

# **In or Out: The Effect of Euro Membership on the Exercise of Real Options**

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## **Abstract**

This empirical study of manufacturing firms (NAICS 33) in the EU15 countries shows that the introduction of the Euro has made Euro firms (firms based in one of the twelve Euro countries) more inclined than non-Euro firms (firms based in one of the three non-Euro countries: UK, Sweden and Denmark) to undertake various forms of real actions (exercise real options) such as to establish alliances / partnerships, to enter new markets / market segments, to switch suppliers, and to generally expand in the Euro-area. The results are important in understanding the potential long-term effects of Euro membership.

**Key words:** *Euro membership, Real options, Long-term effect, Manufacturing firms*

**JEL Classification:** *F23, G31*

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# **In or Out: The Effect of Euro Membership on the Exercise of Real Options**

## **1. Introduction**

This paper addresses the potential long-term effects of Euro membership by investigating the extent to which Euro membership influences the behavior of European firms in relation to the exercise of real options such as to establish alliances / partnerships, to enter new markets / market segments, to switch suppliers, and to generally expand in the Euro-area. The motivation is to look beyond the apparent small trade effects of the Euro and focus on investments (in a broad sense) that provide indications about the potential long term effects of Euro membership.

Baldwin (2006a) finds that the Euro<sup>1</sup> is the world's largest economic policy experiment: In 1999, European nations accounting for 20% of world output, 30% of world trade and 300 million people started using the same currency. Since then, the Euro has become the second most traded currency in the world trailing the US dollar and surpassing the Japanese Yen and the British Pound (Bank for International Settlements, 2005). Three EU member states (Denmark, Sweden, and UK) did not adopt the Euro but continue to use their national

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<sup>1</sup> The Euro was introduced on January 1, 1999, and is the single currency of the 12 EU member states that form the Euro-area (Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal and Spain). Greece became the 12th Euro-area member state on January 1, 2001, when the Greek drachma was locked vis-à-vis the Euro. The introduction of the Euro implies that the 12 Euro-area member states now have a single currency, a common interest rate and a common central bank, ECB.

currencies<sup>2</sup>. Together with the twelve Euro-area member states these three non-Euro member states form the EU15 (the fifteen “old” EU member states)<sup>3</sup>.

The Euro was established in order to reach a real single market for goods and services, to eliminate foreign exchange risks and transaction costs, and to integrate financial markets (European Central Bank, 2005). In an influential paper Rose (2000) uses a gravity model to assess the separate effects of exchange rate volatility and currency union on international trade. He finds a large positive effect of a currency union on international trade and argues that “the European EMU may thus lead to a large increase in international trade, with all that that entails.” With the wisdom of hindsight Baldwin (2006a) estimates the actual effect of the Euro on trade within the Euro-area to be “something like five to ten percent on average” and without trade diversion as to the three EU15 countries that did not adopt the Euro. Baldwin questions if not “Britain, Denmark and Sweden were the clever ones from a mercantilist perspective - they got the better market access without sacrificing their main macro-policy tool”.

However, Mongelli and Vega (2006) argue that it will take considerably more time for the full effects of the Euro to unravel. The expectation is that monetary integration will contribute to the narrowing of “distances” and to a change in the incentive structure of agents (Grauwe and Mongelli, 2005). The EMU project represents a still recent regime shift. Thus, we need indications as to the dynamics beyond the present trade statistics.

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<sup>2</sup> Denmark and UK decided to opt-out and not move to stage 3 of the EMU (i.e. to adopt the Euro) whereas Sweden did not fulfill all criteria for moving to stage 3 of the EMU.

<sup>3</sup> In 2004 ten more states joined the EU (Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia,) of which Slovenia (January 2007), Cyprus (January 2008) and Malta (January 2008) have adopted the Euro. In 2007 two more states joined the EU (Romania and Bulgaria).

This paper confronts the challenge by looking beyond the trade statistics and analyzes to what extent the introduction of the Euro impacts on firms' motivation to exercise real options. One measurement problem – apart from the introduction of the Euro representing a recent regime shift – is to disentangle the effects of the Euro “from other developments such as, the liberalisation of international capital movements, financial deregulation, globalization, and the advancement in information and communication technology” (Mongelli and Vega, 2006). However, the three EU15 countries that did not adopt the Euro works as a close-to-perfect control group. These three countries all have a history of EU membership (i.e. they have all shared other relevant aspects of EU membership) and they have all been exposed to “outside” developments in a more or less similar fashion as the twelve Euro countries. Thus, the purpose of the paper is to empirically investigate the relationship between the introduction of the Euro, Euro membership and the exercise of real options to find (1) the extent (if any) of real options exercises by EU15 manufacturing firms (NAICS 33) triggered by the introduction of the Euro, and (2) whether such exercise of real options depends on Euro membership and other firm characteristics.

The results of the paper are based on public information and closed-end questionnaires sent to listed EU15 manufacturing firms (NAICS 33). The results of the study indicate that small, profitable and financially constrained firms are more likely than other firms to find that the introduction of the Euro has caused them to exercise real options such as to establish alliances / partnerships, to enter new markets / market segments, to switch suppliers, and to generally expand in the Euro-area. Furthermore, Euro membership turns out to be a decisive factor for the exercise of such real options. The study shows a clear distinction between firms based in Euro countries (“Euro firms”) and firms based in non-Euro countries (“non-Euro

firms”). Euro firms are more likely to exercise real options because of the introduction of the Euro than non-Euro firms.

The results contribute to the existing literature by focusing on the potential long-term effects of the introduction of the Euro. So far the existing literature has been able to show a fairly modest effect of the Euro in terms of trade statistics (please see Mongelli and Vega, 2006, for an overview of various quantifications). The results in this paper indicate that the introduction of the Euro and the effective elimination of exchange rate uncertainty and transaction costs inside the Euro-area have an important impact on Euro firms’ willingness to engage in investments (in a broad sense) that have potential long-term effects beyond the present trade statistics.

The paper proceeds as follows. The next section gives an overview of the recent literature on the effect of the introduction of the Euro on trade and investments and establishes a link between the introduction of the Euro and the real option literature and terminology. The third section describes the methodology of the study. The fourth section surveys the relationship between the introduction of the Euro, Euro membership and the exercise of real options. The fifth section tests which firm specific factors can explain the likelihood that a firm will exercise real options because of the introduction of the Euro. The sixth section focuses on the impact of Euro membership and the seventh section provides further robustness checks. A conclusion is provided in the last section.

## 2. The Effect of the Euro

The first subsection provides a brief review of the literature on the effect of the introduction of the Euro on trade and investment. In the second subsection, the introduction of the Euro is linked to the real option literature and terminology.

### 2.1. Literature overview

Rose (2000) argues that given the fact that exchange rate volatility was low before EMU, the effect of a currency union could be expected to be low. On the other hand, Rose argues, the sharing of a common currency could lead to an increase in the depth of trading relations. A very stable exchange rate may not be the same as membership of a currency union. As such, sharing a common currency is a much more serious and durable commitment than a fixed exchange rate. Rose notes that empirically, there is much more intense trade *inside* countries than *between* countries, a “home bias” in international trade. A common currency represents a serious government commitment to long-term integration. This commitment could, in turn, induce the private sector to engage in greater international trade.

Carr (1999) argues that the transition to a single currency will force managers to rethink many of their assumptions about doing business in Europe. The patchwork of national currencies has always made it hard for firms to think on the continental level. In this line of reasoning Gentz (1999), a member of the Board of Management of Daimler-Chrysler in Stuttgart, Germany, argues that by eliminating foreign exchange risks, the Euro removes an obstacle to effective business planning. In the past, fluctuating foreign exchange rates could undermine even the best-thought-out business strategies and quickly erase hard-won

productivity gains. The need for pan-European perspective on products, prices, supply chains, and financing will conflict with the old model of organizing around country-specific business units. As such, Gentz argues that a single currency should be viewed not only as a challenge but also as an opportunity.

Micco, Stein and Ordoñez (2003) note that the uncertainty and risk involved in trade transactions is reduced because a common currency eliminates bilateral nominal exchange rate volatility. While there are ways to hedge against this risk, doing so may be costly. Kenen (2003) points out, that it is not always possible to fully hedge against large, long-lasting changes in exchange rates, since producers are uncertain not only about the price they will receive for their exports, but also about the demand for their products. Thus, the producer does not know how much foreign currency he will earn, and how much he should sell in the forward market. As such, a financial transaction that was made in order to hedge against business risks may turn into a speculation because the underlying business rationale disappears. Goldberg, Benet and Cannong (2003) note that company resource allocation and strategic decisions are less hindered by foreign exchange volatility concerns after the introduction of the Euro.

Baldwin (2006a) finds that the boost to trade after the introduction of the Euro did not occur, as expected, by lowering the transaction costs for trade within the Euro-area. Had it done so, the stimulus would have been a fall in the prices of goods traded between Euro-area members relative to those traded with countries outside the currency union. Baldwin fails to find this expected relative decline and the trade diversion it would have generated from the three countries that stayed out (UK, Sweden, and Denmark). Baldwin and Nino (2006) find it particularly puzzling that the Euro does not seem to have caused trade diversion (i.e. the

Euro's pro-trade effect does not seem to be limited to countries that have adopted the Euro) and the fact that there seems to have been no major impact on trade prices even though trade volumes seem to have jumped up. One explanation given is that the introduction of the Euro has brought down the fixed cost of trading in the Euro-area. This has made it possible for firms selling products to just a few of the twelve Euro countries to expand their market across more or all of them. This explains why the boost to trade has essentially been a one-off adjustment; and why countries that stayed out have benefited almost as much as those that joined. Baldwin, Skudelny and Taglioni (2005) observe that Europe has a high share of small firms that either do not export, or export very little. One factor that keeps them from exporting is the uncertainty involved in trade. The introduction of the Euro has reduced this uncertainty.

Bris, Koskinen and Nilsson (2006) find that the introduction of the Euro has stimulated investments in firms that come from countries that previously had weak currencies. The positive effect of the Euro on investments for firms in the weak Euro-area countries is consistent with the real impact of the removal of foreign exchange risks, since firms in these countries are ex ante firms for which the elimination of foreign exchange matters the most. Bris et al. do not find such a positive impact on investments for firms based in formerly strong countries.

Mongelli and Vega (2006) argue that a single currency among partner countries precludes future competitive devaluation and thus facilitates foreign direct investment and the building of long-term relationships. Producers may be more willing to undertake large fixed costs involved with exporting toward other partner countries of the currency area. Grauwe and Mongelli (2005) analyze the endogenous effects of monetary integration i.e. whether sharing



a single currency may set in motion forces bringing countries closer together. They find that monetary integration will contribute to a narrowing of “distances” and to a change in the incentive structure of agents.

