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On the Determinants of Euro Area FDI to the United States: The Knowledge-Capital-Tobin's Q Framework

by

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On the Determinants of Euro Area FDI to the United States: The Knowledge-Capital-Tobin's Q Framework

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Abstract

The long-run determinants of euro area FDI to the United States during the period 1980-2001 are explained by employing the Tobin's Q-model of investment. By using the fixed effects panel estimator, stock market developments in the euro area countries – including a measure adjusted for economic developments common to both the United States and the euro area - are found to influence euro area FDI to the United States. Moreover, the inclusion of the Tobin's Q enhances the traditional knowledge-capital framework specification. Overall, the empirical findings suggest that euro area patents (ownership advantage), various variables related to productivity in the United States (location advantage), the volume of bilateral telephone traffic to the United States relative to euro area GDP (ownership advantage), euro area stock market developments (Tobin's Q), and the real exchange rate are statistically significant determinants of euro area FDI to the United States.

JEL Classification Codes: F21, F23.

Key words: Euro area, Foreign Direct Investment, Multinational firms, Tobin's Q.

Outline

Non-Technical Summary

Global foreign direct investment (FDI) flows skyrocketed in the 1990s from USD 209 billion in 1990 to USD 1393 billion in 2000 to decline to USD 651 billion in 2002. Meanwhile, world FDI stocks generated sales by foreign affiliates of around USD 18 trillion, compared with global exports of USD 8 trillion in 2002. Employment by foreign affiliates reached an estimated 53 million workers in 2002, which is three times the number recorded in 1982. Most FDI occurs between developed countries, for example: FDI stocks are concentrated in the European Union and the United States, accounting for 72% of the total world outward stock and 56% of the total world inward stock in 2002. Traditionally, the United States has been one of the largest recipients of FDI accounting for 19% of the world inward stock in 2002, particularly from the euro area. In view of these developments, investigating the determinants of euro area FDI to the United States constitutes an important and interesting undertaking.

The present paper derives FDI from an intertemporal maximisation problem faced by the multinational firm. In other words, it adopts an investment-based approach à la Tobin (Tobin, 1969) with convex adjustment costs. Tobin's Q theory suggests that if the market value of a firm over its book value is greater than one - implying the existence of “intangibles” such as brands, reputation and knowledge or growth potential that business analysts and shareholders value - then the firm should increase its capital stock, as investing is profitable. The innovation in this paper is the interpretation that a rise in the capital stock can take the form of both domestic investment and investment abroad (i.e., mergers and acquisitions or “green field” investment). As a result, a rise in the euro area stock market (our proxy for euro area Tobin's Q) should lead to an increase in euro area outward FDI.

The theoretical model is evaluated empirically by using a panel of eight (or sometimes nine) euro area countries for the period 1980 to 2001. The results substantiate the theoretical predictions that the euro area stock market price is an important explanatory variable of euro area FDI to the United States.

The technology boom in the United States – and the desire of euro area firms to acquire the new technologies of US companies – seems to have been a key factor behind FDI outflows to the United States, particularly in the second-half of the 1990s. In order to understand more fully the importance of US-specific technology variables as a pull factor of euro area FDI, we separate the euro area stock market price into the US knowledge-capital element and the investment climate in the euro area. The traditional technology variables included in the knowledge-capital framework, such as US patents in high-tech sectors and US expenditure in

manufacturing R&D, are statistically significant in explaining euro area FDI to the United States. However, the investment climate in the euro area enhances the traditional knowledge-capital framework specification by adding further explanatory power to the FDI equation.

A major benefit of finding the stock market term statistically significant is that it provides a data series which is available up to the current date. Therefore, it allows one to derive a better judgement of current and future movements in FDI given that other variables which explain FDI – such as patents and expenditure in R&D – are only available with a considerable lag. Indeed, the average stock price decline in the euro area in 2002 and 2003 has corresponded with the significant declines in euro area FDI outflows to the United States over the same period.

1. Introduction

Global foreign direct investment (FDI) flows skyrocketed in the 1990s from USD 209 billion in 1990 to USD 1393 billion in 2000 to decline to USD 651 billion in 2002. Meanwhile, world FDI stocks generated sales by foreign affiliates of around USD 18 trillion, compared with global exports of USD 8 trillion in 2002. Employment by foreign affiliates reached an estimated 53 million workers in 2002, which is three times the number recorded in 1982. Most FDI occurs between developed countries, for example: FDI stocks are concentrated in the European Union and the United States, accounting for 72% of the total world outward stock and 56% of the total world inward stock in 2002. Traditionally, the United States has been one of the largest recipients of FDI accounting for 19% of the world inward stock in 2002.[1]

Also, euro area companies invested extensively in the United States. The share of euro area FDI to the United States relative to total FDI inflows in the United States, while characterised by a U-shape in the 1980s, was around 34% in both 1980 and 1990, but increased to 64% by 2001. The stock of euro area FDI in the United States in real terms in 2001 was around fourteen times as large as it was in 1980. However, most of this growth occurred in the second half of the 1990s, as the size of real euro area FDI outflows to the United States reached their peak in 2000, amounting to around ten times the magnitude of outflows in 1995. In view of these developments, investigating the determinants of euro area FDI in the United States constitutes an important and interesting undertaking.

The theoretical and empirical literature on FDI is generally based on the so-called OLI-framework proposed by Dunning (1977).[2] Dunning identifies three conditions that must be satisfied for there to be a strong incentive for a firm to engage in FDI. First, a firm must have an *Ownership advantage* for a product or production process to which other firms do not have access (i.e., patent, blueprint, or trade secret).[3] Second, the foreign country must offer a *Location advantage* such that goods can be produced or supplied more cheaply. More recently, stronger emphasis has been given to vertical location advantages which induce quality-seeking FDI or technological sourcing (see Kogut and Chang, 1991; Neven and Siotis, 1996; Fosfuri and Motta, 1999). Third, the multinational firm must have an *Internalisation advantage*, i.e. a strategic reason to exploit its ownership advantage internally rather than licensing or selling it to a foreign firm.

[1] All the above facts are from UNCTAD (2003).
[2] OLI stands for *Ownership, Location* and *Internalisation* advantage.
[3] For example, Barrell and Pain (1997) concentrate on the role of firm-specific assets in the form of technology.

In the trade literature, the OLI-framework has been formalised in the so-called knowledge-capital models of multinational enterprises.[4] Those models look at the FDI implications for market structure, welfare, the equilibrium number of national and multinational firms in a static framework, where FDI is generally exogenously specified as a fixed cost to set-up a plant abroad (Markusen and Venables, 1998; De Santis and Stähler, 2003). Similarly, the empirical studies based on these models generally develop predictions about affiliate production (Carr et al, 2001, Blonigen et al., 2003).

The present paper derives FDI from an intertemporal maximisation problem faced by the multinational firm. In other words, we adopt an investment-based approach à la Tobin (Tobin, 1969) with convex adjustment costs. We argue that Tobin's Q is particularly appropriate for modelling FDI because adjustment costs in international investment are likely to be much higher than for domestic investment. Jovanovic and Rousseau (2002), for example, show that the Q-theory of investment can be used to explain investment via mergers and acquisitions (M&A). They find that M&A investment, which is a sub-component of FDI, responds to stock market developments by more than direct investment. Similarly, Blonigen (1997) finds that the Japanese stock market is an explanatory variable of Japanese FDI in the United States in the late 1980's and early 1990's.

The intuition behind our hypothesis that Tobin's Q can help to explain euro area outward FDI is as follows. Standard Q theory suggests that if the market value of a firm over its book value is greater than one - implying the existence of "intangibles" such as brands, reputation and knowledge or growth potential that business analysts and shareholders value - then the firm should increase its capital stock as investing is profitable. The innovation in this paper is the interpretation that a rise in the capital stock can take the form of domestic investment and of investment abroad (i.e., FDI in the form of both mergers and acquisitions and "green field" investment). As a result, a rise in the euro area stock market (our proxy for euro area Tobin's Q) should lead to an increase in euro area outward FDI as well as domestic investment.[5]

The theoretical model is evaluated empirically by using a panel of eight (or sometimes nine) euro area countries for the period 1980 to 2001. In line with the theoretical model, a

[4] For an overview see Markusen and Maskus (2001) and Markusen (2002).

[5] Generally, studies have found only weak evidence of a positive relationship between stock market valuation and domestic investment. More recently, however, Erickson and Whited (2000) and Bond and Cummins (2001) have re-examined this relationship, and claim that measurement error has reduced the statistical significance of Q in empirical work.

dynamic partial adjustment model is specified and estimated using the least squares dummy variable (LSDV) estimator.

The empirical results provide support to the theoretical predictions, as the euro area stock market price turns out to be an important explanatory variable of euro area FDI to the United States.

The technology boom in the United States – and the desire of euro area firms to acquire the new technologies of US companies – seems to have been a key factor behind FDI outflows to the United States, particularly in the second-half of the 1990s. In order to understand more fully the importance of US-specific technology variables as a pull factor of euro area FDI, we separate the euro area stock market price into the US knowledge-capital element and the investment climate in the euro area. The traditional technology variables included in the knowledge-capital framework, such as US patents in high-tech sectors and US expenditure in manufacturing R&D, are statistically significant in explaining euro area FDI to the United States. However, the investment climate in the euro area enhances the traditional knowledge-capital framework specification by adding further explanatory power to the FDI equation.

