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Has the European Monetary Union Promoted the European Union High-Technology Investments in the United States?

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Abstract

This study examines whether the European Economic and Monetary Union (EMU) has promoted the European Union (EU) high-technology foreign direct investment (FDI) in the U.S. during 1993-2012. The results indicate that the higher bank credit flows have substantially boosted the FDI for the entire period. The results also indicate that the higher stock market capitalization has modestly boosted the FDI during the pre-EMU period. The results have very important implications for the U.S. policies toward the EU FDI. Given the U.S. global technological lead, the U.S. can attract more EU FDI inflows by promoting the transatlantic research collaborations.

JEL Codes: F15; F21; F36; G10; O30

Keywords*: European integration; European Union; Foreign direct investment; Financial market*

1. Introduction

The European Union (EU) countries have always considered the U.S. as a major destination for their high-technology foreign direct investment (FDI). The U.S. has maintained a global lead in advanced technology due to the well-developed research infrastructures. The U.S. universities and research institutes receive sufficient funding for conducting basic scientific research. The U.S. corporations allocate more research spending than their EU counterparts in converting scientific research into competitive commercial products. Given these major advantages, the EU countries would accelerate their technological progress by exploiting the U.S. technology through FDI. The availability of high-quality research institutes and researchers has made the U.S. as the major recipient for the EU high-tech FDI for several decades. Equally important, the formation of the Economic and Monetary Union (EMU) has facilitated the EU development of high-tech industries through the surge in external financing. The removal of the regulatory barriers and the harmonization of financial legislations have further deepened the EU stock market and bank integration since 2000. The creation of the highly liquid financial markets has substantially boosted the market-based and bank-based financing for the EU high-tech companies. This would not only help to enhance their domestic research and development (R&D) activities, but also to increase their FDI in the U.S. The objective of this study is to examine whether the EU financial market development has become the major determinant of the EU high-tech FDI in the U.S. during the period 1993-2012. Specifically, it would assess whether the deepened stock market and bank integration after the EMU formation have substantially boosted the supply of capitals for the EU FDI in the U.S. The results would provide important implications for the future U.S. policy toward the EU FDI. The U.S. can attract more EU FDI by promoting the transatlantic research collaborations. Moreover, the ongoing negotiation of the transatlantic free trade

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agreement would further boost the EU FDI due to the inclusion of more comprehensive investment liberalization provisions.

This study would contribute to the literature in two aspects. First, it would provide valuable insights into the new transatlantic FDI patterns after the deepened EU integration. A number of previous studies have largely concentrated on the EMU effect on the EU countries, overlooking the potential impact on the U.S. There has been very high level of transatlantic FDI flows for decades. The EMU formation is aimed to provide a larger pool of capitals for accelerating the EU high-tech development (Collignon, 2009). The diminishing dependence on the U.S. technology may lead to their decrease in high-tech FDI in the U.S. The results would provide useful insights into the change in the transatlantic economic relationship after the deepened EU integration. This study would contribute to the literature in the EU integration and its impact on the transatlantic economic relationship during the EMU period. Second, the results would have important implications for the potential benefits of the prospective transatlantic free trade agreement, namely the Transatlantic Trade and Investment Partnership (TTIP). The TTIP under negotiations since July 2013 will be expected to facilitate their higher trade and FDI flows. As the U.S. and the EU countries have maintained very low tariffs on each other's exports, the further reduction or elimination of regulatory barriers would further boost their trade flows. Equally important, the inclusion of more comprehensive investment liberalization provisions would promote their FDI flows. The greater access to each other's huge markets would provide more profitable business opportunities for the U.S. and the EU investors. This would provide strong incentive for them to further increase their high-tech FDI. This study investigates the change in the EU FDI flows in the U.S. due to the deepened EU integration. The U.S. can further increase the EU FDI inflows through the TTIP implementation. This study would contribute to the literature in the transatlantic free trade agreement effect on FDI liberalization.

The remainder of the paper is organized as follows. Section 2 presents the literature review on the EU FDI and financial integration. Section 3 describes the empirical methodology. Section 4 presents the results and discusses their significance. Section 5 describes their implications for the U.S. FDI policy toward FDI. Section 6 concludes.

2. Overview of the EU FDI and Financial Integration

2.1. The EU FDI in the U.S.

A number of studies have examined the main determinants of the EU high-tech FDI in the U.S. In general, the FDI can be explained by the market-seeking and technology-seeking purpose. Given the large affluent market, the U.S. has remained as the major destination for the EU FDI for decades. Its market size would allow the EU companies to achieve sales growth and recover their investment costs more quickly (Mold, 2003). Moreover, the EU companies further consolidate their market shares by establishing production affiliates in the U.S. This can better tailor their products to the local consumers. In addition to the market-seeking purpose, the EU companies primarily invest in the U.S. to gain access to its advanced technology (Cohen, 2007). Compared to the U.S. emphasis on high-technology industries, the EU companies are more specialized in the medium-technology industries. They can tap the U.S. research infrastructures to accelerate their technological progress through FDI. The U.S. universities and research institutes are equipped with better developed facilities and highly skilled researchers. Moreover, the U.S. companies allocate more funding on the R&D projects than their EU counterparts, especially converting basic science into commercial products. The EU companies can enhance their technology by concentrating their R&D projects in the U.S. Not surprisingly, many of their

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affiliates spend as much as the average U.S. firms in related activities such as computer manufacturing and communications equipment (Moran and Oldenski, 2013). In addition to mergers and acquisitions, they have also formed a number of collaborations with their U.S. counterparts to gain access to the advanced technology. The EU countries can advance their technological progress by taking advantage of the higher U.S. R&D spending (McGuire and Smith, 2008). Moreover, these large-scale cooperations would allow them to expand the agglomeration effect. They would benefit from the efficiency agglomeration by locating close to the U.S. high-tech companies. This in turn would increase their production efficiency. They would also achieve the larger demonstration effect. The current EU FDI in the U.S. can bolster the confidence of new investors to invest in the U.S. (Barry et al., 2003). The transatlantic collaborations have contributed to the high EU FDI in the U.S. for several decades.

2.2. The EU Financial Market Integration

By the late 1990s, the EU countries have achieved a higher degree of stock market and bank integration. The preliminary liberalization measures had been implemented since the early 1990s to prepare for the EMU formation. During the transition period, the main restrictions on capital flows were removed among the EU countries during 1990-1993. In the subsequent period 1994-1998, the European Monetary Institute was established to strengthen the cooperation between the central banks of individual EU countries and the coordination of the EU monetary policies to ensure price stability. More importantly, they have deepened the stock market integration even prior to the euro launch (De Santis and Gerard, 2009). These major developments have facilitated the creation of the EMU through the euro launch in 1999. Finally, the Financial Services Action Plan was implemented to create a fully integrated eurozone capital and banking market after the elimination of all the regulatory and market barriers (Dierick, 2005). The euro launch has further deepened the EU financial market integration, especially the money, corporate bond, government bond, credit, and equity markets. This has primarily financed the corporate restructuring activities through mergers and acquisitions after the euro introduction. This would be highly favorable to the EU high-tech companies as the larger amount of equity capitals becomes available for their FDI.

