Master’s Thesis
The Effect of Euro on Intra-Eurozone FDI Flows

Master’s thesis within Economics
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Abstract
Since the end of World War II, foreign direct investment (FDI) has been leading the international financial capital flows and has tripled in 2000s over the decade earlier. With its positive effect on economic growth of host countries via spill-overs, it became a race among countries to attract multinational enterprises (MNEs) to invest in their countries. The introduction of European common currency theoretically helps reduce the transaction costs across borders with the reduction of exchange-rate uncertainties and associated costs of hedging, facilitation of international cost comparison. Moreover, mergers and acquisitions activities (M&As) account for 60-80% of FDI flows, and most MNEs engage in both export and setting up affiliates abroad, suggesting complementarity between trade and FDI. Thus reducing cross-border distance costs would encourage MNEs to increase its M&A activities abroad, resulting in more inward FDI flows in the eurozone, especially among member states. The gravity equation is used in this paper to estimate the euro effect from the dataset of inward FDI flows of 24 countries during 1993-2007 and the result confirms that common currency stimulates more intra-eurozone inward FDI flows by approximately 58%.
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1. Introduction

Entrepreneurs have been investing abroad for centuries. Nowak and Steagall (2003) clearly identify differences of the two forms of international investment, i.e. financial capital flows, sometimes called portfolio investment, and foreign direct investment (FDI) into physical assets. The former tends to “fickle to be a reliable source of sustainable economic development” (p. 59) whereas the latter is most-desired by the recipient’s country. Up until the end of World War II, most of the investments were portfolio investment with United Kingdom, France, and Germany as major contributors. Then, in the late 1950s foreign direct investment outpaced portfolio investment and US led the way through its favourable tax regulations.

The 1960s saw a decrease of FDI in some governments while US attracted more into the country. UK was still net investors due to its oil surpluses. While, for 1970s, less-developed countries (LDCs) received both portfolio and direct investments from major international corporations, many of which were from Japan (Södersten & Reed, 1994). Latin American debt crisis during 1980s was a consequence of inability of borrowing LDCs, notably Brazil, Argentina, and Mexico, to repay international creditors. During 1990 – 2000, the foreign direct investment stocks of developed and developing countries have almost tripled from the previous decade as exhibited in figure 1.

The growing of foreign direct investment creates an impact that it becomes a focus of many academic researches. The recent study by European Commission (2009) confirmed the effects of FDI on growth: positive direct effect with higher investment, production, and export; and indirect effect with spill-over on competitiveness, and intense competition within member states. But the early start of the FDI theories can be traced back to the past decades: from export vs. FDI focus in 1960s by Hymer-Kindleberger theory and product cycle theory, internationalisation in 1970s, mergers and acquisitions and international joint ventures (IJVs) in 1980s, and re-focus on cost of doing business abroad and psychic distance in 1990s (Buckley & Casson, 1998). The review of FDI theories is discussed in more details in section 2.1.

The signing of Treaty of Rome in 1957 marked the creation of European Economic Community (EEC). Since then, the European community has seen a strong development of integration and co-operation among member states that led to European Union (EU)
establishment in 1993. The introduction of euro currency in 1999 and its circulation replacing national currencies in 2002 officially marked the eurozone as the world’s second largest economy in terms of GDP. Such integration, by way of financial and trade liberalisation, creates a shift in business environment in a way that offers greater mobility of factors of production. In 2007, EU accepted two new members that make up 27 member states of today.

As European Union strengthens its importance on global economy, there are evidences by Oxelheim & Ghauri (2004) and Gugler (2004) among others that the race for inward FDI within EU becomes more intense. The magnitude is, however, more amplified in the Western than the transitional economies of Central and Eastern European counterparts, with a few exceptions of Hungary, Poland, and Czech Republic in the late 1990s (McMillan & Morita, 2003).

This paper attempts to determine whether the European currency union, the adoption of euro, has the stimulating effect, namely the euro effect, on inward FDI flows within member countries. The relationship between trade and FDI whether they complement each other or a substitute and how most FDI is done are key to predict the result. Quantitatively, this paper will utilise gravity equation in order to confirm the euro effect.

The rest of the paper is organised as follows: section 2 reviews the theoretical framework on FDI and provides summary of the previous studies of regional common currency effect on FDI. Section 3 explains the methodology to measure such effect and the data sources for empirical analysis is given in section 4. Finally, the conclusion of this paper and suggestion for further research are provided in section 5.

For clarification early on, the term eurozone or euro area is the economic and monetary union (EMU) of 16 European Union member states using the euro currency, i.e. Austria, Belgium, Cyprus, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, the Netherlands, Portugal, Slovakia, Slovenia, and Spain. The other 11 EU member states still maintaining use of national currencies are Bulgaria, Czech Republic, Denmark, Hungary, Poland, Romania, Sweden, and United Kingdom. The year of accession for each country is given in Appendix 1.
2. Theoretical framework

In this section, the foundation in theories of foreign direct investment is provided for analysis in this paper. Section 2.1 gives the definition and brief review of the evolutionary development of theories and important research studies on FDI. In section 2.2, it then narrows down to focus on the transaction costs and the trade-off associated with FDI. The complex relationship between trade and FDI is explained in section 2.3. Then, geographical economics theory of multinationals is introduced in section 2.4 in order to provide a background for measuring such effect. Lastly, section 2.5 summarises the previous studies on the effect of regional common currency and FDI.

2.1. Foreign direct investment theories

Foreign direct investment as defined by the International Monetary Fund is “the category of international investment that reflects the objective of a resident entity in one economy (direct investor) obtaining a lasting interest in an enterprise resident in another economy (direct investment enterprise)” (International Monetary Fund, 1993, p. 86). More specifically, OECD defines that the lasting interest is deemed to exist if the direct investor acquires at least 10% of the voting power of the direct investment enterprise (Organisation for Economic Co-operation and Development, 2008).

There are three forms of foreign direct investment as defined by IMF (Bertrand, 2004):

1. Greenfield investments: creation of a subsidiary from scratch by one of more non-resident investors.
2. Cross-border merger & acquisition: the combination of two or more companies belonging to the same legal entity (or not) to achieve strategic and financial objectives.
3. Extension of capacity: increase in the capital (conversely divestment) of established direct investment enterprises.

Normally there are two measuring approaches: as part of capital account of balance of payments by central bank and as sales and assets of foreign-controlled firms by economics ministries, who study the effect of FDI on labour market and spill-over (R. Baldwin & De Santis, 2008). The major sources of FDI data are World Investment Report annually published by UNCTAD, International Direct Investment database collected from OECD member countries, and Balance of Payment database from IMF member economies.

As already mentioned, FDI has been the topic of many academic researches in the last few decades, specifically after World War II in the 1950s. The researchers in the early days have focused on the following fundamental questions:

1. Why do firms go overseas as direct investors?
2. How can foreign firms compete successfully with local firms, given the inherent advantage of local firms operating in the familiar, local business environment?
3. Why do firms opt to enter foreign markets as producers rather than as exporters or licensors? (Casey, 1998)

Early foreign direct investment theories relied much on the behaviour of firms to explain the emergence of multinational enterprises (MNEs) that pushed the globalisation into the world market. Hymer (1976) and Kindleberger (1969), in particular, speculate that FDI occurs under monopolistic competition. The foreign firm has the disadvantage in higher cost
of operation resulting from foreign conditions. Such firm has to offset this with firm-specific advantages, e.g. innovative technology, scale economies, or differentiated products.

