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Taxes and the location of production: evidence from a panel of US multinationals

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Abstract

This paper considers the factors that influence the locational decisions of multinational firms. A model in which firms produce differentiated products in imperfectly competitive markets is developed, in the spirit of Horstmann and Markusen (1992). Firms choose between a number of foreign locations; the outside options of exporting to or not serving the foreign market are explicitly modelled. Particular attention is paid to the impact of profit taxes; the separate roles of effective average and marginal tax rates are identified. The model is applied to a panel of US firms locating in the European market. Agglomeration effects are found to be important. The effective average tax rate plays a role in the choice between locations, but not in the choice of whether to locate production in Europe compared with one of the outside options. © 1998 Published by Elsevier Science S.A.

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1. Introduction

Consider a firm which is deciding whether to enter a foreign market. It can follow one of three strategies: decide not to supply the foreign market; supply it by exporting goods produced at home; or supply it by producing in the foreign location. In the third case, it may then face a choice between several alternative

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sites within the foreign location. This paper investigates which factors are influential in determining the strategy firms take. Its main contributions are threefold: first, the full decision set of the firm is incorporated into one empirically tractable model; second, the role played by different factors – and in particular public policy in the guise of taxes on profits – is clearly identified in each of the different choices; third, the model is applied to firm level data, thus exploiting cross-firm, cross-industry and cross-country variation, as well as variation over time.

The conceptual framework of the paper draws on the standard OLI approach used in analysing multinational enterprises.[1] Thus, we assume that operating across national boundaries is costly. Companies would not undertake such activity unless there were some offsetting gains from doing so. These are likely to be linked to ownership advantages of the multinational, such as the ability to manage or the possession of a patent. In addition, there must be some locational advantages which induce the company to produce in one location rather than another. These are likely to reflect differences in factor prices, tariffs, or access to resources. Third, there must be some internalisation reason why the multinational chooses to undertake foreign production itself, rather than licensing a third party to do so, or forming some other arm's length relationship.

The model developed in this paper primarily concerns the first two elements of the OLI framework, although the role of internalisation is also reflected in the empirical work. In particular, the model draws on that of Horstmann and Markusen (1992), which analyses the endogenous market structure that arises from firms' choices over whether or not to enter foreign markets. We do not solve for the market structure in any location but rather we use the conceptual framework to indicate the factors that are likely to determine firms' behavioral decisions. The model is applied to data on US multinationals to examine the determinants of whether and how they access the European market.

The choice of whether to supply the foreign market by exporting or by locating production there is driven primarily by the cost of transporting the product to the foreign market relative to any gains that might be made by concentrating production in one location. These gains could be due, for example, to exploiting plant level returns to scale. The choice of where to locate a foreign production plant depends on local factor costs. It may also depend independently on the accessibility or proximity of factors of production, such as skilled labour. This suggests that an agglomeration effect may be important – firms in specific industries may tend to locate close to each other and close to clusters of demand.[2]

[1]There is a large literature on the behaviour of multinationals which uses this framework. The original development of the OLI framework was by Dunning (1977), (1981). For more recent surveys see Cantwell (1994); Krugman (1991b); Markusen (1995).

[2]See, for example, Krugman (1991a), (1991b) for a discussion of these issues.

One factor of interest is profits taxes. Such taxes may play a number of roles. The cost of capital, influenced by the effective marginal tax rate, is a factor in determining the optimal level of output in each location, which in turn affects the decision of whether to locate there. However, that indirect effect on the choice of location is likely to be less important than the more direct effect of the effective average tax rate. A firm choosing amongst a small number of locations will compare the post-tax level of profits arising in each location. In this comparison it is the effective average tax rate that is relevant. The role of these alternative tax effects is a key feature of the empirical work presented below.

Markusen (1995) summarises a number of stylised facts concerning the behaviour of multinationals, which are incorporated into the modelling strategy in this paper. For example, horizontal foreign direct investment is quantitatively more important than vertical integration. The degree to which multinationals dominate industries varies considerably across industries and appears to be correlated with relatively high levels of expenditure on research and development (R&D) and with a relatively high proportion of skilled labour.

In providing evidence on these issues, previous empirical papers have generally dealt with only one of the choices facing multinational companies in determining whether, and if so how, to enter a foreign market. For example, using industry level data, Brainard (1997) investigates the choice between exporting to the foreign market and producing locally, and finds support for the ''proximity-concentration'' hypothesis. Head et al. (1995) examine the decision of Japanese firms of in which US state to locate when investing in the USA. They find important agglomeration effects, arising from the benefits of being in close proximity to other firms in the same industry as well as to other Japanese firms. Cummins and Hubbard (1994) use firm level data to investigate the investment behaviour of foreign affiliates of US multinationals and find that tax plays a role in determining the level of investment. However, they do not consider the outside options of exporting to, or not accessing, the foreign market, in effect implicitly assuming that the activities of the subsidiary are independent of the rest of the activities of the multinational. Blomstrom and Lipsey (1993) use confidential data from a number of US multinationals to examine the link between the size of the multinational and the size of its foreign activities. They find, for example, that larger multinationals do not have a relatively large foreign activity, although earlier papers[3] found size an important factor in determining whether a firm produced abroad. Other empirical work at the firm level in which the location of production is considered includes Severn (1972); Lipsey and Weiss (1984); Blomstrom et al. (1988); Stevens and Lipsey (1992).

In a separate body of work a number of empirical studies have investigated the role of profits taxes on flows of foreign direct investment (FDI). These have

[3]See, for example, Horst (1972); Lipsey et al. (1983).

generally used aggregate data, mainly on flows into the US.[4] This paper does not consider flows of FDI, but instead investigates the production which multinationals undertake abroad, which is related to the size of the capital stock owned abroad. As Auerbach and Hassett (1993) point out, these are very different concepts. For example, to the extent to which multinationals finance their foreign activity locally, there may be real investment without any international capital flows. Hines (1996) presents a detailed analysis of the impact of tax on the location of FDI into US states, and finds large tax effects.

The paper is organised as follows. Section 2 sets out an organising framework for the analysis of the factors which influence the firm's strategic decisions. Section 3 describes the data and econometric methods. Section 4 presents the results, and Section 5 briefly concludes.

2. The conceptual framework

The strategic choices facing multinational companies are set out in a simple static model which allows for the possibility of increasing returns to scale in production and for costs of transporting goods, which is similar in spirit to that of Horstmann and Markusen (1992).

Consider a case in which there are two markets, a home market and a foreign market. The markets are segmented in the sense that consumers are immobile and therefore have the opportunity to purchase goods in only one market. If a firm chooses to sell its product in the foreign market, it can do so in one of two ways. It can produce all goods at home and export to the foreign market or, alternatively, it can choose to produce abroad. However, there may be several alternative locations for production abroad, in which case the firm must also decide where to locate.[5] In the empirical application we examine the case of US multinationals and consider the two markets to be North America and Europe. If a US multinational decides to produce in Europe, it must also decide in which European country to locate. Note that we do not model flows of capital between the two locations. Rather the model describes how the representative firm decides where to locate its productive capital.[6]

Consider the profit-maximising behaviour of a single representative firm that

[4]See for example, Hartman (1984); Boskin and Gale (1987); Newlon (1987); Slemrod (1990); Swenson (1994) on US data and Devereux and Freeman (1995) on G7 data.

[5]In practice, firms often locate in more than one country. This issue is discussed further in the empirical application.

[6]The source of finance used to purchase the capital stock is not explicitly included in the model. It is simplest to assume that there is a perfectly elastic supply of funds available from the ''world'' market at the world rate of interest for use in any location. The model cannot therefore be interpreted as explaining flows of foreign direct investment.

engages in Cournot competition with its rivals, producing a single differentiated good. There is a fixed cost of setting up the company, F. There may also exist increasing returns to scale at the plant level, at least over a range of output. This could reflect, for example, a fixed cost of setup for each plant with constant marginal costs, or the possibility of a minimum efficient scale of production. There are also costs of exporting from home to serve the foreign market, which are assumed to be proportional to the volume of exports.

Within this framework, it would be possible to derive equilibrium conditions by specifying an endogenous market structure. For example, Horstmann and Markusen (1992) assume the existence of a single company at home and abroad, with the endogenous market structure being either a monopoly or duopoly in each market, depending on whether either or both firms attempt to sell their differentiated goods in each market. However, equilibrium conditions are not developed here; rather the model is simply used to identify the likely determinants of firms' locational decisions.