The banking sectors remain to be the major source of financing for the EU countries. Despite the deepened stock market integration, the larger banks still provide the majority of corporate financing in the major EU countries such as Germany and France. The EMU formation through the euro launch has also deepened the bank integration since the late 1990s. It has further accelerated the harmonization of the remaining EU financial legislations and regulations. This has led to the surge in the cross-border bank lending such as the inter-bank loans. Nonetheless, certain segments of the banking sectors have remained very fragmented. The retail banking sector is still less integrated than the wholesale banking sector because the former emphasizes more customer trust upon banks (Frangakis, 2009). The EU customers can develop long-term business relationship with their local retail banks. This has limited foreign bank ability to compete in the local retail banking sectors. Moreover, the euro launch has promoted the bank mergers and acquisitions among the eurozone countries since the mid-1990s. Specifically, the domestic mergers between the larger private banks were aimed to consolidate their domestic market shares, while the cross-border mergers were made to expand their business lines such as corporate finance and asset management (Dermine, 2006). The intense competition has increased the pressure on banks to provide more competitive bank loans to consolidate their market shares. Hence, the EU high-tech companies can obtain more bank loans at lower cost to increase their FDI. To a certain degree, the deepened EU bank integration after the EMU formation has

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strengthened the dominance of the bank financing for the EU FDI in the U.S. More details on the EU financial integration are provided in Table 1.

Table 1. History of the EU Financial Integration

The Economic and Monetary Union (EMU) represents a major step in the European Union (EU) integration. It mainly involves the coordination of economic policy-making between member states; coordination of fiscal policies, notably through limits on government debt and deficit; the implementation of independent monetary policy run by the European Central Bank (ECB); and the launch of the single currency 'euro'.

On the basis of the Delors report, the Madrid European Council decided in June 1989 to launch the first stage of EMU: full liberalisation of capital movements by July 1, 1990. The three stages of EMU are:

Stage 1: (from July 1, 1990 to December 31, 1993): in principle, all restrictions on the capital movement between the member state were abolished.

Stage 2: (from January 1, 1994 to December 31, 1998): convergence of Member States' economic policies and strengthening of cooperation between Member States' national central banks. The coordination of monetary policies was institutionalised by the establishment of the European Monetary Institute (EMI), whose task was to strengthen cooperation between the national central banks and to carry out the necessary preparations for the introduction of the single currency. The national central banks were to become independent during this stage.

European Central Bank (ECB) was established in June 1998. Monetary policy for the euro area is managed through the ECB and the national central banks of the euro-area member states, which together make up the Eurosystem. Decisions on monetary policy in the euro area can only be taken by the Governing Council of the ECB, which comprises the governors of the national central banks of the euro-area member states and the members of the ECB's Executive Board.

The Treaty on European Union (the Maastricht Treaty) lays down the ECB's mission which is to ensure price stability within the euro area. The ECB aims to keep price inflation in the euro area below but close to 2% over the medium term. This 2% inflation target is considered optimal for promoting growth and employment.

Stage 3: (underway since January 1, 1999): the gradual introduction of the euro as the single currency of the member states and the implementation of a common monetary policy under the aegis of the ECB starting January 1, 1999. The euro banknotes would be put into circulation on January 1, 2002. By January 2015, these countries include Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Portugal, Slovakia, Slovenia, and Spain. They joined the euro area and their central bank automatically became part of the Eurosystem.

Source: ec.europa.eu/economy_finance/euro/emu/

3. Econometric Specification

3.1. Estimation Model

This study would assess the EU financial integration impact on the EU high-tech FDI in the U.S. during the period 1993-2012. It would determine whether the higher financial market development after the EMU formation becomes the major determinant of the EU FDI decisions. The econometric specification is based on the standard gravity equation which explains the bilateral trade flows. The equation can be applied to predict the FDI flows as the FDI and trade flows share some common features. Trading countries with similar income levels tend to experience higher bilateral flows (Brenton et al., 1999). This explains the persistent high level of intra-EU trade flows. More importantly, those with higher bilateral trade flows tend to have higher bilateral FDI flows (Guerin, 2006). A number of recent studies have modified the gravity equation to predict the FDI flows (Brouwer et al., 2008; Egger, 2004; Portes and Rey, 2005). Some of them have included various financial market variables to estimate these flows (Giovanni, 2005). Given the huge transatlantic trade flows, the gravity equation can be used to estimate the EU FDI flows in the U.S. This study would include the financial market

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development and macroeconomic variables as the potential EU FDI determinants. In contrast to previous studies, the equation considers the source country rather than host country variables as the major EU FDI determinants. The host country factors merely focus on the U.S. market attractiveness as the pull factor for the EU FDI inflows, whereas the source country factors measure the wider scope of EU characteristics that can promote the EU FDI. Specifically, they can better explain the cross-country EU differences in their propensity to invest in the U.S. The modified gravity equation that includes the source country variables would provide an alternative empirical model for explaining the EU FDI flows. The source country variables refer to the EU financial market variables that can measure the stock market and bank development effect on the EU FDI flows. The EMU formation has further accelerated the stock market development by boosting their size and liquidity. The larger and more liquid stock markets provide additional financing for the EU high-tech FDI. Similarly, the EMU has facilitated the deepening of the EU bank integration. To meet the growing competition after the euro launch, the EU banks have become more integrated as they increasingly engage in merger and acquisition activities. The banking sectors provide the alternative financing for the EU FDI. Hence, the stock market and bank development variables can measure whether the higher stock market and bank development have promoted the EU FDI in the U.S. during the EMU period.

The ordinary least squares (OLS) model estimating the EU FDI is given as:

$$\begin{aligned}\log(FDI_{it}) = {} & \alpha + \beta_1 \log(StkCap_{it}) + \beta_2 \log(Turnover_{it}) + \beta_3 \log(BankCred_{it}) + \beta_4 \log(PrivCred_{it}) \\ & + \beta_5 \log(BankFDI_{it}) + \beta_6 \log(R\&DExp_{it}) + \beta_7 \log(Trade_{it}) + \beta_8 \log(BankCon_{it}) \\ & + \beta_9 \log(GDPpc_{it}) + \beta_{10} \log(ExchRate_{it}) + \beta_{11} \log(LabSec_{it}) + \beta_{12} \log(LabCost_{it}) \\ & + \alpha_i + \lambda_t + \gamma_i + \varepsilon_{it} \qquad (1)\end{aligned}$$

where FDI_{it} is the FDI stocks of the host country i in the U.S. at year t (1993-2012). The FDI refers to the high-tech and medium-tech manufacturing FDI such as chemicals, computers and electronics, electrical equipment, machinery, and transportation equipment. All variables are measured in U.S. dollars adjusted for inflation to the base year 2005. The host countries include the 13 EU countries, in which 10 of them also belong to the eurozone countries.[2] The EMU would have strong impact on the eurozone rather than EU financial markets as the former markets have adopted the euro currency since 1999. However, it may also have substantial effect on the EU financial markets because of their strong economic ties with their eurozone counterparts, especially the United Kingdom. Hence, the analysis would yield more meaningful results by including both the eurozone and EU countries in the sample. A total of twelve independent variables are included as the potential determinants of the EU FDI in the U.S. Before describing them in details, Table 2 reports their summary statistics.

The variables of interest are the EU stock market and bank development variables. The two stock market variables (*Turnover* and *StkCap*) measure the stock market turnover and

[2] The EU countries include Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, the Netherlands, Spain, Sweden, and the United Kingdom. All of them except Denmark, Sweden, and the United Kingdom are also the eurozone countries. The rest of the 14 EU countries are excluded due to the data availability problems.

