Competition between Latin America and China for US direct investment

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COMPETITION BETWEEN LATIN AMERICA AND CHINA FOR US DIRECT INVESTMENT

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Abstract

There is a belief that the Chinese economy competes with the Latin-American ones for investment flows. Here we analyze the determinants of the US FDI outflows to the most representative Latin-American economies. We develop such assessment with a double-procedure cointegration analysis based on the time-series methodologies of Toda and Yamamoto (1995) and Liu, Song and Romilly (1997). The results suggest that long-run investment to the Latin-American region mainly depends on the performance of the US economy. Furthermore, they suggest the existence of a substitution effect between the Latin American countries and China for US investment flows.

Resumen

Existe una creencia de que la economía china compite con las latinoamericanas por flujos de inversión. Aquí analizamos los determinantes de los flujos de IED de EEUU a las economías latinoamericanas más representativas. Desarrollamos dicha evaluación con un análisis de procedimiento doble de cointegración basado en las metodologías de series de tiempo de Toda y Yamamoto (1995) y Liu, Song y Romilly (1997). Los resultados sugieren que la inversión de largo plazo en la región latinoamericana depende, primordialmente, del desempeño de la economía estadounidense. Además, los resultados sugieren la existencia de un efecto de sustitución de flujos de inversión de EEUU entre los países latinoamericanos y China.

JEL CLASSIFICATION*: F21, F40*

KEYWORDS: *FDI, Latin America, China, US, Cointegration*

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1. Introduction

Foreign direct investment (FDI) has been increasing at an extraordinary speed during the last twenty years. In the second half of the last decade, world inflows grew at an annual rate of almost 40 percent. For third consecutive year, global FDI inflows rose in 2006 – by 38% – to reach $1,306 billion (UNCTAD, 2007a). The largest inflows among developing economies went to China, Hong Kong (China) and Singapore. It is expected that the region will become even more attractive to efficiency-seeking FDI, as countries such as China and India plan to significantly improve their infrastructure. In UNCTAD's *World Investment Prospects Survey,* more than 63% of the responding transnational corporations (TNCs) expressed optimism that FDI flows would increase over the period 2007-2009. According to the survey, the most attractive FDI destination countries are China and India, while East, South and South-East Asia is considered the most attractive region (UNCTAD, 2007b).

China has been the world´s fastest-growing economy for the last twenty five years. Since the start of the economic reform process in 1978, the economy has shown an average real growth rate of 9.4 percent per year, according to official statistics. One of the most important elements of China's economic reform has been the promotion of foreign direct investment inflows. When China initiated its 'open-door' policy, the amounts of FDI flows were very small. It was not until the mid-1980s that FDI in China surged and marked the beginning of China's ride on the wave of globalization.[1] In the early 1990s, it once again gained momentum. In 2002, despite the widespread decline in FDI in the world, China experienced an increase in FDI inflows and overtook the United States to become the world's second largest destination of FDI.

While increases in FDI from the outside world are complementary to China's efforts to modernize its economy, many developing countries seem to be worried about the prospect of a rising China that absorbs more and more of the investment from major multinationals. Several governments in Latin America have publicly noted that the emergence of China has diverted direct investment away from their economies.[2] Policymakers and analysts in the developing world are convinced that the rise of China has contributed to the "hollowing out" phenomenon, with foreign and domestic investors leaving their countries and investing in China instead. This in turn has led to continued loss of manufacturing industries and jobs, undermining the vitality of these economies.[3]

[1] China opened up Special Economic Zones (SEZs) in the southeast part of China in an attempt to attract foreign capital from its neighbors. Four SEZs were established in two southeast coastal provinces, Guangdong and Fujian. In Guangdong province, three SEZs are established in Shenzhen, Zhuhai, and Shantou. The main Chinese strategy is to attract capital-intensive industries via an export-manufacturing framework that uses special economic zones.

