³⁶ A limitation of this variable is that its accuracy depends on the assumption that pharmaceutical production within a country is near its capital city. A close look at the firm-level data used here reveals that this is true for most of the countries under investigation but less true for Austria, Germany, Italy, and Spain.

³⁷ By this definition, *FAM* can be regarded as a hybrid variable at both country-level and firm-level.

environment, its intra-country upstream-downstream linkages, or its marketing network in that country. Familiarity is confirmed as having a positive impact on MNEs' overseas investments in Rangan (2000), which finds that MNEs invest more in 'familiar' countries.

All country-level variables are listed along with their sources and expected signs in Appendix 3.

3.5 Specification of Equations

All explanatory variables enter the CLM equations in logarithm form except those variables that are in percentage form.³⁸ The use of logarithm-form variables allows us to interpret the coefficients as elasticities, while the coefficients of ratio-form and percentage-form variables can be roughly interpreted as elasticities as well. For the high-performance sample, most country-level variables enter the model as their average values, based on as many years as available over sample period, with agglomeration variables lagged by one year prior to the sample to reduce endogeneity.³⁹ For the new-firm sample, where possible, all country-level variables are lagged one year prior to the year when a firm was established, in order to minimize the simultaneity problem and to account for the fact that decisions to locate are influenced by what happens in the period prior to the investment.

Equations (1) and (2) below are the baseline models for the high-performance and new firm samples. The baseline models include the four key variables that the location choice literatures identifies as impacting directly on the location of MNEs, namely, market size (to capture the market seeking driver), labour costs (to capture the drive to seek low-cost locations for production), infrastructure (as a measure of the state of development of the country) and corporate taxes (as a measure of the main negative fiscal instrument perceived by MNEs). The strategy is to estimate the baseline model and then explore the impact of introducing alternatively the various alternative agglomeration variables. In addition, we explore how including the distance and familiarities variables impacts on MNEs. The baseline models for the high-performance sample and new-firm sample are

³⁸ For example, PHARSHR1/2, CHEMSHR1/2, EATR.

³⁹ Expansion took place over the period from 1995 to 2003 and it was continuously influenced by the country-level variables and their changes in every year; therefore variables in any single year cannot capture their aggregated effects on expansion.

$$\begin{aligned} & \Pr(y = k | 1, \dots, J) \\ & = \Lambda(\beta_1 \ln MKSIZE + \beta_2 \ln LCOST + \beta_3 \ln MOTDEN + \beta_4 EATR + \varepsilon), \end{aligned} \quad (1)$$

$$\begin{aligned} & \Pr(y = k | 1, \dots, J) \\ & = \Lambda(\beta_1 \ln MKSIZE + \beta_2 \ln LCOST + \beta_3 \ln MOTDEN + \beta_4 EATR + \beta_5 \ln AREA + \varepsilon), \end{aligned} \quad (2)$$

4. Location-Choice Results

Before describing empirical results, we note first that the estimated coefficients can be adjusted to allow interpretation as average probability elasticity (APE) following Head et al. (1995) and Head and Mayer (2004). The APE of a variable is calculated as

$$b_k(1 - Pr),$$

where b_k is the coefficient of the variable k and Pr equals to $\frac{1}{L}$ with L being the number of alternative countries in the choice set. In this study, there are eleven countries in each sample so one needs to multiply the coefficients of logarithm-form variables by a parameter of 0.91 to get APE. The coefficients of percentage-form variables can also be roughly interpreted as elasticities as well (see Bartik, 1985, pp. 18-19).

4.1 Results for the High-expansion Sample

Table 1 reports the results for the baseline model and its extensions to include two alternative absolute measures of pharmaceutical agglomeration with and without the distance to Brussels. Starting with the baseline model in Column 1, we find that the pharmaceutical market size ($\ln MKSIZE$) has statistically significant and positive effect on location choice, with an APE of 0.9.⁴⁰ This finding is consistent with the results found in other studies and it suggests that market size still matters in the Single Market despite the fact that the additional costs of transacting across national borders are supposed to be negligible.

The labour-cost variable ($\ln LCOST$) is found having no significant impact on location choice, while $\ln MOTDEN$, serving as a proxy to the development of

⁴⁰This implies that a 10 per cent increase in a country's market size will increase the probability of this country being chosen by 9 per cent.

infrastructures, is found to have a positive effect that is significant at 1 per cent level. As would be expected, the impact of the effective average tax rate (EATR) is negative and it is statistically significant at 1 per cent level. Its APE is approximately -0.1 per cent.