Vernon (1966) contributes to the development of FDI theories by linking international comparative advantage to foreign direct investment. His product life cycle theory begins with the technological innovation turning into the actual production in the home country. Foreign demand, which is created by demonstration effect of richer countries, is satisfied through exportation. As the foreign demand for product grows, local firms could decide to enter foreign market by continuing export, licensing, or establishing manufacturing subsidiaries in the foreign countries with lower cost of production. The product now becomes standardised and mass produced, while the new market is achieved through price reductions or product differentiation. The two conditions that MNEs will decide to pursue the direct investment approach are (1) the size of the foreign market that justifies the investment and (2) the remaining advantages that offset the risk of doing business abroad.

In the internalisation theory, Rugman (1981) examines the alternative mode to licensing and provided motivation for foreign direct investment apart from merely imperfect market condition. MNEs in this theory are faced with each mode of entry - the export marketing costs, knowledge dissipation costs associated with licensing, and foreign operational cost for FDI, respectively. These special costs vary differentially with time and cause switches of mode. Williamson (1973) uses transaction cost economics and opportunism behaviour of trade partners to explain the internalisation of firm. Regardless of Rugman’s extreme concept of MNEs as a monopolist due to firm specific advantage in knowledge, the theory still offers the explanation that firm’s overseas expansion permits it to turn information into a valuable property specific to the firm and is the source of its differentiation. This argument carries on to the conclusion by Magee (1981), in her appropriability theory, that younger, more innovative firms generate information at a faster pace and thus tend to become direct investors, while more mature ones opt for licensing instead.

Södersten & Reed (1994) add trade barriers, e.g. tariffs and import quotas, as a policy design to also explain FDI. The import restrictions that the government imposes on foreign products have several effects that may encourage FDI. The higher product price in the protected market increases the profits of firms producing locally. Foreign firms thus have incentive to establish their subsidiaries. Moreover, to maintain market share, firms may attempt defensive investment in countries with import barriers. This happened to be the case of Ford and General Motors global expansion and many Japanese car manufacturers entering US and UK markets. However, there are cases that import restrictions have a negative effect on FDI. See Corden (1997) for a comprehensive discussion.

Eclectic theory, developed by Dunning (1977), integrates three factors to explain why MNEs decide to be direct investors. These are (1) Ownership advantages that existing or potential rivals do not possess, (2) Locational considerations to which it would be more profitable to utilise these assets abroad, and (3) Internationalisation gains in the firm’s own production. The alternate and more common name OLI paradigm hence is derived from these three factors. The ownership advantages may result from having patents, control over raw materials, superior technology or management skills that offsets disadvantages from operating in a foreign environment. Attractive location for production, in terms of material or labour cost, gives explanation to why firms invest abroad rather than export or license. The internationalisation gains determine the decision whether the firm carries out the production within the firm or externally. The independent and joint influences of determinant factors, i.e. ownership, location, and internalisation, on choice of entry mode is extensively studied by Agarwal & Ramaswami (1992) using US service industry data. Some of the main findings are that the ability to establish foreign presence is constrained by their size and
multinational experience, and preference towards export, joint venture, or sole venture is associated with the extent of contractual risks.

As more FDI data becomes readily available, the observation of actual FDI flows prompted the development, further from the more descriptive OLI paradigm, of the New Trade Theory during 1980s and 1990s. The general-equilibrium framework provides an explanation of the pattern of multinational activity related to country characteristics, which once perplexes the economists, and incorporates the real-world market condition of numerous firms in the industry (Markusen, 2002). The theory also distinguishes the horizontal versus vertical FDI as a result of proximity-concentration trade-off. Horizontal FDI is where firms locate multi-plants of similar activities in many countries and vertical FDI is where firms distribute various stages of production among countries. Various models, oligopoly and monopolistic in particular, are presented by Helpman (1984) on horizontal FDI, and Markusen (2002) on vertical FDI to provide better understanding of multinational activities and location choices.

Moving further from the process of becoming foreign investors (the 'why' and 'where'), from 1980s onwards, FDI theories become more focused on management strategies (the 'how'). Porter (1986) characterises industries as ranging from multidomestic, in which a competition in one country is independent of others, to globally, in which “a firm's competitive position in one country is significantly influenced by its position in other countries” (p. 12). The multinational firm's strategies in Porter's view are based on the extent of value-adding, coordination, and configuration of activities. The simplified version of the firm's international strategy, using the strategic management terminology of describing MNEs, is illustrated in figure 2.

![Figure 2: Types of international strategies](image)

Bartlett, Ghoshal, & Beamish (2008) categorise four stages MNEs undertake in extensive details. Starting from International, managers think that overseas operations are only to support domestic parent company so as to contribute to incremental sales. At Multinational stage, the growing exposure and importance of foreign sales prove to be opportunities of “more than marginal significance” (p. 11) and thus they adopt more flexible approach to respond to the market requirements with more autonomous authorities in marketing, man-
agement and other activities. Global stage is where the firm realises the inefficiencies of manufacturing infrastructure resulting from multinational stage. Scale economies are the main goal at this stage with only a few highly efficient plants. More complex requirements on investment, technology transfer, local contents from the governments and price expectation from customers have pressured the MNEs to balance both efficiencies of global scale and market responsiveness of multinational strategy simultaneously, hence the Transnational stage.

Retrospectively, the theories on FDI can be classified into three groups: industrial organisation (Hymer, Kindleberger, Vernon), internalisation process (Buckley and Casson, Rugman), and international strategic management (Porter, Bartlett et al.). The industrial organisation school explains the reasons that firms undertake FDI to achieve monopolistic power obtained from firm-specific advantages in innovative technological processes and management skills. The internalisation theory focuses on transaction costs that would incur from relying on trade partners through exporting or licensing. Firms would decide the internalisation approach through FDI when such costs are sufficiently high. Lastly, once firms decide to invest abroad, the managers balance the value-adding, coordination, and configuration aspects as well as the geographical concentration in order to stay competitive against local and other multinational rivals.

2.2. Transaction Costs

Schiavo (2007) uses a simple model under option value approach to suggest that eliminating exchange rate volatility results in nonnegative impulse to cross-border investment. This and the empirical result support the pro-FDI euro effect in which the common currency decreases the costs incurred by the exchange-rate uncertainty that direct investors encounter while conducting business in foreign markets. The conclusion by EC Commission that “there is evidence that foreign direct investment responds positively to exchange rate stability” (Commission of the European Communities, 1990, p. 21) also confirms this.