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capitalization. The stock traded turnover ratio variable (*Turnover*) equals the value of stocks traded divided by the total value of stocks listed on domestic market. It reflects the trading volume of the stock market relative to its size. It is considered as a more objective indicator for stock market liquidity regardless of the size of the economy as it measures the volume of stocks being traded relative to the stock market size. A small but liquid stock market would still have a high value of *Turnover*, whereas a large but inactive stock market would have a low value of *Turnover* (Levine and Zervos, 1998). *Turnover* is also adjusted for the pure price increase effect as both the numerator and denominator have the price components (Beck and Levine, 2004). Another stock market variable is the stock market capitalization variable (*StkCap*) that equals the total value of stocks listed on domestic market divided by GDP. It measures the stock market size relative to the economy. A larger value of *StkCap* indicates a large country with larger stock market size. A country with well-developed stock market would have a larger stock market relative to the size of its economy (Beck and Levine, 2002). For the bank variables, *BankCred* and *PrivCred* measure the bank credit and private credit flows. *BankCred* equals the total amount of bank credits provided by deposit money banks to the private sectors divided by GDP. It is a less comprehensive measure of financial intermediary development than *PrivCred* because it does not include non-bank credits to the private sectors (Beck et al., 2000). *PrivCred* equals the credit value provided by financial intermediaries to the private sector divided by GDP. It measures total credits issued to the private sectors, but excludes credits issued to governments and public agencies. In sum, a large value of *PrivCred* and *BankCred* indicates the higher level of financial services, which suggests the higher banking sector development (Levine et al., 2000).

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Table 2: Summary Statistics

	EUFDI	MKTCAP	TURNOVER	BANKCRED	PRIVCRED	TRADE	R&DGDP	GDPPC	BANKCON	EXCHRATE	LABSEC	LABCOST
Mean	2.39E+10	77.12867	81.19865	128.6339	113.4443	48.83048	1.372394	35619.68	77.50125	1.730950	43.85673	87.29650
Median	7.23E+09	67.29671	73.20075	122.7093	104.1967	34.70866	1.314105	31611.56	82.99253	0.824000	44.10000	87.84640
Maximum	1.53E+11	323.6560	269.8216	234.4390	232.0975	247.9019	3.199394	112028.5	100.0000	10.33800	68.90000	115.2897
Minimum	1.01E+08	12.78787	0.145454	48.60891	30.76999	11.38329	0.371772	13009.10	32.73900	0.500000	15.50000	63.81300
Std. Dev.	3.03E+10	48.73612	52.84780	42.33210	44.66279	42.40959	0.607520	16438.55	18.32796	2.246414	10.77366	11.21794
Skewness	1.502102	1.302263	0.735579	0.604784	0.769547	2.600536	0.696493	2.100851	-0.847201	2.180312	-0.218710	-0.098528
Kurtosis	5.059643	5.724340	3.325024	3.059898	3.033793	10.19668	3.054093	9.493074	2.647596	6.166962	3.330874	2.033412
Jarque-Bera	143.7299	153.8938	24.59108	15.88862	25.67446	854.1360	21.05283	647.9884	32.44785	314.6508	3.258814	10.54216
Probability	0.000000	0.000000	0.000005	0.000355	0.000003	0.000000	0.000027	0.000000	0.000000	0.000000	0.196046	0.005138
Sum	6.21E+12	20053.45	21111.65	33444.81	29495.53	12695.93	356.8225	9261117.	20150.33	450.0470	11402.75	22697.09
Sum Sq. Dev.	2.38E+23	615179.2	723358.6	464129.7	516644.0	465830.5	95.59173	7.00E+10	87001.75	1307.011	30062.59	32593.13
Observations	260	260	260	260	260	260	260	260	260	260	260	260

In addition to the stock market and bank variables, the other source country variables include the EU bank FDI, R&D spending, bilateral trade, and bank concentration ratio. *BankFDI* is the level of EU bank FDI in the U.S. As the EU multinational companies heavily rely on borrowing from the major EU banks, their U.S. affiliates would prefer to obtain bank loans from the EU bank branches in the U.S. This would allow the EU banks to maintain very close business relationship with their corporate clients in the U.S. Hence, the EU bank FDI can provide the crucial financing for the EU high-tech FDI. For the EU R&D variable, *R&DExp* is the amount of the EU business expenditure on R&D activities as a share of their GDP. It can have both positive and negative effect on the EU FDI. The increase in spending reflects the EU company emphasis on research activities in the EU countries, which would reduce their reliance on similar activities abroad. This would decrease their FDI in the U.S. But the increase in spending also reflects the EU company determination to advance technological progress. One way is to tap the U.S. advanced technology through FDI. This may further increase their high-tech FDI in the U.S. *Trade* is the bilateral trade flows between the U.S. and the EU countries. It measures the amount of their total exports and imports divided by the EU GDP. The higher EU familiarity with the U.S. through trade would boost the EU FDI in the U.S. Strong trade ties would bolster the short-term financial linkages through trade financing. It would create demand and supply channels through which the EU companies can gain access to the U.S. capitals. This would make it less costly for the EU companies to invest in the U.S. (Guerin, 2006). Therefore, the higher trade flows would promote the EU FDI in the U.S. Finally, *Bankcon* is the bank concentration ratio. It measures the fraction of bank assets held by the three largest banks in each of the EU countries. The higher bank concentration ratio would result in the lower bank credit availability (Cetorelli and Gambera, 2001). As the EU high-tech companies are highly dependent on external financing, they would face very limited access to financing in highly concentrated banking markets. Hence, the higher bank concentration would reduce the EU FDI in the U.S.

Several conventional variables are included as the potential EU FDI determinants. *GDPpc* is the GDP per capita of the EU countries. It reflects the EU capital abundance. The advanced EU countries reflected by their higher GDP per capita tend to make more FDI. *ExchRate* is the average annual exchange rate between the EU countries and the U.S. The euro launch that eliminates exchange rate volatility among the EU countries would stabilize the euro value against the U.S. dollar, thereby boosting the EU FDI in the U.S. Finally, two variables are used to measure the availability of skilled and low-cost labor force. *LabSec* is the proportion of the EU labor force that has received secondary education as a percentage of the total labor force. It indicates the potential amount of skilled labor available for R&D activities. The larger supply of skilled labor would enable the EU companies to conduct advanced research locally rather than in the U.S. This would decrease the EU FDI in the U.S. *LabCost* is the EU unit labor cost in manufacturing sector. It reflects the potential labor competitiveness in conducting advanced research more efficiently. The availability of low-cost labor force would minimize the local production costs. This would decrease the EU FDI in the U.S.

Given the existence of fixed effects, equation (1) is controlled for both the country and time fixed effects. α_i measures the country fixed effects among the EU country *i*. The variation in these effects comes from the omitted variables that vary across the EU countries, but not over time. The inclusion of these effects would control for the omitted variable bias such as the individual EU country preference for FDI in the U.S. For decades, the U.S. has established very strong economic ties with the major EU countries such as the United Kingdom, Germany, France, and Italy. Due to their emphasis on advanced technology, these countries have accounted for most of

the U.S. high-tech FDI in Europe. Their collaborations have led to a number of joint ventures between the U.S. and EU companies. Given their strong cooperation, the EU countries would strongly prefer to invest in the U.S. Their preference for the U.S. would be captured by the country fixed effects. Moreover, λ_t measures the time fixed effects for the study period 1993-2012. The variation in these effects originates from the omitted variables that vary over time but not across the EU countries. The inclusion of these effects would eliminate the omitted variable bias such as the EMU effect over time. It measures the two-stage EU integration effects on the EU FDI. The EU Single Market creation since the mid-1990s has accelerated the EU financial market integration. To prepare for the EMU formation, the EU countries have launched the financial market liberalization through the removal of the regulatory barriers and the harmonization of financial legislations. Subsequently, the euro introduction has deepened the financial market integration. The creation of highly liquid and integrated stock markets and banking sectors would substantially boost the financing for the EU FDI. Equally important, the euro introduction eliminates the exchange rate volatility among the eurozone countries. The more stable euro value against the U.S. dollar would promote the EU FDI in the U.S. In sum, the deepened EU integration process would have larger positive effect on the EU FDI in the mid-1990s and early 2000s. These subperiods are captured by the time fixed effects.