## **2.2. Real options and the introduction of the Euro**

The three most common options that occur in capital budgeting are: the option to wait for the optimal time to invest; the option to grow in the future; and the option to abandon a poorly performing project (Berk and DeMarzo, 2007). These three basic real options (defer option, growth option, and abandonment option) form the cornerstone of real option methodology. Although there are other, more sophisticated ways of classifying<sup>4</sup> real options, we content that for the present study this basic categorization is sufficient<sup>5</sup>.

Three elements have to be present in order for the concept of real options to be relevant: irreversibility, uncertainty, and choice of timing (Dixit and Pindyck, 1995)<sup>6</sup>. These elements are apparently present in the case of investments, because most corporate investments involve a certain element of sunk costs, are carried out in an uncertain environment, and involve some kind of managerial flexibility in timing. Thus, real options seem to be a relevant concept in the context of corporate investments.

A central element in real option valuation is uncertainty. Dixit (1989) finds that the most important feature of entry and exit decisions in an environment of ongoing uncertainty is

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<sup>4</sup> E.g. Trigeorgis (1993) lists seven real options: (1) option to defer, (2) time to build option (staged investment), (3) option to alter operating scale (e.g., to expand; to contract; to shut down and restart), (4) option to abandon, (5) option to switch (e.g., outputs or inputs), (6) growth option, and (7) multiple interacting options.

<sup>5</sup> For two founding text books on real options please refer to Dixit and Pindyck (1994) and Trigeorgis (1996).

<sup>6</sup> Amram and Kulatilaka (2000) propose that real options should be defined as “the subset of strategic options in which the exercise decision is largely triggered by market-priced risk, a risk that is captured in the value of a traded security”. We do not restrict ourselves to this more narrow definition of real options.

“hysteresis”. Dixit defines hysteresis as the failure of an effect to reverse itself as its underlying cause is reversed. Dixit (1992) exemplifies such hysteresis with the foreign firms that entered the US market when the dollar appreciated in the first half of the 80s and their non-exit from this market when the US dollar fell back to its original level. Some degree of inertia in investment decisions under uncertainty is optimal when sunk costs are present. A sudden drop in uncertainty leads to less inertia and more entry and exit decisions.

According to the traditional net present value (NPV) criterion of capital budgeting managers will undertake a real investment if the NPV is greater than zero. However, when introducing flexibility in the timing of the project’s launch, managers may decide not to undertake the investment when the NPV is only marginally above zero and instead may consider waiting for new information in order to avoid the regret associated with undertaking a project that may prove to be a poor choice. Only if the expected NPV is above a certain threshold, the manager will proceed. On average, the more uncertain the environment, the greater the required expected NPV before managers decide on proceeding with the investment.

The introduction of the Euro resembles a (sudden) drop in uncertainty in relation to the future development of exchange rates among a number of European countries. Although the Euro is only one among a number of currencies in the world, the elimination of the risk of price fluctuations between a number of European currencies sharply reduces the uncertainty in relation to exchange rates. Depending on the specific set-up and the competitive environment of the firm in question, this reduction in uncertainty is more or less crucial. A Spanish firm exporting to Germany may find the change important as the Spanish exporter and the German importer now operate under the same currency. At the same time, a British firm exporting to

Germany may find the change more in terms of appearance than material change (the Euro against the British Pound instead of Deutsche Mark against the British Pound).

In a financial market context an option is proprietary. If an investor buys a call option e.g. to buy one share of IBM stock for a specified amount by a specified date, it is the exclusive right of the investor to exercise the option. In a non-financial context such exclusiveness is often not the case. A firm that considers approaching a new supplier, targeting new customers, forming a new alliance etc. is generally not operating in a vacuum. The real options facing the firm are to some extent shared with competitors. A competitor may pre-empt the options of the firm by acting first. Thus, a framework integrating real options and game theory is useful. Smit and Trigeorgis, 2007, argue that the importance of making an early investment commitment (game theory) while maintaining managerial flexibility (real options) should be recognised. Introducing a game theoretic aspect to our real option methodology above may lead to new insights as to the expected effect of the introduction of the Euro on the exercise of real options. One of the reasons for introducing the Euro was to reach a real single market for goods and services (European Central Bank, 2005). To the extent that such a market creates more fierce competition among firms that are more and more similar, exercising real options early in order to pre-empt competitive exercise becomes increasingly relevant.

Exchange rate risk is only one risk among a bunch of different risks facing the corporate firm and in an integrated risk management perspective changing operations (real investments and disinvestments) is only one of three tools<sup>7</sup> for such risk management. Thus, the effect from

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<sup>7</sup> Meulbroek (2002) notes that firms have three fundamental ways of implementing risk management objectives: modifying the firm's operations, adjusting its capital structure, and employing targeted financial instruments.

the introduction of the Euro on the exercise of real options in a European perspective is an empirical question to be addressed.

To some extent the arguments above may be reversed. A sudden *increase* in uncertainty in relation to future exchange rates can lead to investments in flexibility following the arguments of Capel (1997), Kogut and Kulatilaka (1994) among others. Ménil (1999) notes that foreign capacity allows a multinational firm with market power to take advantage of unexpected declines in variable costs in the foreign country. An increase in uncertainty in relation to future exchange rates can lead to an increase in investments in flexibility in order to exploit fluctuating exchange rates thus yielding an opposite effect compared with the previous framework where a reduction in uncertainty was hypothesized to increase investments. However, when the Euro was introduced the likely alternative scenario was not a sudden increase in uncertainty. The likely alternative scenario was a continuation of the status quo with exchange rates among the twelve EU countries fluctuating within bands and/or within different more or less reliable schemes. By eliminating the (small) uncertainty in relation to future exchange rates among a number of European countries, some investments in flexibility may have been foregone. We do not believe that a reduction in flexibility investments outweighs the increase in investments described previously but ultimately it remains an empirical question. We address this empirical question indirectly by analyzing the effect of the introduction of the Euro on the exercise of real options and thus on the hypothesized net increase in investments in a broad sense.

### 3. Methodology of study

This study is based on public information from Amadeus<sup>8</sup> and on questionnaires sent to EU15<sup>9</sup> firms in NAICS 33 (North American Industry Classification System). In NAICS industries are classified according to a six-digit code. The first digit of the six-digit code divides firms into nine major groups<sup>10</sup>: Our focus is on the Manufacturing group (3). Within Manufacturing NAICS divides firms into 3 groupings<sup>11</sup> (the second digit of the six-digit code) of manufacturing subsectors (the third digit of the six-digit code). Our focus is on the third grouping of manufacturing sectors (3). This grouping (NAICS 33) includes: Primary Metal Manufacturing (331), Fabricated Metal Product Manufacturing (332), Machinery Manufacturing (333), Computer and Electronic Product Manufacturing (334), Electrical Equipment, Appliance, and Component Manufacturing (335), Transportation Equipment Manufacturing (336), Furniture and Related Product Manufacturing (337), Miscellaneous Manufacturing (339). NAICS 33 includes firms such as Electrolux (Sweden), Nokia (Finland), Renault (France), Siemens (Germany), Tomkins (UK), Vestas (Denmark) and Volkswagen (Germany).

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<sup>8</sup> Amadeus is a comprehensive, pan-European database containing financial information on approaching nine million public and private companies in 38 European countries. Information from Amadeus was obtained in 2005 for selection of target firms as well as in 2007 for accounting information.

<sup>9</sup> EU15: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxemburg, Netherlands, Portugal, Sweden, Spain, and UK

<sup>10</sup> The nine groups: 1) Agriculture, Forestry, Fishing and Hunting; 2) Mining, Utilities, Construction; 3) Manufacturing; 4) Wholesale Trade, Retail Trade, Transportation and Warehousing; 5) Information, Finance and Insurance, Real Estate and Rental and Leasing, Professional, Scientific, and Technical Services, Management of Companies and Enterprises, Administrative and Support and Waste Management and Remediation Services; 6) Educational Services, Health Care and Social Assistance; 7) Arts, Entertainment, and Recreation, Accommodation and Food Services; 8) Other Services (except Public Administration); and 9) Public Administration.

<sup>11</sup> The three groupings: 1) Food Manufacturing, Beverage and Tobacco Product Manufacturing, Textile Mills, Textile Product Mills, Apparel Manufacturing, Leather and Allied Product Manufacturing; 2) Wood Product Manufacturing, Paper Manufacturing, Printing and Related Support Activities, Petroleum and Coal Products Manufacturing, Chemical Manufacturing, Plastics and Rubber Products Manufacturing, Nonmetallic Mineral Product Manufacturing; 3) Primary Metal Manufacturing, Fabricated Metal Product Manufacturing, Machinery Manufacturing, Computer and Electronic Product Manufacturing, Electrical Equipment, Appliance, and Component Manufacturing, Transportation Equipment Manufacturing, Furniture and Related Product Manufacturing, Miscellaneous Manufacturing.

Our focus is on firms in NAICS 33 for two reasons. Firstly, narrowing the focus group provides room for a more targeted test as firms are more similar within a grouping of manufacturing subsectors (NAICS 33) than within the manufacturing group (NAICS 3) or across groups (NAICS 1 to NAICS 9). Secondly, NAICS 33 comprises the most important group of firms in terms of extra-EU as well as intra-EU exports<sup>12</sup>.

The total number of publicly listed firms in our focus group (NAICS 33) was 598 firms. The websites of these firms were searched for useful e-mail addresses. Requests for initial contact information were sent twice with a seven-day interval to all firms with useful e-mail addresses. The purpose of this first e-mail was to establish a communication link with the firm before sending the questionnaire. 262 firms replied. The questionnaire was sent to these firms. 73 firms responded to the questionnaire reaching an overall response rate of 12.2 percent (please refer to Table 1).

\* Please insert Table 1 approximately here \*

In relation to geographical non-response bias, firms from Finland tended to respond significantly more than firms on average while firms from France, Greece and UK tended to respond less. Apart from these biases the sample seems to resemble the geographical dispersion of firms in the population. Dividing the firms into Euro firms and non-Euro firms,

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<sup>12</sup> The group "Machinery, transport equipment" (SITC 7) held 44.9 percent of all extra-EU exports and 32.0 percent of all intra-EU exports in 2005 (European Commission, 2006). SITC 7 is the classification in the SITC (Standard International Trade Classification) structure that is closest to NAICS 33. SITC 7 includes (71) power-generating machinery and equipment, (72) machinery specialized for particular industries, (73) metalworking machinery, (74), general industrial machinery and equipment, and machine parts, (75) office machines and automatic data-processing machines, (76) telecommunications and sound-recording and reproducing apparatus and equipment, (77) electrical machinery, apparatus and appliances, and electrical parts thereof (including non-electrical counterparts of electrical household-type equipment, (78) road vehicles (including air-cushion vehicles), (79) other transport equipment.

the former have a response rate of 13.9 percent while the latter have a response rate of 9.5 percent. Neither deviates significantly from the overall response rate of 12.2 percent.