The concept of transaction costs, as discussed by Coase (1937) and defined by Cheung (1992), is all costs that are not conceivable in the so called Robinson-Crusoe economy or that arise due to the existence of the institutions. Williamson (1979) describes in details the three dimensions of transactions, i.e. uncertainty, frequency of transactions, and the degree that the investment is transaction-specific and its implications on various types of transactions. But it is De Sousa and Lochard (2004) who provide an excellent explanation of the relationship between EMU and transaction costs as following:

EMU reduces transaction costs. Among others: (i) it reduces currency conversion costs; (ii) it suppresses in-house costs of maintaining separate foreign currency expertise; (iii) it eases price decisions and comparison of international costs; (iv) it removes intra-euroland exchange rate volatility and thus increases the certainty-equivalence value of expected profits of risk averse firms and avoids the need of costly hedging techniques. (p. 2)

European Commission (1990) provides a detail of such currency conversion costs as consisting of two parts:

1. Financial costs of the bid-ask spreads and commission fees incurred to banks for currency conversion.

2. In-house costs of managing intra-EU transactions in the accounting department of MNEs.

An estimate of the net saving from having one common currency, is €13-19bn (at 1990 price), as reproduced in table 1.
Table 1: Cost savings on intra-EU settlements by single EU currency

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<th>Financial transaction costs:</th>
<th>Estimated range (€ bn, 1990)</th>
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<tr>
<td>Bank transfers</td>
<td>6.4</td>
</tr>
<tr>
<td>Banknotes, eurocheques, traveller's cheques, credit cards</td>
<td>1.8</td>
</tr>
<tr>
<td>In-house costs</td>
<td>3.6</td>
</tr>
<tr>
<td>Reduction of cross-border payments cost</td>
<td>1.3</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>13.1</strong></td>
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Source: European Commission (1990)

Moreover, Byrne & Davis (2005) discover negative long-run effect of both nominal and real exchange-rate volatility on investment in the G7 and conclude that EMU has the implication to favour investment as it will reduce such volatility. However, Darby et al. (1999) demonstrate the case that the rising exchange-rate volatility can also raise the investment and used the data in five major countries as case study. They conclude the extent of the volatility to be smaller than cost of capital and expected earnings effects but larger than exchange-rate misalignment. Moreover, EMU will not be in big favour for Italy and UK, especially in high-tech industry, large infrastructure, and big market development projects.

In general, the reduction of transaction costs may promote intra-eurozone FDI as MNEs increase investments within the zone and encourage firms to expand across border within the zone as barrier is lowered.

However, when considering the existence of both vertical and horizontal MNEs (see section 2.4) and the relationship of FDI and trade (see section 2.3), there appear to be a trade-off associated with FDI and the reduction of transaction costs, in which Bénassy-Quéré et al. (2001) focused on the real exchange rate level and volatility and the relationship between FDI and trade.

FDI and trade are substitutes in case firms mainly intend to serve local market. An appreciation of local currency increases the purchasing power of local consumers and foreign firms can expect more profits in setting up subsidiaries in the market. This will thus leads to higher inward FDI. While host country real exchange rate depreciation leads to a reduction of cost of capital, which in turn leads to an increase in outward FDI. On the other hand, in case of re-export, FDI and trade, are complementary and an appreciation of local currency increases labour costs and lowers inward FDI flows (Bénassy-Quéré, et al., 2001).

For high exchange rate volatility, greenfield or horizontal FDI intending to serve foreign markets, is a substitute to exports (Cushman, 1988). Lowering such volatility favours vertical FDI and thus FDI becomes complementary to trade. Also, if the production is for re-export, FDI then complements exports.

In order to determine the effect of common currency, transaction costs offer part of the answer because the relationship between trade and FDI does complicate the matter. The next section explains this relationship in detail. Once it becomes clear, understanding how FDI is mostly done in the real world will thus guide what to expect of the euro effect.
2.3. Relationship between Trade and FDI

Trade and FDI have a complex relationship, one that many researchers still have a debate whether they are complementary or substitute.

At a glance, FDI allows firms to lower transaction costs and create efficiency spillover effect on both home and host countries. The spillover effect then translates into more production at home and suggest a complementarity between FDI and trade. Fontagné (1999), however, looks at this relationship in a more dynamic way and combines results from micro-, industry-, and macro-level perspectives. At firm-level, the relationship depends on the conditions of investment and countries, while at macroeconomic and sectoral levels, the evidences suggest a complementarity, especially in short term. In the longer term, e.g. advanced internationalisation stage, the substitution effect seems evident.

Oberhofer & Pfaffermayr (2008) offer a clearer answer at firm-level by studying the strategy of European MNEs using AMADEUS database and conclude that most MNEs choose to set subsidiaries abroad when the distance is considerable together with exporting to nearby markets. The main determinant for this complementary strategic action is productivity.

Substitution effect can be found in vertically integrated firms, as identified in Blonigen (2001) when studied the product-level data of Japanese auto parts to US market. However, this substitution can often be found in a one-time instead of gradual shift and many firms do choose both modes instead of complete substitution.

Flam and Nordström (2007) summarise that the reduction of transaction costs from having common currency is ambiguous. Vertical FDI, or a fragmentation of production process, is complementary to trade. But vertical FDI makes up for only a small share of FDI. While horizontal FDI in general results in more trade and less FDI. The exception that horizontal FDI is complementary to trade is export-platform horizontal FDI, which requires an import of intermediate goods. Lastly, a common currency has an ambiguous effect on M&As but as shown later in section 2.4, the evidence points to complementarity.

2.4. Trade theory and geographical economics

Many early discussions and theories have been mostly descriptive in explaining the reasons behind foreign direct investment decisions. However, in reality, the way FDI is done has proved to be beneficial as modern theories nowadays, i.e. new trade theory among others, attempt to incorporate the observations from the real world into the models.

Modern trade theory explains the reason why firm goes multinational to serve foreign market profitably (horizontal MNEs) and to obtain lower-cost inputs (vertical MNEs). Helpman and Krugman (1985) develop the general-equilibrium model of MNEs out of industrial organisation (incentive to integrate two economic activities in a firm) and trade theory (incentive to expand economic activities geographically).

In this model, MNEs exist in the face of differentials in factor endowments between countries so price equalisation does not occur. Firms therefore have incentives to go abroad. Furthermore, there are two sectors, food and manufactures. Food is produced using capital and labour, while manufactures require capital, labour, and headquarters services. Therefore, the capital-intensive headquarters services will be located in capital-rich country, which becomes a net exporter of such capital-intensive services and a net importer of labour-intensive products. However, the model assumes no transport cost nor trade barriers, which contradicts with the reality. Also, the model implies that there will be no FDI.
between countries with similar factor endowments, whereas it happens to be so in the real world.

Geographical economic model also explains the existence of MNEs. Brakman et al. (2001) adapt a model by Ekholm and Forslid (1997), which is a variation of the core model by Dixit and Stiglitz (1977). They introduce more sophisticated firm behaviour with more stages in decision process and more strategic considerations.

Horizontally integrated multinationals symmetrically divide production over the two countries at no extra costs and prices in both countries are the same. Headquarters services are produced in the country with lowest wage. Complete agglomeration, that is clustering of economic activities at either country 1 or 2, is unlikely. Multinational production makes countries become more similar.

In vertically integrated multinationals, firm has to choose where to locate the headquarters and production plant. With transport costs, both headquarters and production will locate in the larger country whose wages are relatively lower. Also, there will be a tendency of complete agglomeration.

The implication of this is that, with MNEs present, agglomeration or clustering pattern is less likely to happen and all countries become more specialised in production of the same product, making them more similar. Also, as most FDI takes place between similar countries, MNEs thus will drive more FDI.

2.5. Regional common currency and FDI

The previous studies on the effect of euro on FDI have a mixed result at best (Coeurdacier, De Santis, & Aviat, 2009; De Sousa & Lochard, 2006; Rose, 2000; Russ, 2007; Schiavo, 2007; Taylor, 2008). This can be attributed to the lack of available data and well-developed methodology to measure FDI effect as discussed by Baldwin & De Santis (2008).