In addition to the fixed effects, equation (1) is also controlled for the random effects. γ_i represents the unobserved effects that are not correlated with all the explanatory variables during the time periods. Compared to the fixed effects model, the random effects model takes into account the variation between the EU countries and variation within these countries. Moreover, the random effects model allows the estimation of effects of time-invariant variables. The Hausman test can determine whether the random effects estimator is unbiased if the effect is uncorrelated with the explanatory variables. It is a test of the significance of the difference between the fixed effects and random effects estimates. Finally, ε_{it} is the error term.

This study also conducts the feasible generalized least squares (FGLS) estimation of equation (1). It would yield the cross-section weights results controlling for the cross-section heteroskedasticity and the cross-section seemingly unrelated regression (SUR) results controlling for both the cross-section heteroskedasticity and contemporaneous correlations.

3.2. Two-Stage Least Squares and Generalized Method of Moments Estimations

Equation (1) is initially estimated by the OLS method. However, there may be endogeneity problem between the EU financial development and FDI. The EU financial development would promote the EU FDI in the U.S. through the increase in financing. However, the higher FDI would increase the demand for financial services, which in turn would accelerate the financial development. To address this concern, this study would use the two-stage least squares (2SLS) method to re-estimate the endogeneous variables (*StkCap*, *Turnover*, *BankCred*, and *PrivCred*). It is important to find the variables that are highly correlated with the stock market and bank variables but are not correlated with ε_{it}. The instrumental variables (IV) would replace the stock market variables and bank variables in equation (1). To better capture the fixed effects, the 2SLS method would also control for the country fixed effects. The Hausman test is first conducted to examine whether the stock market (*StkCap*) and bank variables (*BankCred* and *PrivCred*) are indeed endogenous.[3] To test the endogeneity of *StkCap*, the test first obtains the first stage residuals and then includes it in equation (1) as an extra explanatory variable. The residual series for *StkCap* is significant at the 10% level. There is some evidence that *StkCap* may be

[3] The stock turnover variable is not included in the estimation as it consistently yields insignificant results.

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endogenous.[4] Thus, the test is also conducted on *BankCred* and *PrivCred*. The results indicate that the residual series for *BankCred* is highly significant at the 1% level, suggesting that *BankCred* is indeed endogenous. The residual series for *PrivCred* is not statistically significant at all, suggesting that *PrivCred* is not endogeneous.[5]

Having confirmed the endogeneity of these variables, the analysis would next determine whether the IV for these variables are appropriate. The Wald tests are first performed to test the joint significance of the IV (*CapForm* and *StkTrade*) for *StkCap*. *CapForm* is the gross capital formation as a percentage of GDP. It measures the potential demand for financial services by the EU companies. *StkTrade* measures the total value of stocks being traded on domestic market divided by GDP. It reflects the stock market liquidity relative to the size of the economy. As it measures the total volume of stocks being traded as a share of total output, it reflects the stock market liquidity relative to the size of the economy. The results show the large F-statistic value (52.907), confirming that both *CapForm* and *StkTrade* are the suitable IV for *StkCap*.[6] The Wald tests are also used to test the joint significance of the IV (*PrivCred* and *Saving*) for *BankCred*. *Saving* is the amount of GDP minus the final consumption expenditure. It refers to the amount of domestic saving available for bank credit and private credit flows. *PrivCred* has been explained earlier. The results clearly show the large F-statistic value (435.001), indicating that both *PrivCred* and *Saving* are the suitable IV for *BankCred*. Hence, the Wald tests confirm that the selected IV are suitable for *StkCap* and *BankCred*.

In addition to the 2SLS method, equation (1) is re-estimated by the dynamic generalized method of moments (GMM) method to control for the biases related to endogeneity, omitted variables, and unobserved country fixed effects. It can also address the heteroskedasticity and serial correlation problem. More importantly, the dynamic GMM method also captures the lagged effect of the EU FDI. The dynamic rather than system GMM method is used because the system GMM method requires that the initial levels of the FDI do not deviate systemically from their long-run values. However, the FDI stocks and their lagged values included as the dependent and independent variables may not be stationary. Therefore, this study would use the dynamic GMM method to estimate equation (1). The first difference procedure is chosen as the transformation method to remove the cross-section fixed effects. The bank and stock market IV used in the 2SLS method are included as the IV in the dynamic GMM method.

3.3. Data Description

The data on the EU high-tech FDI in the U.S. are obtained from the U.S. Bureau of Economic Analysis. The FDI data in U.S. dollars are adjusted for inflation by using the U.S. GDP deflators with base year of 2005, which are calculated based on the data in the World Bank database. As all the independent variables are given in U.S. dollars, they are adjusted for inflation using this method. For the main explanatory variables, the stock market and bank variables are obtained from the World Bank database. All these variables except the turnover ratio are expressed as a percentage of GDP. For the other variables, the EU bank FDI data are also obtained from the U.S. Bureau of Economic Analysis. The data on bank concentration ratio are taken from the Data Market database. The data on business enterprise R&D spending are drawn from the Organization for Economic Cooperation and Development (OECD) statistical extract. The data on the bilateral trade flows are taken from the OECD Statistical Extract database. The

[4] The results are available upon request.
[5] The results are available upon request.
[6] The results are available upon request.

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latest trade data for 2011 and 2012 are obtained from the International Monetary Fund's (IMF) *Direction of Trade Yearbook Statistics*. For the rest of the conventional variables, the data on GDP per capita and labor force with secondary school education are drawn from the World Bank database. The data on exchange rate volatility are obtained from the IMF's *International Financial Statistics*. The data on unit labor cost are taken from the OECD Statistical Extract. Finally, the IV data on capital formation, stock market traded, and gross domestic saving are all drawn from the World Bank Database.

4. Estimation Results

4.1. OLS, FGLS, 2SLS, and GMM Results

Before discussing the results in detail, it is important to determine which estimations would yield more significant results for the financial integration effects on the EU FDI. Table 3 presents the OLS results controlling for the country and time fixed effects and random effects.