The population (598 firms) has a median turnover of USD 108 million. The population of Euro firms (366 firms) has a median turnover of USD 137 million and the population of non-Euro firms (232 firms) has a median turnover of USD 79 million. The sample (73 firms) has a median turnover of USD 186 million. The sample of Euro firms (51 firms) has a median turnover of USD 246 million and the sample of non-Euro firms (22 firms) has a median turnover of USD 98 million. As such, the responding firms are generally larger in terms of turnover than the firms in the population. Furthermore, Euro firms are generally larger than non-Euro firms - in the sample as well as in the population.

The sample selection criteria of this study require that the sample includes firms that responded to the questionnaire. As such, there may be sample selection bias if the selection criterion in question, i.e. responding to the questionnaire, is correlated with firms' propensity to use real options. To account for this possibility and correct for sample selection bias we use Heckman's (1979) estimation method to calculate a correction term (called the inverse of Mill's ratio, or Mill's lambda) that reflects how the variables included in the selection equation are related with the selection of the sample. We will include Mill's lambda as an independent variable in our regressions. If the coefficient of Mill's lambda is significant, there is a selection bias.

This research studies the relationship between Euro membership at the country level and real options use at the firm level. The adoption of the Euro is determined by the people and/or the governments of countries, not by firms themselves. In that sense Euro membership is not an

endogenous variable. However, firms' decision on the location of their headquarters may be affected by their real option use or governments' decision to adopt or not to adopt the Euro may be influenced by the importance of cross-border options at the national firm level. Although we doubt the practical validity of this reasoning, we account for endogeneity by using a two-stage model estimation following Heckman (1979) in our robustness tests.

The questionnaire and invitations to participate were sent in the summer of 2005 at least once and no more than four times to each of the 262 firms with whom initial contact had been established. The first request for participation was sent in June 2005 and the last request was sent a month later in July 2005. The questionnaire consisted of 35 questions for which predefined answers could be chosen by checking the appropriate boxes. The questions in the questionnaire are listed in Appendix A.

Survey data for the exercise of real options are provided in the next section as well as the binary and ordered variables used as dependent variables in subsequent analysis. The analysis performed is binary and ordered probit regression analysis<sup>13</sup>.

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<sup>13</sup> The regression analysis is done with limited dependent variables (here binary as well as ordered regression). Standard introductory discussion of these models can be found in Greene (1997). In the binary model, the dependent variable may take on only two values, 0 or 1. In the ordered model, the dependent variable may take on a number of ordered or ranked values, in this case 0, 1, 2, 3, and 4. Estimation is undertaken by maximum likelihood. Our models are binary or ordered probit models as opposed to logit models. The difference between the two approaches concerns the distribution of the error term, normal versus logistic. In practice, it is difficult to justify the selection of one over the other and our conclusions are not materially affected by our choice. The interpretation of the coefficient values in the binary and the ordered model is complicated by the fact that the estimated coefficients cannot be interpreted as the marginal effect on the dependent variable. However, the direction of the effect is less ambiguous. Interpretation difficulties for probit and logit models are described in Hoetker (2007), among others.



#### **4. Euro membership and the exercise of real options**

Euro membership eliminates an uncertainty in relation to the future development of exchange rates. This elimination can trigger the exercise of real options because the value of waiting declines. Table 2 shows the effect of the introduction of the Euro on our sample firms in relation to (1) alliances, (2) new customers, (3) new suppliers, and (4) general expansion.

(1) Alliances refer to the effect to which the introduction of the Euro has enabled the firm to establish a formal and / or informal alliance or partnership with other firms. The uncertainty in exchange rates may have been one of the obstacles for not entering such an alliance / partnership prior to the introduction of the Euro. An example of a partnership is the agreement between Biohit Oyj, Finland, and bioMérieux, France (see Biohit Annual Report 2005). Biohit develops and manufactures laboratory devices and equipment as well as diagnostic tests and analysis systems for use in research institutions, health care and industrial laboratories (NAICS 33). Net sales in 2005 totaled EUR 28.6 million. At the end of 2005 Biohit signed a co-operation agreement with bioMérieux which enables global deliveries of Biohit's liquid handling products and worldwide maintenance services to the bioMérieux organization.

(2) New customers refer to the effect to which the Euro has enabled the firm to enter new markets or market segments. The uncertainty in exchange rates may have been one of the obstacles for not entering new markets or market segments prior to the introduction of the Euro. An example of such an entry is Sirti S.p.A., Italy, and its expansion into a new market segment in Spain (see Sirti 2005 Annual Report). Sirti is the Italian leading firm in engineering and realization of telecommunication networks and systems (NAICS 33).

Revenues from sales of goods and services reached EUR 515.7 million in 2005. Sirti acquired orders for over EUR 78 million in Spain in 2005 (19 percent higher than the previous year). Part of the increase was due to an extension of activities to telecommunications operators (Auna/Ono, Telefonica and others).

(3) New suppliers refer to the effect to which the Euro has enabled the firm to consider new suppliers. The uncertainty in exchange rates may have been one of the obstacles for not shifting suppliers prior to the introduction of the Euro. An example of a new supplier is the case of Danieli & C. Officine Meccaniche S.p.A. in Italy (see Danieli 2004/2005 Annual Report). Danieli operates in the sector for the design, construction and sale of machinery and plant for the iron and steel industry (NAICS 33) and the consolidated revenues reached EUR 1,442.5 million in 2004/2005. Danieli Hi Tech GmbH is a German subsidiary formed in 1999. Danieli Hi Tech GmbH performs commercial and design activities for the Danieli group and effectively creates sourcing of activities from Germany.

(4) General expansion refers to the effect to which the Euro has created new opportunities for the firm to expand in the Euro-area. The uncertainty in exchange rates may have been one of the obstacles for not expanding prior to the introduction of the Euro. An example of an expansion is the case of Benefon Oyj, Finland. Benefon operates in the mobile phone industry (NAICS 33) and had net sales of EUR 7.6 million in 2005 (see Benefon 2005 Annual Report). Benefon's sales efforts are especially focused on customer projects in Western Europe. In 2005 a strategic decision to enter into the growing consumer personal navigation market was made. Benefon launched a new navigation device at a convention in Barcelona, Spain, in February 2006 and launched a new positioning device at an exhibition in Hannover, Germany, in March 2006.

\* Please insert Table 2 approximately here \*

Table 2 shows that a minority of the firms in our sample think that the introduction of the Euro has led them to exercise real options related to alliances, new customers, new suppliers, and general expansion. More interestingly however, Table 2 shows that while this minority is representing every fourth firm on average among the Euro firms, the minority among the non-Euro firms is close to non-existing. Thus, it seems that the introduction of the Euro has had a markedly different effect on Euro firms as opposed to non-Euro firms in relation to the exercise of real options. This is also evident from Table 3.

\* Please insert Table 3 approximately here \*

Table 3 lists survey results for the number of real options exercised because of the introduction of the Euro. The mean number of real options exercised by Euro firms is 1.0 but the equivalent figure for non-Euro firms is a meager 0.1. While half of Euro firms have exercised one or more real options because of the introduction of the Euro, less than one tenth of non-Euro firms have exercised one or more real options. Finally, while one fifth of Euro firms have exercised 3 or 4 real options, none of the non-Euro firms have exercised real options in a corresponding magnitude.

## **5. Firm characteristics and the impact of the Euro introduction**

The last section showed that Euro firms are more likely than non-Euro firms to find that the introduction of the Euro has caused them to consider the exercise of real options related to

establishing alliances / partnerships (“alliances”), entering new markets or market segments (“new customers”), shifting suppliers (“new suppliers”), and expanding in the Euro-area (“general expansion”). However, this immediate finding may be due to or at least be distorted by omitted variable bias. Thus, the purpose of this section is to include other firm characteristics that may explain the importance of the introduction of the Euro in relation to the exercise of real options. The size of the firm, the firm’s sale to the Euro-area, the number of foreign subsidiaries, profitability, solvency ratio, and Tobin’s Q are relevant variables.

(1) The size of the firm (as measured by the logarithm of the consolidated operating income or turnover is hypothesized to have a *negative* relationship to the exercise of real options. Small firms find that the introduction of the Euro and its elimination of several individual currencies have reduced the difficulties in exporting to and dealing with countries in the Euro-area to such a degree that they will be more likely to undertake investments (exercise real options) after the introduction of the Euro. Baldwin, Skudelny and Taglioni (2005) observe that Europe has a high share of small firms that either do not export, or export very little. One factor that keeps them from exporting is the uncertainty involved in trade. The introduction of the Euro has reduced this uncertainty and thus may lead small firms to exercise real options. Blanco (2001) finds that transactions cost savings and the simplification of corporate planning due to the elimination of currency risks have stimulated cross-border sales and investment, especially by small and medium-sized enterprises.

(2) The firm’s sales to the Euro-area (as measured by the firm’s sales to the Euro-area divided by the firm’s total sales) is hypothesized to have a *positive* relationship to the exercise of real options. Whyman (2002) argues that the main impact emerging from the Euro will be experienced by those firms most directly involved in the process, particularly those with a

high proportion of their total output occurring within the Euro-zone. However, this effect may be at least partly offset by firms that are only involved to a small extent in the Euro-area. Baldwin (2006a) argues that the introduction of the Euro has brought down the fixed cost of trading in the Euro-area and thereby made it possible for firms selling products to or buying products from just a few of the twelve Euro countries to expand their involvement.

(3) Foreign subsidiaries (as measured by the square root of the number of subsidiaries abroad) are hypothesized to show a *negative* relationship to the exercise of real options. Following Caves (1971) we use subsidiaries abroad as a proxy for commitment and exposure to a foreign market. The more a firm is already committed to foreign markets, the less likely it is that the introduction of the Euro causes the firm to change action. However, one might also argue that being present in foreign markets is a proxy for the firm's ability to manage internationally and thus a prerequisite or at least a contributing factor for the ability of exercising real options on the international scene.

(4) Profitability (as measured by profit margin) is hypothesized to have a *positive* relationship to the exercise of real options. A firm that is profitable is more likely than an unprofitable firm to exercise real options in order to exploit and expand the underlying sound business.

(5) Solvency ratio (as measured by equity divided by total assets) is hypothesized to have a *negative* relationship to the exercise of real options. Reducing uncertainty matters more for firms with a small financial buffer. Bris, Koskinen and Nilsson (2006) find that the Euro has had a positive impact on financially constrained firms' investments.

(6) Tobin's Q (as measured by the sum of total debt plus the market value of equity divided by the sum of total debt plus the book value of equity) is hypothesized to have a *positive* relationship to the exercise of real options. Tobin's Q is used as a proxy for a firm's growth opportunities in line with Guay and Kothari (2003) and Kedia and Mozumbar (2003). The value of a firm equals the value of assets in place plus the value of growth options. A high Tobin's Q indicates that the majority of the value of the firm is related to growth options, while a low Tobin's Q indicates that the majority of the value of the firm is related to assets in place. The hypothesized positive relationship rests on the premise that firms with a lot of growth options are also the firms most likely to exercise such options. However, if firms have already exercised these options, Tobin's Q will tend to be low and the implied relationship is negative as opposed to positive.