When we add the first pharmaceutical agglomeration variable, $\ln\text{PHAR1}$, we find its coefficient (Col 2) is only significant at 10 per cent level and the APE is approximately 0.3 per cent. The other variables in the baseline model do not change their sign and significance level. When we include $\ln\text{DIST}$ (Col 3), to test whether the closeness to the European “market hub” Belgium, we find it has a negative effect, that is significant at 5 per cent level. This means MNEs were more likely to expand production in those counties that are closer to the European geographic centre, as result consistent with MNEs in the post SMP environment taking the integrated EU market into account as well as the national market. In this specification, where $\ln\text{MKSIZE}$ has positive and significant effect, $\ln\text{PHAR1}$ is no longer statistically significant while $\ln\text{LCOST}$ shows a significant (expected) negative effect. These results imply that the agglomeration of foreign-owned pharmaceutical firms does not have stable effect when specification changes.

In Columns 4 and 5 we re-estimate Columns 2 and 3 using the alternative agglomeration variable $\ln\text{PHAR2}$, which takes account of the national size of the pharmaceutical sector. $\ln\text{PHAR2}$ shows highly significant positive effect in two specifications (Column 4/5), but, perhaps not surprisingly because of the strong correlation effects one would expect to find between market size and these two absolute agglomeration variables, the effect of market size is no longer significant in either of these two specifications. In this specification $\ln\text{DIST}$ does not have a significant effect either (Column 5). To control for the likely correlations, we replace $\ln\text{PHAR1}$ and $\ln\text{PHAR2}$ with their relative versions and the results are reported in Table 2.

The last four columns in Table 2 show that, after controlling for the correlation between market size and agglomeration, we find that both effects are significant in each specification. On the other hand, labour costs and distance to Brussels only show their expected and significant effect in one specification (Column 3), while the effects of infrastructure and EATR consistently give the expected signs at the one or five percent levels throughout all specifications.

Looking at both absolute and relative agglomeration variables, we find that out of eight specifications when one of each variable presents, in seven cases the agglomeration measure has a significant positive coefficient. Therefore, given that trade costs were lower and possibly still decreasing in the post-SMP era, we find the potential agglomeration force did work in a systematic direction on MNE choice. This is consistent with Krugman's model or to Venables and Puga's model in the range where trade-cost are moving from a very high to a medium level – in other words, before congestion costs arise. We conclude that, at firm level, agglomeration forces influence location choices for firms expanding production. In effect, the firms that are expanding production relatively are located in countries of high agglomeration, where agglomeration is measured by the large pool of other foreign-owned pharmaceutical firms or to the total presence of firms that are at the upper tail of the size distribution.

Tables 3 and 4 repeat the analyses in Tables 1 and 2, but on this occasion replacing the pharmaceutical agglomeration variables with the parallel measures for the chemical industry. We find that the coefficient of the narrower measure of agglomeration, $\ln\text{CHEM1}$, is statistically significant in Column 2 but loses significance in Column 3 when the distance measure is included. However, the broader measure of chemical agglomeration, $\ln\text{CHEM2}$ has stable positive effects in two specifications (Column 4 and 5), a finding that is consistent with the input-output linkages in the Venables' and Puga's models, which predict that pharmaceutical production should be attracted to the location where the chemical industry agglomerates. Other variables generally have stable and expected effects across specifications other than the baseline model.

In Table 4, relative chemical agglomeration ($\text{CHEMSHR1}/\text{CHEMSHR2}$) show significant effects in all specifications they appear, again supporting the input-output linkage and further confirming that pharmaceutical MNEs were not only attracted by the linkage between foreign-owned chemical firms, but also attracted by the linkage building at wider upward industry presence of both domestic and foreign-owned firms.

Taking the results for high –expansion location choices together, we can link these results to the NEG theory's implication to the Single Market Programme as follows:

- 1). National market size still attracted MNEs while location close to the European pharmaceutical distribution centre was also preferred by MNEs. Midelfart-Knarvik et al. (2002) noted, a dispersion trend in pharmaceutical production away

from the European geographic centre, Belgium for the period prior to 1990.⁴¹ Our finding from firm's perspective, suggests a contrary outturn, i.e., no evidence of a dispersion trend after the implementation of the SMP. Although general expectation in the post-SMP era is that national market would not matter any more, our analysis suggests that the two markets at national level and European level were both important considerations to MNEs. Moreover, NEG theory's traditional logic of trade costs-agglomeration relationship is that: as trade costs decrease, firms tend to agglomerate together to enjoy economic benefit of access to intermediate goods provider, labour pool and spill-over. But our finding that MNEs tend to be closer to the European pharmaceutical distribution centre proves a new economic benefit source: logistic convenience, which will have influence on the rationalisation of pharmaceutical production by MNEs' in Europe.

2). Agglomeration in the pharmaceutical industry was preferred by MNEs when making location decision regarding production expansion. This finding is in line with both Krugman and Venables-Puga's prediction of agglomeration trend given decreasing trade costs. At the same time the input-output linkage between the pharmaceutical and chemical industry also mattered, which is supporting Venables-Puga's models which feature such linkage.

Before turning to look at the New Firm Sample, we note that two variables (motorway density and EATR) have robust effects across all specifications, while the effect of labour costs is not robust, but whenever it has a significant coefficient, it is negative as location choice theory would suggest.