Table 3: OLS Estimates of the Determinants of the EU FDI in the United States

	(1) 1993-2012 Fixed Effects	(2) 1993-2012 Fixed Effects	(3) 1993-2012 Fixed Effects	(4) 1993-2012 Random Effects	(5) 1993-2012 Random Effects	(6) 1993-2012 Random Effects
StkCap	0.135	0.132		0.369***	0.350***	
	(1.004)	(0.987)		(4.211)	(3.993)	
Turnover			-0.285***			-0.117**
			(-4.275)			(-2.108)
BankCred	0.403**		0.206	0.430***		0.394**
	(2.120)		(1.109)	(2.402)		(2.249)
PrivCred		0.428***			0.450***	
		(2.535)			(2.889)	
BankFDI	-0.005	-0.005	-0.005	-0.002	-0.001	0.002
	(-0.970)	(-0.944)	(-1.106)	(-0.341)	(-0.278)	(0.453)
R&Dexp	0.089	0.009	0.398	0.485***	0.422**	0.748***
	(0.327)	(0.031)	(1.572)	(2.455)	(2.101)	(4.007)
Trade	0.391*	0.377*	0.367*	0.675***	0.667***	0.801***
	(1.692)	(1.636)	(1.653)	(4.174)	(4.105)	(5.452)
Bankcon	-0.936***	-0.951***	-0.825***	-0.510***	-0.522***	-0.185
	(-3.470)	(-3.537)	(-3.216)	(-2.392)	(-2.460)	(-0.903)
GDPpc	0.061	0.109	-0.158	0.039	0.027	0.172
	(0.132)	(0.239)	(-0.353)	(0.152)	(0.105)	(0.726)
ExchRate	0.068	0.030	0.097	-0.198	-0.214	-0.185
	(0.358)	(0.158)	(0.528)	(-1.437)	(-1.542)	(-1.462)
LabSec	1.937***	1.970***	1.978***	1.724***	1.787***	1.557***
	(4.610)	(4.700)	(4.948)	(5.041)	(5.193)	(4.813)
LabCost	-0.094	-0.337	0.302	2.263***	2.065***	2.056***
	(-0.111)	(-0.391)	(0.366)	(4.056)	(3.671)	(3.800)
Adj. R^2	0.921	0.922	0.927	0.512	0.518	0.474
Obs.	260	260	260	260	260	260

Notes: OLS refers to the ordinary least squares estimation.

Regressions (1) to (3) include the country and time fixed effects estimations.

All variables are in logarithm. T-statistics are reported in parentheses.

Cluster-robust standard errors are used.

***, **, * indicate significance at 1%, 5%, & 10%.

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Table 4 presents the FGLS results: columns (1) through (3) report the cross-section weights results, whereas columns (4) through (6) report the cross-section SUR results. The Hausman contrast test is used to determine whether the fixed or random effects coefficients can better estimate equation (1). It can assess how close the differences between the fixed and random effects coefficients are equal to zero. The calculated values of the chi-square statistics are 57.014, 53.395, and 106.326.[7] On the basis of the joint tests, we can reject the null hypothesis that the difference between the fixed and random effects coefficients is zero. This suggests that the fixed effects coefficients are the better estimators than the random effects coefficients. When the fixed effects and random effects coefficients show very significant difference, the fixed effects coefficients should be chosen as they always remain very consistent. In large samples, the fixed effects coefficients converge to the true parameter values, but the random effects coefficients converge to some other value that is not the value of the true parameters. Hence, this study would focus on the fixed effects results to explain the EU FDI flows.

Table 4: FGLS Estimates of the Determinants of the EU FDI in the United States

	(1) 1993-2012 Cross-Section Weights	(2) 1993-2012 Cross-Section Weights	(3) 1993-2012 Cross-Section Weights	(4) 1993-2012 Cross-Section SUR	(5) 1993-2012 Cross-Section SUR	(6) 1993-2012 Cross-Section SUR
StkCap	0.277***	0.270***		0.191***	0.186***	
	(3.991)	(3.872)		(8.329)	(7.797)	
Turnover			-0.146***			-0.183***
			(-2.539)			(-7.449)
BankCred	0.435***		0.275	0.179***		0.067
	(2.533)		(1.470)	(3.260)		(1.142)
PrivCred		0.363***			0.215***	
		(2.414)			(5.155)	
BankFDI	0.002	0.002	0.002	-0.002	-0.001	-0.001
	(0.346)	(0.482)	(0.428)	(-0.905)	(-0.791)	(-0.786)
R&Dexp	0.567***	0.529***	0.949***	0.658***	0.609***	0.988***
	(3.120)	(2.840)	(5.051)	(7.960)	(7.191)	(12.078)
Trade	0.786***	0.776***	0.980***	0.707***	0.701***	0.773***
	(4.337)	(4.756)	(5.754)	(9.989)	(9.975)	(8.923)
Bankcon	-0.268*	-0.257*	-0.105	-0.303***	-0.314***	-0.054
	(-1.765)	(-1.676)	(-0.679)	(-4.737)	(-4.834)	(-0.747)
GDPpc	0.073	0.045	0.346	0.427***	0.410***	0.693***
	(0.327)	(0.199)	(1.410)	(5.537)	(5.114)	(7.141)
ExchRate	0.065	0.039	0.215	0.165***	0.145***	0.216***
	(0.382)	(0.224)	(1.223)	(3.340)	(2.739)	(4.381)
LabSec	1.711***	1.691***	1.816***	1.942***	1.960***	1.994***
	(5.246)	(5.151)	(5.204)	(11.794)	(12.119)	(10.851)
LabCost	2.112***	2.162***	1.885***	2.093***	1.959***	1.814***
	(4.632)	(4.755)	(3.834)	(16.535)	(16.050)	(11.324)
Adj. R^2	0.961	0.960	0.953	0.990	0.989	0.994
Obs.	260	260	260	260	260	260

Notes: FGLS refers to the feasible generalized least squares estimation.
Regressions (4) to (6) include the cross-section seemingly unrelated regression estimations.
All variables are in logarithm. T-statistics are reported in parentheses.
Cluster-robust standard errors are used.
***, **, * indicate significance at 1%, 5%, & 10%.

[7] The results are available upon request.

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The fixed effects and FGLS results show very substantial financial market effect on the EU FDI flows in the U.S. In particular, the bank development variables are positively associated with the EU FDI. The significant bank variables (*BankCred* and *PrivCred*) are all positive for 1993-2012 in both estimations. However, the same result is only confirmed for the stock market variables in the FGLS estimation. As seen in Table 4, the stock market variables (*StkCap* and *Turnover*) have the contrary results. The former is positive whereas the latter is negative. Second, the other main explanatory variables show very similar results in the fixed effects and FGLS estimations. As expected, the bilateral trade flow and bank concentration ratio have positive and negative effect on the EU FDI, respectively. Surprisingly, the EU bank FDI has no impact on the EU FDI as the coefficient on *BankFDI* is never statistically significant in both estimations. Finally, there is very mixed evidence for the EU R&D spending effect on the EU FDI. The FGLS coefficients on *R&DExp* in Table 4 are statistically significant and positive, but the fixed effects coefficients are not significant in columns (1) to (3) of Table 3. The R&D spending may only be considered as one of the potential determinants of the EU FDI.

In addition to the OLS and FGLS estimations, this study re-estimates equation (1) using the 2SLS and dynamic GMM estimations. Equation (1) including *BankCred* and *PrivCred* is estimated separately by the 2SLS estimation. The results are presented in Tables 5 and 6. The pooled results are shown in column (1), whereas the subperiod results are shown in columns (2) and (3). The analysis divides the entire study period into the pre-euro and euro subperiods (1993-1999 and 2000-2012). This would allow us to compare the EU financial integration effect on the EU FDI in the U.S. before and after the EMU formation.[8]

Finally, Table 7 presents the GMM results for the specification including *StkCap* and *BankCred*.[9] The pooled results are reported in column (1). The subperiod results which cover the pre-euro and euro periods are reported in columns (2) and (3). The 2SLS and GMM results are quite similar to the fixed effects and FGLS results. Both of the stock market and bank development have very significant effect on the EU FDI. It is noteworthy that the statistically significant stock market effect is only confirmed by the 2SLS rather than GMM results as shown in Tables 5 and 7. This mixed result is quite similar to the FGLS results in columns (1) and (4) of Table 4 and the fixed effects results in column (1) of Table 3. Moreover, the 2SLS and GMM estimations also yield consistent results for the EU R&D spending and trade effect on the EU FDI. Both variables even show stronger effect as their coefficients are larger in magnitude than their fixed effects and FGLS counterparts. In Table 7, the GMM coefficient on *R&DExp* (0.745) is larger than the 2SLS and FGLS coefficients (0.445 and 0.567) during 1993-2012 in Tables 5 and 4. Thus, the positive effect of trade flow remains the same across all estimations. But this effect clearly diminishes in the GMM estimation as the coefficient on *Trade* falls to 0.368 during 1993-2012, which is smaller than 0.720 and 0.786 for the 2SLS and FGLS coefficients.