The firm can follow one of three strategies. It can produce only at home and sell only at home; produce only at home, sell at home and export to the foreign market; or produce and sell at home and supply the foreign market by producing in one of the foreign locations. We do not consider the possibility that the firm both exports to the foreign location and produces there. Such behaviour might be explained in a model which incorporated vertical integration or some forms of risk. By contrast, we allow only for horizontal integration. This approach can be partly justified by the fact that most output of foreign affiliates of US firms is sold in the foreign country in which it is produced.[7]

Consider the strategies available to the firm as a nested set of options as depicted in Fig. 1. The profit of the representative firm is denoted Π_{dmc} where the three subscripts indicate the strategy followed. Thus, let $d = 1$ if the firm sells only in the domestic market and $d = 2$ if it also chooses to sell in the foreign market. If $d = 2$, the firm can either export to the foreign market, in which case $m = 1$, or produce abroad, in which case $m = 2$. Conditional on accessing the foreign market through production abroad ($d = m = 2$), the firm chooses which of the foreign locations to produce in, $c = 1,2,...n$, where n is the total number of possible locations. Clearly, if $d = 1$, then the choice of m and c does not arise; we denote the level of profit in this case as $\Pi_{1..}$. Similarly, if $d = 2$ and $m = 1$, the choice of c does not arise; the level of profit in this case is denoted $\Pi_{21.}$.

The level of profit that would be earned under each strategy is:

$$\Pi_{1..} = (1 - \tau)p_{1..}Y_{1..} - C(r, w, A, Y_{1..}) - F \tag{1}$$

[7]Brainard (1997) reports that only a small proportion of the output of the foreign affiliates of US firms is exported to the US. The data used in this paper indicate that many firms both export from the US and produce abroad. However, they do not indicate whether they are exporting to a country in which they are also producing.

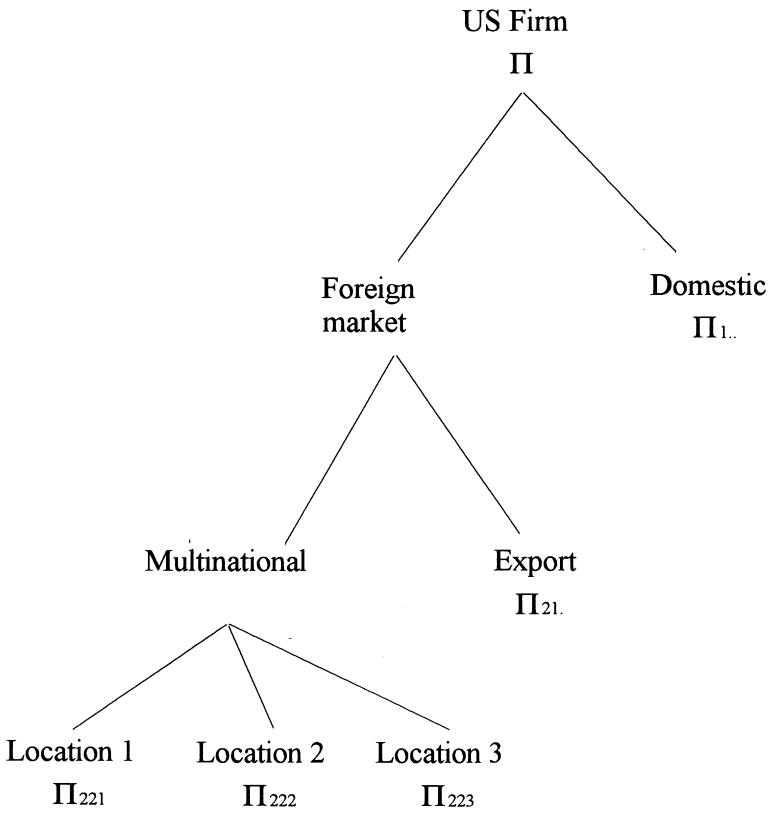

Fig. 1. Firms' choice set.

$$\Pi_{21.} = (1-\tau)(p_{21.}Y_{21.} + p^*_{21.}Y^*_{21.} - sY^*_{21.}) - C(r, w, A, Y_{21.} + Y^*_{21.}) - F \quad (2)$$

$$\Pi_{22c} = (1-\tau)p_{22c}Y_{22c} - C(r, w, A, Y_{22c}) + (1-\tau_c)p^*_{22c}Y^*_{22c} - C(r_c, w_c, A_c, Y^*_{22c}) - F \quad (3)$$

where p is the price in the home market, p^* is the price in the foreign market, Y is the quantity sold in the home market, and Y^* is the quantity sold in the foreign market, where each of these is indexed according to the choice of d, m and c. Prices in each market depend on the quantity sold in that market, although this is not explicitly set out in the expressions. $C(.)$ is the net of tax cost function which indicates the minimum cost of producing a given output, F is firm level fixed costs, and s is the gross transport cost (assumed to be deductible from tax) of exporting one unit of output to the foreign location. We consider the case in which

there are two factors, capital with net of tax unit cost of r, and labour with net of tax unit cost of w. A represents an agglomeration benefit, in addition to any impact on factor costs, of locating near to other similar firms (e.g. because it provides an accessible supply of labour with the relevant skills). Each of these terms, and the statutory tax rate τ, is indexed by the subscript c for production which takes place in the foreign location c, with the home country indicated by the absence of a subscript.

Expression Eq. (1) indicates the net of tax profit of the representative firm if it produces only at home, and sells only in the home market. The corresponding expression if it produces only at home but also chooses to export Y^* to the foreign market is Eq. (2). Tax is charged by the home country on total profit, irrespective of the market in which the product is sold. The foreign country does not charge any tax on imports. If the firm chooses to serve the foreign market by producing in location c, then profits are given by Eq. (3). The tax rate τ_c and the unit factor costs r_c and w_c may reflect taxation both in location c and the home country.

These expressions for the level of profit for each strategy reflect a static framework in that profit does not depend on choices in any other period, or indeed on any variables before the current period. This is clearly an important simplification. In particular, the cost function for producing abroad implicitly includes any fixed costs arising from setting up in a new location, and therefore applies naturally to the initial decision of the firm to produce abroad. But the option of switching between foreign locations may involve different costs and is therefore not captured in this simple framework.[8] However, the profit functions can be thought of as reflecting present values over the life of an investment project; the parameters of the model should then reflect their expected values over that life; to this extent, the strategic choice does not necessarily depend only on current parameters.[9]

The choice between whether to export or produce abroad depends on the size of transport costs relative to possible gains from scale economies at the plant level. If the firm chooses to export to the foreign market, it must pay total transport costs of sY^*. If it instead locates production abroad then it does not pay transport costs. If there are constant returns to scale in production, the choice depends on the relative marginal (and average) cost in the foreign location: the firm will locate all its production for the foreign market abroad if the constant marginal cost of doing so is lower than the sum of the marginal home production cost and transport costs. This would be the case, for example, if production costs were the same at home and abroad. However, if there are plant level economies of scale, the average cost

[8]The empirical application investigates the extent to which the determinants of the initial decision differ from the more general case.

[9]In the empirical application, however, we make the simplifying assumption of static expectations of all parameters.

of production falls with output. In this case, the choice depends also on the size of the output sold in the foreign market, Y^*. As Y^* increases, the lower is the average cost of producing abroad – and assuming the existence of some production for the home market, the rate of reduction of the average cost is likely to be greater for foreign production than for home production. Hence the higher is Y^* the more likely is it that the firm would choose to locate production abroad.

The modelling of the tax system requires some explanation. We model only profits taxes. Profits accruing to production at home and abroad are taxed at the statutory tax rates, τ and τ_c respectively. These rates are applied to the revenue earned in each country. In addition, unit costs, r and w, are net of tax. Labour costs are generally deducted in determining taxable profits, so the unit cost of labour, w, can be thought of as simply the gross wage rate, net of tax: for example, $w=w'(1-\tau)$, where w' is the gross wage rate at home. We also consider the fixed cost, F, to be net of any tax allowances.

The tax treatment of capital costs is more complicated. These are not modelled in detail, but their effect on the cost of a unit of capital is sketched out.[10] In the absence of taxation the cost of using capital (with a value of unity) for one period is $r=i+\delta$, where i is the one-period cost of finance and δ is the one period economic depreciation rate. This cost is affected by two features of the tax code. The first is depreciation allowances. Following the literature on measuring the cost of capital,[11] we model the value of tax savings through the depreciation allowance as reducing the price of a unit of capital from 1 to $1-d$, where d is the present value of tax depreciation allowances. The second is relief for the cost of finance. For example, if the capital stock is financed by debt, interest payments are deductible from taxable profits, so that the net cost of finance is $i(1-\tau)$ where i is the gross interest rate. If it is financed by the issue of new equity, then, under some corporation tax systems there is partial relief against dividend payments. For example, under the UK tax system, the net cost of new equity finance (ignoring risk) would be $i(1-\theta)$, where θ is the rate of relief against dividends. Combining these two features yields an expression for the per period cost of a capital stock of value unity as $r=(1-d)[i(1-\phi\tau)+\delta]$, where the value of ϕ depends on the source of finance used. Clearly, the tax parameters vary across locations of production.