4.2 New-firm Sample

A key feature to emerge in looking at the New Firm Sample is that the results are less robust than those for the high-performance sample. In Table 5 we report the baseline model and its extensions to include separately the two agglomeration variables, with the distance and familiarity variables being added sequentially. In Column 1, both $\ln\text{MKSIZE}$ and EATR have the expected signs, which are significant at the 1 percent level. However, $\ln\text{LCOST}$ has a positive coefficient and it is statistically significant at 1 per cent level. This positive effect is difficult to explain,

⁴¹ Specifically they noted that “12% of Drugs & Medicines production moved out of Germany and Italy and this production was primarily absorbed by Denmark, the UK, Ireland and Sweden.(pp.235)”

but possibly it is signalling the labour quality of high-wage labour to the new potential investor. The two remaining base case variables, $\ln\text{AREA}$ and $\ln\text{MOTDEN}$ do not have significant coefficients – the former is in strong contrast with the result we obtained for the high-performance sample while the latter runs against the common expectation that large country is able to receive more new investment.

The inclusion of $\ln\text{PHAR1}$ in the baseline model yields a significant and positive coefficient but its inclusion causes $\ln\text{MKSIZ}$ to lose its significance, while $\ln\text{MOTDEN}$ has a significantly positive coefficient. This again shows that the correlation between market size and absolute agglomeration may undermine the identification of their effects. The addition of $\ln\text{DIST}$ (Column 3), which has a highly significant negative coefficient, causes several baseline-model variables to lose significance (EATR , $\ln\text{MOTDEN}$, $\ln\text{LCOST}$). In effect, $\ln\text{PHAR1}$ is the only variable that does not lose its significance (but only significant at 5 per cent level now), while $\ln\text{AREA}$ becomes highly significant with the expected positive sign. In Column 4, the strong and statistically significant effect of FAM suggests that perhaps risk aversion plays a strong role in the decision-making process for new subsidiaries in that they are located where existing subsidiaries are already operating. In this version, the positive effect of $\ln\text{PHAR1}$ is only significant at 10 per cent level.

Columns 5-7 repeat the analysis where the agglomeration variable is $\ln\text{PHAR2}$, which is a wider definition of pharmaceutical firms' presence. The results show a broadly similar pattern of variation in the sign, size and significance level of coefficients, though the coefficients of the market size variable are negative and significant at 5 or 10 per cent. The variation of variables' effects casts some doubt over their robustness, and may in part reflect the smaller sample size in the new-firm sample. However, we still are able to identify four variables having consistent effects across specifications. They are $\ln\text{PHAR1/2}$, $\ln\text{DIST}$ and FAM . In particular the inclusion of $\ln\text{DIST}$ causes considerable variation to other variables' effects, suggesting that closeness to the European pharmaceutical distribution centre is the key determinants of MNE's decision of new-firm creation.

As before, to minimise the possible correlation between $\ln\text{PHAR1/2}$ and $\ln\text{MKSIZ}$, we replace $\ln\text{PHAR1/2}$ with their relative counterparts, PHARSHR1/2 and the results are reported in Table 6. As we can see, across six specifications (Column 2 – Column 7), the effects of the first five baseline-model variables are not stable. In addition, PHARSHR1 , the share of foreign-owned firms to all firms in the

pharmaceutical industry, does not have effect at all, but PHARSHR2, the share of large foreign-owned pharmaceutical firms to that in total manufacturing sectors, shows positive and significant effects. On the other hand, the analysis confirms the importance of proximity to Brussels (lnDIST) and the locating MNE parents having an existing country presence in increasing the probability of a country being chosen.

Turning to look at the impact of the chemical sector on new firm location choice, Tables 7 and 8 test the effect of absolute and relative agglomerations respectively. Table 7 shows that CHEM1 has positive and significant effects in two out of three specifications but CHEM2 does not any effect in all specifications it presents. This suggests that it is the presence of foreign owned chemical firms and not just the larger number of chemical enterprises in the country that impacts positively on MNE location choice. In addition, we still observe substantial variation in the sign, size and significance level of coefficients for those baseline-model variables but the effects of the distance and familiarity variables are robust across specifications. In Table 8, the relative measures of chemical agglomeration only appear to have significant coefficient in one specification (Column 5) but not for the rest five specifications.

To summarise the findings of the new-firm sample, we find that

1). The effects of several country-level variables - national market size, labour costs, infrastructure, corporate tax rate – that are commonly seen as important to the location choice of MNEs are not stable. This finding suggests that when pharmaceutical MNEs were making location decisions that where to build up new production facilities, they were not particularly concerned with county-level favourable characteristics, unless they were already familiar with that country. This, combined with the significance of the lnDIST variable, is consistent with their taking a Europe-wide view of the pharmaceutical market, seeking locations that are close to the European distribution centre, namely, Brussels.