In relation to the hypotheses above, it is appropriate to put forward a competing reasoning and thus competing hypotheses. The arguments above rest on the belief / assumption that small, profitable firms with limited commitment to foreign markets and with limited financial resources are likely to benefit from the introduction of the Euro and thus exercise real options in relation to establishing partnerships / alliances, entering new markets / market segments, switching suppliers, and expanding in the Euro-area. However, small firms with limited commitment to foreign markets (limited experience) and with limited financial resources may still find that all the other barriers (technical, cultural, etc.) that exist when dealing across borders are prohibitive. Thus, it can be argued that the firms most likely to benefit from the introduction of the Euro in terms of exercising real options are large firms (operational capacity) with a solid financial ballast (financial capacity) and with some experience (managerial capacity). Which line of reasoning is correct is ultimately an empirical question to be addressed.

Descriptive statistics for the independent variables used in the regression analysis are presented in Table 4. The median (average) firm has an operating income or turnover of EUR 143 million (EUR 2,844 million), a sale in the Euro-area ratio of 50 percent (53 percent), 6 (20) foreign subsidiaries, a profit margin of 5 percent (1 percent), a solvency ratio of 43 percent (47 percent), and a Tobin's Q of 1.3 (1.9).

\* Please insert Table 4 approximately here \*

Table 4 distinguishes between Euro firms and non-Euro firms. Euro firms are in general larger, have more of their sales in the Euro-area, have more foreign subsidiaries, have a lower solvency ratio, and finally have a lower Tobin's Q than non-Euro firms.

Correlation coefficients for the independent variables used in the regression analysis are presented in Table 5. Table 5 shows correlation coefficients between size measured as the logarithm of consolidated operating income or turnover, sales in Euro-area as percent of total sales, number of foreign subsidiaries (square root), profit margin as measured by profit/loss before tax divided by turnover, solvency ratio as measured by equity divided by total assets, and Tobin's Q as measured by the sum of total debt plus the market value of equity divided by the sum of total debt plus the book value of equity, and a Euro firm dummy (firm based in a Euro country = 1). The size variable and the foreign subsidiary variable show a large positive correlation of 0.76. This will be addressed at a later stage.

\* Please insert Table 5 approximately here \*

Since this study's sample selection criteria require that firms used in the analysis have information on their real options related activities, our final sample contains only firms that chose to respond to the questionnaire. Thus, there is a possibility of sample selection bias. Specifically, this would be the case if the selection criterion in question, i.e. the propensity of the firm to respond to the questionnaire, is correlated with firms' exercise of real options. To account for this possibility and correct for sample selection bias we use Heckman's (1976, 1979) two-step estimation method, wherein we first estimate the selection equation using the following probit model:

$$RESP_i^* = CONSTANT + \lambda_1 TURNOVER_i + \lambda_j ECOUNTRY_j \quad (1)$$

$RESP_i$ , the sample selection indicator variable, takes the value of one if the firm has responded to the questionnaire and the value of zero otherwise. On the right hand side of this regression model are the size of the firm and a vector of country indicator variables included to account for country-specific (e.g. cultural, political etc.) effects on the propensity to answer to the questionnaire. After estimating the above probit model using the entire population of firms with available data, we calculate a correction term (called the inverse of Mill's ratio, or Mill's lambda) that accounts for the probability that the firm is being included in the sample. We then include Mill's lambda as an independent variable in all real options exercise regressions. A significant coefficient of Mill's lambda ( $LAMBDA_i$ ) in these regressions would indicate that there is selection bias. More importantly, the coefficients of the other variables obtained under this method will be unbiased.

As discussed above, it is hypothesized that firm characteristics for size, sales to Euro-area, foreign subsidiaries, profitability, solvency ratio, Tobin's Q, and Euro membership can



influence the effect of the introduction of the Euro on the exercise of real options in manufacturing firms. The dependent variable in the binary regression is the exercise of real options as measured by 1 (“Yes”) and 0 (“No”) as described in Table 2. The dependent variable in the ordered regression is the exercise of real options as measured by the sum of 1s and 0s for the four real options as described in Table 3. The following binary or ordered probit regression is analyzed

$$RO_i^* = CONSTANT + \lambda_1 TURNOVER_i + \lambda_2 EUROSALE_i + \lambda_3 FORSUB_i + \lambda_4 PROMAR_i + \lambda_5 SOL_i + \lambda_6 TOBINQ_i + \lambda_7 EUROFIRM_i + \lambda_8 LAMBDA_i \quad (2)$$

where:

$RO_i^*$  in the binary regression measures the effect of the introduction of the Euro on the exercise of real options by a binary variable for firm  $i$  with 0: “No” and 1: “Yes” for Question 5 (Alliances), Question 9 (New customers), Question 23 (New suppliers), and Question 29 (General expansion) respectively as described in Table 2 and

$RO_i^*$  in the ordered regression measures the effect of the introduction of the Euro on the exercise of real options by an ordered variable (the sum of the answers for the four questions above) for firm  $i$  with 0: four “No”; 1: three “No” and one “Yes”; 2: two “No” and two “Yes”; 3: three “No” and one “Yes”; and 4: four “Yes” as described in Table 3.

$CONSTANT$  is a constant in the binary regression.

$TURNOVER_i$  is the logarithm of operating income or turnover for firm  $i$  in 2005 or closest available year,

$EUROSALE_i$  is sales in Euro-area / total sales for firm  $i$  according to Question 3 in the Questionnaire,

$FORSUB_i$  is the square root of the number of foreign subsidiaries in firm  $i$ ,  
 $PROMAR_i$  is the profit margin as measured by profit/loss before tax divided by operating income or turnover for firm  $i$  in 2005 or closest available year,  
 $SOL_i$  is the solvency ratio as measured by equity divided by total assets for firm  $i$  in 2005 or closest available year,  
 $TOBINQ_i$  is the sum of total debt plus the market value of equity divided by the sum of total debt plus the book value of equity for firm  $i$  in 2005 or closest available year,  
 $EUROFIRM_i$  is an indicator variable coded as a “1” if firm  $i$  is based in a Euro country or “0” otherwise,  
 $LAMBDA_i$  is Mill’s ratio as described previously.

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Our ultimate interest is the overall impact of the introduction of the Euro on the exercise of real options (the ordered regression). However, in order to capture information related to the specific areas (“Alliances”, “New customers”, “New suppliers”, and “General expansion”) in which the exercise of real options are done, we move stepwise and initially analyze the impact of the introduction of the Euro on specific areas with and without the Euro membership distinction ((Table 6 and Table 7 respectively).

Table 6 reports the results for the binary (columns 2-5) and the ordered (column 6) regression when the Euro firm variable is not included. Columns 2-5 relate the exercise of real options to specific areas (“Alliances”, “New customers”, “New suppliers”, and “General expansion”) while column 6 relates the exercise of real options to the sum of the specific areas (“Combined”).

\* Please insert Table 6 approximately here \*

Analyzing the specific areas, there is an indication that the introduction of the Euro has made (1) firms with a high profit margin and a low solvency ratio more likely to establish formal and/or informal alliances or partnerships with other firms than firms with a low profit margin and a high solvency ratio, (2) small firms with a high degree of sales in the Euro-area and a high profit margin more likely to enter new markets or market segments than large firms with a low degree of sales in the Euro-area and a low profit margin, (3) firms with a large part of their value tied to assets in place more likely to consider new suppliers than firms with a large part of their value tied to growth options, and (4) firms with a low solvency ratio more likely to expand in the Euro-area than firms with a high solvency ratio. Looking at the overall impact of the introduction of the Euro on the exercise of real options, the combined model indicates that small, profitable and financially constrained (low solvency ratio) firms have felt the largest positive impact. The coefficient for Mill's Lambda is significant or close to significant in most models, thus justifying the correction for sample selection bias. The combined model is statistically significant at the 1 percent level.

Table 7 is exactly the same as Table 6 except that we include the distinction between Euro firms and non-Euro firms. None of the non-Euro firms found that the introduction of the Euro enabled them to establish alliances / partnerships or enter new markets / market segments. Thus, coefficients for columns 2-3 are solely based on the sample of Euro firms (part of the reasoning for including Table 6).

\* Please insert Table 7 approximately here \*

In relation to the specific areas there is an indication that the introduction of the Euro has made (1) firms with a high profit margin more likely to establish formal and/or informal alliances or partnerships with other firms than firms with a low profit margin, (2) small firms with a high profit margin more likely to enter new markets or market segments than large firms with a low profit margin, and (3) firms with a large part of their value tied to assets in place more likely to consider new suppliers than firms with a large part of their value tied to growth options. The results of the combined model in Table 7 confirm the argument that the introduction of the Euro has made *small, profitable* firms with *limited financial resources* more likely than other firms to exercise real options such as to establish alliances / partnerships, to enter new markets / market segments, to switch suppliers, and to generally expand in the Euro-area (in line with the arguments and observations of Baldwin, Skudelny and Taglioni, 2005, and Baldwin, 2006a). The significance of the coefficient for the Euro firm dummy in Table 7 indicates that it is important to distinguish between Euro firms and non-Euro firms in understanding the degree to which the introduction of the Euro has caused firms to exercise real options. The coefficient for Mill's Lambda is significant in the combined model. The combined model is statistically significant at the 1 percent level.

The results of the combined model did not confirm our hypothesis that a large ratio of Euro-area sale should cause the introduction of the Euro to have a larger impact on the exercise of real options. As already noted, this finding may be due to small firms that do not initially have a large ratio of Euro-area sale. Furthermore, the results of the combined model failed to indicate that a firm with few foreign subsidiaries was more likely to exercise real options because of the introduction of the Euro. As noted in relation to Table 5, the size variable and the foreign subsidiary variable have a large, positive correlation coefficient. If we exclude the size variable in the combined model, the coefficient for the foreign subsidiary variable stays

insignificant. Finally, the results of the combined model did not confirm our hypothesis that a firm with many growth opportunities (high Tobin's Q) was more likely to exercise real options because of the introduction of the Euro. It seems that the small, profitable firms that are more likely to exercise real options because of the introduction of the Euro have not tied a large part of their value to growth opportunities.

Most importantly in relation to this study, the combined model in Table 7 shows that a decisive factor for the impact of the introduction of the Euro on the exercise of real options is whether or not the firm is located in a country that has adopted the Euro or not. The coefficient for Euro firm is significant at a 5 percent level (p-value = 0.019). After controlling for firm characteristics that could have explained or actually do explain part of the impact from the introduction of the Euro, the combined model in Table 7 confirms our initial suggestions from Table 2 and Table 3. Being a Euro firm or a non-Euro firm is an important distinction in understanding the impact from the introduction of the Euro on the firm's exercise of real options.