[8] The U.S. financial crisis of 2008 and the eurozone debt crisis since 2010 may have negative impact on the EU FDI. The estimation is conducted for the crisis period 2008-2012. As the results are similar to those of the euro period, the results are not presented here.

[9] The GMM estimation would not be conducted for the specification using *StkCap* and *PrivCred* as most of the explanatory variables are not statistically significant in the 2SLS estimation.

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Table 5: 2SLS Estimates of the Determinants of the EU FDI in the United States

	(1) 1993-2012 2SLS	(2) 1993-1999 2SLS	(3) 2000-2012 2SLS
StkCap	0.439***	0.481*	-0.042
	(3.930)	(1.673)	(-0.125)
BankCred	0.527***	1.167***	0.861***
	(2.864)	(3.065)	(4.239)
BankFDI	0.002	0.010*	-0.001
	(0.360)	(1.621)	(-0.158)
R&Dexp	0.445**	0.281	0.591**
	(2.337)	(0.534)	(2.134)
Trade	0.720***	0.875*	0.107
	(4.493)	(1.753)	(0.568)
Bankcon	-0.342**	-0.335	-0.595***
	(-2.194)	(-1.329)	(-2.582)
GDPpc	0.055	0.511	0.996
	(0.251)	(1.346)	(1.113)
ExchRate	0.003	0.085	1.256
	(0.015)	(0.908)	(1.225)
LabSec	1.730***	2.588***	0.309
	(5.264)	(2.956)	(0.654)
LabCost	1.882***	-3.761**	0.848
	(4.086)	(-1.890)	(0.894)
Adj. R^2	0.962	0.983	0.970
Obs.	260	91	169

Notes: 2SLS refers to the two-stage least squares estimation.
Regressions (1) to (4) are controlled for the cross-section fixed effects.
All variables are in logarithm. T-statistics are reported in parentheses.
Cluster-robust standard errors are used.
***, **, * indicate significance at 1%, 5%, & 10%.

Table 6: 2SLS Estimates of the Determinants of the EU FDI in the United States

	(1) 1993-2012 2SLS	(2) 1993-1999 2SLS	(3) 2000-2012 2SLS
StkCap	-1.131	0.187	-0.651
	(-1.150)	(0.623)	(-1.214)
PrivCred	-7.374	1.291	1.961*
	(-0.917)	(1.232)	(1.688)
BankFDI	0.014	0.007	-0.001
	(0.637)	(1.208)	(-0.085)
R&Dexp	4.008	0.461	0.669*
	(1.434)	(0.675)	(1.669)
Trade	1.550**	1.122**	0.404
	(2.239)	(2.177)	(1.367)
Bankcon	0.304	-0.162	-0.577*
	(0.478)	(-0.702)	(-1.730)
GDPpc	4.832	0.798**	2.270*
	(1.039)	(2.128)	(1.612)
ExchRate	4.240	0.104	2.899*
	(1.113)	(0.967)	(1.794)
LabSec	2.704*	1.624**	0.170
	(1.648)	(1.960)	(0.232)
LabCost	12.768	-2.646	-2.163
	(1.633)	(-1.338)	(-0.779)
Adj. R^2	0.715	0.984	0.944
Obs.	260	91	169

Notes: 2SLS refers to the two-stage least squares estimation.
Regressions (1) to (4) are controlled for the cross-section fixed effects.
All variables are in logarithm. T-statistics are reported in parentheses.
Cluster-robust standard errors are used.
***, **, * indicate significance at 1%, 5%, & 10%.

All of the estimations yield very similar results for the financial market effect. The stock market and bank development have become the main determinants of the EU FDI in the U.S. Other explanatory variables including the EU R&D spending and bilateral trade flow also play a crucial role in influencing the EU FDI decision. Compared to the fixed effects and FGLS estimations, the 2SLS and GMM estimations would provide better estimation of equation (1). While the 2SLS method can resolve the reverse causality problem, the GMM method can reduce the biases related to endogeneity, omitted variables, and unobserved country fixed effects. It can also address the heteroskedasticity and serial correlation problem. Given all these considerations, the rest of the discussions would focus on the 2SLS and GMM results.

Table 7: GMM Estimates of the Determinants of the EU FDI in the United States

	(1) 1993-2012 GMM	(2) 1993-1999 GMM	(3) 2000-2012 GMM
StkCap	0.233	0.364	-0.063
	(0.793)	(0.467)	(-0.273)
BankCred	0.601**	1.018	0.538***
	(2.194)	(1.464)	(2.454)
BankFDI	-0.005	-0.003	-0.004
	(-1.327)	(-0.496)	(-0.918)
R&Dexp	0.745*	0.672	1.270***
	(1.732)	(0.542)	(2.664)
Trade	0.368***	0.970***	-0.249*
	(5.210)	(5.843)	(-1.669)
Bankcon	-0.020	-0.093	-0.130
	(-0.232)	(-0.272)	(-0.853)
GDPpc	0.362*	1.131***	1.821***
	(1.849)	(3.930)	(4.928)
ExchRate	0.104*	0.059	2.175***
	(1.860)	(0.683)	(4.269)
LabSec	-0.108	1.128	-1.632**
	(-0.120)	(1.415)	(-1.772)
LabCost	1.050	-5.000	-0.469
	(1.146)	(-1.582)	(-0.496)
Sargan Statistic	5.513	3.777	0.802
AR(1) Test	-0.912	0.893	-1.321
(p-value)	(0.362)	(0.372)	(0.186)
AR(2) Test	-1.485	-0.958	-1.926
(p-value)	(0.285)	(0.338)	(0.054)
Obs.	260	91	169

Notes: GMM refers to the dynamic generalized method of moments estimation.

All variables are in logarithm. T-statistics are reported in parentheses.

Cluster-robust standard errors are used.

***, **, * indicate significance at 1%, 5%, & 10%.

4.2. Results for the EMU Effect on the EU FDI

This study examines whether the EU financial market integration has promoted the EU high-tech FDI in the U.S. during 1993-2012. The first important issue focuses on whether the bank integration has exerted substantial influence on the EU FDI during the EMU period. To meet the growing competition after the EMU formation, the larger EU banks have engaged in mergers and acquisitions to improve their efficiency (Hartmann et al., 2003). These activities have occurred both within and across the EU countries. This would substantially increase the supply of bank loans, thereby promoting the EU FDI in the U.S. The results provide some support for this argument. The bank credit flow variable has statistically significant and positive effect on the EU FDI. In column (1) of Tables 5 and 7, the 2SLS and GMM coefficients on *BankCred* are positive and highly significant at the 1% and 5% levels for the entire period 1993-2012. The coefficients are very similar in magnitude (0.527 and 0.601). The higher bank credit flows have modestly promoted the EU FDI in the U.S. for about 69%. This confirms that the increase in bank credit flows would facilitate the supply of external financing, thereby boosting the EU FDI in the U.S.