2). In terms of agglomeration effects, results in Table 5 and 6 imply that pharmaceutical agglomeration encouraged MNEs to locate their new firms to the country with greater presence of pharmaceutical firms, irrespective of whether they were domestic or foreign-owned. Tables 7 and 8 suggest that the input-output linkage effects are not strong in the case of new firm location.

4.3 Comparison of Two Samples

Table S1 summarizes the identified determinants for the high-expansion sample and the new-firm sample.

Table S1

	High-expansion Sample	New-firm Sample
	Effect	Effect
Market size	+	No robust effect
Labour costs	- (not always significant)	No robust effect
Motorway density	+	No robust effect
EATR	-	No robust effect
Land mass	na	+ (not always significant)
Agglomeration in pharmaceuticals	+	+ (not always significant)
Agglomeration in chemicals	+	+ (not always significant)
Distance to Brussels	-	-
Familiarity	na	+

In the table, the common determinants for both location decisions are agglomeration and the distance from Brussels. These two determinants work in the direction predicted by NEG models: lower trade costs encourage firms to agglomerate and in doing so, to have better access to the enlarged EU market, they locate closer to Brussels.

The market size, labour costs, motorway density and the tax rate only matter in a robust way in the high-expansion sample, while familiarity of local environment is the unique determinant for the new-firm creation. Therefore, when making the decision of where to expand production, pharmaceutical MNEs appear to respond more to country-level characteristics than they do when they make decisions on where to start up new production facilities.

4.4 Further Extensions

There are several potential improvements of our location-choice model. One obvious one is to use the market potential rather than the domestic market to capture the market pull on location, i.e., its domestic market size plus its potential for MNEs to access to other national markets from this country. Such a variable seems to be more suitable for MNEs' location choices in the EU conducted in post-SMP era because firms have more opportunities to get access to a broad market. This would apply particularly to the new firm sample. A Krugman market potential (Krugman, 1992) and Harris market potential (Harris, 1954) were used in Head and Mayer (2004) to study Japanese firms' location choice in the EU. In preliminary work in this direction, we have used the simpler Harris market potential and find that this inverse-distance weighted market size does have significant positive effect on pharmaceutical MNEs' location choice. However, because the specification including Harris market potential is not perfectly comparable to the specifications presented in this paper, we do not report that preliminary result here but it is available upon request.

Our samples of production expansion and new-firm creation cover a wide range of MNEs in terms of their ownership and size. We are currently looking at the question of whether MNEs were responding to different country-level characteristics in different way according to their heterogeneity. Specifically, we would like to study the possible different location choice responses of EU, non-EU MNEs and top world MNEs. The former MNEs by definition are already in the EU, while non-EU MNEs may be facing a two-tiered choice – whether to locate in Europe at all and if yes, in which country.

The next issue concerns the performance of the conditional logit model. It is well known that the CLM has a strong and restrictive property that is called “Independence from Irrelevant Alternatives (IIA) property”. In earlier work of this paper we have tested the validity of the IIA in our data and found that a mixed logit model is more suitable; however, due to time constraint we have not yet applied the mixed logit model in the current framework.

5. Summary and Some Concluding Thoughts

This paper reports preliminary results from a study of location choice in the European pharmaceutical industry between 1993 and 2004. Our motivation for the study was the opportunity this industry created to explore the role of agglomeration in location choice and whether the domestic market continues to be an important driver of location choice in what has traditionally been a highly-segmented market. Indices of geographical concentration (Location-Gini coefficients; E-G index) based on aggregate sectoral output data in European pharmaceutical indicated mixed trends in agglomeration at national level across EU member states since 1993. Our focus is on the MNE contribution to this process, since MNE production is relatively more footloose and therefore can respond more readily to different factors. We then tested whether the agglomeration of pharmaceutical production in the EU was increasing or not from the firm's perspective, by linking pharmaceutical multinationals' decisions of where to expand production or create new firms to the national agglomeration level of this industry prior to that decision being taken. This was done using a discrete-choice model of location, which allowed us to explore the impact of past agglomeration in the context of the other country-level variables that influence pharmaceutical MNE location choices. We estimated two models, one based on: subsidiary firms that experienced high levels of output expansion in the period between 1995 and 2003, and new subsidiary firms that were established after 1993.

Our results suggest that the local market continues to be a driver of MNE production where this is produced in existing plants. In other words, MNEs are continuing to expand where the local markets are large. This contrasts with the location of production of new firms, where the impact of the local market, while positive in the base model, is not as robust to the inclusion of other variables, especially the agglomeration variables. The same results arise for corporate tax rates, which have a consistently negative effect on location choice for expansion by existing plants but the negative effect in the base model for new firms is not robust. In the case of new firms, proximity to Belgium (the distribution centre for European pharmaceuticals) and the familiarity with particular countries (as measured by having plants already in those countries) are important drivers.