The profit-maximising level of home and foreign output for each strategy can be derived from the first order conditions for each profit function:

$$\frac{\partial \Pi_{1..}}{\partial Y_{1..}} = (1-\tau)p_{1..}\left(1+\frac{1}{\epsilon}\right) - C_{Y_{1..}} = 0 \tag{4}$$

$$\frac{\partial \Pi_{21.}}{\partial Y_{21.}} = (1-\tau)p_{21.}\left(1+\frac{1}{\epsilon}\right) - C_{Y_{21.}+Y_{21.}^*} = 0 \tag{5}$$

[10] A more precise description would require a dynamic model.
[11] See, for example, King and Fullerton (1984).

$$\frac{\partial \Pi_{21.}}{\partial Y^{*}_{21.}} = (1-\tau)(p^{*}_{21.} - s)\left(1 + \frac{1}{\epsilon^{*}}\right) - C_{Y_{21.}+Y_{21.}^{*}} = 0 \tag{6}$$

$$\frac{\partial \Pi_{22c}}{\partial Y_{22c}} = (1-\tau)p_{22c}\left(1 + \frac{1}{\epsilon}\right) - C_{Y_{22c}} = 0 \tag{7}$$

$$\frac{\partial \Pi_{22c}}{\partial Y^{*}_{22c}} = (1-\tau_c)p^{*}_{22c}\left(1 + \frac{1}{\epsilon^{*}}\right) - C_{Y_{22c}^{*}} = 0 \tag{8}$$

where ϵ and ϵ^{*} are the own-price elasticities of demand perceived by the firm for its differentiated product in the home and foreign markets, respectively, which depend on the industry elasticity of demand, the market share of the firm and the degree of substitutability of the differentiated goods.[12]

Assuming a particular functional form for the cost function would allow us to solve for the optimal values of output under each strategy. For example, consider the simpler cost function $C(r, w, Y)$ and suppose that it is Cobb Douglas:

$$C(r, w, Y) = \lambda r^{\alpha} w^{1-\alpha} Y^{\gamma} \tag{9}$$

with $\gamma < 1$ implying increasing returns to scale in production. Differentiating with respect to Y, substituting into Eq. (4) and rearranging yields:

$$Y^{1-\gamma} = \gamma\lambda q^{\alpha} w'^{1-\alpha} p^{-1}\left(1 + \frac{1}{\epsilon}\right)^{-1} \tag{10}$$

where q is a conventionally measured user cost of capital term, $q = (1-d)[i(1-\tau)+\delta]/(1-\tau)$, and w' is the gross wage rate.[13] The role of taxes in determining the optimal level of output for each strategy is therefore through a conventionally-measured cost of capital term, implying that it is the effective *marginal* tax rate that affects the level of investment.

The maximised level of profits from each strategy can be derived by substituting the optimal levels of output implied by Eqs. (4)–(8) into the profit functions Eqs. (1)–(3). The optimal strategy is then the one which yields the highest profits. The firm's strategic decisions are therefore affected indirectly by the determinants of the optimal level of output under each strategy, marginal revenue and marginal cost. These include the gross wage rate and the cost of capital in each potential location of production. They also include other factors that determine marginal

[12]Strictly, these depend on the output level under each strategy and should be indexed by *m*, *d* and *c*. However, we neglect this in order to keep notation manageable.

[13]Note that p and ε depend on Y. With increasing returns to scale ($\gamma < 1$) both marginal revenue and marginal cost fall with output; clearly a stable equilibrium requires the marginal revenue curve to be steeper. In this case, an increase in unit factor costs shifts up the marginal cost curve, resulting in lower output.

costs, such as marginal agglomeration benefits arising from the proximity to other similar industrial production or R&D, or to demand.

More directly, however, the strategic choices of the multinational firm depend on the level of profits under each strategy. Consider, for example, the choice between two foreign locations. This choice depends on the relative size of the net of tax profits, say Π_{221} and Π_{222} Clearly, average costs have a direct influence on the choice between locations. This includes the effective average tax rate: defining $\tilde{\Pi}$ to be profit gross of tax and T to be the effective average tax rate, the firm would choose location 1 iff $\tilde{\Pi}_{221}(1-T_1)>\tilde{\Pi}_{222}(1-T_2)$.[14]

In principle, then, both the effective marginal and effective average tax rates may be relevant in the strategic decisions made by firms. The former have an indirect effect through determining the optimal level of output for each possible strategy and the latter have a direct effect through the net profit of each strategy. Locating production in an area with a low cost of capital may lead to a high optimal level of output, but if the effective average tax rate is high the overall profit level may be less than in an area with a higher cost of capital but a lower effective average tax rate.

3. Data and econometric method

We apply this model to the strategic decisions of US firms considering whether to enter the European market; whether to serve the European market through exporting or local production; and where within Europe to locate production if the latter strategy is taken. In particular, we examine the choice of locating production in France, Germany or the UK. During the period under consideration the proportion of US owned assets located outside the US that were located in the EU varied between 34% and 43%, and the proportion of the total stock of US assets in the EU that was located in the UK, Germany or France varied between 65% and 70%.

3.1. Data

The data for the application come from a number of sources and include information at the firm, industry and country level. The precise definitions and sources of the data are given in Appendix A. The firm level data is taken from

[14]It is possible to consider tax liabilities to consist of two components; the effective marginal tax rate, which determines the cost of capital, and the statutory tax rate which is levied on returns which exceed the cost of capital. The impact of tax on the location decision can be written as a non-linear combination of the statutory tax rate and the effective marginal tax rate. The effective average tax rate effectively summarises the interaction of these two measures.

Standard and Poor's Compustat file. Information on 1632 publicly quoted US firms over the period 1980 to 1994 is used with a total number of observations of 10 285 (most firms are not in the sample for all fifteen years). The geographic segments file contains information on sales, profits, assets and investment of foreign subsidiaries of the US parent company. Each parent firm reports up to four geographic segments. Each segment can include information on up to five regions. These regions can be specific countries or they can be broader geographic areas. All parent firms that report non-zero sales from subsidiaries in Europe have been identified as firms making a direct investment in Europe.

The sample used in this paper is of those firms that report data on exports (including those that report zero exports) and for which geographic segment data exists (although again, firms may report zero foreign production). Firms can be identified as being in one of the four groups in Table 1. The table shows the number of firms and observations in each of the four possible groups. The exports of firms in the final category are assumed to be to countries outside of Europe.

The location in specific countries within Europe can be identified only for some of those firms with production in Europe. Table 2 shows the breakdown of the location data in the geographic segment for the 387 firms (3544 observations) that produce in Europe. Of theses observations, 2774 include ''Europe'' as a location. It is not possible to identify these observations as being located in a precise subset of UK, France and Germany; in general, these observations are therefore not used in the estimation of the lowest level of the decision tree. In fact, this level is estimated primarily on firms which invest in only one location; observations are therefore limited to the bottom three rows of the Table.[15] However, we compare these results with estimating a model using data on all firms which can be identified as locating or not in each of UK, France and Germany: this uses data from the bottom eight rows of the Table.

These firm level variables are supplemented by industry level information on

Table 1
Number of firms and observations exporting and investing in Europe

	Firms	Observations
Domestic production and sales only	49	194
Domestic production only and export	1196	6547
Domestic and European production (no exports)	3	21
Domestic and European production and exports	384	3523

[15]The estimation was carried out using in addition data from rows 2 to 4, on the assumption that in these cases ''Europe'' did not include France, Germany or the UK. The results were very similar to those presented in Section 4, and are therefore not reported.

Table 2
Number of firms and observations producing in Europe

	Firms	Observations
Europe	175	1538
Europe and UK	35	357
Europe and France	6	54
Europe and Germany	12	82
Europe, UK and France	10	107
Europe, UK and Germany	11	148
Europe, France and Germany	9	35
Europe, UK, France and Germany	40	453
UK and France	6	29
UK and Germany	3	82
UK, France and Germany	5	38
France and Germany	2	24
UK	54	428
France	4	47
Germany	15	122

unit labour costs, demand, production, trade flows and R&D expenditure for each country, taken from the OECD STAN and ANBERD databases. These data are used to construct three alternative measures of agglomeration, based on production, demand and R&D. In each case, these are constructed by taking the value of that variable in each industry in country j as a proportion of the total for that industry across all j. In estimating the lower level of the decision tree, only the three European countries are included in these measures. For the higher level, the US is also included.