Overall, the empirical findings suggest that euro area patents (ownership advantage), various variables related to productivity in the United States (location advantage), the volume of bilateral telephone traffic to the United States relative to euro area GDP (location advantage), stock markets prices in euro area countries - adjusted for economic developments common to both the United States and the euro area – (adjusted Tobin's q), and the real exchange rate are statistically significant determinants of euro area FDI to the United States.

The remainder of the paper is structured as follows. Data and trends in FDI are briefly discussed in Section 2. Section 3 presents the theoretical model of FDI based on the knowledge-capital framework and Tobin's Q. Section 4 presents the data set. Section 5 discusses the empirical results. Section 6 concludes.

2. Foreign direct investment: Definitions and trends

The US Bureau of Economic Analysis (BEA) defines FDI as the acquisition of foreign assets (based on residence) with the intention to exert control. More specifically, FDI in the United States is ownership or control, direct and indirect, by one foreign person of 10% or more of the voting securities of a US business enterprise (BEA, 2001). This definition has at least two important features. First, FDI reflects entering into a long-term relationship with the host country. Second, FDI does not merely represent a transfer of resources across national borders, but also a transfer of corporate control.[6]

This study uses balance of payments and direct investment position data in order to construct a series of the stock of FDI for the twelve euro area countries in the United States for the period 1980-2001. The data are obtained from the Bureau of Economic Analysis (BEA), which defines the "intention to exert control" as ownership of more than 10%. These data measure the value of the parent firms' financial stakes in their foreign affiliates. As such, direct investment position data measure FDI as an input of production (Lipsey, 2001).[7]

Figure 1 shows the aggregate euro area stock of FDI in the United States, as well as the annual outflows, calculated at 1995 US dollar constant prices (both expressed as indices with 2000 as the base year). It is clear that the real stock of euro area FDI held in the United States has increased linearly in the 1980's and exponentially in the 1990's. The real stock of FDI in 2001 was fourteen times as large as it was in 1980. On average, the real stock of FDI increased by 14% each year over the period 1980-2001, but the growth in the stock of FDI was particularly strong in the second half of the 1990s. For example, the euro area's real stock of FDI in the United States grew by almost 30% in 1999, while the size of real euro area FDI outflows to the United States reached their peak in 2000 amounting to around ten times the magnitude of outflows in 1995.

[Insert Figure 1, here]

Figure 2 shows the distribution of the euro area's stock of FDI in the United States, indicating that the bulk of euro area FDI to the United States is accounted for by a few countries. Back in 1980, the Netherlands was responsible for 52% of the stock of euro area FDI in the United States followed by Germany and France which held 20% and 14% of the stock respectively. In the 1990s Germany, France and Luxembourg gained substantially in importance as FDI investors in the United States. By 2001, Germany was the biggest investor holding 31% of the euro area stock of FDI in the United States, while the share of the Netherlands fell to 29%, France had 22% and Luxembourg 13%. The seemingly

[6] Direct investment inflows in the United States consist of equity capital inflows, intercompany debt inflows and reinvested earnings. Equity capital inflows are net increases in foreign parents's equity in their US affiliates. Intercompany debt inflows consist of the increase in US affiliates' net intercompany debt payable to their foreign parent. Reinvested earnings of US affiliates are after-tax earnings of the affiliates not distributed as dividends (BEA, 2001). In 2001 the shares of equity capital, inter-company debt and reinvested earnings in total euro area FDI in the United States were 65%, 43% and –9% respectively.

[7] It is important to stress that investment position data are based on the immediate sources and destinations of investment, whereas the ultimate source and final destination might be located in different industries or countries (Lipsey, 2001). This could lead to the overestimation of financial "hubs" as sources or destinations of investment (i.e. Luxembourg and the Netherlands).

disproportionate share of the Netherlands and Luxembourg in euro area FDI may be related to methodological issues regarding the classification of the data.[8] Both countries may act as hubs for FDI resulting from a highly developed and sophisticated financial sector combined with favourable fiscal policies for firms. In addition, we do not have sufficient data for all of the explanatory variables for Luxembourg, therefore, this country was excluded from the empirical analysis. With regard to the Netherlands, it might be appropriate during the econometric analysis to check the robustness of the results by at first including, and then excluding, this country from the sample.

[Insert Figure 2, here]

Figure 3 plots the movements of nominal stock markets indices in France, Germany and the Netherlands, the three major euro area countries undertaking FDI activities, against euro area nominal FDI outflows to the United States. It can be seen that euro area FDI outflows and stock market indices tend to show a significant degree of co-movement over the sample period. Accordingly, Figure 3 suggests that the value of the corporate sector could be a factor positively affecting euro area outward FDI to the United States.

[Insert Figure 3, here]

A sectoral analysis of euro area FDI to the United States – using the M&A database of Thomson Financial – provides some useful insights. For example, Figure 4 (based on the average for the period 1985-2001) shows that services – excluding the financial sector – accounted for 31.1% of total M&As, financial services received 14.9%, while manufacturing amounted to 35.7%. One striking feature is that the proportion of "high-tech" US companies acquired by euro area firms has been increasing over time. In particular, the boom in euro area FDI to the United States in the mid-to-late 1990s was concentrated in high-tech industries. In 2001, for example, the high-tech industries (i.e. a composite of biotechnology, computer equipment, electronics and communication technology sectors, etc.) accounted for 47% of total euro area M&A in the United States compared to an average of 32% over the years 1998-2001 and an average of 21% over the period 1985-1997.

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[8] According to data from the Thomson Merger and Acquisition (M&A) database for 2001 based on ultimate source and target country, Germany and France both account for 31% of the stock of euro area FDI in the US (based on cumulated M&A), the Netherlands for 25% and Luxembourg for only 2%. Thus, it is clear that Luxembourg ought to be excluded from the sample as the data classification method changes the picture dramatically, while for the Netherlands the decision whether or not to exclude it is far from obvious and should be considered as an empirical question.

These stylised facts suggest that euro area corporate sector valuation, as well as the internalisation of US knowledge capital, may affect euro area FDI activities to the United States.

[Insert Figure 4, here]

3. A model of FDI with convex adjustment costs

Assume that multinational firms are characterised by the following production functions: $F\{k_t, P_t\}$ in the home country and $G\{k_t, K_t^j, P_t\}$ in the host country, where k_t denotes the firm's capital stock; P_t the multinational firm-specific asset (ownership advantage) and K_t^j the knowledge-capital in the host country (location advantage).

The multinational firm is able to produce a specific product and is willing to undertake FDI, although it is costly, to enjoy the foreign technological advantages, which can be internalised only by having a presence abroad. In general, K_t^j can be interpreted as the country-specific variables, such as technology, flexibility of the labour markets, other institutions, etc., which increase firms' output.

Assume that markets are segmented so that each firm maximises the present value of its profit function with respect to its inputs and with respect to both domestic investment, I_t, and foreign domestic investment, FDI_t.

Assuming that capital depreciates at a constant proportional rate *h*, the evolution of the capital stock is given by $\dot{k}_t = I_t + FDI_t - hk_t$, where a dot over a variable denotes the derivative of that variable with respect to time.

In addition, assume that each multinational firm faces costs of adjusting its capital stock, which could be higher abroad (i.e. management becomes more spread in the organisation. Training costs in foreign languages might be higher. Additional costs might arise to bridge cultural differences and different practices as well as to understand bureaucracy and institutions abroad). Then, the net real cash flow of a firm operating at home and abroad at time *t*, V_t^j, is:

$$V_t^j = \int_{s=t}^{\infty} e^{-r(s-t)} \left[p_s^F \left(F\{k_s, P_s\} - \frac{\delta^I}{2} \frac{I_s^2}{k_s} \right) - I_s + \frac{p_s^G}{x_s} \left(G\{k_s, P_s, K_s^j\} - \frac{\delta^{FDI}}{2} \frac{FDI_s^2}{k_s} \right) - FDI_s \right] ds ,$$

where p_s^F denotes the domestic good price, p_s^G the foreign good price, x_t the exchange rate (host country currency relative to the home country currency), *r* the constant real interest rate, and δ^{I} and δ^{FDI} the firm's cost parameters of adjusting its capital stock respectively at home and abroad. On the one hand, the more rapidly the firm adjusts its stock of capital, the lower its profits are. On the other hand, the higher the spillovers from the host country and the expected appreciation of the foreign currency, the higher its profits would be. Note that $\delta^{FDI} > \delta^{I}$, only if the low of one-price holds.