Our analysis is limiting in several ways and some of these have already been identified in Section 4.4. We also see further potential in dividing the period in two so

that we can see whether the tendency to agglomeration happened more in the earlier period after 1993 than in the more recent period. There is also the possibility of exploring whether the inclusion of within-country variables, and in particular how a measure of agglomeration at the sub-national level, would impact on the results. Our model implicitly assumes that the distribution of plants within countries is identical, which is clearly restrictive.

Our results are broadly in line with those in the literature, but comparison of our results with those of Head et al. (1999) and Head and Mayer (2004) would best await our separate analysis of EU and non-EU firms. Whether these results from the pharmaceutical sector can be generalised is unknown – but it may be of interest to compare with one of the other very globalised sectors, namely, electronics. The possibility of a significant change in the geographic location of these sectors in Europe is considerable given the inherent dynamics in the two sectors.

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Table 1. CML: Determinants of the Location Choice
High-expansion Sample; Time Period: 1995 - 2003

	Column1 (Baseline)	Column2	Column3	Column4	Column5
lnMKSIZ	0.985*** (0.111)	0.774*** (0.170)	0.968*** (0.199)	0.054 (0.235)	0.113 (0.262)
lnLCOST	-0.234 (0.324)	-0.329 (0.333)	-1.125** (0.532)	0.205 (0.324)	-0.061 (0.581)
lnMOTDEN	0.707*** (0.166)	0.864*** (0.185)	0.877*** (0.190)	1.091*** (0.176)	1.100*** (0.178)
EATR	-0.129*** (0.021)	-0.128*** (0.021)	-0.146*** (0.023)	-0.081*** (0.025)	-0.086*** (0.027)
lnPHAR1		0.316* (0.180)	0.175 (0.193)		
lnPHAR2				0.944*** (0.260)	0.919*** (0.267)
lnDIST			-0.293** (0.148)		-0.081 (0.146)
# of Obs.	222	222	222	222	222
Log-likelihood	-440	-438.4	-436.4	-427.6	-427.4

Table 2. CML: Determinants of the Location Choice
High-expansion Sample; Time Period: 1995 – 2003

	Column1 (Baseline)	Column2	Column3	Column4	Column5
lnMKSIZ	0.985*** (0.111)	0.986*** (0.113)	1.214*** (0.154)	0.958*** (0.116)	0.979*** (0.140)
lnLCOST	-0.234 (0.324)	0.029 (0.357)	-1.307** (0.589)	0.019 (0.334)	-0.166 (0.767)
lnMOTDEN	0.707*** (0.166)	0.458** (0.207)	0.456** (0.217)	0.866*** (0.173)	0.867*** (0.173)
EATR	-0.129*** (0.021)	-0.099*** (0.026)	-0.118*** (0.026)	-0.103*** (0.022)	-0.109*** (0.031)
PHARSHR1		0.164** (0.084)	0.237*** (0.091)		
PHARSHR2				0.242*** (0.081)	0.218* (0.121)
lnDIST			-0.463*** (0.157)		-0.056 (0.208)
# of Obs.	222	222	222	222	222
Log-likelihood	-440	-438	-433.3	-435.3	-435.2

Note: *** significant at 1 per cent, ** significant at 5 per cent level, * significant at 10 per cent level; standard error in parentheses; the coefficients can be interpreted as average partial elasticity (APE) after being multiplied by 0.91. See Section 4 for details about the calculation of APEs.

Table 3. CML: Determinants of the Location Choice
High-expansion Sample; Time Period: 1995 – 2003

	Column1 (Baseline)	Column2	Column3	Column4	Column5
lnMKSIZ	0.985*** (0.111)	0.716*** (0.178)	0.904*** (0.210)	0.450* (0.250)	0.488** (0.228)
lnLCOST	-0.234 (0.324)	-0.644* (0.373)	-1.246** (0.513)	-0.612* (0.353)	-2.320*** (0.653)
lnMOTDEN	0.707*** (0.166)	1.003*** (0.216)	0.967*** (0.218)	0.766*** (0.165)	0.924*** (0.171)
EATR	-0.129*** (0.021)	-0.152*** (0.024)	-0.159*** (0.024)	-0.117*** (0.022)	-0.159*** (0.027)
lnCHEM1		0.480** (0.228)	0.301 (0.245)		
lnCHEM2				0.681** (0.293)	0.951*** (0.294)
lnDIST			-0.270* (0.151)		-0.503*** (0.153)
# of Obs.	222	222	222	222	222
Log-likelihood	-440	-437.7	-436.1	-437.1	-431.4

Table 4. CML: Determinants of the Location Choice
High-expansion Sample; Time Period: 1995 – 2003