The two main measures of tax, the effective marginal and average tax rates, are taken from Chennells and Griffith (1997). They allow for the effect of both the host country tax system and the US tax system on the cost of capital for US multinationals producing in Europe – that is, they include any residual US tax levied when European source income is repatriated to the US.

The methodology for calculating the cost of capital is standard and has been used to consider international investment in OECD (1991) and Devereux and Pearson (1995). The approach to measuring the effective average tax rate is described in Devereux and Griffith (1998). This approach is simple: instead of analysing a marginal investment, we consider an investment with a given stream of returns and hence a given level of profitability in the absence of tax. The effective average tax rate is the proportionate fall in the level of profit, for the same income stream, arising from the introduction of tax. The methodology used to calculate the effective average tax rate is sketched in the Appendix A. We also experiment with a more standard measure of the average tax rate, detailed in

Table 3
Descriptive Statistics of variables used to estimate choice of country

	UK	France	Germany
Observations	428	47	122
Ctry cost of capital	5.092	4.279	5.164
	(1.564)	(1.534)	(2.225)
Ctry statutory tax rate	0.371	0.282	0.593
	(0.064)	(0.064)	(0.031)
Ctry-Ind effective average tax rate	0.224	0.243	0.278
	(0.046)	(0.015)	(0.075)
Ctry-Ind average tax rate	0.305	0.282	0.470
	(0.043)	(0.064)	(0.090)
Ctry-Ind unit labour costs	0.608	0.532	0.780
	(0.116)	(0.081)	(0.162)
Ctry-Ind demand agglomeration	0.252	0.298	0.504
	(0.038)	(0.058)	(0.077)
Ctry-Ind production agglomeration	0.230	0.283	0.551
	(0.047)	(0.069)	(0.077)
Ctry-Ind R&D agglomeration	0.192	0.286	0.624
	(0.081)	(0.094)	(0.097)

Notes: Means are across the firm-years that we observe in each location and not in any other location. Standard deviations are in brackets. The cost of capital is expressed as a percentage rate of return, all other variables are expressed as proportions.

Collins and Shackelford (1995), that is derived from accounting data on tax liabilities and profit for individual firms in each country.[16]

Tables 3 and 4 present some descriptive statistics. The variable names indicate the dimensions in which they vary. All variables are time varying. Ctry indicates variation across countries, Ctry-Ind indicates variation across countries and between industries, and Firm indicates variation across firms. Table 3 shows descriptive statistics for the variables used to estimate the choice between European locations. The means for each country are taken across the observations where the firm is observed locating in that country. The weights implicitly used

[16]The effective tax rate measures are forward-looking in the sense that they compute the present value of tax liabilities over the life of a project. It is necessary to make assumptions about the life of the investment, as well as expected future tax rates and macroeconomic variables such as the inflation rate and exchange rate. In common with our approach for other variables, we assume static expectations for all domestic variables, and assume that the exchange rate is expected to follow purchasing power parity. By contrast, the accounting measure is based on tax liabilities and profits in a given year; this clearly depends on the past and current investment and profitability. While the latter has the advantage of reflecting detailed features of the tax system, such as the treatment of losses, it does not necessarily reflect the expected tax rate over the life of a new investment. The effective tax rate measures also explicitly allow for the residual tax in the home country.

Table 4
Descriptive Statistics of variables used to estimate choice of exporting vs. FDI

	Exporters = domestic production only and export	Multinationals = domestic and foreign production
Observations	6547	3544
US cost of capital	4.292	4.375
	(1.302)	(1.325)
US-Ind effective average tax rate	0.247	0.247
	(0.045)	(0.044)
US-Ind average tax rate	0.311	0.318
	(0.049)	(0.049)
US-Ind unit labour costs	0.646	0.663
	(0.197)	(0.214)
US-Ind production agglomeration	0.611	0.595
	(0.143)	(0.134)
Firm sales (US 1987 $billion)	0.399	1.633
	(2.335)	(3.979)
Firm capital output ratio	0.069	0.060
	(0.156)	(0.054)
Firm R&D share	0.0004	0.0024
	(0.0046)	(0.0104)

Notes: Means are across the firm-years that we observe in each location. Numbers in brackets are standard deviations. The cost of capital is expressed as a percentage rate of return; Sales are in 1987 $billion; all other variables are expressed as proportions.

therefore reflect the distribution of the sample across industries and time, rather than necessarily reflecting the aggregate economy.

Table 4 shows descriptive statistics for the variables used to estimate the choice between exporting from the US and producing in Europe. Firm R&D market share is the total R&D conducted by the firm as a proportion of the total R&D conducted in the US in that firm's primary industry. Again, means are taken across the observations where we observe the firm choosing that option. Multinational firms are, on average, larger than exporting firms, have a slightly lower capital to output ratio and undertake more R&D than other firms in their industry.

3.2. Econometric method

In the next section we estimate the strategic choices of firms, based on the conceptual framework in Section 2. The unobserved level of profit of the i^{th} firm choosing the j^{th} strategy can be written

$$\Pi^{i}_{dmc} = B^{ik\prime}_{d}\phi + Z^{ik\prime}_{dm}\gamma + X^{ik\prime}_{dmc}\beta + \varepsilon^{i}_{dmc} \tag{11}$$

where B_d^{ik} is a vector of explanatory variables that determine whether or not the firm accesses the foreign market (d); Z_{dm}^{ik} is a vector of explanatory variables that determine whether or not the firm exports or becomes a multinational (m), conditional on accessing the foreign market; X_{dmc}^{ik} is a vector of variables that determine the choice of location (c), conditional on producing abroad; ε_{dmc}^{i} is a residual. Explanatory variables can vary over firm (i) and industry (k).

Consider the i^{th} firm ($i=1...I$) that chooses the j^{th} strategy ($j=1...J$). The level of profits that firm i would earn if it chose strategy j is denoted Π_j^i and is a latent variable. We observe an indicator, y_j^i, of which strategy the firm has chosen:

$$\begin{aligned} y_j^i &= 1 \quad \text{if } \Pi_j^i = \max(\Pi_1^i, \Pi_2^i, ..., \Pi_J^i) \\ y_j^i &= 0 \quad \text{otherwise.} \end{aligned} \tag{12}$$

The set of strategic choices are estimated as a nested multinomial logit model.[17] The probability of firm i choosing strategy j can be written as the product of the conditional probabilities of each choice. Using the definitions in the previous section, denote the probability of serving the foreign market as P_d, the probability of producing in Europe as against exporting, conditional on having decided to serve the foreign market as P_{2m}, and the choice of location in Europe, conditional on having decided to be a multinational, as P_{22c}. We can then write the probability of firm i choosing strategy $j=dmc$ as:

$$P_{dmc}^i = P_d^i * P_{2m}^i * P_{22c}^i.$$

The model is estimated sequentially.[18] First we obtain estimates of the coefficients from the conditional probability at the lowest level of the decision tree (P_{22c}^i), identifying the determinants of the choice of the location of production, conditional on locating in Europe. We observe an indicator, y_{22c}^i of which strategy the firm chooses at the lowest level of the decision tree. For each c:

$$\begin{aligned} y_{22c}^i &= 1 \quad \text{if } \Pi_{22c}^i = \max(\Pi_{221}^i, \Pi_{222}^i, ..., \Pi_{22C}^i) \\ y_{22c}^i &= 0 \quad \text{otherwise.} \end{aligned} \tag{13}$$

This will depend on the elements of X_{dmc}^{ik}.

[17] Estimating a single multinomial logit model allowing for all options open to the firm requires the assumption of the ''independence of irrelevant alternatives (IIA)'', which would imply, for example, that the probability of choosing to produce in the UK rather than export from the US, is independent of the option of producing in France. This seems unlikely to apply in this model. Instead, the set of strategic choices are estimated as a nested multinomial logit model; this follows the nested structure of the conceptual framework, and requires the assumption of IIA only at each level. See Maddala (1983) or McFadden (1983) for a description of the econometric model. Goldberg (1995) provides an interesting recent application.

[18] This gives consistent (though not efficient) estimates of parameters. See McFadden (1983); Maddala (1983).