The studies of EU Single Market Programme (SMP) by European Commission (1997) assess the impact of the programme on trade and FDI. Even before the introduction of euro currency, this in-depth economic study already provides a useful guideline for other studies of similar theme. The OLI paradigm mentioned earlier lays a foundation for the study’s forecast. Moreover, Markusen (1995) specifies that for ownership advantages knowledge-based assets, e.g. human capital or patents, are more important than physical capital assets for FDI decision for two reasons: more locational transferability at low cost and low-cost additional supply similar to the characteristics of a public good. Therefore, the implication is that the single market will lead to the results of sectors characterised with knowledge-based assets having more FDI relative to trade, while capital-intensive sectors like manufacturing will have more trade relative to FDI.

Looking at total world foreign direct investment in the last two decades, the large portion is in the form of M&As, even though the methodology of collecting M&A data has still been inconsistent across countries as expressed in a paper prepared by Statistics Canada (2004). During 1987-2006, M&A transactions account for an average of 61.5% with a peak of 82.8% in 2000 as shown in figure 3.

Neary (2007) proposes that trade liberalisation can favour a competitive environment that low-cost firms have incentive to acquire or merge with high-cost firms. Following this, a monetary union like of EMU, which reduces trade costs and eliminates exchange-rate uncertainty, probably encourages merger and acquisition transactions. Coeurdacier et al. (2009) add further that a monetary union boosts financial integration and makes cross-border capital investment less risky through reduction of the cost of capital and exchange-
rate risk, stabilising inflation. Moreover, their analysis on European integration leads to the conclusion that institutional changes, in this case EU single market and EMU, “acted as trigger factors of capital reallocation of manufacturing across the globe” and that “the impact of the euro is very strong for M&As within the same sector (horizontal) in manufacturing” (p. 88).

Source: UNCTAD FDI Statistics

Figure 3: Comparison of worldwide FDI and M&A transactions

In estimating the impact of various determinants of cross-border M&As, Coeurdacier et al. (2009) choose gravity FDI model, similar to gravity trade model\(^1\), pioneered by Tinbergen (1962), as a framework with the following expression:

\[ M \& A_{i,j,s,t} = e^{\alpha_i + \alpha_j + \alpha_s (GDP_{i,j,s,t}^s GDP_{i,j,s,t}^t)} Z_{i,j,s,t}^\theta \eta_{i,j,s,t} \]

where \( M \& A_{i,j,s,t} \) is M&As between source country \( i \) and host country \( j \) in sector \( s \) at time \( t \); \( GDP_{i,j,s,t} \) is market size of sector \( s \) in country \( i \); \( Z_{i,j,s,t} \) is control variables that might affect M&As; and \( \alpha_i, \alpha_j, \alpha_s, \alpha_t \) are the source and host country fixed effects, a sectoral-fixed effect, and a time-fixed effect, respectively. The findings of EMU impact on cross-border M&As are that the euro increased cross-border M&As among the euro area of the manufacturing sector by about 200 percent. But the effect on service sector is zero, which may be interpreted as that the sector has not exploited the opportunities of the euro.

Although many studies have found significant effect of EMU on trade (Micco, Stein, Ordonez, Midelfart, & Viaene, 2003; Rose, 2000; Rose & Stanley, 2005), the reason behind the increase in trade has not been extensively investigated. For this, De Sousa and Lochard (2004) used a gravity model to link the effect of a currency union on trade through FDI channel and found that “half of EMU effect on trade is indirect, coming from an increase in FDI” since, from the study, both appear to be complementary. Linking this with section 2.3, the EMU induces more inward FDI, which then generates more trade.

In summary, the theories and empirical evidences from previous studies point toward a conclusion that the euro common currency is associated with a precipitation in inward FDI flows among EMU members at varying degree depending on the set of methodologies and

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\(^1\) The simple specification of the gravity equation for any given time period is provided by McCullum (1995):

\[ \ln x_{i,j} = \alpha + \beta_1 \ln y_i + \beta_2 \ln y_j + \beta_3 \ln \text{dist}_{i,j} + \beta_4 \text{D}_{i,j} + \eta_{i,j} \]

where \( x_{i,j} \) is the shipments of goods from region \( i \) to region \( j \); \( y_i \) and \( y_j \) are gross domestic product, \( \text{dist}_{i,j} \) is the distance from \( i \) to \( j \), \( \text{D}_{i,j} \) is a dummy equal to 1 for interprovincial trade and 0 for province-to-state trade, and \( \eta_{i,j} \) is an error term.
data collection. The bottom line is that such effect is small in recent studies, ranging from a mere +15% to a staggering +200% in early papers according to Baldwin and De Santis (2008). This paper also confirms the positive effect on FDI inflows as will be presented in later sections.
3. Methodology and Data

The gravity model is often used and theoretically justified in several empirical studies to explain bilateral FDI (Anderson & van Wincoop, 2003; Bergstrand & Egger, 2007; Head & Ries, 2007). In this paper, the gravity model (see Appendix 2 for formal derivation) is also used to test the euro effect on inward FDI. The model is specified in log-linearised form as

\[
\ln FDI_{ijt} = \alpha_i + \beta_0 \ln GDP_i + \beta_1 \ln GDP_j + \beta_2 \ln Dist_{ij} + \gamma CL_{ij} + \eta CB_{ij} + \theta EMU_{ijt} + Yr_t + \epsilon_{ijt}
\]

The independent variables are GDP of FDI receiving countries, specified as \(i\), and of partner countries, \(j\), the distance of each country pair, dummies for common language \((CL_{ij})\), contiguous border \((CB_{ij})\), common currency dummy \((EMU_{ijt})\) with the following condition: 1 if the country pair is both EMU members, and 0 otherwise, and a set of year dummies \(Yr_t\) to absorb the heterogeneity generated by the annual macroeconomic shocks during the span of this study. The implication of this equation is that the amount of FDI flow to a particular country is affected by the country’s sizes, measured by GDP of the country pair, the transaction cost proxied by their distances, and the role of common language and contiguous border between country pairs. These variables have been common in previous trade and FDI studies. To test the hypothesis regarding the euro effect, the variable signifying the country’s association with EMU is added to the model.

For the analysis, the approach is to examine a panel data of bilateral FDI flows from 1993-2007. The dataset is composed from a pool of the available data comprising of FDI inflows from OECD International Direct Investment Statistics, real GDP data from IMF World Economic Outlook database, and CEPII data on distance, common language, and contiguous borders. As it turns out there are more observations on the receiving country’s side, the dataset in use here is based on the receiving countries. See table 2 for source and definitions of the variables used in the estimation.

For the inflow FDI data, the reporting countries used for observations are the main 12 EMU countries of 2007 – Austria, Belgium, Germany, Spain, Finland, France, Greece, Ireland, Italy, Luxembourg, the Netherlands, and Portugal; and another 12 OECD countries – Australia, Switzerland, Czech Republic, Denmark, Hungary, Japan, Norway, Poland, Sweden, Slovakia, United Kingdom, and United States. Although, Belgium and Luxembourg is treated as single country throughout this analysis due to their joint reporting practice up to 2002.