## **6. Elaborations on the impact of Euro membership**

Table 8 elaborates on the importance of being a Euro firm or a non-Euro firm in relation to the effect of the introduction of the Euro on the exercise of real options. Model 1 ("Basis") of Table 8 is equivalent to the combined model of Table 7 while Models 2-5 in Table 8 are elaborations on this base model.

\* Please insert Table 8 approximately here \*

Bris, Koskinen and Nilsson (2006) find that the Euro has increased investments for firms from countries that previously had weak currencies. Bris et al. categorize Finland, Italy, Ireland, Portugal and Spain as weak countries (i.e. countries with a recent currency crisis). Greece is not included in their sample. The positive effect of the Euro on investments for firms in the weak Euro-area countries is consistent with a real impact of the removal of foreign exchange risks, since firms in these countries are ex-ante firms for which the elimination of currency risks is the most valuable.

In line with the above reasoning, Model 2 (“Strong/weak”) reports the results when the Euro firm variable is exchanged by two variables thus distinguishing between firms located in a strong Euro country, firms located in a weak Euro country, and firms located in a non-Euro country (default). The countries are allocated into weak Euro countries and strong Euro countries in accordance with Bris et al. above (adding Greece to the weak Euro countries). In Model 2 the coefficients for the strong Euro firm and the weak Euro firm are of the same magnitude and significant at the 5 percent and 1 percent level (p-values = 0.018 and 0.056 respectively) in explaining the degree to which the firm will consider the exercise of real options because of the introduction of the Euro. A Wald coefficient test (not shown) confirms that the coefficients for the weak and the strong Euro firm variables are not significantly different from each other.

The results of Model 2 in Table 8 suggest that the distinction between firms based in strong Euro countries and firms based in weak Euro countries is not essential. The crucial factor seems to be whether or not the firm is based in a country that has adopted the Euro. Whether or not the Euro country in which the firm is located has a recent history of currency crises

does not seem to affect the degree to which the introduction of the Euro causes the firm to consider the exercise of real options.

Hofstede (1980) identifies four primary dimensions to differentiate cultures: Power Distance Index, Individualism, Masculinity, and Uncertainty Avoidance Index<sup>14</sup>. A high Uncertainty Avoidance Index<sup>15</sup> indicates that the country has a low tolerance for uncertainty and ambiguity. Thus, Euro firms in countries with a high Uncertainty Avoidance Index may perceive the introduction of the Euro as a more material change than Euro firms in countries with a low Uncertainty Avoidance Index.

Model 3 (“UAI”) in Table 8 reports the results when the Euro firm variable is substituted by a Euro firm times UAI variable thus differentiating within Euro firms between firms from countries with a low Uncertainty Avoidance Index and firms from countries with a high Uncertainty Avoidance Index. The coefficient for the new variable is significant at a 1 percent level (p-value = 0.006) – marginally more significant than the “clean” Euro firm dummy in Model 1. Adding the Uncertainty Avoidance Index as a new independent variable (not shown) together with the “old” Euro firm variable makes the coefficient for the Uncertainty Avoidance Index as well as the coefficient for the Euro firm variable insignificant.

Before jumping to the conclusion that the inclusion of the Uncertainty Avoidance Index does not add value, it is interesting to note that if the Uncertainty Avoidance Index is added to the

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<sup>14</sup> From 1967 to 1973, while working at IBM as a psychologist, Hofstede collected and analyzed data from over 100,000 individuals from forty countries. The results from these studies form the backbone of the model that identifies four primary dimensions to differentiate cultures. Please refer to Hofstede (1980) for further information.

<sup>15</sup> Singapore (8) is the country in the world that has the lowest score on the Uncertainty Avoidance Index while Greece (112) is the country that has the highest score.

model and the Euro firm variable is excluded, the coefficient for the Uncertainty Avoidance Index is significant on its own. This makes room for an alternative explanation. Whether or not a firm is based in a Euro country or not does not matter. What matters is the country's tolerance for uncertainty and ambiguity.

The weighted (weighted according to number of firms in the sample) average of the Uncertainty Avoidance Index is 70 for the twelve Euro countries while the sample weighted average is 33 for the three non-Euro countries<sup>16</sup>. None of three non-Euro countries have a higher Uncertainty Avoidance Index than any of the twelve Euro countries. In our sample the correlation between Euro membership and the Uncertainty Avoidance Index is 0.81. Thus, in relation to the model it does not make much difference whether we include a Euro firm variable or an Uncertainty Avoidance Index variable. The conclusions as to the significance or insignificance of the other variables are not materially affected either.

However, if in fact what matters is the country's tolerance for uncertainty and ambiguity rather than whether or not the country has adopted the Euro or not, we should be able to find that *within* Euro firms the inclusion of the Uncertainty Avoidance Index is important for understanding the impact of the introduction of the Euro on the exercise of real options. If we include an Uncertainty Avoidance Index variable in Model 1 (and exclude the Euro firm variable) and restrict the sample to only include Euro firms, the coefficient for the Uncertainty Avoidance Index is not statistically significant.

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<sup>16</sup> For the twelve Euro countries the Uncertainty Avoidance Index is: Austria (70), Belgium (94), Finland (59), France (86), Germany (65), Greece (112), Ireland (35), Italy (75), Luxembourg (70), Netherlands (53), Portugal (104), and Spain (86). The simple average for the twelve Euro countries is 76. The weighted average (weighted according to number of firms in the sample) is 70. For the three non-Euro countries the Uncertainty Avoidance Index is: Denmark (23), Sweden (29), and UK (35). The simple average for the three non-Euro countries is 29. The sample weighted average (weighted according to number of firms in the sample) is 33.



By itself it is interesting to note the high correlation between Euro membership and the country's Uncertainty Avoidance Index and one might speculate to what degree (if any) the country's tolerance for uncertainty and ambiguity has been a contributing factor for the decision to adopt or not to adopt the Euro, but in terms of the topic of this paper we are back to the old conclusion: What seems to matter is whether a firm is based in a country that has adopted the Euro or not.

Model 4 ("Euro+UK") in Table 8 restricts the sample to only include Euro firms and UK firms. The group of non-Euro firms comprises 15 UK firms, 6 Swedish firms and 1 Danish firm. UK., Sweden and Denmark have so far been treated as one homogenous control group. However, the three countries have different backgrounds in terms of history (e.g. UK. and Denmark joined the EU in 1973 while Sweden joined the EU in 1995) and also in terms of exchange rate fluctuations vis-à-vis the Euro. Denmark is a member of the ERM2<sup>17</sup> and has experienced very small changes in its exchange rate towards the Euro, while UK. and Sweden have experienced more exchange rate volatility. Thus, for the period 1999-2005 the average / minimum / maximum exchange rate for the British Pound per Euro was 0.65 / 0.57 (+12.4%) / 0.72 (-10.7%), for the Swedish Krona per Euro 9.03 / 8.09 (+10.4%) / 9.95 (-10.2%), and for the Danish Krone per Euro 7.44 / 7.42 (+0.3%) / 7.47 (-0.4%). In terms of standard deviation for the period the numbers are 5.1%, 3.5%, and 0.2% respectively. When excluding the non-UK non-Euro firms (i.e. firms from Sweden and Denmark) from the sample, the conclusions as to the significance or insignificance of the coefficients for the various variables are unaffected. Thus, a competing (or complementary) conclusion as to the effect of

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<sup>17</sup> In 1999, ERM2 replaced the original ERM (European Exchange Rate Mechanism). Denmark - the only EU15 country in ERM2 - is a member of ERM2 together with some of the "new" EU countries. Currencies in ERM2 are allowed to float within a range of  $\pm 15\%$  with respect to a central rate against the Euro. In the case of Denmark, the national bank of Denmark keeps the exchange rate within the narrower range of  $\pm 2.25\%$  against the central rate of 1 EUR = 7.46038 DKK.

the introduction of the Euro on the exercise of real options could be stated in terms of UK firms versus Euro firms rather than non-Euro firms versus Euro-firms.

Model 5 (“Euro”) in Table 8 restricts the sample to Euro firms. The results from this model confirm that - apart from the important distinction between Euro firms and non-Euro firms shown in Models 1-4 – the firms that have been the most likely to react to the introduction of the Euro by exercising real options such as to establish alliances / partnerships, to enter new markets / market segments, to switch suppliers, and to generally expand in the Euro-area are small, profitable firms with limited financial resources.

In relation to Mill’s lambda, the coefficient is statistically significant at the 10 percent level or close to being statistically significant in all models in Table 8. This significance highlights the importance of correcting for sample selection bias in studies like the present.

## **7. Further robustness considerations**

Our conclusions from Table 8 are robust to alternative measurements of the size variable. The size variable used in the regression analysis is based on operating income or turnover. Substituting this by a size variable based on total assets, total market value of the firm, or number of employees does not change the results in any significant way.

The sales in Euro-area variable is a measure of the percentage of the firm’s sales that goes to the Euro-area. The coefficient for such a variable is not statistically significant in Table 8. One might argue that it is more relevant to measure the percentage of the firm’s sales that is *exported* to the Euro-area. However, the coefficient for such an export variable is not

significant. One might also argue that it is relevant to include a measure of the degree to which the firm is sourcing from the Euro-area<sup>18</sup>. However, such an addition does not add value. By itself the coefficient for such a sourcing variable is not significant and the inclusion does not affect the overall conclusions.

We measure the firms' commitment and exposure to foreign markets by the number of foreign subsidiaries. The coefficient for such a variable is not statistically significant in Table 8. Substituting the number of foreign subsidiaries with the number of foreign countries in which the firm has subsidiaries does not change the result. Only if we restrict the variable to include either number of foreign subsidiaries or number of foreign countries *within* the Euro-area, the coefficient turns out to be statistically significant (without changing the conclusions in relation to the other variables). It seems that the degree to which the firm is committed and exposed to markets – whether for marketing or sourcing – in (other) Euro countries is correlated with the impact of the introduction of the Euro on the exercise of real options. However, a question mark can be put to the likely cause and effect relationship. It might be that the introduction of the Euro led some firms to establish subsidiaries in the Euro-area.

We measure profitability by profit margin<sup>19</sup>. If we measure profitability by return on shareholders' funds<sup>20</sup>, the coefficient for such a variable is not significant. If we create a very simple profitability measure, a dummy variable for whether or not the firm generates a

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<sup>18</sup> Based on answers to question 20 in the Questionnaire.

<sup>19</sup> In Amadeus, profit margin is defined as profit / loss before taxation divided by operating revenue or turnover. Such a measure is distorted by the financial leverage of the firm as the profit / loss before tax includes the effect of financial revenues and expenses.