The firm chooses the paths of domestic investment and FDI by maximising V_t^j subject to the evolution of the capital stock. Therefore, the current-value Hamiltonian is equal to

$$H\{k_t, I_t, FDI_t\} = \left[p_s^F \left(F\{k_t, P_t\} - \frac{\delta^I}{2}\frac{I_t^2}{k_t} \right) - I_t + \frac{p_s^G}{x_s}\left(G\{k_t, P_t, K_t^j\} - \frac{\delta^{FDI}}{2}\frac{FDI_t^2}{k_t} \right) - FDI_t \right]$$
$$+ q_t\left(I_t + FDI_t - hk_t\right),$$

where q_t denotes the shadow value of the state variable (the value of a unit of capital).

The derivatives of the Hamiltonian with respect to the control variables, I_t and FDI_t, yield the condition under which a firm invests to the point where the cost of acquiring capital equals the value of the capital:

$$1 + p_t^F \delta^I \frac{I_t}{k_t} = q_t, \tag{1}$$

$$1 + \frac{p_t^G}{x_t}\delta^{FDI}\frac{FDI_t}{k_t} = q_t. \tag{2}$$

Therefore, domestic and foreign investments are positive only when the shadow price q_t of installed capital exceeds unity, the price of new, uninstalled capital.

The derivative of the Hamiltonian with respect to the state variable, k_t, yields the condition under which the marginal revenue product of capital equals the opportunity cost of a unit of capital:

$$p_t^F F_k\{k_t, P_t\} + \frac{p_t^G}{x_t} G_k\{k_t, P_t, K_t^j\} = (r+h)q_t - \dot{q}_t. \tag{3}$$

In other words, owning a unit of capital for a period requires forgoing rq_t of real interest and involved offsetting gains of $\dot{q}_t$.

Finally, the transversality condition $\lim_{t\to\infty} e^{-rt} q_t k_t = 0$ states that the value of the capital stock must approach zero.

Provided that permanent bubbles in the shadow price of capital are ruled out, so that $q_t \to 0$ as $t \to \infty$, the solution of the differential equation (3) yields the so-called marginal-q.

That is, the value of a unit of capital at a given time equals the discounted value of its future marginal revenue products:[9]

$$q_t = (r+h)^{-1}\left(p_t^F F_k\{k_t, P_t\} + \frac{p_t^G}{x_t} G_k\{k_t, P_t, K_t^j\}\right). \tag{4}$$

By using (4), (1) and (2) can be rewritten as follows:

$$\frac{I_t}{k_t} = \frac{1}{\delta^I p_t^F}\left[(r+h)^{-1}\left(p_t^F F_k\{k_t, P_t\} + \frac{p_t^G}{x_t} G_k\{k_t, P_t, K_t^j\}\right) - 1\right], \tag{5}$$

$$\frac{FDI_t}{k_t} = \frac{1}{\delta^{FDI}} \frac{x_t}{p_t^G}\left[(r+h)^{-1}\left(p_t^F F_k\{k_t, P_t\} + \frac{p_t^G}{x_t} G_k\{k_t, P_t, K_t^j\}\right) - 1\right]. \tag{6}$$

Expressions (5) and (6) should explain respectively euro area domestic investment and FDI activities.

As mentioned earlier, it seems that the technology boom in the United States – and the desire of euro area firms to acquire the new technologies of US companies – seems to have been a key factor behind FDI outflows to the United States, particularly in the second-half of the 1990s. This motivation for undertaking FDI would fall under the heading of vertical location advantages within the knowledge-capital framework. In order to understand more fully the role of these vertical location advantages, namely the importance of US-specific technology variables as a pull factor of euro area FDI, assume that $F\{k_t, P_t\} = P_t k_t^{1-\alpha}$ and $G\{k_t, K_t^j, P_t\} = P_t K_i^j k_t^{1-\alpha}$ with $0 < \alpha < 1$. Then, $F_k\{k_t, P_t\} = (1-\alpha) P_t k_t^{-\alpha}$ and $G_k\{k_t, K_t^j, P_t\} = (1-\alpha) P_t K_i^j k_t^{-\alpha}$. Hence, $G_k\{k_t, K_t^j, P_t\} = K_i^j F_k\{k_t, P_t\}$. Substituting the latter expression into (5) and (6) yields

$$\frac{I_t}{k_t} = \frac{1}{\delta^I p_t^F}\left[(r+h)^{-1} p_t^F F_k\{k_t, P_t\}\left(1 + K_t^j \frac{1}{z_t}\right) - 1\right], \tag{7}$$

$$\frac{FDI_t}{k_t} = \frac{1}{\delta^{FDI}} \frac{z_t}{p_t^F}\left[(r+h)^{-1} p_t^F F_k\{k_t, P_t\}\left(1 + K_t^j \frac{1}{z_t}\right) - 1\right], \tag{8}$$

where $z_t = x_t \dfrac{p_t^F}{p_t^G}$ denotes the real exchange rate expressed in terms of the home currencies.

[9] Expression (3) is a first-order linear differential equation with a variable coefficient and a variable term of the type $\dot{y}_t + u_u y_t = w_t$, here with $y_t = q_t$, $u_u = r + h$ and $w_t = p_t^F F_k + p_t^G G_k / x_t$. The constancy of r helps simplifying the mathematical solution of the problem. Needless to say that the intuition of the model would hold if r were time variant.

The reduced forms (7) and (8) show that domestic investment and FDI are a positive function (of the discounted value) of the knowledge capital of the host country (vertical location advantage) and of the marginal revenue product of capital in the home country excluding the spillovers coming from the host country (investment climate in the euro area). Both equations can be estimated independently.[10]

Two alternative specifications could be studied: first, the Tobin's Q represented by (6); second, the separation of Tobin's Q into the vertical location element and the part relating to the investment climate in the euro area, as represented by (8). Accordingly, by using proxies for what we call "unadjusted" and "adjusted" Tobin's Q, two alternative specifications are tested. In particular, if stock market developments adequately capture vertical location advantages, we expect US technology variables to be insignificant when using the unadjusted Tobin's Q and significant when using the adjusted measure.

In addition, (8) also shows that FDI is a positive function of the contemporaneous home country's real exchange rate and a negative function of the future home country's real exchange rate. Therefore, an expected appreciation of the US dollar, by increasing the value of the discounted stream of expected profits made in the United States expressed in terms of the home currency, would encourage euro area FDI to the United States. Under the hypothesis that prices are relatively sticky and that the spot exchange rate is a good predictor of future exchange rates, then one can expect a negative relationship between euro area FDI to the United States and the home countries' real exchange rate, if the capital gain hypothesis holds.

The dynamics of the system between the capital shadow price (3) and the capital stock (1)-(2) has a unique saddle path that gradually converges to the steady state. Since the Tobin's Q model is based upon the assumption that the optimal stock of capital does not adjust instantaneously to shocks, a standard econometric framework to capture this feature is the partial adjustment model, which we estimate in Section 5.[11]

4. Data, variables and econometric specification

4.1 Proxying Tobin's Q

The marginal Q in equation (8) reflects the discounted value of the marginal product of capital in the euro area, which determines the level of investment abroad – we call this the

[10] This result is based on the hypothesis that multinational firms are not financially constrained. However, our approach is supported by the weak evidence that outward FDI competes with domestic investment found by Stevens and Lipsey (1991), who analysed the interdependence between domestic and foreign investment when firms are financially constrained.

"unadjusted" Tobin's Q_{it}. It is not observable.[12] However, as suggested by Barro (1990), the stock market price is a good proxy for the discounted stream of the future marginal product of capital. Since real FDI is evaluated in US dollars, the euro area stock market price indices are measured in US dollars and in real terms, as suggested by expression (8).

To the extent that the euro area stock market was assumed to have been subject to a permanent bubble, the theoretical model relating to Tobin's Q would no longer be compatible with the existence of a stable equilibrium. However, one should stress that if temporary bubbles occur, they do not necessarily change fundamentally the relationship between the stock market valuation and investment. For example, Chirinko and Schaller (2001) explicitly address the impact of bubbles on corporate investment. Focussing on Japan, they demonstrate that bubbles will tend to stimulate (equity-financed) investment over and above the optimal level of investment based on the (unobserved) real Q. Similarly, in investigating the Japanese investment in the United States, Blonigen (1997) uses the Japanese stock market variable to control for the speculative equity bubble in Japan.

The investment climate in the euro area $(r+h)^{-1} p_t^F F_k$ in equation (8) reflects euro area marginal Q excluding the positive vertical location spillovers from the host country, and we call this the "adjusted" Tobin's $\widetilde{Q}_{it}$ measure. By using $(r+h)^{-1} p_t^F F_k$, one could consider the present model as an extension of the knowledge-capital framework by controlling for the investment climate in the euro area. This could, therefore, provide a test as to whether Tobin's Q adds further explanatory power in addition to the variables included in the traditional knowledge-capital framework.

The problem is how to adjust the Tobin's Q measure, in order to subtract the vertical location advantages and, thereby, derive $\widetilde{Q}_{it}$. Our methodology to derive $\widetilde{Q}_{it}$ is to regress the real stock market indices of each euro area country on the real US stock market index and use the residuals as our measure of $\widetilde{Q}_{it}$. We choose this methodology, not only because it subtracts any vertical location spillovers from US firms to euro area multinational firms, but

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[11] The partial adjustment model to explain FDI activities was also used by Barrel and Pain (1996) and Cheng and Kwan (2000).