	Column1 (Baseline)	Column2	Column3	Column4	Column5
lnMKSIZ	0.985*** (0.111)	1.065*** (0.119)	1.350*** (0.174)	1.124*** (0.128)	1.151*** (0.136)
lnLCOST	-0.234 (0.324)	-0.248 (0.322)	-1.772*** (0.619)	-0.990*** (0.352)	-1.217** (0.518)
lnMOTDEN	0.707*** (0.166)	0.468** (0.196)	0.481** (0.200)	0.598*** (0.155)	0.629*** (0.164)
EATR	-0.129*** (0.021)	-0.113*** (0.023)	-0.149*** (0.026)	-0.135*** (0.023)	-0.142*** (0.026)
CHEMSHR1		0.075** (0.035)	0.105*** (0.037)		
CHEMSHR2				0.216*** (0.054)	0.199*** (0.061)
lnDIST			-0.478*** (0.157)		-0.099 (0.162)
# of Obs.	222	222	222	222	222
Log-likelihood	-440	-437.7	-432.6	-431.7	-431.5

Note: *** significant at 1 per cent, ** significant at 5 per cent level, * significant at 10 per cent level; standard error in parentheses; the coefficients can be interpreted as average partial elasticity (APE) after being multiplied by 0.91. See Section 4 for details about the calculation of APEs.

Table 5. CLM : Determinants of the Location Choice
New-firm Sample; Time Period: 1993 - 2004

	Column1 (Baseline)	Column2	Column3	Column4	Column5	Column6	Column7
lnMKSIZ	0.493*** (0.170)	-0.253 (0.307)	-0.477 (0.378)	-0.592 (0.381)	-0.669* (0.384)	-1.156** (0.493)	-1.183** (0.497)
lnLCOST	1.770*** (0.577)	1.403** (0.608)	-0.902 (0.897)	-0.739 (0.908)	2.290*** (0.618)	-0.359 (0.923)	-0.259 (0.932)
lnMOTDEN	0.042 (0.206)	0.767** (0.304)	0.337 (0.313)	0.290 (0.314)	0.525** (0.253)	0.229 (0.259)	0.199 (0.261)
EATR	-0.071*** (0.023)	-0.064*** (0.024)	-0.013 (0.030)	-0.005 (0.031)	-0.033 (0.026)	0.033 (0.036)	0.034 (0.037)
lnAREA	0.041 (0.178)	-0.003 (0.207)	0.832*** (0.286)	0.897*** (0.292)	0.352 (0.218)	1.286*** (0.339)	1.298*** (0.345)
lnPHAR1		0.920*** (0.280)	0.615** (0.277)	0.524* (0.280)			
lnPHAR2					1.052*** (0.316)	0.976*** (0.318)	0.834*** (0.318)
lnDIST			-0.990*** (0.238)	-0.995*** (0.242)		-1.091*** (0.240)	-1.091*** (0.244)
FAM				1.134*** (0.245)			1.111*** (0.249)
# of Obs.	129	129	129	129	129	129	129
Log-likelihood	-273.6	-267.2	-258.1	-247.4	-267	-255.3	-245.4

Table 6. CLM : Determinants of the Location Choice
New-firm Sample; Time Period: 1993 - 2004

	Column1	Column2	Column3	Column4	Column5	Column6	Column7
lnMKSIZ	0.493*** (0.170)	0.480*** (0.175)	0.057 (0.238)	-0.135 (0.246)	0.245 (0.221)	-0.035 (0.256)	-0.219 (0.264)
lnLCOST	1.770*** (0.577)	2.056*** (0.632)	-0.746 (0.932)	-0.612 (0.947)	2.405*** (0.660)	0.039 (1.019)	0.060 (1.030)
lnMOTDEN	0.042 (0.206)	-0.013 (0.211)	-0.306 (0.254)	-0.231 (0.258)	0.382* (0.228)	0.078 (0.251)	0.071 (0.253)
EATR	-0.071*** (0.023)	-0.061** (0.025)	-0.005 (0.032)	-0.002 (0.033)	-0.012 (0.029)	0.008 (0.032)	0.012 (0.033)
lnAREA	0.041 (0.178)	0.066 (0.181)	0.986*** (0.296)	1.003*** (0.299)	0.272 (0.220)	0.849*** (0.279)	0.916*** (0.285)
PHARSHR1		0.127 (0.107)	0.200 (0.122)	0.143 (0.124)			
PHARSHR2					0.478*** (0.113)	0.276** (0.120)	0.232* (0.122)
lnDIST			-1.152*** (0.243)	-1.117*** (0.244)		-0.835*** (0.251)	-0.870*** (0.254)
FAM				1.153*** (0.248)			1.139*** (0.247)
# of Obs.	129	129	129	129	129	129	129
Log-likelihood	-273.6	-272.9	-259.5	-248.7	-263.6	-258	-247.4

Note: *** significant at 1 per cent, ** significant at 5 per cent level, * significant at 10 per cent level; standard error in parentheses; the coefficients can be interpreted as average partial elasticity (APE) after being multiplied by 0.91. See Section 4 for details about the calculation of APEs.