Next we estimate the probability of whether the firm exports or becomes a multinational (P^i_{2m}). We observe an indicator, y^i_{2m}, of which strategy the firm chooses at this level of the decision tree, such that:

$$\begin{aligned} y^i_{2m} &= 1 \quad \text{if } \Pi^i_{22c} - \Pi^i_{21.} > 0 \\ y^i_{2m} &= 0 \quad \text{otherwise.} \end{aligned} \tag{14}$$

This will depend on the elements of Z^{ik}_{dm} and an ''inclusive value'' term, INC^i_{dm}, which reflects the expected profitability from choosing to locate investment in Europe and is given by, $\text{INC}^i_{dm} = \ln(\Sigma^C_{c=1} \exp(X^{ik}_{dmc}\hat{\beta}))$ where $\hat{\beta}$ are obtained from Eq. (13).[19]

The final choice of whether or not to supply the European market is given by

$$\begin{aligned} y^i_d &= 1 \quad \text{if } \Pi^i_{21.} - \Pi^i_{1..} > 0 \\ y^i_d &= 0 \quad \text{otherwise.} \end{aligned} \tag{15}$$

This will depend on the elements of B^{ik}_d and an ''inclusive value'' term, INC^i_d, derived from Eq. (14). However, for data reasons spelt out below, we are not able to identify this higher level separately from the decision of whether to export or become a multinational. We therefore estimate the top stage using elements of Z^{ik}_{dm} only and then using Z^{ik}_{dm} and B^{ik}_d together.

Dynamics are not included in the model. We assume that the elements of X^{ik}_{dmc}, Z^{ik}_{dm} and B^{ik}_d are independent of the error term, ε^i_{dmc}. Unobservable fixed effects corresponding to each choice j are dealt with by including option specific constants at each level. However, unobservable fixed effects corresponding to each firm i are considerably more difficult to deal with. In effect, we treat each observation for each firm in different time periods as independent. However, as a check on this specification, we also estimate the lowest level of the model only on firms which set up in Europe for the first time in that period.

Neither the conceptual framework nor the econometric specification of the model permit a firm to choose to locate in more than one country. However, in practice some firms do so. It is again difficult to allow for this possibility. Instead, we estimate parameters using firms which invest in only one location, and assume that this gives a consistent estimate for firms which invest in several locations. We conduct an indirect test of this assumption by estimating a binary logit model for the choice of whether or not to locate production in each country, conditional on choosing to be a multinational, and comparing the results of the group of firms that invest in only one location with those that invest in more than one.

[19]The coefficient on INC^i_{dm} is a ''dissimilarity parameter''. A test of whether IIA could apply more generally is whether this is equal to unity.

4. Empirical specification and results

The next sub-section presents estimates of the determinants of the choice of location within Europe and the subsequent sub-section presents estimates of the higher level choice of whether or not to produce in Europe.

4.1. The choice of location of production

Consider first the lowest level of the firm's decision tree – in the empirical application, the choice of whether to locate in the UK, France or Germany conditional on having chosen to locate production in Europe. The firm will choose to locate in the country in which it will earn the highest profits. For example, the decision to locate in the UK ($c=2$) relative to France ($c=3$) is determined by whether $\Pi_{222}-\Pi_{223}\lesseqgtr 0$. In investigating the lowest branch of the decision tree, we are concerned only with the elements of Eq. (11) that vary across locations, X^{ik}_{dmc}. Factors that do not vary across locations will not affect this decision (unless they have a differential impact across locations), thus any elements that are common to both locations will cancel out.

Defining the profit earned by firm i in the foreign location as Π^{i*}_{22c}, and using a linear approximation, the factors which affect the location choice c can be summarised as:

$$\Pi^{i*}_{22c} = \alpha_c + \beta_1 q_c + \beta_2 T^k_c + \beta_3 \mathrm{ULC}^k_c + \beta_4 A^k_c + \varepsilon^i_c \tag{16}$$

where q is the cost of capital, T is the effective average tax rate, ULC is unit labour costs, and A is one of three possible measures of agglomeration. All variables vary over time; q varies across countries (c); all other variables vary across industries (k) and by country.

The user cost of capital and unit labour costs affect the level of profit both directly through total costs and indirectly through $\hat{Y}^{*}_{22c}$. We include industry level values of unit labour costs for each country instead of raw wage costs, in order to condition on differences in productivity. Total costs clearly play a role independently of marginal costs. As noted above, this implies that the effective *average* tax rate may also be important. The final element of the cost function is the agglomeration term, A. We investigate three forms of agglomeration that may be important: production, R&D and local demand. In each case, they are measured by the proportion of that variable in each location in the firms primary industry (see Appendix A for the precise definition). The first two measures may reflect advantages gained from spillovers that accrue due to the proximity of production or R&D activities of a similar nature. These could include, for example, access to a pool of skilled labour or advantages from infrastructure development.

In the model, demand conditions play a role in the location decision indirectly through the impact of the elasticity of demand on $\hat{Y}^{*}_{22c}$. However, since the model considers only one foreign market, the elasticity of demand is only relevant to the choice of the location of production of an individual firm to the extent that it varies with the level of output. However, demand is clearly not uniformly distributed across Europe; given some transport costs associated with exporting goods within Europe, firms have an incentive to locate near the source of demand. This provides a rationale for a demand agglomeration affect.

Estimates of the coefficients of the model described in Eqs. (13), (11), (16) are given in Table 5. The coefficients are the marginal impact on the *odds ratio* of a firm going to the UK or France relative to Germany, conditional on the firm having chosen to become multinational. All specifications include a constant specific to the location, which captures unobservable fixed effects associated with that location. These could, for example, include language, culture, geographic location with respect to the rest of Europe, or proximity to a financial centre. All specifications also include a full set of time dummies, to control for common macroeconomic shocks.

In column (1) the impact of the two measures of taxation from the conceptual model – the effective marginal tax rate, through the cost of capital, and the

Table 5
Choice of location of production

	(1)	(2)	(3)	(4)
No of observations	597	597	597	593
Log likelihood	−434.0	−431.1	−427.4	−429.2
Ctry cost of capital	−0.129	−0.080	−0.072	−0.073
	(0.095)	(0.097)	(0.098)	(0.097)
Ctry-Ind effective average tax rate	−8.24	−6.53	−6.83	−5.96
	(1.49)	(1.93)	(1.89)	(1.99)
Ctry-Ind unit labour costs	–	0.301	−0.197	0.902
		(0.924)	(0.957)	(0.947)
Ctry-Ind production agglomeration	–	1.88	–	–
		(0.899)		
Ctry-Ind demand agglomeration	–	–	3.54	–
			(1.07)	
Ctry-Ind R&D agglomeration	–	–	–	1.41
				(0.625)
UK constant	0.529	1.32	1.60	1.44
	(0.291)	(0.483)	(0.468)	(0.505)
France constant	−1.57	−0.843	−0.611	−0.748
	(0.330)	(0.480)	(0.465)	(0.492)

Notes: Standard errors are in brackets. All columns include year dummies.

effective average tax rate – are investigated in isolation from the other factors.[20] As predicted by the model, the effective average tax rate for location *c* is strongly negatively correlated with the probability of choosing that location. However, the cost of capital term is not significant. It is worth noting, though, that the cost of capital measure varies only over countries and time, while the effective average tax rate also varies across industries. This is likely to mean that the coefficient on the latter will be more precisely estimated. Nevertheless, since the cost of capital is predicted to have only an indirect effect on location choice, the relative significance of the effective average tax rate is clearly consistent with the predictions of the model.

In columns (2) to (4) we add non-tax variables arising from the conceptual framework: unit labour costs and alternative measures of agglomeration – production in column (2), demand in column (3) and R&D in column (4). The three measures of agglomeration are highly colinear; we therefore do not include them together in a single specification. In principle, all of these variables may have an effect at the margin on the level of output, conditional on the choice of location. However, the average level may also have a more direct effect on the location choice.

The inclusion of these variables has little effect on the two tax terms: the coefficient on the cost of capital remains insignificant, while that on the effective average tax rate remains a significant determinant of the location choice. Although the coefficient is lower than in column (1), it is reasonably stable across the three alternative specifications.

Unit labour costs are statistically insignificant in all columns. This may be due to considerable measurement error – only industry-wide differences in productivity are allowed for, which may not adequately reflect the skill mix required by a particular firm given heterogeneity across firms within a given industry.

The coefficients on all of the agglomeration terms are positive and significant. Given the colinearity between these variables, however, it is difficult to pin down the precise nature of the benefits of agglomeration. The benefits of locating production near to other firms producing in the same industry is consistent with the effects found, for example, by Head et al. (1995) for Japanese firms investing in the US.