[12] The marginal Q is equal to the stock market capitalisation divided by the replacement cost of capital, if the production function is characterised by constant returns to scale (Hayashi, 1982). However, it is common knowledge that multinational firms are characterised by large set up costs and, as a result, by increasing returns to scale. It is important to mention, however, that the stock market capitalisation divided by the replacement cost of capital is strongly correlated with developments in stock market prices. For example, the correlation coefficient between these two variables for both Germany and the United States is equal to 99% over the monthly period 1973-2003.

also because it corrects for any excessive correlation between stock markets across the two economic areas, thereby removing the stock market bubble of the late 1990s.[13]

Obviously, this adjusted measure will also take out the information relating to common developments in economic fundamentals in the two regions. As a result, we expect that using the adjusted $\widetilde{Q}_{it}$ measure will not only render significant those variables related to vertical location advantages – such as US technology variables – but might also affect the significance of euro area technology variables. However, this approach should give us a much clearer understanding of the role of both technology variables and stock market price developments.

4.2 Ownership and location advantage variables

While discussing the data for the explanatory variables, it is useful to show how the respective variables enter the knowledge-capital framework as a way of highlighting the contribution of this paper to the existing literature. Considerable emphasis is given to knowledge-related variables in the discussion of both ownership and location advantages, while internationalisation advantages are given less attention, as the latter typically originate from information imperfections related to knowledge transfers.

Ownership advantages usually originate from the presence of firm-specific assets (P_t in the model). In practice, such assets could, for example, be related to technological or marketing capabilities. In the present paper we focus on the importance of firm-specific assets in the form of technological capabilities. More specifically, we use data on patents granted to euro area firms – obtained from the US Patents and Trademark Office (USPTO) as they reflect private knowledge (henceforth referred to as PAT_{it}).[14]

The location advantages are often linked to firms' desire to locate close to the market they wish to supply. The *advantage* of locating close to the market increases with the information flows across affiliates. Following Portes and Rey (2003), the overall flow of information between countries is measured by the ratio of the volume of bilateral telephone traffic – obtained from the International Telecommunication Union (ITU) – and the corresponding euro area country GDP (IC_{it}). The inverse of this ratio could be also interpreted as a measure of transaction costs.

[13] Forbes and Rigobon (2002) point out that the high comovement of national stock markets in the second half of the 1990s may have not reflected economic fundamentals. Therefore, the comovement may be considered as excessive.

[14] See Griliches (1990) for a discussion of patents as economic indicators.

Traditionally, vertical FDI (leading to the international fragmentation of production processes) has been associated with the persistence of significant factor cost differentials. However, it seems unlikely that the rapid increase in euro area FDI to the United States is driven by the desire to exploit factor cost differentials. As highlighted previously, the notion of vertical FDI has been extended in order to account for quality-seeking FDI (or 'technology sourcing'). Instead of "cost-reducing" FDI, firms might engage in FDI in order to acquire new technologies which could increase the productivity of the firms as a whole (Kogut and Chang, 1991; Neven and Siotis, 1996). Indeed, often cross-border M&A activities occur such that the technology of the involved firms is made available to all affiliates. One might argue that euro area FDI to the United States may have been partly motivated by the desire to "internalise" the stock of US knowledge-capital, which is considered to be one of the main drivers behind the strong performance of the US economy during the second half of the 1990s.[15]

To account for "vertical" location advantages, we employ a proxy for the pool of knowledge-capital present in the US economy; that is, real expenditure on R&D in the United States (RD_{USt}), obtained from the US National Science Foundation (NSF). Figure 5 shows the strong rise during the second half of the 1990s in both US R&D expenditure and the share of US patents in high-tech sectors. Therefore, in order to capture the increasing importance of high-tech sectors in terms of technological capabilities and the associated compositional change in FDI towards these sectors, we also use as an alternative measure the number of patents granted to US firms in high-tech sectors relative to the total number of patents granted to US firms (HT_{USt}).

[Insert Figure 5, here]

4.3 The real exchange rate

The real exchange rate is defined in the model as the bilateral real exchange rate between the United States and the corresponding euro area countries (RER_{it}). As mentioned in the previous section, the capital gain hypothesis implies a negative relationship between euro area FDI to the United States and the home countries' real exchange rate.

[15] The number of patents granted to US firms has increased at an accelerating pace over the last two decades in the "New Economy" sectors as well as in the economy as a whole. Over the period 1995-2000, the number of patents increased by 53% in the whole economy and by 101% in the "New Economy" sectors. Over the period 1995-1999 total expenditure on R&D in the United States increased by 31% while in the "New Economy" sectors this amounted to 42%.

However, alternative hypotheses can lead to different outcomes. The imperfect-capital-market theory of FDI, for example, suggests that a depreciation of the US dollar, by increasing the relative wealth position of foreigners, makes foreign firms relative to domestic firms in a better position to bid on an asset, thereby favouring FDI activities in the United States (Froot and Stein, 1991). Blonigen (1997) instead argues that a real dollar depreciation vis-à-vis yen, by raising the Japanese firms' reservation bid, made Japanese acquisitions more likely in US industries with firm-specific assets.

The coefficient on the real exchange rate could also capture the link existing between multinational firms' exports and their FDI activities. The loss in competitiveness from an appreciation of the home countries' real exchange rate would reduce (rise) FDI activities, if FDI and exports were complements (substitute).

4.4 Control variables

Relative interest rates are added to capture the relative cost of capital (RI_{it}). The higher the cost of capital in the euro area relative to the United States, the lower will be the level of investment of euro area firms in the United States (Barrell and Pain, 1997). We also add relative unit labour costs, which are defined as wages divided by labour productivity (RC_{it}), to capture differences in the real cost of labour. As such, relative unit labour costs could both be a proxy for cost-reducing as well as for quality-seeking (i.e., higher productivity) FDI.

As the dependent variable is the absolute real value of the stock of FDI one should account for the market size of the source country. Therefore, in addition to the structural variables discussed so far, real GDP of the home country (GDP_{it}) is also included. For a more detailed description of the data sources, and the derivation of the various variables, the reader is referred to the Appendix.

4.5 The empirical specification

In summary, the following specification is estimated by pooling the data across either eight or, including the Netherlands, nine euro area countries for the period 1980-2001:[16]

$$\begin{aligned} \ln SFDI_{it} &= \alpha_1 + \alpha_2 SFDI_{it-1} + \alpha_3 \ln GDP_{it} + \alpha_4 \ln PAT_{it} + \alpha_5 \ln RER_{it} + \alpha_6 \ln RI_{it} + \\ &\quad \alpha_7 \ln IC_{it} + \alpha_8 \ln \widetilde{Q}_{it} + \alpha_9 \ln RC_{it} + \alpha_{10} \ln TECH_{USt} + \varepsilon_{it} \end{aligned} \tag{9}$$

where $SFDI_{it}$ denotes the real stock of euro area FDI in the United States, GDP_{it} euro area countries' real GDP, PAT_{it} euro area countries' patents, RER_{it} the real exchange rate

[16] Greece, Luxembourg and Portugal were excluded due to data limitations.

expressed in terms of euro area countries' currencies, RI_{it} relative cost of capital, IC_{it} information flows, RC_{it} relative unit labour costs, ($TECH_{USt}$) various proxies for US technology, such as R&D activities in US manufacturing (RD_{USt}) or the relative number of patents granted to US firms in the high-tech sectors (HT_{USt}) or the US stock market index (SMI_{USt}).

First, we estimate equation (9) with the "adjusted" Tobin's Q measure ($\widetilde{Q}_{it}$); second, we re-estimate equation (9) by replacing ($\widetilde{Q}_{it}$) with the "unadjusted" measure (Q_{it}). If the measures of Tobin's Q are statistically significant, we expect that the technology variables will be significant and positively signed when we include ($\widetilde{Q}_{it}$), but statistically insignificant when we replace ($\widetilde{Q}_{it}$) with (Q_{it}).

5. Empirical results

The model was estimated using the least squares dummy variables (LSDV) estimator for two main reasons: first, the euro area countries are not a random sample; second, the country-specific characteristics might be correlated with other regressors if fixed effects are not included. In this regard, we carried out Hausman tests, which evaluate the null hypothesis that individual-level effects are adequately modelled by a random-effects model. The null was rejected at the 5% level of significance, which is to be expected given the cross-country type of panel dimension used in our analysis. However, it is well-known that the LSDV estimator yields biased results in dynamic panels with finite T (Nickell, 1981).[17] Nevertheless, the LSDV estimator will still provide reasonable results in the present case as T (= 22) is relatively large compared to the size of N (= 9).[18] The reported regressions do not include time fixed effects. In principle, time fixed effects could control for common trends in FDI and stock market valuations as well as time varying unobervables in the US. However, including time dummies in the model gives rise to serious multicollinearity problems. This may not be

[17] The bias results from the correlation between the lagged dependent variable and the transformed residuals. Nickell (1981) shows that the lagged dependent variable is biased towards zero, but that the bias decreases in T and disappears when T goes to infinity.