<sup>20</sup> In Amadeus, return on shareholders' funds is calculated by profit / loss before tax divided by shareholders' funds. Such a measure is distorted by the financial leverage of the firm because the tax liability of the firm is affected by the tax shield from interest payments. Thus, return on shareholders' fund is a "rough" pretax estimate of return on shareholders' funds.

positive or negative profit (loss), the coefficient for such a dummy variable is statistically significant (whether or not the profit is calculated before or after tax).

We use solvency ratio as a measure of financial resources / financial ability. If we instead use current ratio (current assets divided by current liabilities) as our measure of how financially constrained a specific firm is, the coefficient for such a variable turns out to be only close to significant.

We use Tobin's Q as a proxy for a firm's growth opportunities. Alternatively we could have used a measure related to the firm's research and development expenses. However, data were not available for all firms. The coefficients for variables such as price / book ratio or price / earnings ratio are not statistically significant.

In Table 8 we use an ordered regression analysis on the Euro impact. Another possibility is to use a binary regression analysis in which we distinguish between the 45 firms (Table 3) which find that the introduction of the Euro has not enabled them to exercise real options and the 28 firms ( $14+4+8+2=28$ , Table 3) which find that the introduction of the Euro has enabled them to exercise one or more real options. Such a binary regression analysis would not exploit the information content in the extent of real option exercise among the 28 firms that do exercise real options. On the other hand, the results of such a binary regression analysis would show if the conclusions from Table 8 are driven by a few firms in the right hand end of the scale. The results of a binary regression analysis (not shown) confirm our findings in relation to the importance of Euro membership. The qualitative conclusions in relation to the other parameters are also unaffected.

The population of listed EU15 manufacturing firms (NAICS 33) consists of 598 firms divided between 366 Euro firms and 232 non-Euro firms (Table 1). As a rough survivorship bias test we look at the similar population at the introduction of the Euro. The introduction of the Euro could – in principle at least – have markedly changed the balance between Euro firms and non-Euro firms by altering the competitive structure in the manufacturing industry. In such a case we could be comparing e.g. a lot of young Euro firms fairly new to the manufacturing industry with a few remaining old non-Euro firms. Such an extreme is, however, not supported by the data. The population of listed EU15 manufacturing firms (NAICS 33) around the introduction of the Euro<sup>21</sup> consisted of 584 firms divided between 392 Euro firms<sup>22</sup> and 193 non-Euro firms.

As a final robustness check, we want to check for the possibility that the relationship between the location of a firm (i.e. incorporation in a Euro vs. non-Euro country) and real options use could be endogenous. This is conceivable if, for example, both the choice of location of the firm and the attitude toward exercising real options were functions of a list of common variables. We account for endogeneity by using a two-stage model estimation following Heckman (1979).<sup>23</sup> The results obtained using this procedure, not presented here, are qualitatively similar to the ones presented here.<sup>24</sup>

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<sup>21</sup> Data on listed EU15, NAICS 33 firms around the introduction of the Euro was obtained from an Amadeus update dated February, 2000.

<sup>22</sup> In order to be consistent, this number includes Greek firms although the Greek drachma was locked vis-à-vis the Euro on January 1, 2001.

<sup>23</sup> In the first stage, we estimate the probability of a firm being located in a Euro member country as a function of several firm characteristics as well as a measure of cultural distance relative to the average of all EMU-member country scores computed across the four of Hofstede's cultural dimensions. The latter variable serves as an instrument. In the second stage, we estimate model (2) using the fitted value of Euro membership.

<sup>24</sup> We chose not to present these for the sake of brevity, and, because the Hausman test did not indicate a strong case for endogeneity. The results are available from the authors upon request.

## 8. Conclusions

This empirical study of listed EU15 manufacturing firms (NAICS 33) examines the impact of the introduction of the Euro on the exercise of real options. The study contributes to the existing body of literature by focusing on the potential long-term effects of the introduction of the Euro. The study shows that the introduction of the Euro has made Euro firms more inclined than non-Euro firms to exercise real options such as to establish alliances / partnerships, to enter new markets / market segments, to switch suppliers, and to generally expand in the Euro-area. Furthermore, the study shows that small, profitable, and financially constrained firms are the ones most likely to exercise such options because of the introduction of the Euro.

The exercise of real options may not have an immediate and sizeable short-term effect on trade but can have important long-term effects. By reaching out for strategic alliances, by targeting new markets / market segments, by restructuring their supplier network, and by generally aiming for an expansion in the Euro-area, the Euro firms may gain a medium to long term competitive advantage compared to their non-Euro colleagues. As such, the study highlights an important long-term aspect of the question posed by Baldwin (2006b): “In or Out: Does it Matter?”. This study supports the notion that it does matter.

A related and obvious question is whether the actual exercise of options leads to an increase in firm value. Bris, Koskinen and Nilsson (2008) find that the introduction of the Euro has increased Tobin’s Q ratios in the Euro-area countries that previously had weak currencies. Using Tobin’s Q measures for firm value, we fail to find a value effect from the exercise of

real options in our sample. This comes as no surprise, since Tobin's Q is also used as a proxy for a firm's growth opportunities (Guay and Kothari, 2003, and Kedia and Mozumbar, 2003).

The empirical evidence in the present study is restricted to manufacturing firms (NAICS 33). We believe that the generality of the findings can be extended to other industries although findings for these industries may be less significant due to the important role of export for the manufacturing firms in our sample. On the other hand, it should be noted that the study only looks at listed firms, thus excluding small firms that could have made the effect from the introduction of the Euro on the exercise of real options more pronounced. Ultimately, the generality of the findings of this study remains an empirical question to be addressed. We believe that our findings are relevant for a wide range of firms in Europe.

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## Appendix A: English version of the questionnaire

### Introductory questions

- 1 What is the name of the company that you represent/work for?
- 2 How many years you have worked for this company?
- 0-3
  - 3-6
  - 6-9
  - 9-12
  - More than twelve

### Organization

- 3 Where do you sell your products and/or services?
- 0-20% EMU
  - 21-40% EMU
  - 41-60% EMU
  - 61-80% EMU
  - 81-100% EMU
- 4 To which country/ies do you sell your products and/or services?
- 0-20% Domestic
  - 21-40% Domestic
  - 41-60% Domestic
  - 61-80% Domestic
  - 81-100% Domestic
- 5 Did the introduction of the Euro enable to you establish a formal and/or informal alliances or partnerships with other companies (to access bigger markets, to share resources or information)?
- Yes.
  - No.
- 6 If Yes then where?
- Domestically
  - Within EMU countries
  - Within EU countries, not members of the EMU
  - Others
- 7 Did the introduction of the euro enable you to consolidate or rearrange considerably some of your department(s)?
- Yes
  - No
- 8 If yes then in which department(s):
- Accounting
  - Marketing
  - Currency
  - Manufacturing
  - Sales
  - Other(s) please specify (box)

### Customer

- 9 Do you consider that the Euro has enabled you to enter new markets or market segments?
- Yes
  - No
- 10 Consider the following sentence: "Our customers are more price sensitive than before the introduction of the Euro".
- Yes, I strongly agree
  - Yes, I agree
  - Uncertain
  - No, I disagree
  - No, I strongly disagree
- 11 Consider the following sentence: "Our customer base increased after the introduction of the Euro"?
- Yes, I strongly agree
  - Yes, I agree

Uncertain  
No, I disagree  
No, I strongly disagree

### **Prices and Products**

- 12 Are you currently charging the same price for the same product/service within all EMU countries?**  
Yes  
Yes but not for all products/services  
No  
Not applicable
- 13 Has the introduction of the Euro made it easier to compare prices in other EU member states?**  
Yes  
No
- 14 Has your company/business benefited from this?**  
Yes  
No
- 15 Consider the following sentence: "In isolation, the introduction of the Euro has allowed us to reduce product prices due to less currency risk in exporting within the euro-zone".**  
I strongly agree  
I agree  
Uncertain  
I disagree  
I strongly disagree
- 16 Do you put a mark-up on prices of goods exported to non-EMU countries because of currency fluctuations?**  
Yes  
No  
Not applicable
- 17 Have you changed prices due to increased competition after the introduction of the Euro?**  
Yes, lowered prices significantly,  
Yes, lowered prices slightly,  
No change,  
Yes, raised prices slightly,  
Yes, raised prices significantly
- 18 Following the introduction of the Euro, have you adjusted your prices for psychological impact (e.g. to €9.99)?**  
Yes  
No

### **Suppliers**

- 19 Has the introduction of the Euro caused you to change your suppliers?**  
Yes, the Euro was the main reason  
Yes, the Euro was a contributing factor  
No, we have not changed suppliers
- 20 Where are your current suppliers located?**  
0-20% EMU  
21-40% EMU  
41-60% EMU  
61-80% EMU  
81-100% EMU
- 21 Where are your current supplier located?**  
0-20% Domestic  
21-40% Domestic  
41-60% Domestic  
61-80% Domestic  
81-100% Domestic
- 22 What are your arrangements with your suppliers?**  
Long-term agreements with most important suppliers,  
which allow us to tailor delivery of the product or service to our needs;

Shorter-term business arrangements,  
based on the best alternative in terms of price, quality or service.

Other

Not available

**23 Did the introduction of the Euro enable you to consider new suppliers?**

Yes

No

**Competition**

**24 Try to estimate the origin of the competition you face in your markets?**

National

European Monetary Union Members

European Union members, not in the EMU

Non European Union

Not applicable

**25 Is the competition you face heavily price-focused?**

Yes, we compete primarily on price;

No, we compete both on price and quality;

No, we compete only by differentiating our products and services  
from the competition.

Not applicable

**26 Has the elimination of currency exchange costs and risks (due to the introduction of the Euro) facilitated entry of new foreign competitors in your markets?**

(This will not be true if a lot of non-currency barriers slow down the entry of new competitors in your markets. For example: regulations, language differences, cultural barriers, difficulty in installing distribution channels, technological expertise, high investments required, required knowledge of the local market.)

Yes, EMU has significantly increased foreign competition in our markets;

Yes, competition has increased in our market to a certain extent

The EMU has not changed the level of competition

No, competition has decreased in our markets to a certain extent

No, EMU has significantly decreased foreign competition in our markets.