Another major concern is whether the EMU formation has enhanced the bank credit effect on the EU FDI. As seen in the subperiod results in columns (2) and (3), the EMU formation has not further boosted the effect. The magnitude of this effect remains quite large before and after the EMU formation although it diminishes in the latter period. The 2SLS coefficient falls from 1.167 during 1993-1999 to 0.861 during 2000-2012. This implies that the deepened bank integration reflected by the higher bank credit flows would dramatically boost the EU FDI for about 130% after the EMU formation. Interestingly, the GMM coefficient only appears highly significant during this period. The substantial bank integration effect in the pre-EMU period can be attributed to the EU membership effect. The EU implementation has somewhat facilitated the bank integration during the 1990s. The banking deregulation policies have allowed the EU banks to establish business in any member countries without further authorization. This has also stimulated the cross-border bank mergers and acquisitions among the EU countries since the late 1990s. This has led to the growing supply of cross-border bank loans among these countries (Howarth and Quaglia, 2013). All these developments have contributed to the substantial bank integration effect on the EU FDI before the EMU formation. Moreover, the dominance of bank financing during 1993-2012 may be due to the EU reliance on bank loans as their main source of financing. Most of the major EU high-tech investors in the U.S. are the bank-based countries such as Germany and France. The EU banks provide the majority of external financing for the corporate sectors. Besides, most of the financial services to the corporate sectors are primarily provided by the EU banks rather than non-bank financial firms (Freixas et al., 2004). The deepened bank integration after the EMU formation has bolstered the importance of bank-based financing for the EU FDI. To consolidate their market share after the euro launch, the EU banks have improved their competitiveness through mergers and acquisitions among the EU countries (Hartmann et al., 2003). These activities have further boosted the amount of cross-border bank lending to the EU companies. Besides, the growing competition after the euro launch has rendered the banks to provide loans at lower cost. This has increased the availability of affordable bank financing for the EU high-tech FDI. All these developments have reinforced the continued dominance of bank financing in these countries. They can also explain the substantial bank integration effect on the EU FDI in the U.S. before and after the EMU formation.

The second important issue is whether that the stock market integration has spurred the EU FDI during the EMU period. The EU stock markets have become more integrated after the euro launch. The creation of more integrated and highly liquid stock markets has facilitated the larger

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amount of capitals to the EU companies (Lorca-Susino, 2010). This in turn would promote the EU FDI in the U.S. The results show very mixed support for this argument. As seen in the 2SLS and GMM results in Tables 5 and 7, only the 2SLS coefficient on *StkCap* becomes highly significant and positive (0.439) for the entire period 1993-2012. This suggests that the higher stock market capitalization would moderately boost the EU FDI for nearly 55%. Furthermore, the subperiod results show the similar effect but at a lower statistical significant level during the pre-EMU period. As reported in column (2) of Table 5, the 2SLS coefficient (0.481) only becomes marginally significant at the 10% level during 1993-1999. The initial stock market integration reflected by the higher stock market capitalization may promote the EU FDI for 61% before the EMU formation. This may be due to the implementation of preliminary financial liberalization measures since the early 1990s. The capital flow restrictions were gradually removed among the EU countries during 1990-1993. This has somewhat accelerated the stock market integration progress before the EMU formation. In fact, the major equity markets in Germany, France, and Italy have become more integrated due to the prospect of the EMU formation and the euro adoption (Hardouvelis et al., 2006). This has increased the amount of equity capitals available in these markets. To meet the growing competition, the larger and more liquid stock markets would provide a larger amount of equity capitals at lower cost (Mylonidis and Kollias, 2010). Hence, the equity capitals may become the main alternative financing to the bank loans for the EU companies, thereby boosting their FDI in the U.S. This explains why the initial stock market integration during the pre-EMU period may influence the EU FDI decision.

The subperiod results reveal that the stock market integration after the EMU formation has no impact on the EU FDI. The 2SLS and GMM coefficients on *StkCap* are not statistically significant during 2000-2012. This is very surprising given the rapid growth of market-based financing after the EMU formation. The euro launch has led to the deepened stock market integration, especially in the money, credit, equity, corporate and government bond markets. More importantly, the market-based financing would be more accessible than the bank-based financing to the EU companies as the former is less risk averse than the latter. The innovative EU companies generally prefer new equity capitals over bank loans to fund the risky high-tech investments (Aghion et al., 2004). Although the EU banks provide most of the financing for the larger EU corporations, they remain very reluctant in financing very risky high-tech investments due to their uncertain profit returns. In contrast, the stock market investors are more willing to take on risky investments in order to maximize their profits (Maskus et al., 2012). The deepened stock market integration would substantially increase the stock market liquidity and size. These markets can provide the EU companies with more equity capitals at lower cost, thereby promoting the FDI in the U.S. However, the insignificant stock market capitalization coefficient during 2000-2012 indicates that the stock market integration has not resulted in the higher EU FDI during the EMU period.

4.3. Results for the Conventional Variables on the EU FDI

The 2SLS and GMM estimations have yielded very conclusive results for the R&D spending and trade effects on the EU FDI. The EU R&D spending clearly has strong positive effect on the EU FDI in the U.S. after the EMU formation. As seen in Tables 5 and 7, the pooled results indicate that the 2SLS and GMM coefficients on *R&DExp* are both positive and statistically significant over the entire period 1993-2012. But the subperiod results indicate that both coefficients only remain statistically significant over the EMU period 2000-2012. The 2SLS coefficient (0.591) suggests that the higher EU R&D spending would substantially boost the EU FDI in the U.S. for 81% during the EMU period. This is highly expected as the EMU formation

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is aimed to increase the amount of external financing for the high-tech investments. The surge in EU R&D spending has facilitated the high-tech development since 2000. As reflected in the high EU R&D spending, the EU strong emphasis on advanced technology has continued to promote the EU high-tech FDI in the U.S. Some of the EU companies even accelerate their technological progress by tapping the U.S. technology through FDI. The U.S. still has clear advantages in certain advanced technologies given the support of adequate research funding and infrastructures (Schwartz, 2010). The EU access to the high-quality research facilities and specialists would substantially improve their innovative capabilities. They are considered as the crucial factors to maintain the high level of EU FDI inflows. Therefore, the surge in the EU R&D spending would be a moderately influential determinant of the EU FDI in the U.S.

Second, the EU trade flows with the U.S. only have strong positive effect on the EU FDI in the U.S. before the EMU formation. The pooled results confirm that both the 2SLS and GMM coefficients on *Trade* are positive and highly significant over 1993-2012. But as the subperiod results reveal, the same results are only obtained for the pre-EMU period 1993-1999. The large magnitude of the 2SLS coefficient (0.875) reflects that the higher EU trade flows with the U.S. would drastically boost the EU FDI for about 140% before the EMU formation. The EU countries become more familiar with the U.S. through strong trade ties, which would make it less costly for them to invest in the U.S. (Guerin, 2006). Thus, the growing trade flows would bolster the high financial linkages through trade financing. It would provide the channels through which the EU companies can tap the huge U.S. capitals. The results support the assertion that the higher trade flows would lead to the higher EU FDI in the U.S. Surprisingly, the trade effect no longer exists after the EMU formation. The EMU has primarily promoted the intra-EU trade flows, possibly diverting trade from the U.S. Hence, the EU trade effect on the FDI has disappeared during this period.