[18] For example, Judson and Owen (1999) compare the bias of six different estimators of dynamic panel data models: the OLS estimator, the LSDV estimator, a corrected LSDV estimator as proposed by Kiviet (1995), two GMM estimators suggested by Arellano and Bond (1991), and the IV techniques used by Anderson and Hsiao (1981). Their findings are that the LSDV estimator performs just as well, or better than the majority of the alternatives as T increases and is larger than N. In addition, Kiviet (1995) notes that although the LSDV estimator is biased, its standard deviations are very small compared to different IV-estimators. Therefore, on the basis of the MSE-criterion (efficiency versus bias), Kiviet argues that LSDV may be preferable to alternative estimators.

surprising given that some explanatory variables do not vary across countries and the panel has relatively large T compared N. When a full set of time dummies is included the results remain qualitatively unchanged.[19]

Before discussing the results obtained from the estimation of our theoretical model, it is useful to develop a benchmark model of FDI based on traditional specifications adopted in the knowledge-capital literature. As such, the benchmark model allows us to assess the value-added of the theoretical model developed in this paper once Tobin's Q is included. We also experiment with different technology variables in order to obtain a more detailed understanding of the role of different US technological developments in explaining the surge in outward FDI from the euro area to the United States.

We begin with the benchmark model in equation (9) but excluding the Tobin's Q measure. The Netherlands are initially dropped from the sample, because of its suspected role of this country as a hub for multinational enterprises. The results are shown in Table 1 (regressions 1 and 2) and confirm the idea that firm-specific assets are an important determinant of FDI (i.e. euro area patents, PAT_{it}).[20] The positive and significant effect for expenditure on R&D in the US suggests that the presence of knowledge-capital plays an important role in attracting euro area investors. The sign on the real exchange rate is negative, but not always significant. Relative real interest rates are negative, but insignificant in all specifications. The statistical significance of other variables generally improve when the relative interest rate variable is dropped (regression 2). Telephone traffic relative to euro area GDP is positively signed and statistically significant, indicating that FDI increases with the flow of information. Relative unit labour costs are positive as expected, but only weakly significant. Meanwhile, home country GDP is positive and significant. In sum, the results obtained for the benchmark model are in line with our expectations, although not all variables are found to be strongly significant.[21]

[Insert Table 1, here]

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[19] Multicollinearity reduces the statistical significance and the magnitude of the estimates, but generally (as in our case) does not change the signs on the estimated coefficients. In addition, STATA automatically drops the R&D variable as the matrix of covariates becomes singular when time dummies are included. For the remaining variables the main conclusions are unchanged.

[20] A proxy for the market size of the United States was initially included, but the variable proved insignificant. The variable was subsequently omitted because of the collinearity with other economic aggregates (see also Culem, 1988). In addition, relative effective corporate tax rates were included using comparable rates compiled by Martinez-Mongay (2000). However, they were also found insignificant and, therefore, they were omitted.

[21] The tables of results report tests for autocorrelation which is a Lagrange Multiplier test for serial correlation of order 1 which is calculated by regressing the residuals on all of the regressors of the original model and the lagged residuals. The reported F-tests of the significance of the residuals show that serial correlation is not a problem in any of the regressions.

Regressions 3-5 of Table 1 then add the adjusted Tobin's Q ($\widetilde{Q}_{it}$) to the benchmark model along with various alternative proxies for US technological developments. As expected, adjusted Tobin's Q is positive and statistically significant at the 1% significance level. All in all, the investment climate in the euro area countries – as proxied by $\widetilde{Q}_{it}$ – is found to affect the level of euro area investment abroad. In addition, allowing for the impact of $\widetilde{Q}_{it}$ in the euro area improves the overall performance of the model, which suggests that models of FDI that do not account for the investment climate in the home country could be mis-specified.[22]

The results are basically the same for most of the variables if the Netherlands are included in the sample (see Table 2), except for euro area GDP, which is generally found statistically insignificant. To a certain extent, this result might capture the idea that the Netherlands is a "hub" for multinational enterprises. In other words, the relative small size of the Netherlands together with large FDI outflows from this country to the United States might bias the panel results for euro area GDP.

[Insert Table 2, here]

Table 3 shows the results using the unadjusted Tobin's Q. They confirm the role of the euro area stock markets developments as an important variable for explaining euro area FDI to the United States. Interestingly, comparing the results obtained with the adjusted Tobin's Q measure ($\widetilde{Q}_{it}$) reveals that the point estimate for Tobin's Q is very similar. Most importantly and, as expected, euro area patents and the US technology variables are no longer significant, which is consistent with the theoretical framework. All in all, the results of Tables 1-3 suggest that:

- The investment climate in the euro area, as proxied by adjusted Tobin's Q, seems to add further explanatory power in addition to the information provided by the variables included in the traditional knowledge-capital framework (see Tables 1 and 2).
- Stock market developments, as proxied by unadjusted Tobin's Q, adequately capture ownership and vertical location advantages (i.e., Table 3 shows that the unadjusted Tobin's Q makes the technology variables insignificant) in explaining FDI activities.

[22] It has been argued that, when using a generated regressor, statistical inference is invalidated, as the uncertainty introduced by the generated regressors is taken into account when using standard OLS. However, whilst this is true for predicted variables from an auxiliary regression, Pagan (1984) shows that this is not the case for generated residuals. More specifically, Pagan shows that OLS consistently estimates coefficients and standard errors in the presence of *unlagged* generated residuals. As this is the case for our adjusted Q, there appears no need to adjust the standard errors to account for the presence of generated residuals.

[Insert Table 3, here]

In the rest of this section, we focus on the results of regressions 3-5 in Table 1. Euro area firm-specific assets measured by patents are found to play an important role in explaining euro area FDI to the United States. Also, Barrel and Pain (1997) use patents as a measure of ownership advantage to assess the relevance of firm-specific assets in the European context and find significant positive effects.

The coefficient of the real exchange rate is negative and significant at the 1% significance level: as the US dollar appreciates, the value of the discounted stream of expected profits in the United States in the home currency increases, encouraging current euro area FDI to the United States. This result is in contrast with the findings by Klein and Rosengreen (1994) and Blonigen (1997). Klein and Rosengreen (1994) find a positive relationship between FDI inflows into the United States and the real depreciation of the US dollar over the period 1979-1991, in line with the imperfect-capital-market theory of FDI developed by Froot and Stein (1991).[23] Blonigen (1997) also finds a similar relationship, which support his hypothesis that a real dollar depreciation made Japanese acquisitions in the US manufacturing with firm-specific assets more likely in the 1980's and early 1990's.

Another explanation for the negative sign of the real exchange rate could be related to the link between intermediate inputs and FDI. Recent data show that euro area export values of intermediate inputs to the United States represent almost 50% of euro area export values of goods to the United States. In other words, euro area affiliates of multinational enterprises in the United States might have been using intermediate inputs in the production processes exported to them by their parent companies. A depreciation of the euro area countries' real exchange rate would increase euro area export competitiveness and, as a result, encourage FDI to the United States; thereby, offering another explanation for the negative coefficient between FDI and the real exchange rate.

Bilateral telephone traffic relative to euro area GDP is found to be positively and significantly related to euro area FDI to the United States suggesting that an increase in information flows has a positive impact on euro area FDI.

Relative unit labour costs are found to have a positive and significant effect on euro area outward FDI to the United States. Intuitively, it does not seem to be realistic that euro area firms engage in FDI to the United States in order to save on labour costs. A more feasible

[23] It is interesting to point out that they use as a regressor the relative stock market index, which however is employed to control for relative wealth.

interpretation might be that the significance of the relative unit labour costs term is being driven by developments in labour productivity differentials.

The R&D variable, a proxy for vertical location advantages, has a positive sign and is statistically significant (regression 3), which is taken as evidence that the presence of knowledge-capital in the US economy attracts euro area FDI. This result complements previous findings by Kogut and Chang (1991), who focus on Japanese FDI in the United States, and Neven and Siotis (1996), who found that expenditure on R&D in Europe is an important determinant for European inward FDI from the United States and Japan.

In terms of US technology, Figure 4 showed that much of euro area outward FDI to the US was concentrated in high-tech sectors. Therefore, we also consider the relative importance of the new economy sectors based on a measure of US patent applications (i.e. the number of US patents in high-tech sectors relative to the total number of US patents).[24] The high-tech patents share variable is found to be positively signed and statistically significant (regression 4), which is consistent with the stylised facts. This variable is also capturing the compositional change towards high-tech sectors in euro area FDI to the United States as shown in Figure 4. Finally, euro area GDP is found to be positive and statistically significant.

In principle, the empirical model could be criticised as it employs measures of current technology in the United States, rather than a proxy for the (discounted) future values of the US stock of knowledge ($(r+h)^{-1} K_s^j$). As a robustness check, we replace the US technology-variable with the US stock market index, which is a proxy for the discounted stream of future profits in the US economy and, therefore, a proxy for $(r+h)^{-1} K_s^j$. The US stock market index (SMI_{USt}) is positively signed and statistically significant (regression 5). Interestingly, the coefficients of the other variables, including the adjusted Tobin's Q, remain similar to the previous specifications and are all significant. In order to provide a broad summary, one might argue that all of the US technology variables may, in various ways, be related to US productivity developments – therefore, one could interpret all of the US technology variables, as well as relative unit costs (which includes productivity), as representing productivity effects.