The 33 partner countries include 24 reporting countries and additional 9 countries – Bulgaria, Canada, Cyprus, Estonia, Lithuania, Latvia, Malta, Romania, and Slovenia. The resulting dataset thus comprises of 736 country pairs and 11,040 observations².

One interesting point in the dataset is that FDI inflow data includes both zero and negative values. According to Frankel et al. (1997), zero-value flow can result from the two possibilities, being (1) the country pair has no FDI flow between them in a given period due to their small size and remoteness or (2) the value is too minute and subject to rounding since the unit is in million dollars. Because determining which possibility is it for a specific observation proves to be too difficult, if not impossible, the bias from this would inevitably occur while interpreting the result. Meanwhile, the negative values are simply a divestment, for example a multinational selling assets out to locals or to other multinationals.

² The total number of country pairs is equal to 12 EMU countries + 12 OECD countries – 1 (Belgium and Luxembourg counted as one) x 33 – 1 (Belgium-Luxembourg) = (12 + 12 – 1) x (33 – 1) = 736. The number of observations is equal to 736 x duration of study (1993-2007) = 736 x 15 = 11,040.
tence of both zero and negative values poses a problem when dealing with log-linearised form of gravity equation as real number logarithms can only take positive real numbers. Although there have been proposed remedies for zero-value trade data, including drop-off, ad hoc small-value addition, semi-log formulation, nonlinear multiplicative estimation (Frankel, et al., 1997), Poisson pseudo-maximum likelihood estimation (Silva & Tenreyro, 2005), and Heckman sample selection model (Linders & De Groot, 2006; Shepherd, 2009), the presence of negative values in FDI data has not been mentioned as extensively.

Table 2: Definition and source of the main variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\ln F{DI}_{ij}$</td>
<td>Natural log value of inward FDI flows into receiving country $i$ from country $j$ at current US dollar, deflated based on country $i$.</td>
<td>OECD Direct Investment by Country 2009</td>
</tr>
<tr>
<td>$\ln GDP_{it}$</td>
<td>Natural log value of Real Gross Domestic Product of FDI receiving nation at current US dollar, deflated using chain-linked CPI with national base year.</td>
<td>International Monetary Fund (IMF) World Economic Outlook Database, April 2010</td>
</tr>
<tr>
<td>$\ln GDP_{jt}$</td>
<td>Natural log value of Real Gross Domestic Product of FDI partner nation at current US dollar.</td>
<td>IMF World Economic Outlook Database, April 2010</td>
</tr>
<tr>
<td>$\ln Dist_{ij}$</td>
<td>Natural log value of the weighted distance between the capitals and large cities of the country pair as measured by geographical coordinates.</td>
<td>Centre d’Étude Prospectives et d’Informations Internationales (CEPII)</td>
</tr>
<tr>
<td>$CL_{ij}$</td>
<td>Dummy for common official language of the country pair.</td>
<td>CEPII</td>
</tr>
<tr>
<td>$CB_{ij}$</td>
<td>Dummy for contiguous border of the country pair.</td>
<td>CEPII</td>
</tr>
<tr>
<td>$EMU_{ijt}$</td>
<td>Dummy with a condition 1 if both countries $i$ and $j$ are members of EMU and 0 otherwise.</td>
<td>The euro area 1999-2009, European Central Bank</td>
</tr>
<tr>
<td>$DFDI$</td>
<td>Dummy indicating a transformation of zero- and negative-valued data.</td>
<td></td>
</tr>
<tr>
<td>$Yr_t$</td>
<td>Set of Year dummies from 1994-2007 excluding 1993 to avoid dummy trap.</td>
<td></td>
</tr>
</tbody>
</table>

In this paper, the method used to deal with zero and negative values is following Yeyati et al. (2007) transformation: $\ln F{DI}_{ij} = \text{sign}(F{DI}_{ij}) \ln(1+\left|F{DI}_{ij}\right|)$. A dummy determining the
transformed observations, $DFDI$, is then included in the estimation equation, which then becomes:

$$
\ln FDI_{ijt} = \alpha_j + \beta_1 \ln GDP_i + \beta_2 \ln GDP_t + \beta_3 \ln Dist_{ij} + \gamma CL_{ij} + \eta CB_{ij} + \theta EMU_{ijt} + \kappa DFDI + Yr_t + \epsilon_{ijt}
$$

The expected relationship is that the inward FDI flow is affected positively by the size of the receiving country, as measured by its GDP, and negatively by the transaction cost associated with distance. Moreover, countries sharing common language, contiguous border, and common currency are expected to have a positive relationship with regards to inward FDI flows. The result of this paper will be reflected in the sign and more importantly the size of $EMU_{ijt}$ coefficient ($\theta$).

The next section will provide empirical analysis of the dataset and, with the econometric tools, produce the result that quantitatively measures the euro effect.
4. Empirical analysis

4.1. Descriptive statistics

For the first look at the dataset, a simple descriptive statistics of the selected independent variables is provided in table 2 below, grouped into total, EMU, and Non-EMU countries.

Table 3: Descriptive statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group</th>
<th>Observations</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnFDI(_{ijt})</td>
<td>Total</td>
<td>7,443</td>
<td>2.4862</td>
<td>4.1806</td>
<td>-10.74</td>
<td>11.69</td>
</tr>
<tr>
<td></td>
<td>EMU</td>
<td>3,819</td>
<td>2.3422</td>
<td>4.1527</td>
<td>-10.10</td>
<td>11.69</td>
</tr>
<tr>
<td></td>
<td>Non-EMU</td>
<td>3,624</td>
<td>2.6379</td>
<td>4.2050</td>
<td>-10.74</td>
<td>11.60</td>
</tr>
<tr>
<td>lnGDP(_{it})</td>
<td>Total</td>
<td>11,040</td>
<td>12.8562</td>
<td>1.3964</td>
<td>9.91</td>
<td>16.28</td>
</tr>
<tr>
<td></td>
<td>EMU</td>
<td>5,280</td>
<td>12.9224</td>
<td>1.0595</td>
<td>11.10</td>
<td>14.94</td>
</tr>
<tr>
<td></td>
<td>Non-EMU</td>
<td>5,760</td>
<td>12.7955</td>
<td>1.6435</td>
<td>9.91</td>
<td>16.28</td>
</tr>
<tr>
<td>lnGDP(_{jt})</td>
<td>Total</td>
<td>11,040</td>
<td>12.0428</td>
<td>2.0996</td>
<td>0.00</td>
<td>16.28</td>
</tr>
<tr>
<td></td>
<td>EMU</td>
<td>5,280</td>
<td>12.0428</td>
<td>2.0996</td>
<td>0.00</td>
<td>16.28</td>
</tr>
<tr>
<td></td>
<td>Non-EMU</td>
<td>5,760</td>
<td>12.0428</td>
<td>2.0996</td>
<td>0.00</td>
<td>16.28</td>
</tr>
<tr>
<td>lnDist(_{ij})</td>
<td>Total</td>
<td>11,040</td>
<td>7.4679</td>
<td>1.1949</td>
<td>2.58</td>
<td>9.77</td>
</tr>
<tr>
<td></td>
<td>EMU</td>
<td>5,280</td>
<td>7.3021</td>
<td>1.0399</td>
<td>2.58</td>
<td>9.77</td>
</tr>
<tr>
<td></td>
<td>Non-EMU</td>
<td>5,760</td>
<td>7.6199</td>
<td>1.3028</td>
<td>3.99</td>
<td>9.77</td>
</tr>
</tbody>
</table>

The FDI inflow variable has 7,443 observations resulting in 32.5% missing values, which are typical for FDI and trade data due to small-country omission, confidentiality, or unknown entirely (Feenstra, Lipsey, & Bowen, 1997). The mean and standard deviation for FDI and GDP in Non-EMU group are slightly higher mainly due to United States. Also, because Non-EMU group includes countries outside Europe, thus results in higher mean and standard deviation in the distance variable.