Of course, since production in location *c* is correlated with sales in *c* the

[20]The effective marginal tax rate is the proportional difference between the cost of capital in the presence and absence of taxation. In the absence of taxation, the cost of capital is the same for each European location in any one time period (although it would be different across different time periods); we assume that the US parent requires a real rate of return equal to the US real interest rate. In estimating the choice between the European locations, it is only the difference across locations that is relevant. In this case, the difference in the cost of capital is identical to the difference in the effective marginal tax wedge: the effective marginal tax rate is simply this wedge expressed as a proportion of the cost of capital.

measure of production agglomeration may reflect the importance of proximity to markets, for example in industries where transport costs within Europe for the final product are high. Certainly, column (3) confirms that the ''demand'' agglomeration term also has a important significant positive effect on location choice.[21]

The third measure of agglomeration, based on the concentration of European R&D in each industry in each location, is introduced in column (4). Again, this term has a significant and positive effect on location choice. This could reflect the benefits from locating near other firms in the same industry conducting R&D. These may accrue due to the spillover of new ideas and production process, or through access to a skilled workforce.

In Table 6 we present a number of specification checks of the empirical model in column (3) of Table 5. We investigate three specific issues. First, in columns (1) to (3), we examine alternative measures of tax rates. Column (1) adds the statutory tax rate in each location. This may play a role in location choices for at least two reasons. One possibility is that firms do not in fact consider more complex measures of taxation, such as the effective average tax rate. A second is that the statutory tax rate is important in affecting the overall tax liability of a firm which shifts profits from one jurisdiction to another. There is some evidence that firms need to locate real activities in a jurisdiction with a low statutory tax rate before they can benefit from shifting income there from other jurisdictions.[22] Since the statutory tax rate varies only across countries and time, it is not possible to include time dummies in this specification. However, inclusion of the statutory tax rate has little effect on the model: the results for the other two tax variables are largely unaffected, and the statutory tax rate itself plays an insignificant role.[23]

The next two columns test the sensitivity of the results to alternative measures of the average tax rate. The measure of the effective average tax rate so far used is based on the methodology set out in the Data Appendix, which computes the tax rate for any given level of profitability. The value used in estimation is based on the average rate of profit in each industry in each country. This may give rise to potential endogeneity, in that the measure may reflect the underlying profitability of each location. To check against this possibility, column (2) instead uses the average rate of profit for all firms in our sample, 40%, for all observations.

The coefficient on the effective average tax rate remains negative and significant and at a similar level to column (3) in Table 1. The standard error rises, which is

[21]The importance of being located close to demand was emphasised by Krugman (1991a), (1991b), among others.

[22]See, for example, Grubert and Slemrod (1993); Weichenrieder (1996).

[23]As discussed in Section 2, the effective average tax rate could be seen as reflecting the interaction between the cost of capital and the statutory tax rate. Dropping the effective average tax rate from this specification yields signficant coefficients on both the cost of capital (-0.227 with a standard error of 0.083) and on the statutory tax rate (-8.97 with a standard error of 2.90).

Table 6
Specification tests for choice of location of production

	Tests of tax variables			New entrants	Binomial logit model	
	(1)	(2)	(3)	(4)	(5)	(6)
No of observations	597	597	597	51	1791	3669
Log likelihood	−431.6	−440.3	−437.1	−43.3	−791.4	−2072.3
Ctry cost of capital	−0.123	−0.048	−0.032	0.151	−0.101	−0.013
	(0.088)	(0.055)	(0.089)	(0.251)	(0.057)	(0.036)
Ctry-Ind effective average tax rate	−6.31	–	–	−8.14	−8.51	−1.46
	(1.77)			(6.14)	(1.17)	(0.632)
Ctry effective average tax rate	–	−7.22	–	–	–	–
		(3.11)				
Ctry-Ind average tax rate	–	–	−0.340	–	–	–
			(0.984)			
Ctry statutory tax rate	−4.68	–	–	–	–	–
	(3.09)					
Ctry-Ind unit labour costs	−0.152	1.53	1.88	0.077	−0.419	1.03
	(0.860)	(0.709)	(0.751)	(2.60)	(0.694)	(0.343)
Ctry-Ind demand agglomeration	3.16	3.19	3.80	1.46	4.83	−0.093
	(1.01)	(0.974)	(1.07)	(2.78)	(1.17)	(0.590)
UK constant	0.529	1.39	2.48	0.853	2.78	1.39
	(0.678)	(0.429)	(0.446)	(0.958)	(0.249)	(0.142)
France constant	−1.47	−0.814	0.121	−0.392	−0.563	−0.384
	(0.623)	(0.420)	(0.446)	(0.861)	(0.248)	(0.118)

Notes: Standard errors are in brakets. Year dummies are included in columns (1), (3), (5) and (6). Industry dummies are included in columns (5) and (6). The alternative tax rate measures are discussed in the text and Appendix A.

consistent with the variable in column (2) being subject to more measurement error.

The effective average tax rate measure depends to some extent on arbitrary assumptions regarding the financing of investments. In column (3) we therefore use a completely different measure of the average tax rate, based on firm accounting data in each location. This measure of the average tax rate is not significant. This may reflect significant measurement error. One reason may be that this measure primarily reflects taxes paid in the host country; it does not make any allowance for residual US taxes.

The second specification issue, investigated in column (4), is that the sample contains repeated observations on the same firms in different years. It is likely to be the case that the choice of remaining in a specific European location is different from the choice of where to locate a new investment. We investigate this issue by re-estimating the model on only those firms that are ''new entrants'' to Europe; that is, which report locating in Europe in the current period, but not locating in Europe in the previous period. There are 148 such ''new entrants'' in our sample, 51 of which locate in only one of the UK, France or Germany. Since the size of this sample is small, we are not able to include time dummies.

The estimation results are reasonable given the small sample size. The coefficient on the effective average tax rate remains negative, and roughly the same size, although it is no longer statistically significant. Similarly, demand agglomeration remains positive but also loses its significance.

The third issue investigated in Table 6 reflects the possible difference between firms that locate in only one country and firms that locate in more than one country. There may be several reasons why firms locate in more than one country. A simple extension to the conceptual framework above would be to allow for transport costs of shifting goods between locations in Europe; offsetting such costs against the possible fixed costs arising from setting up in each location might imply that some firms (with relatively small transport costs) would choose one location while others (with relatively high transport costs) would choose more than one location. Other possibilities include models of vertical integration, in which either different levels of production or other splits of the firms activities – for example marketing and finance – may be located in different jurisdictions.

However, it is difficult to deal with firms which locate in more than one country within the context of the econometric framework used here. Consider, for example, the possible extension of the lowest level of estimation to include, say, firms that locate in France and the UK, as well as those that locate only in France or only in the UK. It is difficult to assess which variables should be used to investigate such choice; certainly there is no reason to suppose that, say, the effective average tax rate would have the same impact on the choice between investing in the UK or France as it would on the choice between only the UK and both the UK and France.

We therefore investigate this issue using a different approach. We follow the procedure of Grubert and Mutti (1996) of estimating a binary choice model (in our

case a logit) of the choice facing a firm as to whether or not to locate in each country, independently of whether it locates in other countries. Thus, the dependent variable is y_c^i,

$$\begin{aligned} y_c^i &= 1 \quad \text{if firm } i \text{ locates in country } c \\ y_c^i &= 0 \quad \text{otherwise.} \end{aligned} \tag{17}$$

The observations for the three countries are stacked together, so that the 597 observations used above reflect 1791 choices in this framework. Since y_c^i is independent of the choice for any other country, this model can also be applied to firms which choose more than one location.

The results of estimating this model on the sample of firms that locate in only one country are presented in column (5). They are similar to the estimates shown in column (3) of Table 5. That is, the cost of capital is insignificant, the coefficient on the effective average tax rate is negative and highly significant, that on demand agglomeration is positive and highly significant, and unit labour costs are insignificant. Column (6) presents the results of estimating this model on all firms which can be identified as either locating or not locating in each of France, Germany and the UK. Because we can now include firms that locate in more than one location (see Table 2) this yields 1223 observations (compared to 597), and hence 3669 choices. The results in column (6) are similar to those in column (5) to the extent that the coefficient on the effective average tax rate remains negative and significant, albeit much smaller. However the other significant variable from column (5), the demand agglomeration term, is no longer significant. By contrast, the coefficient on unit labour costs is positive and significant; this is contrary to theory and may indicate the misspecificatin of this model. Apart from this, however, column (6) suggests that the effective average tax rate is relevant for the location decisions of all firms, but that its power is weakened in the case of firms that choose to invest in more than one location.

Overall, these results provide some support for the conceptual model outlined above. Factors that influence the choice of location are the effective average tax rate and agglomeration terms.