In all regressions, the coefficient of the lagged dependent variable is close to 0.8, but statistically different from unity. Therefore, the persistence in accumulating capital stock in

[24] We used patent data rather than R&D data for the share of US patents in high-tech sectors as the patent data allow a more detailed breakdown into high- and low-tech sectors.

the United States by euro area multinational firms appears to be high. In the long run, according to the estimated coefficient in the alternative specifications, a 10% increase in the stock market of the euro area in real terms implies a 5.8-7.8% increase of the euro area FDI stock in the United States.

An additional possible criticism to the empirical analysis is related to the spurious regression problem, as most of the employed variables are non-stationary and we estimate the model in terms of levels.[25] However, when estimating in levels, spurious regression may be a far less important problem in panel estimation compared to time series estimates. For example, Phillips and Moon (1999) show that for panels with large (T and N) the fixed effects estimator consistently measures a long-run effect even when both the variables and the error term are I(1). This is because the covariance between the I(1) regressor and the I(1) error term, which produces the spurious regression in time series, is much weaker in panels because of the averaging across independent groups. Nevertheless, to ensure that a spurious regression has not been estimated, we test whether the residuals of the specifications are stationary processes. The multivariate augmented Dickey-Fuller (MADF) test of Taylor and Sarno (1998), and the Levin-Lin (2002) and Im, Pesaran and Shin (2003) tests for unit roots strongly reject the null hypothesis that the residuals of the panel regressions are I(1) (see Table 4). The residuals of the LSDV estimates are stationary and, therefore, the LSDV results are not spurious.

[Insert Table 4, here]

Moreover, one might argue that FDI and real exchange rates are simultaneously determined. Therefore, we also estimated the equations reported in Tables 1-3 using the Arellano-Bond estimator and found that the GMM results produce very similar results to the reported LSDV results. It should also be emphasised that the GMM results are less likely to be affected by spurious regression problems, as they are based on equations expressed in first differences.

6. Conclusions

The literature on domestic investment and FDI has developed in a somewhat separate manner. The present paper represents a first step at bringing together elements of these two strands of literature by focussing on the long-term determinants of euro area FDI to the United States

[25] In the context of I(1) variables, an alternative possibility is to use the cointegration approach (Kao, 1999; Pedroni, 1999). However, given the large number of variables employed and the relative size of T and N, it was deemed that the cointegration approach was inappropriate for our analysis.

during the period 1980-2001. The theoretical model developed in this paper essentially incorporates the traditional FDI model based on the knowledge-capital framework within a model of investment with convex adjustment costs, i.e. the Q-model of investment.

The empirical results, which are based on a dynamic specification estimated using a fixed effects estimator, substantiate the theoretical predictions that the investment climate in the euro area, as reflected in Tobin's Q, turns out to be an important explanatory variable of euro area FDI to the United States. Furthermore, Tobin's Q, measured in the paper by stock market price indices, seems to add further explanatory power to FDI equations in addition to the information provided by the traditional variables included in the knowledge-capital framework, such as patents and expenditure in R&D. A major benefit of finding the stock market term statistically significant is that it provides a data series which is available up to the current date. Therefore, it allows one to derive a better judgement of current and future movements in FDI given that other variables which explain FDI – such as patents or expenditure in R&D – are only available with a considerable lag.

To disentangle the effects of technology on FDI, we have adjusted the euro area stock market indices by regressing them on the US stock market index. The retrieved residuals were then used as our measure of the "adjusted" Tobin's Q. By so doing, however, we correct not only for positive spillovers from US firms to euro area multinational enterprises (which capture vertical location advantages) and for excessive correlation of stock markets, but also for comovement of other economic fundamentals between the two regions. In accordance with the theoretical framework, when the adjusted Tobin's Q measure is employed, several technology variables typically used in the knowledge-capital framework to capture ownership and location advantages become significant, while they are insignificant when using the unadjusted Tobin's Q.

Moreover, the volume of bilateral telephone traffic relative to euro area GDP was used to account for the importance of information flows in explaining FDI. Finally, the negative sign of the real exchange rate could be interpreted as representing the higher expected value of repatriated profits when expressed in the home country currency or could indicate the existence of a link between FDI activity and euro area intermediate inputs exported to the United States.

In summary, according to the knowledge-capital-Tobin's Q framework proposed in this study, euro area patents (ownership advantage), various variables related to productivity developments in the United States (location advantage), the volume of bilateral telephone traffic to the United States relative to euro area GDP (location advantage), the adjusted euro area stock market (adjusted Tobin's Q) and the real exchange rate all have the expected signs in line with our priors and are statistically significant. In particular, in the long run and *ceteris paribus*, a 10% increase in the stock market of the euro area in real terms implies a 5.8-7.8% increase of the euro area FDI stock in the United States depending upon the chosen specification.

According to the BEA, euro area FDI outflows to the United States have continued to decline in 2002 and 2003 together with the annual average stock price decline in the euro area (see Figure 3). Moreover, the euro-dollar real exchange rate based on the producer price index appreciated on an annual basis by 14.7% in 2002 and 16.5% in 2003. The fall in euro area equity prices and the appreciation of the euro might have played an important role in explaining the fall of euro area FDI outflows to the United States in 2002 and 2003.

One possible extension of this research is to test for statistical significance of euro area firms' financial conditions, as a substantial body of literature suggests that firms with high cash-flow should invest more, as they have additional means of self-financing. This analysis could be carried out by means of a cash-flow measure, which is orthogonal to future expected earnings. However, these exercises are usually carried out using firm level data.

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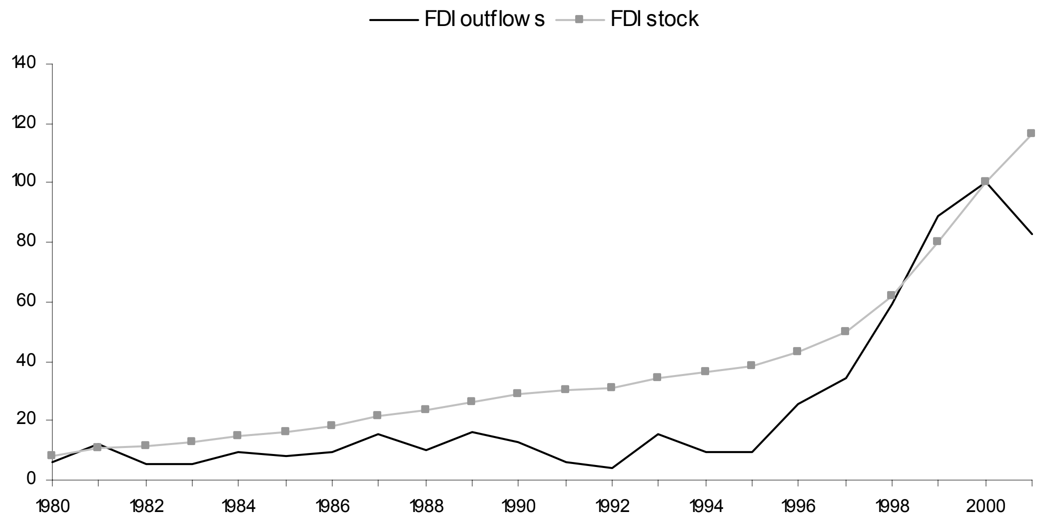
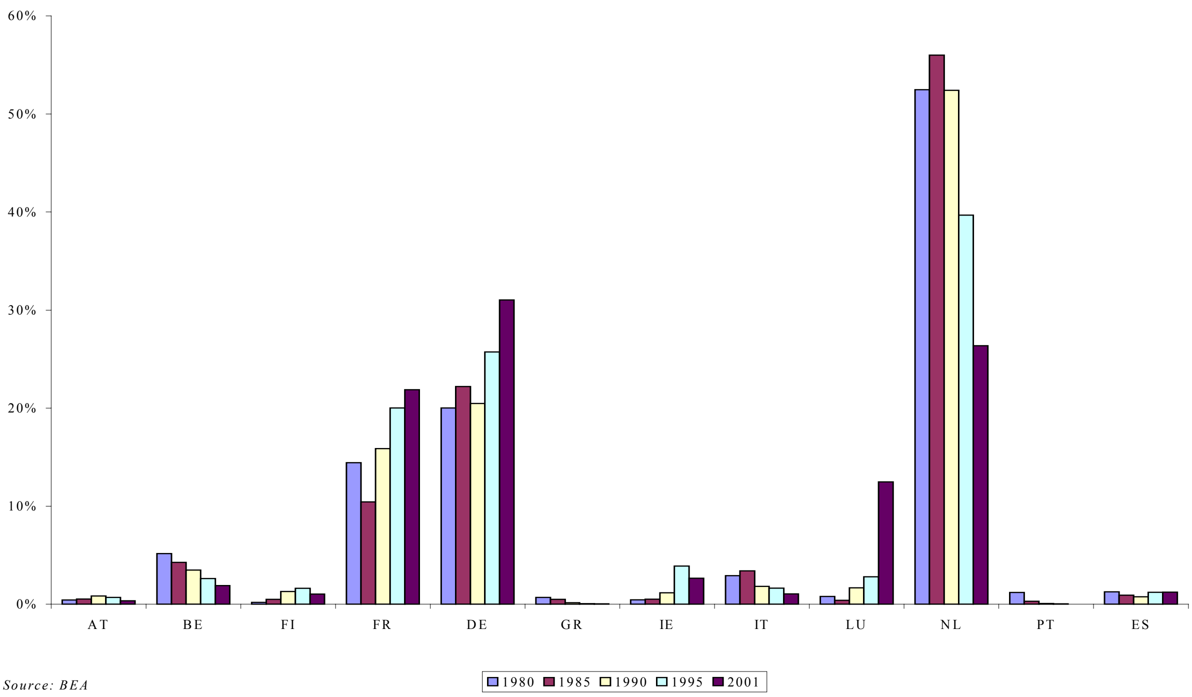
Figure 1: Euro area stock and outflows of FDI to the United States

(Indices: 2000=100, 1995 constant prices)



Source: Authors' calculations based on BEA nominal data.