The Pearson correlation matrix is provided in table 3 below in order to check the problem of multicollinearity. The result is encouraging as there appears to be no serious collinearity problem in the data. Wooldridge test for serial correlation in this panel data also shows no autocorrelation problem (p-value at 0.146)\(^3\).

\(^3\) Please refer Appendix 3 for all tests mentioned in this section.
### Table 4: Pearson correlation matrix

<table>
<thead>
<tr>
<th></th>
<th>lnGDP_{it}</th>
<th>lnGDP_{jt}</th>
<th>lnDist_{ij}</th>
<th>CL_{ij}</th>
<th>CB_{ij}</th>
<th>EMU_{ijt}</th>
<th>DFDI</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnGDP_{it}</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lnGDP_{jt}</td>
<td>0.010</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>lnDist_{ij}</td>
<td>0.280**</td>
<td>0.118**</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CL_{ij}</td>
<td>0.100**</td>
<td>0.078**</td>
<td>-0.018</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CB_{ij}</td>
<td>-0.017</td>
<td>0.075**</td>
<td>-0.371**</td>
<td>0.326**</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EMU_{ijt}</td>
<td>0.030**</td>
<td>0.141**</td>
<td>-0.175**</td>
<td>0.030**</td>
<td>0.103**</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>DFDI</td>
<td>-0.014</td>
<td>-0.061**</td>
<td>0.019*</td>
<td>-0.049**</td>
<td>-0.051**</td>
<td>-0.020*</td>
<td>1.000</td>
</tr>
</tbody>
</table>

**p < 0.01, * p < 0.05

### 4.2. Pooled OLS estimation

Next, the dataset is then regressed to estimate the coefficients in the gravity equation. The pooled Ordinary Least Square (OLS) estimation is presented in table 5. The pooled OLS regression model seems to fit the data reasonably well with the $R^2$ of 0.61 meaning that about 61% of the regressant can be explained by the independent variables. The variables are as expected, with GDP, common language, contiguous border, and EMU status having a positive and distance a negative relationship with FDI inflows. However, $CB_{ij}$ and $EMU_{ijt}$ appear insignificant in this result. Also, Breusch-Pagan test suggests that the heteroskedasticity exists as p-value rejects the null hypothesis of constant variance in the disturbances. Switching to use Huber/White robust variance estimator corrects this heteroskedasticity problem but both $CB_{ij}$ and $EMU_{ijt}$ remain insignificant.

In terms of interpreting the result, the $EMU_{ijt}$ coefficient of 0.080 implies that the country pair joining the EMU has $e^{0.08} = 1.083$ times more inward FDI flows. However, the $EMU_{ijt}$ only explain the overall effect of euro on FDI, that is, it does not account for the change in status of a country joining EMU and adopt the euro at the specific year during the span of study. As a result of using a pooled OLS regression on panel data, there appears a bias similar to the infamous study by Rose (2000), explained in depth by Baldwin (2006). Moreover, the Breusch-Pagan Lagrangian Multiplier test rejects OLS as a consistent model.

### 4.3. Two-way error component regression model

To answer the research problem that specifically addresses the significance of joining the EMU and isolates the euro effect, the two-way error component regression model is used. This way the estimation gives the comparison between the FDI flows before and after joining the EMU.

The two-way error component regression model is the individual-specific effects model with two-way error components disturbances. The general specification is given as:

$$y_{it} = \alpha + X_{it}'\beta + \varepsilon_{it}$$

$$\varepsilon_{it} = Z_{it}\mu_i + Z_{it}\lambda_t + v_{it}$$
where $i$ denotes entities, e.g. countries$^4$, $t$ denotes time. The disturbances are defined as two-way – the unobservable individual effect ($\mu_i$), e.g. common language as in this study, and unobservable time effect ($\lambda_t$), e.g. the year of joining EMU. The terms $Z_{it}$ and $Z_t$ are matrices of all the dummy variables that can have impact on the dependent variable and are included in the regression. The last term, $\nu_{it}$, is the remaining disturbances. The unobservable individual effect is time-invariant characteristics, i.e. they do not change over time, while the time effect is individual-invariant and accounts for time-specific effect that is not included in the regression (Baltagi, 2005).

There are two main models for this type of estimation: fixed-effects and random-effects models.

The main assumptions for fixed-effect estimation is that $\mu_i$ and $\lambda_t$ are to be estimated, $v_{it} \sim \text{IID}(0, \sigma^2_\nu)$, and $X_{it}$ are independent of $v_{it}$ for all $i$ and $t$. However, the distance, common language, and contiguous border variables are dropped from the estimation because fixed-effect estimation removes the effect of time-invariant unobserved characteristics, through Within transformation$^5$. The resulting estimators measure “the association between individual-specific deviations of regressors from their time-averaged values and individual-specific deviations of the dependent variable from its time-averaged value” (Cameron & Trivedi, 2005, p. 703). Moreover, the estimates of $\beta$ from within transformation are consistent in the fixed-effect model, where OLS estimators are not. The variable drop then affects the efficiency of the estimation due to loss in degree of freedom, but only slightly in this study as the result shows.

For random-effect model, the assumptions are $\mu_i \sim \text{IID}(0, \sigma^2_\mu)$, $\lambda_t \sim \text{IID}(0, \sigma^2_\lambda)$ and $v_{it} \sim \text{IID}(0, \sigma^2_\nu)$ independent of each other, $X_{it}$ is independent of $\mu_i$, $\lambda_t$, $v_{it}$ for all $i$ and $t$. Therefore, the model does not lose any degree of freedom as $\mu_i$ and $\lambda_t$ are random and dependent of $v_{it}$. The model is more suitable for large panel dataset compared to fixed-effect.

Table 5 below compares the three approaches: pooled OLS, fixed-effect, and random-effect estimation. In order to choose the more appropriate and consistent model between fixed- and random-effect model, the Hausman test is conducted (see Appendix 3). The hypothesis for Hausman test is whether the error term is correlated with the regressors. Accepting the null hypothesis that the error term is not correlated thus favours random-effect model.

As predicted, the drop of time-invariant variables does reduce the goodness-of-fit, i.e. the overall $R^2$ in this estimation decreased slightly to 0.567. Furthermore, from Hausman test, it is significant and conclusive to choose fixed-effect over random-effect model.

---

$^4$ In this paper, the study focuses on country pair, thus $i$ becomes $ij$ instead. This is similar to a study done by Glick & Rose (2002) among others.