As noted above, the coefficients presented in the Tables are the marginal impact on odds ratios. A more intuitive interpretation of the magnitude of the effects is given by considering the marginal effect or the elasticity.[24] Using the estimates

[24]The marginal effect in a conditional logit model is

$$\frac{\partial P_j}{\partial x_j} = P_j(1 - P_j)\beta$$

and the elasticity is

$$\frac{\partial \ln P_j}{\partial \ln x_j} = \beta x_j P_j$$

see Greene (1993), pp 664–672.

from column (3) of Table 5, the mean marginal effect of increasing the UK effective average tax rate by 1 percentage point is to reduce the conditional probability of a firm locating in the UK by 1.29 percentage points. Similarly, for France the equivalent impact of a 1 percentage point increase in the effective average tax rate is to reduce the conditional probability of a firm locating there by 0.50 percentage points. For Germany the impact is to reduce the conditional probability of a firm locating in Germany by 0.97 percentage points. The mean elasticities of the probability of choosing each location with respect to the effective average tax rate are -0.4 for the UK, and -1.7 for France and Germany.[25] The magnitude of these effects seems plausible.

4.2. The choice of whether to produce in Europe

We now turn to estimating the higher levels of the decision tree in Fig. 1. We begin by considering the choice between producing in or exporting to Europe, conditional on having decided to supply the European market. As Eq. (14) indicates, the decision whether to produce in the US or Europe is determined by whether $\Pi_{22c} - \Pi_{21.} \gtrless 0$. Again, factors that do not vary across the two options will not enter this decision. Factors that influence the optimal choice of location within Europe will enter indirectly through the inclusive value term, INC, which measures the expected level of profits from the lowest level using the estimates obtained from the specification in column (3) of Table 5. In the results which follow, a positive term indicates a positive effect on $\Pi_{22c} - \Pi_{21.}$, that is a positive effect on the probability of locating in Europe.

A linear approximation of Eqs. (2) and (3), which forms the basis of the discrete choice estimated in column (2) of Table 7, is

$$\Pi^i_{21.} = \alpha_1 + \beta_1 q + \beta_2 T^k + \beta_3 \mathrm{ULC}^k + \beta_4 A^k + \beta_5 S^i + \beta_6 KY^i + \varepsilon^i_{21.} \tag{18}$$

$$\Pi^i_{22c} = \alpha_2 + \beta_7 q + \beta_8 T^k + \beta_9 \mathrm{ULC}^k + \beta_{10} A^k + \beta_5 S^i + \beta_6 KY^i + \beta_{11} \mathrm{INC}^i + \varepsilon^i_{22c} \tag{19}$$

q, T, ULC, and A represent US values of the cost of capital, effective average tax rate, unit labour costs and agglomeration respectively, S is firm sales and KY is the firm specific capital output ratio.[26] The variables which do not vary across firms may affect the overall profit differently depending on, for example, the proportion of the firm's production undertaken in the US. The coefficients therefore differ across the two options; we estimate the difference between these coefficients. Differences in the firm specific variables across firms may also affect their choices.

[25] The marginal effects and the elasticities for the effective average tax rate are virtually identical for columns (2) and (4) of Table 5.

[26] Transport costs also played an important role in the conceptual framework set out in Section 2. Unfortunately, however, reliable data on transport costs is not available. We include industry specific dummies in the estimation which partially controls for differences in transportation costs.

Table 7
Multinational vs. export; supplying vs. not supplying European market

	(1)	(2)	(3)	(4)	(5)
No of observations	10 091	9972	9972	9972	9972
Log likelihood	−6210.1	−5886.9	−5876.1	−5911.2	−5876.5
Ctry cost of capital	0.039	−0.087	−0.078	−0.030	−0.119
	(0.043)	(0.059)	(0.059)	(0.025)	(0.048)
Ctry-Ind effective average tax rate	−4.58	−1.53	−2.08	–	–
	(1.45)	(1.86)	(1.87)		
Ctry effective average tax rate	–	–	–	−0.373	–
				(1.32)	
Ctry-Ind average tax rate	–	–	–	–	−0.995
					(1.45)
Ctry-Ind unit labour costs	–	−0.181	−0.150	0.299	−0.134
		(0.253)	(0.254)	(0.197)	(0.253)
Firm capital output ratio	–	−0.821	−0.869	−0.877	−0.877
		(0.250)	(0.254)	(0.253)	(0.254)
Firm sales	–	0.266	0.230	0.232	0.232
		(0.016)	(0.017)	(0.017)	(0.017)
Firm R&D share	–	–	0.040	0.041	0.040
			(0.010)	(0.011)	(0.010)
Ctry-Ind production agglomeration	–	3.22	3.18	2.43	3.74
		(1.06)	(1.06)	(0.844)	(1.01)
Inclusive value	−1.36	0.558	0.596	0.103	0.912
	(3.98)	(4.24)	(4.240)	(0.111)	(4.23)

Notes: Standard errors are in brackets. All columns include industry and US regional dummies. All columns except (4) include year dummies.

Here, both *S* and *KY* may proxy scale economies; the higher are plant level fixed costs – assumed to be positively correlated with *KY* – the lower the probability of producing in a separate plant in Europe. Other fixed costs not captured by *KY* may be proxied by *S*.[27] In Table 7 the country specific variables all refer to the USA; those of other countries are incorporated into the inclusive value term.

As at the lowest level of estimation, we begin in column (1) of Table 7 by examining the correlation of the two main tax measures, here conditional on the inclusive value term, INC. As in the previous results, the US cost of capital does not play a significant role in the choice of whether or not to locate in Europe. However, the coefficient on the US effective average tax rate is significant. At first sight, the negative sign of this coefficient is counter-intuitive; it indicates that a higher US effective average tax rate would reduce the probability of locating in Europe. However, two important factors need to be taken into account. First, the US levies a tax on repatriated profits if the tax charged in Europe is lower than would have been charged in the US. For repatriated profits, this implies that the tax rate faced by a firm locating abroad cannot be less than that faced if it located only in the US. So a rise in the US tax rate does not necessarily make other locations more attractive to US firms. Second, non-US resident firms producing in the US are also liable to tax on that activity under the US tax system; here a rise in the US tax rate does not necessarily disadvantage US firms.[28] Combining these factors implies that the main impact of a rise in the US tax rate would be to disadvantage US firms which produce abroad relative to non-US firms producing outside the US which did not have to pay the higher US tax rate. This suggests a negative impact of the US tax rate on the decision to produce abroad, as indicated in column (1).

Before estimating the model more fully, two problems discussed in the data section should be noted. First, the destination of exports from the US is not observed: it is therefore not possible to distinguish firms which export to Europe from those which do not export to Europe, but which export to some other location. Second, the fact that only a small number of observations (194) are purely domestic makes it very difficult to estimate the determinants of the highest level choice, Eq. (15), of whether or not to supply the European market, if it is assumed that all firms which export from the US, but do not produce in Europe, in fact export to Europe.

[27]Previous studies have indicated that the absolute or relative size of the firm may also be important in the decision of whether to produce abroad. For example, Caves (1996) discusses ''a fixed transactions costs of learning how things are done abroad''. Blomstrom and Lipsey (1993) find a threshold effect: they find that size is not important once a threshold level has been passed. This is consistent with the fixed costs becoming insignificant at a certain level of operation. See also Horst (1972); Lipsey et al. (1983).

[28]Unless the total tax levied on non-resident firms exceeds the US tax, in which case the total tax levied may be unaffected by a rise in the US tax.

Column (2) of Table 7 examines the choice between producing in Europe and exporting to Europe by making this assumption that all firms which export from the US, but do not produce in Europe, in fact export to Europe. The relevant variables in this choice are the elements of Z_{dm}^{ik} in Eq. (11) and are shown in Eqs. (18) and (19). The agglomeration term, *A*, is here taken to be production agglomeration. The demand agglomeration term is not relevant at this decision level; R&D is discussed below. Including these additional terms means that the effective average tax rate does not play a significant role in the choice of whether to locate in Europe. Given the earlier discussion, this is not particularly surprising; any effects on the relative competitiveness of US resident companies are likely to be of second order importance. The insignificance of the tax measures, consistent across all other columns in the Table, mirrors the results of Devereux and Freeman (1995) in that taxes appear to be important in determining the location of production conditional on producing abroad, but not important in the decision as to whether or not to produce abroad.

The insignificant coefficient on the inclusive value term suggests that the industry specific factors modelled at the lower level are not the primary factors driving firms to produce in Europe rather than export, even though they play a role in determining where firms locate.

The two firm level variables, *KY* and *S*, are both very significant and have the expected sign. US unit labour costs are not significant, but the production agglomeration term is positive and significant. On the reasoning of the lower level, this is counter-intuitive: if there are positive spillover effects arising from close proximity to other production in the same industry, then a higher level of agglomeration in the US should reduce the probability of locating in Europe. One possible explanation of this result is that it reflects the choice of whether to supply the European market, rather than the choice between producing in Europe versus exporting. A high level of agglomeration in the US may indicate that firms which produce there have some competitive advantage over those which do not; supplying the European market is therefore likely to be profitable for such firms.