Table 7. CLM : Determinants of the Location Choice
New-firm Sample; Time Period: 1993 - 2004

	Column1	Column2	Column3	Column4	Column5	Column6	Column7
lnMKSIZ	0.493*** (0.170)	-0.188 (0.344)	-0.508 (0.456)	-0.625 (0.455)	0.450 (0.296)	0.050 (0.329)	-0.147 (0.342)
lnLCOST	1.770*** (0.577)	0.416 (0.784)	-1.940* (1.019)	-1.643 (1.037)	1.726*** (0.629)	-1.214 (0.983)	-0.989 (0.997)
lnMOTDEN	0.042 (0.206)	0.648** (0.327)	0.352 (0.360)	0.309 (0.359)	0.057 (0.224)	-0.126 (0.233)	-0.096 (0.235)
EATR	-0.071*** (0.023)	-0.086*** (0.025)	-0.033 (0.028)	-0.022 (0.029)	-0.071*** (0.023)	-0.030 (0.027)	-0.020 (0.028)
lnAREA	0.041 (0.178)	0.007 (0.194)	0.836*** (0.273)	0.899*** (0.280)	0.040 (0.178)	0.814*** (0.250)	0.882*** (0.260)
lnCHEM1		0.912** (0.382)	0.749* (0.432)	0.645 (0.432)			
lnCHEM2					0.054 (0.309)	0.133 (0.336)	0.104 (0.341)
lnDIST			-1.053*** (0.232)	-1.047*** (0.237)		-1.079*** (0.227)	-1.068*** (0.232)
FAM				1.154*** (0.245)			1.180*** (0.246)
# of Obs.	129	129	129	129	129	129	129
Log-likelihood	-273.6	-270.5	-259.2	-248.1	-273.6	-260.8	-249.3

Table 8. CLM : Determinants of the Location Choice
New-firm Sample; Time Period: 1993 - 2004

	Column1	Column2	Column3	Column4	Column5	Column6	Column7
lnMKSIZ	0.493*** (0.170)	0.483*** (0.171)	0.146 (0.216)	-0.072 (0.228)	0.499*** (0.180)	0.155 (0.222)	-0.068 (0.233)
lnLCOST	1.770*** (0.577)	1.778*** (0.579)	-1.042 (0.915)	-0.830 (0.921)	0.588 (0.737)	-1.093 (0.943)	-0.873 (0.957)
lnMOTDEN	0.042 (0.206)	0.106 (0.222)	-0.128 (0.264)	-0.072 (0.270)	-0.035 (0.209)	-0.150 (0.231)	-0.110 (0.237)
EATR	-0.071*** (0.023)	-0.074*** (0.023)	-0.029 (0.027)	-0.020 (0.028)	-0.061** (0.025)	-0.029 (0.027)	-0.019 (0.028)
lnAREA	0.041 (0.178)	0.014 (0.184)	0.790*** (0.263)	0.847*** (0.273)	0.069 (0.178)	0.795*** (0.255)	0.871*** (0.264)
CHEMSHR1		-0.031 (0.041)	-0.006 (0.044)	-0.012 (0.044)			
CHEMSHR2					0.194*** (0.074)	0.009 (0.089)	0.001 (0.090)
lnDIST			-1.064*** (0.227)	-1.047*** (0.232)		-1.057*** (0.252)	-1.058*** (0.254)
FAM				1.182*** (0.246)			1.181*** (0.246)
# of Obs.	129	129	129	129	129	129	129
Log-likelihood	-273.6	-273.3	-260.8	-249.3	-270.2	-260.8	-249.3

Note: *** significant at 1 per cent, ** significant at 5 per cent level, * significant at 10 per cent level; standard error in parentheses; the coefficients can be interpreted as average partial elasticity (APE) after being multiplied by 0.91. See Section 4 for details about the calculation of APEs.

Appendix 1. The Amadeus Database and Identification of Subsidiaries

Compiled by the Bureau Van Dijk, the *Amadeus* collects both public and private firm accounts for 38 European countries. It is able to provide researchers with comprehensive information on increasing numbers of firms from 1992. This information covers the balance sheet, the profit and loss account, various financial ratios, the ownership data, the industry classification code, address details and the year of incorporation. Therefore, it allows one to trace a firm's birth and evolution over time.

In the build-in ownership database in the *Amadeus*, each firm is linked to its shareholders and the value of each shareholder's share in that firm is available. We mainly rely on this ownership database to identify a subsidiary firm's parent. Sometimes, a firm may have more than one MNE shareholder, and its MNE shareholders may be inter-linked. Usually the *Amadeus* marks one of the MNE shareholders as the ultimate owner of the subsidiary firm. In the event that it does not, we define, from among all MNE shareholders a subsidiary has, the MNE shareholder that has the largest share (directly, or indirectly through other subsidiaries) as its ultimate owner. By doing so, each subsidiary is linked to only one MNE shareholder as its MNE parent, and all ultimate MNE parents defined by this way are independent of each other. Therefore, these clean "parent - subsidiary links" allow us to study ownership effect on MNEs' location choices (through subsidiaries).