[2] Further econometric analyses are required to address this question (see, for example, Eichengreen and Tong 2005; Olarreaga, Lederman, and Cravino 2007; Garcia Herrero and Santabárbara 2005; and Chantassasawat et al. 2004).

[3] It is important to mention that the continued growth of China also has some positive effects on Latin America. In first place, it means a bigger market. In the last few years, prices of commodities and raw materials such as copper, aluminum, cement, steel, petroleum and soybeans have soared partly due to the breakneck pace of China's

It is not hard to find analysts, commentators and policymakers in Latin America who have voiced concerns about the emergence of China, claiming that China is adversely affecting direct investment flows into their economies. Cesar Gaviria, head of the 34-country Organization of American States, was quoted to have said, "The fear of China is floating in the atmosphere here. It has become a challenge to the Americas not only because of cheap labor, but also on the skilled labor, technological and foreign investment front." Panama's Vice Minister of Foreign Affairs, Nivia Rossana Casrellen, said, "The FTAA is moving ahead because of a collective will to speed up development and a collective fear of China" (Miami Herald November 21, 2003). According to Business Week's Mexico City Bureau Chief, Geri Smith, "China has siphoned precious investment and jobs from Mexico…" (Business Week, November 8, 2004).[4]

Lora (2005) attempts to provide a comparison between China and Latin America based on the main variables that are closely associated with growth, and/or the ability of countries to attract foreign direct investment. His study argues that China's strengths in relation to Latin America derive from the size of the economy, the country's macroeconomic stability, the abundance of low-cost labor, the rapid expansion of its physical infrastructure, and its ability to innovate.[5] China's main weaknesses are a by-product of the lack of separation between market and state. This situation derives in poor corporate governance practices, a fragile financial system and a tendency to misallocate savings (which are manifested through excess of investments in many sectors).

What makes China an outstanding case, according to the competitiveness indicator[6], is the stability of its macroeconomic environment. China ranks seventh in the world according to this indicator, outperforming the typical country of any region of the world, including many developed countries. The Latin American countries analyzed in this study, in contrast, rank between 35 (Mexico) and 126 (Brazil)[7], revealing that Latin America, in macroeconomic terms, is one of the most unstable regions in the world. (WEF, 2008).

Olearreaga et al. (2007) find that China accumulated larger stocks of FDI than Latin America from 1990 to 1996, but not since 1997. However, this was not the case for U.S. capital invested in the manufacturing sectors of host countries, as stocks in China grew faster than in most Latin American countries between 1997 and 2003. Conventional wisdom also suggests that US TNCs are moving cutting edge R&D to China, in order to take advantage of low cost technologically skilled workers. But a study by Branstetter and Foley (2007) suggests that the above is not true. This conclusion is based on a comprehensive survey of the activities of US

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industrialization. This seems to have benefited countries such as Brazil, Argentina and Venezuela as China became one of their largest export markets. (IDB, 2006). Mexico's export products are similar to those of China, which is why it is likely to face a greater challenge. Secondly, the growing FDI outflows from China are also important. In 2004, 50 per cent of Chinese FDI went towards Latin American (more than the 30 per cent than went towards Asia) (Lall, Albaladejo and Mesquita, 2004).

[4] More references are in Olarreaga et al (2007)

[5] For a comparison of factor endowments and export structures in China and Latin America see Schott (2004). For a comparison of transportation costs and their role in export competitiveness see Hummels (2004).

[6] The best-known international competitiveness indicator is the Growth Competitiveness Index published annually by the World Economic Forum. See WEF (2008)

[7] The country with best performance in Latin America is Chile with rank 12, the next in the region is Mexico with rank 35.

multinationals in China. The authors argue that the US firms account for a small component of total FDI inflows into China. US affiliates have contributed very little to Chinese fixed asset investment or employment growth.[8] Moreover, in 2004 the Chinese operations of US firms accounted for only 1.9% of total foreign affiliate sales and 0.7% of total foreign affiliate assets. These small numbers reflect China's poverty, its distance from the US market, and, to a lesser extent, its imperfect institutions (Ibid.).