$^5$ For full specification, see Wallace and Hussain (1969).
Table 5: Estimation results comparison

<table>
<thead>
<tr>
<th>Variables</th>
<th>Pooled OLS</th>
<th>Fixed-effect</th>
<th>Random-effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>lnGDP_{it}</td>
<td>0.301 +</td>
<td>0.127</td>
<td>0.277 +</td>
</tr>
<tr>
<td></td>
<td>(0.024)</td>
<td>(0.142)</td>
<td>(0.039)</td>
</tr>
<tr>
<td>lnGDP_{jt}</td>
<td>0.280 +</td>
<td>0.169</td>
<td>0.214 +</td>
</tr>
<tr>
<td></td>
<td>(0.019)</td>
<td>(0.147)</td>
<td>(0.032)</td>
</tr>
<tr>
<td>lnDist_{ij}</td>
<td>-0.284 +</td>
<td>0 $\Delta$</td>
<td>-0.219 +</td>
</tr>
<tr>
<td></td>
<td>(0.035)</td>
<td>0</td>
<td>(0.051)</td>
</tr>
<tr>
<td>\text{CL}_{ij}</td>
<td>0.972 +</td>
<td>0 $\Delta$</td>
<td>0.954 +</td>
</tr>
<tr>
<td></td>
<td>(0.125)</td>
<td>0</td>
<td>(0.230)</td>
</tr>
<tr>
<td>\text{CB}_{ij}</td>
<td>0.148</td>
<td>0 $\Delta$</td>
<td>0.182</td>
</tr>
<tr>
<td></td>
<td>(0.121)</td>
<td>0</td>
<td>(0.191)</td>
</tr>
<tr>
<td>EMU_{ijt}</td>
<td>0.080</td>
<td>0.457 +</td>
<td>0.225 *</td>
</tr>
<tr>
<td></td>
<td>(0.100)</td>
<td>(0.148)</td>
<td>(0.125)</td>
</tr>
<tr>
<td>DFDI</td>
<td>-6.318 +</td>
<td>-6.542 +</td>
<td>-6.396 +</td>
</tr>
<tr>
<td></td>
<td>(0.068)</td>
<td>(0.106)</td>
<td>(0.087)</td>
</tr>
<tr>
<td>Y_{it}</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>constant</td>
<td>-1.123 +</td>
<td>0.641</td>
<td>-0.383</td>
</tr>
<tr>
<td></td>
<td>(0.423)</td>
<td>(2.603)</td>
<td>(0.682)</td>
</tr>
<tr>
<td>Observations</td>
<td>7,443</td>
<td>7,443</td>
<td>7,443</td>
</tr>
<tr>
<td>R^2</td>
<td>0.611</td>
<td>0.567</td>
<td>0.566</td>
</tr>
</tbody>
</table>

+ $p < 0.01$, * $p < 0.1$

$\Delta$ The time-invariant variable is removed from Fixed-effect estimation.

Standard errors in parenthesis. For Fixed- and Random-effect models, standard errors are robust.

The interpretation of the variable of interest, $EMU_{ijt}$, from this output is that a change in the status of the country pair from not joining the eurozone to becoming member states does significantly induce $e^{0.457} - 1 = 58\%$ more FDI inflows.
5. Conclusions

The economic impact of the integration of monetary union is a topic of study that even though many years have passed since EMU inception the discussion still goes on with no definite conclusion. Among them, the effect of common currency on trade and FDI varies in the results, however the trend is moving in one direction in recent years as more data becomes readily available. In general, most of the previous studies on FDI have pointed the stimulating effect of the EMU that also supports the theories of FDI. The reduction of transaction costs from exchange-rate volatility and its associated hedging costs, facilitation of international cost comparison provides an explanation for the positive effect. In this paper, the euro effect is estimated by a gravity equation on a panel data of inward FDI flows covering a 15-year span both before and after the introduction of euro. The fixed-effect model isolating the euro effect while taken into account the different timing of the currency adoption gives the significantly positive result, approximately 58%. This means that the EMU induces 58% more intra-EMU FDI flows during the span of study.

The global financial crisis in late 2007 raises a challenge for nations to reconsider the decision to join the monetary union. It is a matter of cost-benefit analysis whether the extent of benefit of joining, including more inward FDIs and more trade, outweighs the cost of national macroeconomic stabilisation freedom. To achieve this, it is a task of the economists to assist policymakers in presenting the accurate estimation from adequate dataset. This paper hopefully will contribute to fulfil that task.

In order to provide suggestions to improve future researches, the study could address other policies aiming at stronger economic integration, e.g. Single Euro Payment Area (SEPA), TARGET2, which ultimately affect the pan-European multinationals. However, the timing of such policies are dynamic as some policies are currently in its implementation stage, an investigation thus requires a careful treatment.

Acknowledgements

I would like to thank Martin Andersson and Dimitris Soudis for helpful supervision and guidance, without whom this paper would be incomplete; professors at Department of Economics for everything; my parents Peng & Malee, sisters Thanaporn, Wanthana, and Zuwannee, especially my uncle and aunt Thongchai & Sawittri for their loving support, my friends in Thailand, Jönköping, Stockholm, Poland, Germany, Taiwan, South Korea, all of whom I have met during my study and exchange semester, you keep me going, especially Sanja Matic for keeping me motivated to work on the thesis, Saidas Rafijevas, Liwei Lui, Xiaorui Wang, Richard Johansson for fun moments; Fai, P'Jeab, P'Por, Anne, Pomme, Fon, Pu, Mui, Bell, June, N’Pim for kind friendship and all the help; last but not least colleagues at Cotto and Double A, especially P'Wang, P'Nung, Pueng, Kwang, Jack, and many more for being there and help me through the day.
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## Appendix

### Appendix 1: Year of accession

#### Table A1: Year of accession of EMU and EU member countries

<table>
<thead>
<tr>
<th>Country</th>
<th>EMU</th>
<th>EU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>1999</td>
<td>1995</td>
</tr>
<tr>
<td>Belgium</td>
<td>1999</td>
<td>1952</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>-</td>
<td>2007</td>
</tr>
<tr>
<td>Cyprus</td>
<td>2008</td>
<td>2004</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>-</td>
<td>2004</td>
</tr>
<tr>
<td>Denmark</td>
<td>-</td>
<td>1973</td>
</tr>
<tr>
<td>Estonia</td>
<td>-</td>
<td>2004</td>
</tr>
<tr>
<td>Finland</td>
<td>1999</td>
<td>1995</td>
</tr>
<tr>
<td>France</td>
<td>1999</td>
<td>1952</td>
</tr>
<tr>
<td>Germany</td>
<td>1999</td>
<td>1952</td>
</tr>
<tr>
<td>Greece</td>
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</tr>
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*Source: EUROPA*
Appendix 2: Derivation of gravity equation

Most of the derivation of the gravity equation was focused on trade (Anderson & van Wincoop, 2003; R. E. Baldwin & Taglioni, 2008). Adopting the framework to FDI, however, a proper derivation has not been around until recently with the work of Kleinert and Toubal (2005). The derivation of proximity-concentration type of gravity equation in brief is presented here along with the application to get the estimation equation.

New Trade theory lays the economic background for this gravity equation, thus assumes the market as imperfect, specifically monopolistic competition. Consumer preferences can be defined as having a love for variety and willing to pay the price plus markup, i.e. above marginal cost, as charged by producers who, in this case, differentiate their products from the others in the market.