Not applicable

**27 Has the Euro contributed to altering the amount of sales and/or service that you export?**

Yes, a significant increase

Yes, a slight increase

No change,

Yes, slightly decrease

Yes, significantly decrease

**28 Within which market was the greatest impact?**

European Monetary Union Members

European Union members, not in the EMU

Non European Union

**29 Has the Euro created new opportunities for your company to expand in the Euro-Zone?**

Yes

No

**30 Consider the following sentence; "The introduction of the Euro has contributed to more consolidation in your industry through mergers, acquisitions and take-overs".**

Yes, I strongly agree

Yes, I agree

Uncertain

No, I disagree

No, I strongly disagree

**Finance**

**31 Has the introduction of the Euro enabled your company to obtain finance from banks or other financial institutions in foreign countries?**

Yes

No

**32 Have you found it easier to raise capital?**

Yes, significant easier

- Yes, slightly easier  
No change,  
No, slight more difficult  
No, significant more difficult
- 33 Have you experienced lower cost of borrowing after the introduction of the Euro?**  
Yes, a significant increase  
Yes, a slight increase  
No change,  
No, a slight decrease  
No, a significant decrease
- 34 Have you used hedging to a larger degree than what was the case before the introduction of the Euro?**  
Yes, a significant more  
Yes, a slight more  
No change,  
No, slightly less  
No, significantly less
- 35 Overall, has your company gained overall from using the Euro?**  
Yes, significantly gained  
Yes, slightly gained  
No change  
No, slightly lost  
No, significantly lost

**Table 1**      **Response rates for sample firms by country**

This table lists survey results for sample EU15 manufacturing firms (NAICS 33). Firms are classified by country. The population consists of 598 firms. 262 firms responded to an initial contact e-mail. The questionnaire (Appendix A) was sent to these 262 firms. 73 firms answered the questionnaire (overall response rate of 12.2 percent). Firms are divided into Euro firms (firms based in a EU15 Euro country) and non-Euro firms (firms based in a EU15 non-Euro country).

Country	Total number of firms	Number of replies from e-mail	Number of replies to questionnaire	Response Rate
Austria	9	6	3	33%
Belgium	11	10	4	36%
Finland	35	26	12	34%
France	97	20	3	3%
Germany	98	52	15	15%
Greece	43	10	1	2%
Ireland	2	1	1	50%
Italy	29	11	6	21%
Luxembourg	2	2	0	0%
Netherlands	26	17	3	12%
Portugal	1	1	1	100%
<u>Spain</u>	<u>13</u>	<u>5</u>	<u>2</u>	<u>15%</u>
Euro firms	366	161	51	13.9%
Denmark	9	9	1	11%
Sweden	24	16	6	25%
<u>UK</u>	<u>199</u>	<u>76</u>	<u>15</u>	<u>8%</u>
Non-Euro firms	232	101	22	9.5%
All firms	598	262	73	12.2%



**Table 2 Euro introduction and the exercise of real options**

This table provides the survey responses from 73 firms (Table 1) to questions on the exercise of real options related to Alliances (Question 5 in the Questionnaire); New customers (Question 9 in the Questionnaire); New suppliers (Question 23 in the Questionnaire); and General expansion (Question 29 in the Questionnaire). The wording of the questions is shown in footnotes 1, 2, 3, and 4 respectively. Respondents were asked to respond “Yes” or “No” to each question. The number of firms responding “Yes” and “No” is provided in each cell (the percentage in parentheses). Firms are divided into Euro firms (firms based in a EU15 Euro country) and non-Euro firms (firms based in a EU15 non-Euro country).

	Alliances <sup>1</sup>	New customers <sup>2</sup>	New suppliers <sup>3</sup>	General expansion <sup>4</sup>
Yes	8 (16%)	13 (25%)	14 (27%)	16 (31%)
No	<u>43 (84%)</u>	<u>38 (75%)</u>	<u>37 (73%)</u>	<u>35 (69%)</u>
Euro firms	51 (100%)	51 (100%)	51 (100%)	51 (100%)
Yes	0 (0%)	0 (0%)	2 (9%)	1 (5%)
No	<u>22 (100%)</u>	<u>22 (100%)</u>	<u>20 (91%)</u>	<u>21 (95%)</u>
Non-Euro firms	22 (100%)	22 (100%)	22 (100%)	22 (100%)
Yes	8 (11%)	13 (18%)	16 (22%)	17 (23%)
No	<u>65 (89%)</u>	<u>60 (82%)</u>	<u>57 (78%)</u>	<u>56 (77%)</u>
All firms	73 (100%)	73 (100%)	73 (100%)	73 (100%)

<sup>1</sup> Question 5: “Did the introduction of the Euro enable to you establish a formal and/or informal alliances or partnerships with other companies (to access bigger markets, to share resources or information)?”

<sup>2</sup> Question 9: “Do you consider that the Euro has enabled you to enter new markets or market segments?”

<sup>3</sup> Question 23: “Did the introduction of the Euro enable you to consider new suppliers?”

<sup>4</sup> Question 29: “Has the Euro created new opportunities for your company to expand in the Euro-Zone?”

**Table 3 Euro introduction and number of real options exercised**

This table lists survey results for the number of real options exercised as described in Table 2. The number of firms is provided in each cell. Firms are divided into Euro firms (firms based in a EU15 Euro country) and non-Euro firms (firms based in a EU15 non-Euro country).

	N	Number of real options exercised					Mean
		0	1	2	3	4	
Euro firms	51	25	13	3	8	2	1.0
Non-Euro firms	22	20	1	1	0	0	0.1
All firms	73	45	14	4	8	2	0.7

**Table 4** Descriptive statistics of independent variables

This table provides descriptive statistics for independent variables used in the binary probit regression analysis and the ordered probit regression analysis. The variables are: size measured as consolidated operating income or turnover in million Euro in 2005 (or closest available year), size measured as the logarithm of consolidated operating income / turnover, sales in Euro-area as percent of total sales, number of foreign subsidiaries, number of foreign subsidiaries (square root), profit margin as measured by profit/loss before tax divided by turnover, solvency ratio as measured by equity divided by total assets, and Tobin's Q as measured by the sum of total debt plus the market value of equity divided by the sum of total debt plus the book value of equity. Firms are divided into Euro firms (firms based in a EU15 Euro country) and non-Euro firms (firms based in a EU15 non-Euro country).

Variable	N	Mean	Median	Max.	Min.	Std. Dev.
<b>Turnover (million Euro):</b>						
Euro firms	51	3,871	198	99,820	5.4	14,918
Non-Euro firms	22	462	99	5,325	0.1	1,146
All firms	73	2,844	143	99,820	0.1	12,546
<b>Turnover (log):<sup>1</sup></b>						
Euro firms	51	2.4	2.3	5.0	0.7	0.9
Non-Euro firms	22	1.9	2.0	3.7	-0.9	1.0
All firms	73	2.3	2.2	5.0	-0.9	1.0
<b>Sales in Euro-area:<sup>2</sup></b>						
Euro firms	51	60%	70%	90%	10%	26%
Non-Euro firms	22	38%	30%	90%	10%	29%
All firms	73	53%	50%	90%	10%	28%
<b>Foreign subsidiaries:</b>						
Euro firms	51	22	7	218	0	44
Non-Euro firms	22	14	4	86	0	21
All firms	73	20	6	218	0	39
<b>Foreign subsidiaries (square root):</b>						
Euro firms	51	3.5	2.6	14.8	0	3.2
Non-Euro firms	22	2.9	2.0	9.3	0	2.4
All firms	73	3.3	2.4	14.8	0	3.0
<b>Profit margin:</b>						
Euro firms	51	3%	4%	30%	-60%	15%
Non-Euro firms	22	-2%	8%	23%	-100% <sup>3</sup>	35%
All firms	73	1%	5%	30%	-100%	35%
<b>Solvency ratio:</b>						
Euro firms	51	43%	41%	93%	-47% <sup>4</sup>	22%
Non-Euro firms	22	57%	58%	93%	24%	21%
All firms	73	47%	43%	93%	-47%	22%
<b>Tobin's Q:</b>						
Euro firms	51	1.6	1.3	8.1	0.6	1.3
Non-Euro firms	22	2.5	1.8	8.6	0.8	1.7
All firms	73	1.9	1.3	8.6	0.6	1.5

<sup>1</sup> The log of turnover is calculated based on turnover in million Euro, thus creating a negative minimum value as turnover values below 1 million Euro are present. This causes no problems in subsequent regression analysis.

<sup>2</sup> Based on answers to question 3 in the Questionnaire (Appendix A): "Where do you sell your products and/or services?". The percentages are calculated by translating 0-20% EMU into 10%, 21%-40% EMU into 30% and so forth. One firm did not answer this particular question. The "Sales in Euro-area" for this firm is estimated from its annual accounts.

<sup>3</sup> One firm was restricted to -100 percent. The actual figures for this particular start-up firm are a turnover of GBP 0.1 million and a profit/loss before tax of GBP -2,2 million (due primarily to administrative expenses of GBP 2.5 million).

<sup>4</sup> This particular firm had a negative solvency ratio in 2004 and in 2005 but a positive solvency ratio in 2006 after a capital infusion.

**Table 5 Correlation coefficients of independent variables**

This table provides correlation coefficients for independent variables used in the binary probit regression analysis and the ordered probit regression analysis. The variables are: size measured as the logarithm of consolidated operating income or turnover, sales in Euro-area as percent of total sales, number of foreign subsidiaries (square root), profit margin as measured by profit/loss before tax divided by turnover, solvency ratio as measured by equity divided by total assets, Tobin's Q as measured by the sum of total debt plus the market value of equity divided by the sum of total debt plus the book value of equity, and a Euro firm dummy (firm based in a EU15 Euro country =1).

	Turnover (log)	Sales in Euro-area	Foreign subs.(sq. root)
Turnover (log)	1.00		
Sales in Euro-area	0.04	1.00	
Foreign subs. (sq.rt.)	0.76	-0.13	1.00
Profit margin	0.48	0.03	0.24
Solvency ratio	-0.47	-0.25	-0.27
Tobin's Q	-0.39	-0.16	-0.20
Euro firm	0.24	0.35	0.09
	Profit margin	Solvency ratio	Tobin's Q
Turnover (log)			
Sales in Euro-area			
Foreign subs. (sq.rt.)			
Profit margin	1.00		
Solvency ratio	-0.13	1.00	
Tobin's Q	-0.16	0.04	1.00
Euro firm	0.10	-0.30	-0.26

**Table 6 Regression analysis without Euro membership distinction**

This table reports binary (columns 2-5) and ordered (column 6) probit estimates of the relationship between the exercise of real options and firm characteristics based on the responses of 73 firms (Table 1). P-values are listed in parentheses below the coefficients. The dependent variable in the binary regression is the exercise of real options as measured by 1 ("Yes") and 0 ("No") as described in Table 2. The dependent variable in the ordered regression is the exercise of real options as measured by the sum of the answers for the four questions (columns 2-5) with 0: four "No"; 1: three "No" and one "Yes"; 2: two "No" and two "Yes"; 3: three "No" and one "Yes"; and 4: four "Yes" as described in Table 3. The independent variables are: a constant, size measured as the logarithm of consolidated operating income or turnover, sales in Euro-area as percent of total sales, number of foreign subsidiaries (square root), profit margin as measured by profit/loss before tax divided by turnover, solvency ratio as measured by equity divided by total assets, Tobin's Q as measured by the sum of total debt plus the market value of equity divided by the sum of total debt plus the book value of equity, and Mill's lambda. Significance levels are indicated as follows: \*\*\* (1 percent), \*\* (5 percent), and \* (10 percent).