By defining an ultimate owner as having the largest share in a firm, we avoid the complication of joint ventures. According to the ownership database in the *Amadeus*, only one joint-venture case where two parents have exactly 50 per cent shares each in a subsidiary is found, which is Bracco Spa, an Italian company owned equally by E.MERCK (Germany) and Brafina Finanziaria Spa (Italy). We somewhat arbitrarily treat Bracco Spa as the subsidiary of E.MERCK because E.MERCK is a leading European pharmaceutical multinational.

Appendix 2. Descriptive Statistics and the Locational Distribution of Two Samples

A1: Summary Statistics for the High-Performance Sample

Existing Pharmaceutical Firms Experiencing Above-median Growth in Terms of Turnover between 1995 and 2003, Value in 2003, Number=222

Variable	Mean	Median	Std.Dev.	Min	Max
No. of Employees	754.2	287	1,292.7	11	10,076
Turnover (thousand USD)	462,365.5	98,443	939,702.1	2,523	6,669,416
Fixed Assets (thousand USD)	314,650.4	25,870	1635887.7	8	18,724,261
Age (to 1993)	28.1	23	22	3	120
Growth Rate of Turnover (Ratio of Turnover in 2003 to Turnover in 1995)	23.6	3.2	183.1	2.1	2601

A2: Geographic Distribution of the High-Performance Sample (by Ownership)

Nationality	Location											Sum
	Belgium	Denmark	France	Germany	Greece	Ireland	Italy	Portugal	Spain	Sweden	Great Britain	
EU MNE Parent	6	4	46	5	4	2	21	7	39	2	12	148
US MNE Parent	3	0	10	2	1	0	10	1	8	0	13	48
Other Non-EU MNE Parent	1	0	8	1	0	1	9	0	3	0	3	26
Sum	10	4	64	8	5	3	40	8	50	2	28	222

A3: Summary Statistics for the New-Firm Sample

New Pharmaceutical Firms Established between 1995 and 2004, Value in 2003, Number=129					
Variable	Mean	Median	Std.Dev.	Min	Max
No. of Employees	316	152	449	14	2,960
Turnover (thousand USD)	155,809	44,933	407,725	1	3,304,014
Fixed Assets (thousand USD)	44,046	12,566	107,456	0	841,936
Age (to 2003)	5.7	6	3.0	1	11

A4: Geographic Distribution of the New-Firm Sample (by Ownership)

Nationality	Location											Sum (Share)
	Austria	Belgium	Denmark	Finland	France	Germany	Ireland	Italy	Spain	Sweden	Great Britain	
EU MNE Parent	1	6	2	3	29	5	4	4	11	4	7	76
US MNE Parent	0	4	0	0	9	2	3	2	0	1	4	25
Other Non-EU MNE Parent	0	2	1	1	9	2	2	0	3	0	8	28
Sum	1	12	3	4	47	9	9	6	14	5	19	129

Appendix 3. List of Country-Level Variables

Variable	Description	Expected sign	Source
PHAR1/2	Number of foreign-owned firms in the pharmaceutical sector with foreign owner has at least 25 per cent share. / Number of domestic and foreign-owned firms in the pharmaceutical sector.	?	OECD STAN industry data
PHARSHR1/2	Share of foreign-owned firms in the pharmaceutical sector (with foreign owner has at least 25 per cent share) to that of total manufacturing sectors. / Share of domestic and foreign-owned firms in the pharmaceutical sector to that of total manufacturing sectors. See footnote 32 for details.	?	OECD STAN industry data
CHEM/2	Number of foreign-owned firms in the chemical sector with foreign owner has at least 25 per cent share. / Number of domestic and foreign-owned firms in the chemical sector.	+	OECD STAN industry data
CHEMSHR1/2	Share of foreign-owned firms in the chemical sector (with foreign owner has at least 25 per cent share) to that of total manufacturing sectors. / Share of domestic and foreign-owned firms in the chemical sector to that of total manufacturing sectors.	+	OECD STAN industry data
MKSIZE	National consumption of drugs and medicines (millions USD, deflated to base year 1994).	?	OECD Health Data
LCOST	National labour compensation per worker in the pharmaceutical industry (euros). Labour compensation is defined as “wages as well as the costs of supplements such as employer's compulsory pension or medical payments.”	-	OECD STAN industry data
EATR	National effective average tax rate (per cent) created by Devereux and Griffith (2003).	-	The Institute for Fiscal Studies
DIST	Geographic distance from capital city to Brussels (km).	-	CEPII's dyadic CIA World
AREA	Land mass (sq. km) excluding water area.	+	Factbook 2006
MOTDEN	Motorway density in km per million inhabitants.	+	EUROSTA/OECD
FAM	Dummy variable =1 if for a firm, there are at least one other firm from the same MNE existed in a country, or a firm is located in the same country with the parent company.	+	Ownership Database in the <i>Amadeus</i>