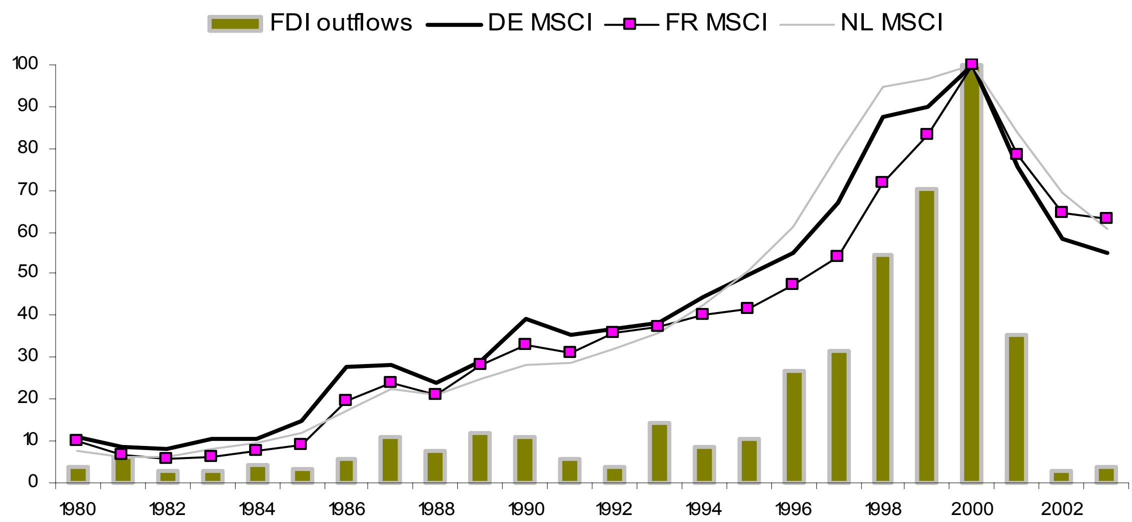
Figure 2: FDI outflows to the United States for each euro area country expressed as a share of total euro area FDI to the United States



Source: BEA

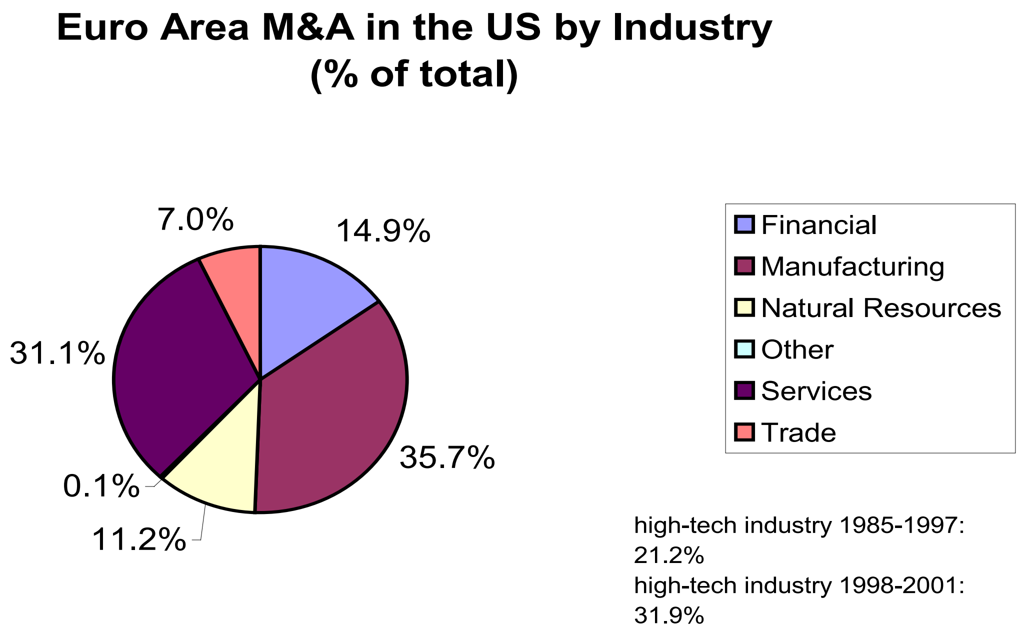
Figure 3: Euro area FDI outflows to the United States and equity market indices in three major euro area countries

(Indices: 2000=100, US dollars)



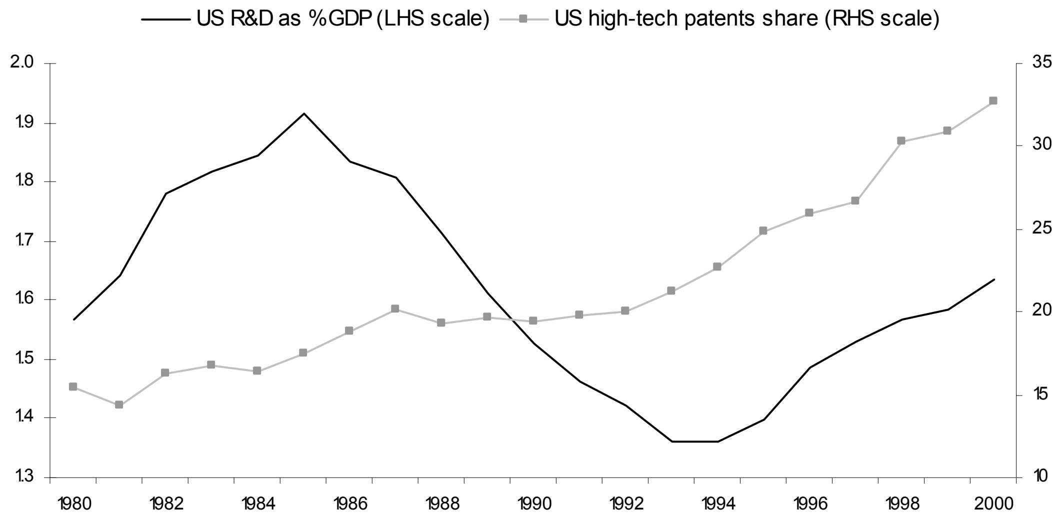
Source: Authors' calculations based on BEA and Morgan Stanley

Figure 4: Sectoral distribution of euro area Mergers and Acquisitions in the US



Source: Thomson

Figure 5: US R&D expenditure as a percent of GDP and US high-tech patents as a percentage of total US patents



Source: BEA, NSF, USPTO.

Table 1: The determinants of euro area FDI to the United States
(using adjusted Tobin's Q; excluding the Netherlands)

	OLI		OLI plus Tobin's Q		
	(1)	(2)	(3)	(4)	(5)
$SFDI_{t-1}$	0.82	0.82	0.81	0.82	0.82
	(16.5) ***	(23.0) ***	(24.2) ***	(26.2) ***	(27.3) ***
GDP_{it}	0.29	0.28	0.34	0.31	0.27
	(2.22) **	(2.07) **	(2.52) **	(2.28) **	(2.11) **
PAT_{it}	0.19	0.20	0.21	0.17	0.16
	(1.76) *	(2.23) **	(2.46) **	(2.19) **	(1.99) **
RER_{it}	-0.16	-0.17	-0.26	-0.32	-0.31
	(-1.55)	(-1.97) **	(-2.68) ***	(-3.76) ***	(-3.72) ***
RI_{it}	-0.03	-	-	-	-
	(-0.26)				
IC_{it}	0.08	0.09	0.10	0.10	0.10
	(1.96) **	(1.90) *	(2.98) ***	(2.73) ***	(2.65) ***
$\widetilde{Q}_{it}$	-	-	0.11	0.13	0.14
			(3.93) ***	(4.90) ***	(4.68) ***
RC_{it}	0.71	0.68	0.90	0.87	0.81
	(1.60)	(1.54)	(2.21) **	(1.99) **	(1.80) *
RD_{USt}	0.33	0.35	0.31	-	-
	(1.99) **	(2.73) ***	(2.51) **		
HT_{USt}	-	-	-	0.25	-
				(2.29) **	
SMI_{USt}	-	-	-	-	0.10
					(2.37) **
Constant	-5.83	-5.98	-6.34	-3.36	-3.52
	(-3.31) **	(-4.47) ***	(-5.33) ***	(-2.51) **	(-2.84) ***
AR(1)	-0.48	-0.37	-0.59	-0.69	-0.51
N(0,1)	[0.60]	[0.71]	[0.55]	[0.49]	[0.61]
Number of observations	168	168	168	168	168

*, **, *** indicate 10%, 5% and 1% significance levels. Robust t-values in parentheses.