	Alliances <sup>1</sup> (Binary)	New customers <sup>2</sup> (Binary)	New suppliers <sup>3</sup> (Binary)	General expansion <sup>4</sup> (Binary)	Combined <sup>5</sup> (Ordered)
Constant	0.60 (0.735)	0.25 (0.884)	1.61 (0.267)	0.58 (0.663)	
Turnover (log)	-0.85 (0.155)	-1.08 ** (0.048)	-0.74 (0.112)	-0.71 (0.107)	-0.92 ** (0.015)
Sales in Euro-area	0.49 (0.585)	1.64 * (0.068)	0.14 (0.841)	0.22 (0.749)	0.53 (0.355)
Foreign subsidiaries (square root)	0.17 (0.182)	0.08 (0.522)	-0.05 (0.724)	0.15 (0.152)	0.13 (0.147)
Profit margin	8.43 * (0.051)	8.76 ** (0.032)	2.72 (0.113)	2.26 (0.351)	4.04 * (0.071)
Solvency ratio	-4.35 ** (0.047)	-2.69 (0.129)	-0.75 (0.558)	-2.53 * (0.062)	-2.61 ** (0.018)
Tobin's Q	-0.07 (0.693)	-0.18 (0.393)	-0.75 ** (0.047)	0.07 (0.679)	-0.19 (0.150)
Lambda	2.91 (0.134)	4.39 ** (0.016)	3.39 ** (0.036)	2.63 * (0.076)	3.28 ** (0.011)
N	73	73	73	73	73
N=0	65	60	57	56	45
N=1	8	13	16	17	14
N=2					4
N=3					8
N=4					2
Prob > chi2	0.2835	0.0090 ***	0.0207 **	0.1222	0.0099 ***
Pseudo R2	0.1702	0.2740	0.2152	0.1438	0.1136

<sup>1</sup> A binary variable based on Question 5: "Did the introduction of the Euro enable to you establish a formal and/or informal alliances or partnerships with other companies (to access bigger markets, to share resources or information)?" Answers are 0:"No" and 1:"Yes".

<sup>2</sup> A binary variable based on Question 9: "Do you consider that the Euro has enabled you to enter new markets or market segments?" Answers are 0:"No" and 1:"Yes".

<sup>3</sup> A binary variable based on Question 23: "Did the introduction of the Euro enable you to consider new suppliers?" Answers are 0:"No" and 1:"Yes".

<sup>4</sup> A binary variable based on Question 29: "Has the Euro created new opportunities for your company to expand in the Euro-Zone?" Answers are 0:"No" and 1:"Yes".

<sup>5</sup> An ordered variable based on Question 5, Question 9, Question 23, and Question 29. Answers are 0: four “No”; 1: three “No” and one “Yes”; 2: two “No” and two “Yes”; 3: three “No” and one “Yes”; and 4: four “Yes”.

**Table 7 Regression analysis with Euro membership distinction**

This table reports binary (columns 2-5) and ordered (column 6) probit estimates of the relationship between the exercise of real options and firm characteristics based on the responses of 73 firms (Table 1). P-values are listed in parentheses below the coefficients. The dependent variable in the binary regression is the exercise of real options as measured by 1 ("Yes") and 0 ("No") as described in Table 2. The dependent variable in the ordered regression is the exercise of real options as measured by the sum of the answers for the four questions (columns 2-5) with 0: four "No"; 1: three "No" and one "Yes"; 2: two "No" and two "Yes"; 3: three "No" and one "Yes"; and 4: four "Yes" as described in Table 3. The independent variables are: a constant, size measured as the logarithm of consolidated operating income or turnover, sales in Euro-area as percent of total sales, number of foreign subsidiaries (square root), profit margin as measured by profit/loss before tax divided by turnover, solvency ratio as measured by equity divided by total assets, Tobin's Q as measured by the sum of total debt plus the market value of equity divided by the sum of total debt plus the book value of equity, a Euro firm dummy (firm based in a EU15 Euro country =1), and Mill's lambda. Significance levels are indicated as follows: \*\*\* (1 percent), \*\* (5 percent), and \* (10 percent).

	Alliances <sup>1</sup> (Binary <sup>6</sup> )	New customers <sup>2</sup> (Binary <sup>6</sup> )	New suppliers <sup>3</sup> (Binary)	General expansion <sup>4</sup> (Binary)	Combined <sup>5</sup> (Ordered)
Constant	0.59 (0.742)	0.54 (0.761)	1.46 (0.322)	-0.11 (0.934)	
Turnover (log)	-0.67 (0.251)	-0.98 * (0.075)	-0.74 (0.112)	-0.62 (0.150)	-0.83 ** (0.026)
Sales in Euro-area	0.17 (0.871)	1.23 (0.233)	-0.04 (0.964)	-0.29 (0.704)	-0.04 (0.953)
Foreign subsidiaries (square root)	0.13 (0.290)	0.06 (0.652)	-0.05 (0.698)	0.13 (0.223)	0.10 (0.258)
Profit margin	7.28 * (0.092)	8.80 ** (0.032)	2.64 (0.125)	1.89 (0.391)	3.72 * (0.075)
Solvency ratio	-3.49 (0.109)	-2.27 (0.196)	-0.73 (0.566)	-2.16 (0.101)	-2.28 ** (0.034)
Tobin's Q	-0.02 (0.918)	-0.11 (0.642)	-0.71 * (0.066)	0.12 (0.519)	-0.15 (0.257)
Euro firm			0.31 (0.584)	1.10 * (0.063)	1.13 ** (0.019)
Lambda	1.70 (0.418)	3.09 (0.108)	3.12 * (0.067)	1.49 (0.348)	2.27 * (0.091)
N	51	51	73	73	73
N=0	43	38	57	56	45
N=1	8	13	16	17	14
N=2					4
N=3					8
N=4					2
Prob > chi2	0.5707	0.0613 *	0.0319 **	0.0512 *	0.0019 ***
Pseudo R2	0.1295	0.2328	0.2192	0.1948	0.1513

<sup>1</sup> A binary variable based on Question 5: "Did the introduction of the Euro enable to you establish a formal and/or informal alliances or partnerships with other companies (to access bigger markets, to share resources or information)?" Answers are 0:"No" and 1:"Yes".

<sup>2</sup> A binary variable based on Question 9: "Do you consider that the Euro has enabled you to enter new markets or market segments?" Answers are 0:"No" and 1:"Yes".

<sup>3</sup> A binary variable based on Question 23: "Did the introduction of the Euro enable you to consider new suppliers?" Answers are 0:"No" and 1:"Yes".



<sup>4</sup> A binary variable based on Question 29: "Has the Euro created new opportunities for your company to expand in the Euro-Zone?". Answers are 0:"No" and 1:"Yes".

<sup>5</sup> An ordered variable based on Question 5, Question 9, Question 23, and Question 29. Answers are 0: four "No"; 1: three "No" and one "Yes"; 2: two "No" and two "Yes"; 3: three "No" and one "Yes"; and 4: four "Yes".

<sup>6</sup> The number of observations is 51 since all 22 non-Euro firms answered "No" to this question.

**Table 8** Ordered regression analysis on Euro impact

This table reports ordered probit estimates of the relationship between the exercise of real options and firm characteristics based on the responses of 73 firms (Table 1). P-values are listed in parentheses below the coefficients. The dependent variable is the exercise of real options as measured by the sum of the answers for the four questions (Question 5, 9, 23, and 29) with 0: four “No”; 1: three “No” and one “Yes”; 2: two “No” and two “Yes”; 3: three “No” and one “Yes”; and 4: four “Yes” as described in Table 3. The independent variables are: size measured as the logarithm of consolidated operating income or turnover, sales in Euro-area as percent of total sales, number of foreign subsidiaries (square root), profit margin as measured by profit/loss before tax divided by turnover, solvency ratio as measured by equity divided by total assets, Tobin’s Q as measured by the sum of total debt plus the market value of equity divided by the sum of total debt plus the book value of equity, a Euro firm dummy coded as 1 if the firm is based in a EU15 Euro country, a strong Euro firm dummy coded as 1 if the firm is based in a strong EU15 Euro country (Austria, Belgium, France, Germany, Luxembourg, Netherlands), a weak Euro firm dummy coded as 1 if the firm is based in a weak EU15 Euro country (Finland, Greece, Ireland, Italy, Portugal, and Spain), and UAI (Uncertainty Avoidance Indicator). Model 1 is the combined model from Table 7. Model 2 distinguishes between firms from strong and weak EU15 Euro countries. Model 3 includes the UAI for Euro firms. Model 4 only includes UK and Euro firms. Model 5 only includes Euro firms. Significance levels are indicated as follows: \*\*\* (1 percent), \*\* (5 percent), and \* (10 percent).

	Model 1 (Basis)	Model 2 (Strong/weak)	Model 3 (UAI)	Model 4 (Euro+UK)	Model 5 (Euro)
Turnover (log)	-0.83 ** (0.026)	-0.87 ** (0.022)	-0.95 ** (0.014)	-0.86 ** (0.023)	-0.87 ** (0.025)
Sales in Euro-area	-0.04 (0.953)	-0.10 (0.880)	-0.30 (0.659)	0.12 (0.855)	0.62 (0.399)
Foreign subsidiaries (square root)	0.10 (0.258)	0.10 (0.273)	0.12 (0.183)	0.11 (0.225)	0.13 (0.144)
Profit margin	3.72 * (0.075)	3.78 * (0.071)	4.25 ** (0.047)	4.00 * (0.067)	5.01 ** 0.038
Solvency ratio	-2.28 ** (0.034)	-2.40 ** (0.029)	-2.66 ** (0.014)	-2.21 ** (0.045)	-2.22 * (0.059)
Tobin’s Q	-0.15 (0.257)	-0.16 (0.238)	-0.17 (0.216)	-0.13 (0.332)	-0.82 (0.568)
Euro firm	1.13 ** (0.019)			1.15 * (0.055)	
Strong Euro firm		1.20 ** (0.018)			
Weak Euro firm		1.02 * (0.056)			
Euro firm * UAI			0.02 *** (0.006)		
Lambda	2.27 * (0.091)	2.57 * (0.082)	2.53 * (0.055)	2.20 (0.121)	2.32 (0.106)
N	73	73	73	66	51
N=0	45	45	45	39	25
N=1	14	14	14	13	13
N=2	4	4	4	4	3
N=3	8	8	8	8	8
N=4	2	2	2	2	2
Prob > chi2	0.0018 ***	0.0031 ***	0.0007 ***	0.0060 ***	0.1279
Pseudo R2	0.1513	0.1528	0.1651	0.1399	0.0861