The setting is two economy, $i$ and $j$, with two sectors, agriculture ($A$) and manufacturing ($M$). Dixit-Stiglitz utility function of a representative consumer in $j$ is defined as

Utility function: \[ U_j = C_A^\mu C_M^{1-\mu}, \quad 0 < \mu < 1. \]

The consumption function is assumed to have constant elasticity of substitution (CES),

Consumption: \[ C_{Mj} = \left[ \sum_i n_i x_{ij}^{(\sigma-1)/\sigma} \right]^{\sigma/(\sigma-1)}; \quad \sigma > 1 \]

where $n_i$ is the varieties produced in $i$, $x_{ij}$ is a consumption of one variety, $\sigma$ is the elasticity of substitution. The manufacturing sector is under monopolistic competition. Each variety is symmetric, and produced by one firm. Price index is defined as

Price index in Manufacturing: \[ P_{Mj} = \left[ \sum_i n_i p_{ij}^{1-\sigma} \right]^{1/(1-\sigma)}. \]

The demand in country $j$ for differentiated products is given as

Total Demand: \[ D_j = (1 - \mu)Y_j \]

Demand for each variety: \[ x_{ij} = p_{ij}^{-\sigma} (1 - \mu)Y_j P_j^{\sigma-1} \]

thus quantities sold is determined by price in $j$, price index in $j$, and market size.

The choice to export or produce abroad depends on profit, so in order to produce abroad the profit has to be larger than profit from export, i.e.

Condition to produce abroad: \[ \pi_i^{\text{FDI}} - \pi_i^{\text{Export}} > 0 \Leftrightarrow (1 - \rho) \left[ p_{ij}^{\text{FDI}} x_{ij}^{\text{FDI}} - p_{ij}^{\text{Export}} x_{ij}^{\text{Export}} \right] > f_j \]

where $f_j$ is fixed cost of setting up plant in $j$ and $\rho$ is producer’s markup. Considering the export, this involves an iceberg-type distance costs, defined as

Iceberg export cost: \[ p_{ij}^{\text{Export}} = p_{ij} \tau_{ij} \]

while producing abroad involves intermediate goods imported from $i$. 

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Cost of producing abroad: \[ C_j = \left( \frac{w_j}{\alpha} \right)^{\alpha} \left( \frac{q_{ij}}{1-\alpha} \right)^{1-\alpha} \] follows Cobb-Douglas function, \( w_j \) is labour wage in \( j \), \( \alpha \) is cost share of labour, \( q_{ij} \) is the price of intermediate goods, and \( 1-\alpha \) is cost share of intermediate goods. However, importing the goods also involves the distance costs, so that

Price of intermediate goods: \( q_{ij} = q_{ii} \tau_{ij} \).

Therefore, the monopolistic price set for products produced abroad becomes

Monopolistic optimal price: \( p_{ij} = \frac{c_{ij}}{\rho} = (1-\alpha)p_{ii} \tau_{ij} \).

Ultimately, the total production in \( j \) is defined as

Total value of production abroad: \( n_j p_{ij} x_{ij} = n_j p_{ii}^{1-\sigma} \left( (1-\alpha) \tau_{ij} \right)^{-\sigma} \frac{(1-\mu)Y_j}{P^{1-\sigma}} \), which also equals aggregate sales of foreign affiliates at the equilibrium.

Applying this with the derivation by Baldwin & Taglioni (2008) to determine country \( i \)'s price by first setting country \( i \)'s total production equal to the sum of all market sales, this corresponds to the condition that clears the market,

Market-clearing condition: \( Y_i = \sum n_i p_{ii}^{1-\sigma} \left[ (1-\alpha) \tau_{ij} \right]^{1-\sigma} \frac{(1-\mu)Y_j}{P^{1-\sigma}} \)

Price of country \( i \): \[ p_{ii}^{1-\sigma} = \frac{Y_i}{\sum n_i \left[ (1-\alpha) \tau_{ij} \right]^{1-\sigma} \frac{(1-\mu)Y_j}{P^{1-\sigma}}} = \frac{Y_i}{\omega_i}; \quad \omega_i = \sum n_i \left[ (1-\alpha) \tau_{ij} \right]^{1-\sigma} \frac{(1-\mu)Y_j}{P^{1-\sigma}} \]

Substituting back and the FDI is then expressed as,

\[ FDI_{ij} = n_i \left[ (1-\alpha) \tau_{ij} \right]^{1-\sigma} \frac{(1-\mu)Y_i Y_j}{P_{ij}^{1-\sigma} \omega_i} \]

Looking back to the origin of the gravity,

Newton’s gravity: \[ F_{ij} = \frac{G M_i M_j}{\text{dist}_{ij}^2} \]

the equation is then transformed in economic terms as,
FDI gravity equation:  
\[ FDI_{ij} = G_{ij} \frac{YY_j}{dist_{ij}^{\sigma-1}} \]

\[ G_{ij} = n_i (1 - \alpha)^{1-\sigma} \frac{1}{P_j^{1-\sigma} \omega_i} \]

Lastly the estimation, a log-linearised form of the above equation, becomes,

Estimation equation:
\[
\ln FDI_{ij} = \ln n_i + (1 - \sigma)\ln(1 - \alpha) + (1 - \sigma)\ln \tau_{ij} \\
+ (1 - \mu)\ln Y_i + (1 - \mu)\ln Y_j - \ln P_{ij}^{1-\sigma} - \ln \omega_i \\
\ln \tau_{ij} = \beta_1 \ln dist_{ij} + \beta_2 \ln EMU_{ij} + \beta_3 \ln Z_{ij} \\
\ln FDI_{ij} = \ln n_i + (1 - \sigma)\ln(1 - \alpha) + \beta_1 (1 - \sigma)\ln dist_{ij} \\
+ \beta_2 (1 - \sigma)\ln EMU_{ij} + \beta_3 (1 - \sigma)\ln Z_{ij} \\
+ (1 - \mu)\ln Y_i + (1 - \mu)\ln Y_j - \ln P_{ij}^{1-\sigma} - \ln \omega_i 
\]

where the distance cost, \( \tau_{ij} \), is associated with geographical distance \( \text{dist} \), common currency \( \text{EMU} \), and other factors \( Z \).
Appendix 3: Tests

1. Wooldridge test for autocorrelation in panel data
   
   H0: no first-order autocorrelation
   
   \[ F(1, 654) = 2.1118 \]
   \[ \text{Prob} > F = 0.1460 \]

2. Breusch-Pagan/Cook-Weisberg test for heteroskedasticity
   
   H0: constant variance
   
   \[ \chi^2 = 178.80 \]
   \[ \text{Prob} > \chi^2 = 0.0000 \]

3. Breusch-Pagan Lagrangian Multiplier (LM) test for random effects
   
   ln\( \text{FDI}_{ijt} \) = \( X'\beta + u_{ij} + \varepsilon_{ijt} \)
   
   Test: \( \text{Var}(u) = 0 \)
   
   \[ \chi^2 = 1,236.19 \]
   \[ \text{Prob} > \chi^2 = 0.0000 \]

4. Hausman test
   
   H0: difference in coefficients is not systematic, or
   
   \[ H = (\hat{\beta}_{1,RE} - \hat{\beta}_{1,FE})' \hat{V}(\hat{\beta}_{1,FE})^{-1} \hat{V}(\hat{\beta}_{1,RE}) (\hat{\beta}_{1,RE} - \hat{\beta}_{1,FE}) \]
   
   \[ \chi^2 = 86.91 \]
   \[ \text{Prob} > \chi^2 = 0.0000 \]