Table 2: The determinants of euro area FDI to the United States
(using adjusted Tobin's Q; including the Netherlands)

	OLI		OLI plus Tobin's Q		
	(1)	(2)	(3)	(4)	(5)
$SFDI_{t-1}$	0.84 (18.5) ***	0.83 (22.6) ***	0.82 (23.8) ***	0.83 (26.1) ***	0.83 (26.8) ***
GDP_{it}	0.22 (1.72) *	0.19 (1.34)	0.24 (1.67) *	0.22 (1.43)	0.18 (1.19)
PAT_{it}	0.19 (1.86) *	0.20 (2.29) **	0.22 (2.47) **	0.18 (2.15) **	0.17 (1.96) *
RER_{it}	-0.13 (-1.36)	-0.15 (-1.85) *	-0.23 (-2.43) **	-0.29 (-3.46) ***	-0.28 (-3.39) ***
RI_{it}	-0.07 (-0.72)	-	-	-	-
IC_{it}	0.07 (1.64)	0.08 (1.69) *	0.10 (3.07) ***	0.09 (2.32) **	0.09 (2.26) ***
$\widetilde{Q}_{it}$	-	-	0.10 (3.07) ***	0.12 (3.74) ***	0.12 (3.68) ***
RC_{it}	0.64 (1.59)	0.54 (1.40)	0.75 (2.07) **	0.68 (1.74) *	0.63 (1.53)
RD_{USt}	0.29 (2.04) **	0.34 (2.84) ***	0.30 (2.62) ***	-	-
HT_{USt}	-	-	-	0.22 (2.23) **	-
SMI_{USt}	-	-	-	-	0.09 (2.20) **
Constant	-4.93 (-3.44) ***	-5.20 (-4.07) ***	-5.50 (1.19)	-2.69 (-1.80) *	-2.80 (-1.95) *
AR(1)	-0.56	-0.27	-0.48	-0.56	-0.40
N(0,1)	[0.57]	[0.78]	[0.63]	[0.57]	[0.69]
Number of observations	189	189	189	189	189

*, **, *** indicate 10%, 5% and 1% significance levels. Robust t-values in parentheses.

Table 3: The determinants of euro area FDI to the United States
(using the unadjusted Tobin's Q)

	Excluding the Netherlands		Including the Netherlands	
	(1)	(2)	(3)	(4)
$SFDI_{t-1}$	0.78	0.78	0.81	0.81
	(21.8)	(21.6)	(21.9)	(21.5)
	***	***	***	***
GDP_{it}	0.33	0.34	0.18	0.20
	(2.68)	(2.79)	(1.14)	(1.21)
	***	***		
PAT_{it}	0.11	0.10	0.15	0.13
	(1.44)	(1.46)	(1.69)	(1.55)
			*	
RER_{it}	-0.31	-0.31	-0.23	-0.26
	(-3.72)	(-3.76)	(-2.27)	(-3.19)
	***	***	**	***
IC_{it}	0.13	0.13	0.10	0.10
	(3.72)	(4.05)	(2.54)	(2.75)
	***	***	**	***
Q_{it}	0.14	0.15	0.10	0.11
	(3.11)	(4.57)	(1.93)	(2.83)
	***	***	*	***
RC_{it}	0.99	0.98	0.66	0.63
	(2.35)	(2.30)	(1.70)	(1.53)
	**	**	*	
RD_{USt}	0.05		0.11	
	(0.27)	-	(0.63)	-
HT_{USt}		0.0		0.01
	-	(0.02)	-	(0.08)
Constant	-3.85	-3.58	-3.24	-2.54
	(-2.81)	(-2.98)	(-2.30)	(-1.66)
	***	***	**	*
AR(1)	-0.32	-0.31	-0.12	-0.08
N(0,1)	[0.75]	[0.76]	[0.91]	[0.94]
Number of observations	168	168	189	189

*, **, *** indicate 10%, 5% and 1% significance levels. Robust t-values in parentheses.

Table 4: Unit root tests on the residuals
(using adjusted Tobin's Q; excluding the Netherlands)

		OLI regression (2)	OLI plus Tobin's Q regression (3)
Deterministic trend	*Lags*	*Im-Pesaran-Shin* *t-statistic (P-value)*	*Im-Pesaran-Shin* *t-statistic (P-value)*
	0	-8.6 (0.000)	-8.8 (0.000)
Constant	1	-6.1 (0.000)	-6.1 (0.000)
	2	-4.0 (0.000)	-4.2 (0.001)
	0	-8.9 (0.000)	-9.1 (0.000)
Constant and trend	1	-6.5 (0.000)	-6.7 (0.000)
	2	-4.4 (0.000)	-4.5 (0.000)
		Levin-Lin *t-statistic (P-value)*	*Levin-Lin* *t-statistic (P-value)*
	0	-8.9 (0.000)	-9.2 (0.000)
Constant	1	-6.1 (0.000)	-6.2 (0.000)
	2	-2.8 (0.003)	-3.0 (0.001)
	0	-9.4 (0.000)	-9.5 (0.000)
Constant and trend	1	-6.4 (0.000)	-6.4 (0.000)
	2	-2.5 (0.006)	-2.5 (0.006)
		MADF t-statistics (5% critical values)	*MADF t-statistics (5% critical values)*
Constant	1	181.4 (38.9)	187.6 (38.9)
	2	124.2 (41.7)	130.2 (41.7)

Data appendix

All variables are in logs.

GDP_{it}	Real euro area country GDP based on gross domestic product at current prices deflated by the national GDP deflator and evaluated in US dollars. Source: European Commission (DG ECFIN).
HT_{USt}	The lagged ratio of number of patents granted in the United States to US firms in high-tech sectors (sectors US SIC 357 and US SIC 365-67) over total number of patents granted in the United States to US firms. Source: USPTO.
IC_{it}	Lagged volume of bilateral telephone traffic as proxy for information costs divided by real euro area country GDP. Number of total minutes called abroad for each source country are available for 1980-2000 from the International Telecommunications Union. Bilateral telephone traffic with the United States is only available for the period 1991-2000 for a number of countries. In the case where no data on the volume of bilateral telephone traffic were available, total telephone traffic was used in combination with the ratio of bilateral telephone traffic over total international telephone traffic. The ratio was assumed constant over time. In the case that no bilateral data at all were available the ratio of a 'similar' country was used (BE=LUX and NL; FR=IT; UK=IRE; ES=PRT). Although this procedure is far from perfect (and responsible for excessively high values for Ireland), it is better than using simply total international telephone traffic. Note that with LSDV time-invariant effects are wiped out. As a result the coefficients will be unaffected. Source: ITU.
PAT_{it}	5-Year moving average of patents granted in the US to euro area firms in country *i*. Source: USPTO.
Q_{it}	Stock market indices were obtained from Datastream Global Indices and Morgan Stanley. These indices are based on a representative sample of stocks in each market in order to make them internationally comparable. Tobin's Q is measured by the stock market price indices in US dollars and deflated by the corresponding national GDP deflator. Source: Thomson Datastream, Morgan Stanley.
$\tilde{Q}_{it}$	The real euro area stock market indices are regressed on the real US stock market index. The retrieved residuals are defined as "adjusted" Tobin's Q.
RC_{it}	The ratio of real unit labour costs in the euro area over real unit labour costs in the US. Real unit labour costs based on nominal unit labour costs, total economy, deflated with national GDP deflator (1995=100). Source: European Commission (DG ECFIN).

RD_{USt} Real stock of manufacturing R&D in United States measured as real current expenditure on R&D.
Source: NSF, OECD.

RER_{it} The real bilateral exchange rate as obtained by multiplying the nominal exchange rate expressed in euro area currencies by the ratio of the GDP deflator at home and that in the United States.
Source: BIS, IMF.

RI_{it} Relative long-term real interest rate measured by the ratio of euro area real interest rate over US real interest rate based on the nominal long term interest rate (OECD) and the GDP deflator.
Source: OECD.

$SFDI_{it}$ The real stock of FDI of country *i* in the US at time *t* in US dollars is calculated as the cumulative sum of real flows plus the real benchmark stock of FDI in 1980 (deflated by the national GDP deflator). By so doing, the issue of the revaluation effects due to asset price changes is avoided.
Source: BEA (www.bea.gov).

SMI_{USt} US stocks market index in US dollars deflated by the US GDP deflator.
Source: Thomson Datastream.