The above overview of facts, opinions and studies shows the importance of further research regarding possible effects of growing FDI inflows to China on the investment traditionally received by Latin America. In this article, we examine empirically whether recent FDI to China have influenced the main traditional destinations of the US foreign direct investment in the region. Specifically, we focus on a group of representative Latin American economies. These are Argentina, Brazil, Chile, Columbia, Mexico, and Venezuela. Particularly, for the case of Mexico, we develop a simulation exercise to assess the impact that an increase of the US investment flows to China may have on the Mexican economy.

The organization of this article is as follows. After this brief background discussion, in the section 2, present the methodology and the empirical model. In section 3, we present and discuss our results. Section 4 concludes.

2. Methodology

In recent years, VAR and VECM methodologies have been used to test causal relationships among financial and economic variables. A pioneering application of these methodologies is that of McMillin (1988), which was was developed to analyze the effects of monetary shocks on business cycles. Other applications are found in Bernanke and Blinder (1992), Sims (1992), and Johansen (1998). Such applications were used to describe the effects and channels of monetary transmission in developed economies. More recent applications are those of Nielsen (2002) and Awokuse (2003). The latter studies were used to analyze the Danish exports and to validate the export-lead growth hypothesis for the Canadian economy.

The application of these methodologies in the Latin American context is relatively rare. Recently, Abugri (2008) has used them to analyze the interactions between financial markets and macroeconomic performance in four Latin American economies. Other country-specific applications have focused on the Mexican economy. Among these applications those of Cuadros (2000) and De la Cruz and Nuñez (2006) are particularly relevant. The former analyzes the relationship between savings and growth determinants, while the latter focuses on the long-run relationship between FDI and the growth of the Mexican economy.

Here we attempt to provide confirmatory evidence about the role of China in the Latin American region by using two time series methodologies. The first is that proposed by Gunduz and Hatemi-J (2005), which has two relevant aspects: 1) the application of the information criterion introduced by Hatemi-J (2003) to determine the optimal lag order in a vector

[8] See Branstetter and Foley (2007).

autoregressive model (VAR)[9]; and 2) the Toda and Yamamoto (1995) procedure to build a VAR by levels. [10] The second methodology is that of Liu, Song and Romilly (1997), which is used to test the existence of causal relationships between integrated series exists by employing a vector error correction (VECM) with the Hatemi-J lag's test to estimate the correct VAR's order.

The VECM analysis procedure used in this article was originally applied by Liu, Song and Romilly (1997), Chandana and Basu (2002) and Liu, Burridge, y Sinclair (2002). This methodology allows us to study causality among non-stationary time-series that have long-run relationships. The analysis is based on the construction of a VECM that allows us to understand causality in a multivariate framework. In order to achieve this goal, we first verify the existence and number of unit roots by applying the Dickey-Fuller test (1979). Once the integration order is established, the second step consists in the application of the Johansen and Juselius (1990) cointegration test, by means of which we can build the VECM using maximum likelihood techniques to a VAR model assuming that the errors are Gaussian.

The VECM allows us to study both weak causality and bidirectionality through the application of zero constraints over the adjustment factors and the lags of the variables included in the vector. In the latter case, the procedure allows us to establish, variable per variable, the existence of Granger causality and the direction of it (see Appendix A). With the VECM we also have the possibility to test for weak exogeneity. If the long-run relationship is significant enough to explain the evolution of the endogenous variables, and if uni or bidirectional causalities really exist between variables, both can be estimated. Finally, because all the variables used are expressed as logarithms, the VECM shows the relationships in terms of growth rates, and, by extension, it can be established how the evolution of investment in one country affects the dynamic of others.