This challenges the interpretation of column (2) as reflecting the choice between exporting to Europe and producing in Europe, in turn reflected in the extreme interpretation of the data that all exporting firms which do not produce in Europe instead export to Europe. An alternative extreme interpretation is that no firms export to Europe. In this case the distinction between firms which produce in Europe and those which do not is equivalent to choosing whether or not to supply the European market.

The empirical specification in columns (3), (4) and (5) include the elements of both B_d^{ik} and Z_{dm}^{ik} and thus can be interpreted as estimating both Eqs. (14) and (15) together. In practice this means we add a measure of the relative importance of each firm's R&D: the amount of R&D done by the firm, relative to the total amount done in its primary industry in the US. This is related to the firm level fixed cost, which may provide an intangible asset, for example, a patent gained

through R&D expenditure. The existence of such intangible assets gives an advantage to the firm over and above potential competitors in the foreign location, and makes it more likely that the firm would choose to supply the foreign market. The nature of R&D also makes it more likely that the firm would produce abroad itself, rather than licence some local third party, which may subsequently use the information which it gained to compete with the US firm.

Adding the R&D term in column (3) has little effect on the other variables. However, the R&D term itself is positive and strongly significant, supporting the proposition that R&D intensive firms are more likely to supply a foreign market and possibly to produce abroad.

In columns (4) and (5) alternative measures of the average tax rate are used to check the robustness of the results. The two measures used are those also used in Table 6. Column (4) includes the effective US average tax rate measured using a constant profit rate of 40%. Since this varies only over time, it is not possible to include time dummies in this specification. The coefficient on the effective average tax rate is considerably lower than in column (3), and it remains insignificant. Including this term and dropping time dummies has little impact on the other variables. Column (5) includes instead the average tax rate constructed from firm level accounting data. This also has a negative, but insignificant effect. Again, the other coefficients are not significantly affected. At this level, then, none of the measures of US taxation plays a significant role.

5. Conclusions

This paper has investigated the locational decisions of US firms. We have presented a theoretical structure, drawing on a model by Horstmann and Markusen (1992) which leads naturally to estimation of the determinants of these decisions using a nested multinomial logit model. The model has explicitly allowed firms to take the outside option of not serving the foreign market, or accessing it through exports. We have applied the model to a sample of US firms choosing whether and how to supply the European market. In general, we take Europe to be a single market and allow the firms to choose to produce in one of the UK, France and Germany.

The empirical results are generally consistent with the theoretical structure. We would expect marginal factor costs to be most important in determining the level of output in each location, conditional on having chosen that location. The cost of capital, reflecting the effective marginal tax rate, is generally not significant in any of the strategic choices. However, as the theory predicts, the effective average tax rate does play an important role in the choice of location, conditional on producing in Europe. Our central estimate is that, conditional on the firm having decided to produce in Europe, a 1 percentage point increase in the effective average tax rate

in the UK would lead to reduction in the probability of a US firm choosing to produce there by around 1.3 percentage points. The equivalent marginal effects for France and Germany are 0.5 percentage points, and around 1 percentage point, respectively. This suggests that tax is a quantitatively significant factor in location decisions. However, the effective average tax rate does not play a significant role in the choices between producing in Europe abroad as opposed to either exporting to Europe or not serving the European market at all.

According to the conceptual framework, marginal unit labour costs should be significant in determining the level of output in a given location, while average unit labour costs should be significant in the choice of location, and possibly in the choice as to whether to produce in Europe. In practice, we cannot distinguish between marginal and average unit labour costs; the measure used does not play a significant role in any of the strategic choices.

Other factors predicted by the theory play a significant role. Most striking are agglomeration benefits. However, it is difficult to distinguish between the relative importance of three forms of (colinear) agglomeration – proximity to other firms producing in the same industry, to final demand, or to other firms in the same industry with relatively high R&D. Each of these may play a role. These agglomeration benefits affect primarily the decision where to locate, conditional on choosing to locate abroad. In addition, also as predicted by theory, firms in industries with high R&D – and therefore probably with high intangible assets and relatively skilled workers – are more likely to produce abroad. Firms with high plant level fixed costs are less likely to produce abroad.

Two important restrictions were made in setting up and estimating the model. First, the model is static, and therefore does not distinguish between, for example, the choice of one firm as to whether to produce in Europe for the first time, and the choice of another firm as to whether to change locations within Europe. Second, the model does not allow for firms to locate in more than one foreign location. Extensions to allow for each of these factors are left for future research.

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Appendix A

The firm level data are from Standard and Poor's Compustat file which contains accounting information on US resident firms. The industry level data for each of the countries is taken from the OECD STAN (Structural Analysis) industrial database and the OECD ANBERD database.

Observations that were not for twelve month accounting periods were dropped as were those which did not report exports and geographic segments sales data (although either could be zero). Where data were not available in every year all observations before the missing year were deleted, but those after were kept.

The firm level variables (Compustat mnemonic) and industry level variables (STAN and ANBERD mnemonic) are:

$$\text{Firm capital output ratio} = \frac{\text{capital expenditure (CAPX)}}{\text{sales (SALE)}};$$

$$\text{Firm R\&D market share} = \frac{\text{R\&D expenditure (XRD)}}{\text{total industry R\&D expenditure in the US (BERD)}};$$

Firm sales are world-wide sales (SALE);

Ctry-Ind unit labour costs are labour costs expressed in 1987 prices per employee as a proportion of value added at 1987 market prices per employee:

$$\text{ULC} = \frac{\left(\frac{\text{LC}}{\text{EM}} * \frac{1}{\text{CPI}}\right)}{\left(\frac{\text{KV}}{\text{EM}}\right)}$$

where LC is labour costs, EM is numbers employed, CPI is the consumer price index, and KV is value added at real market prices.

Ctry-Ind demand agglomeration for the UK, France and Germany is the proportion of demand in each country as a proportion of total demand in the three countries. Ctry-Ind demand is defined as production minus exports plus imports (PR − EX + IM).

US-Ind demand agglomeration is the proportion of demand in the US as a proportion of total demand in the three European countries plus the US.

Ctry-Ind and US-Ind production agglomeration are constructed in an identical approach, using net industry production (industry production in each country net of firm production).

Ctry-Ind and US-Ind R&D agglomeration are also constructed in the same way using industry R&D.

Tax measures

The cost of capital and effective average tax rates are taken from Chennells and Griffith (1997). They are calculated using country and time specific inflation rates and a real interest rate of 10%. The marginal investor is assumed to be tax exempt. Exchange rates are assumed to be expected to preserve purchasing power parity. Effective tax rates are calculated for investment in two types of assets and for seven forms of finance. Weighted averages are constructed across types of asset and types of finance. Weights are from OECD (1991): assets – 64% plant and machinery and 36% buildings; parent firm finance – 55% retained earnings, 10% new equity, and 35% debt; subsidiary finance – 33% retained earnings, 33% new equity from the parent and 33% debt from the parent.

Average tax rates are calculated using two different methodologies. The first (defined as the effective average tax rate in this paper) uses information on the tax system, in a similar way to the King and Fullerton (1984) approach. The basic approach is similar to that in Devereux and Griffith (1998). Consider an investment project with cost $C=1$, and the present value of its income stream V. Suppose $V>$C and denote the difference economic rent, R, so that

$$V-C=R.$$

For a given income stream calculate its net present value in the absence of tax, V^{NT}, and in the presence of tax, V^{T}, inclusive of any tax depreciation allowances (so that $C=1$ in the presence and absence of tax). The effective average tax rate is then defined as

$$\text{AETR}=\frac{V^{NT}-V^{T}}{V^{NT}}.$$

Since the AETR varies according to the level of economic rent, or profitability, it is necessary to choose a value of profitability, or equivalently R. Using National Accounts for each country, average industry profitability was calculated as (Value Added − Labour Costs)/Capital Stock. The Capital Stock was calculated as

$$K_{it}=K_{it-1}+(1-\delta)I_{it}$$

where δ is the economic depreciation rate, taken to be 9.14% (OECD, 1991)

The second method uses firm level accounting data from Global Vantage accounting data on individual firms in each country to calculate the firm level average tax rate. These are constructed as ''provision for tax'' divided by ''net pre-tax income''. They are averaged across firms to construct an estimate of the average tax rate for each industry in each country, using only estimated firm level tax rates in the range 0–70%. This truncation produces averages similar to the median of the non-truncated sample. Where there was insufficient information in Global Vantage to calculate an industry specific average the country average

(constructed in a similar manner) is used. The construction of average tax rates from firms' financial statements is discussed by Collins and Shackelford (1995).

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