The results only show very modest bank concentration and exchange rate volatility effects on the EU FDI. The bank concentration ratio may have the negative effect as expected. The 2SLS coefficients on *BankCon* (-0.342 and -0.595) become statistically significant for 1993-2012 and 2000-2012, whereas the GMM coefficient is not significant at all. There is some evidence to suggest that the higher bank concentration ratio may modestly decrease the EU FDI for about 45% during the EMU period. The higher bank concentration would normally lead to the lower bank credit availability (Cetorelli and Gambera, 2001). The EU high-tech companies generally have very limited access to external financing in highly concentrated banking markets. They in turn would reduce their FDI in the U.S. Moreover, the negative bank concentration effect during the EMU period can be attributed to the deepened bank integration through mergers and acquisitions. The EU banks become more concentrated, which would reduce the bank credit supply to the EU companies. Similar to the bank concentration effect, the exchange rate volatility between the euro and the U.S. dollar may slightly boost the EU FDI. The GMM coefficients on *ExchRate* (0.104 and 2.175) are statistically significant for 1993-2012 and 2000-2012, whereas the 2SLS coefficient is not significant at all. This indicates that the higher euro value against the U.S. dollar may promote the EU FDI in the U.S. after the EMU formation. The euro appreciation facilitated by the EMU since 2000 would boost the EU FDI because of the lower transaction cost faced by the EU investors.

Finally, the EU bank FDI has very little or no effect on the EU high-tech FDI. The 2SLS coefficient on *BankFDI* (0.010) only becomes marginally significant at the 10% level during 1993-1999, whereas the GMM coefficient is not significant at all. This implies that the EU bank FDI may boost the EU high-tech FDI for only 1% during the pre-EMU period. This is quite

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surprising given the fact that the EU companies traditionally rely on the bank-based financing for their FDI. The possible explanation is that the large EU companies seek major financing from the EU banks in their home countries rather than from their bank affiliates in the U.S. This allows the major EU banks to develop closer customer relationship with the EU companies. They can better tailor their business services to the corporate borrowing needs. In this case, they are more confident in seeking financing directly from the EU banks in their home countries. This explains why the EU bank FDI has little or no effect on the EU high-tech FDI in the U.S.

5. Implications for the U.S. Policies toward the EU High-Tech FDI

The results have very important implications for the U.S. policies toward the EU high-tech FDI. The results confirm the EU strong emphasis on advanced technology. In addition to the higher domestic R&D spending, the EU countries would accelerate their technological progress by exploiting the U.S. technology through FDI. Their affiliates in the U.S. can improve their innovative capabilities by forming research collaborations with their U.S. counterparts. This can further enhance the EU capabilities in converting basic scientific research into competitive commercial products. Having become more familiar with the U.S. market, the affiliates can better tailor their products to the local consumers. Besides, these products become more competitive in other countries by incorporating the U.S. technology, thereby boosting their export competitiveness. Given these considerations, the U.S. can boost the EU high-tech FDI inflows by bolstering the transatlantic research cooperation. Specifically, the U.S. can facilitate the EU alliance with the U.S. universities and research institutes. The U.S. research centers have developed better cooperation with the private sectors through technology transfer. Given the lead in basic science, they can facilitate the transfer of scientific knowledge to industrial sectors (Mowery, 2011). To encourage more transatlantic cooperation, the U.S. should allocate additional funding such as subsidies to the U.S. universities and research centers collaborating with the EU companies. This would enable the transatlantic joint ventures to undertake more costly innovative research over the long run.

Second, the results indicate that the bank-based financing remains the main source of external financing for the EU FDI. The EMU formation has deepened both the stock market and bank integration during the 2000s. Nonetheless, the major EU countries such as Germany and France still rely on the bank loans rather than equity capitals as their primary source of financing. The surge in the bank mergers and acquisitions after the euro launch has contributed to the growing supply of bank loans, which has accounted for the majority of new financing for the EU high-tech companies. The use of bank loans rather than equity capitals is preferable as they allow these companies to maintain control rights over their operations (Aghion et al., 2004). Given the continued dependence on bank financing, the U.S. should further boost the inward EU bank FDI to finance more EU high-tech FDI. In particular, the U.S. can promote the greater bank presence from the United Kingdom, the Netherlands, and Switzerland as they remain to be the largest EU high-tech investors in the U.S. To meet the growing competition after the euro launch, the larger EU banks have expanded their business abroad to maintain their profitability. The huge EU high-tech FDI in the U.S. would provide them with very profitable opportunities for increasing their bank FDI. To facilitate this, the U.S. can reduce the regulatory barriers for the EU bank entry into the country. Special preference should be given to those banks providing sizable loans to the EU high-tech affiliates in the U.S. The increase in EU bank financing would contribute to the steady growth of the EU high-tech FDI in the U.S. over the long run.

Finally, the results suggest that the bilateral trade flows would boost the EU high-tech FDI in the U.S. The U.S. should finalize the free trade agreement (i.e., TTIP) with the EU countries to

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boost their FDI. The important issues to be resolved include market access for goods, services, investment, public procurement, and non-tariff barriers. Since the existing tariffs are relatively low, the negotiations are focused on the total elimination of regulatory trade barriers in the major industries such as agriculture, automobile, chemical, and pharmaceuticals. More importantly, the TTIP implementation would further increase the transatlantic FDI due to the inclusion of more comprehensive investment liberalization provisions (Crotti et al., 2010). These include the guarantees of market access for foreign investors by national treatment and most-favored nation treatment and credible commitments against discriminatory and discretionary treatment. These provisions combined with effective dispute settlement would help promote the bilateral FDI between the U.S. and the EU countries (Berger et al., 2013). In particular, further reductions or elimination of regulatory barriers would bring substantial gains to the EU countries. Given that the U.S. is the largest recipient for their high-tech FDI, the EU countries can substantially expand their U.S. market shares by increasing their FDI. The TTIP can ensure the greater market access for the EU companies. More profitable investment opportunities would become available as certain sensitive industry sectors further open up for the transatlantic collaborations. The TTIP would bolster the stronger transatlantic research cooperation and therefore promote the EU high-tech FDI in the U.S. over the long run.

6. Conclusion

This study examines whether the EU financial market integration has promoted the EU high-tech FDI in the U.S. during 1993-2012. The results indicate that the higher bank credit flows would facilitate the supply of external financing for the EU companies, thereby promoting the EU FDI in the U.S. The bank credit effect has remained substantial before and after the EMU formation. In fact, this effect may have already existed prior to the EMU formation. Second, the results remain very mixed for the stock market integration effect on the EU FDI. The pooled results indicate that the higher stock market capitalization would boost the EU FDI, whereas the subperiod results suggest very modest relationship between them prior to the EMU formation. The explanation can be attributed to the implementation of preliminary financial liberalization measures since the early 1990s.

The results have very important implications for the U.S. policies toward the EU high-tech FDI. The results confirm the EU emphasis on advanced technology. In addition to the higher R&D spending, the EU countries would accelerate their technological progress by exploiting the U.S. technology through FDI. The U.S. can attract more EU high-tech FDI inflows by promoting the transatlantic research cooperation. Second, the results indicate that the bank-based financing remains the main source of external financing for the EU FDI. The surge in the bank mergers and acquisitions after the euro launch has contributed to the growing availability of bank loans. Given the continued dominance of bank financing, the U.S. should further boost the EU bank FDI to finance more EU high-tech FDI.

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