As said, the first step includes the construction of the vector error correction models (VECM models); to do this, we use transformed stationary time series (see Appendix B).[11] Furthermore, the selection of the optimal number of lags of the dependent variable depends on an Akaike criterion. The use of this criterion in addition to the Johansen-Joselius procedure allows us to prove the existence of cointegration (i.e. long-run relationships) among the variables.

VECM models allow us to study the interrelations of Latin-American economies with themselves and with the US economy. We use one VECM model (VEC 1), to study the

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[9] Statistically, testing the existence of some log-run relationship requires a *pth*-order structural and dynamic VAR model. For this purpose, it is important to consider the choice of the optimal lag order (p). Here the number of lags selected depends on the new Hatemi-J´s (2003) information criterion. Such criterion allows us to find the optimal lag order when the variables contain stochastic trends. Then we use the Johansen and Juselius (1990) procedure to find the number and to estimate the cointegrated relationships.

[10] The Toda and Yamamoto (1995) procedure guarantees that the asymptotical distribution theory can be applied. Basically, the authors propose an augmented VAR (p+d) model for testing causality, if the variables are integrated (p is the VAR's lag order and d is the integrations order of the variables).

Consequently, the following VAR (p), in levels, is used:

$$y_t = v + A_1 y_{t-1} + \ldots A_p y_{t-p} + \varepsilon_t \qquad (1)$$

Where:

ν is a vector of intercepts, y_t is the number of variables [I (d)] and ε is the vector of errors terms (See Appendix A).

[11] The time series transformation was justified by the showing that all variables were I(1).

relationships between investment flows to Argentina, Brazil, Mexico and Venezuela. We then use a second VECM model (VEC 2) to study the relationships between investment flows to Chile, Colombia and Mexico. In both vectors we include the Gross Domestic Product of United States (US GDP) as an exogenous variable, in order to capture the influence of the American business cycle on the amounts that the US invests beyond its borders.

The final step of the procedure involves the construction of two additional VECM models to focus on the interrelations between Latin America and China. Specifically, we include FDI flows from the US to China as an exogenous variable in the VECM models described earlier. We do this to focus on the possible impact of investment flows to China on Latin America and vice versa. Furthermore, we study the effects of a shock in US estment flows to China on the Mexican economy by developing an impulse-response analysis, applying the Toda and Yamamoto (1995) procedure. Finally, a VAR (p+d) is built to prove the robustness of the results.

3. Results

We assess the determinants of the US investment flows to some of the most representative Latin American economies. In particular, we evaluate the interrelations that these economies have with each other, with the US and with the China. This assessment is based on the double step-procedure described earlier. The data used are yearly figures for the period 1966-2006, and were obtained from the US Bureau of Economic Analysis.

3.1. US-Latin America Relationships

We begin by exploring the correlations between the economic performance of US and the amounts of US investment in the Latin American economies. Our analysis shows that there is a strong correlation between the economic growth of United States and its investment abroad (See Table 1).

Table 1
FDI Correlation

	Argentina	Brazil	Chile	Colombia	Mexico	Venezuela	US GDP
Argentina	1.00	0.95	0.95	0.85	0.86	0.87	0.85
Brazil	0.95	1.00	0.92	0.77	0.85	0.80	0.94
Chile	0.95	0.92	1.00	0.798	0.90	0.90	0.90
Colombia	0.85	0.77	0.79	1.00	0.69	0.81	0.88
Mexico	0.86	0.85	0.90	0.69	1.00	0.94	0.88
Venezuela	0.87	0.80	0.90	0.81	0.94	1.00	0.75
US GDP	0.85	0.94	0.90	0.85	0.88	0.75	1.00

Source: Bureau of Economic Analysis

Statistically, this correlation analysis can only be considered a first approximation of the relationships between the health of US economy and US investment flows to the Latin American countries. However, simple correlations do not allow us to establish causality nor the existence of close relationships between each Latin-American country and US, nor between the Latin-American countries themselves. It is necessary to use Granger causality techniques in order to clarify such relationships.

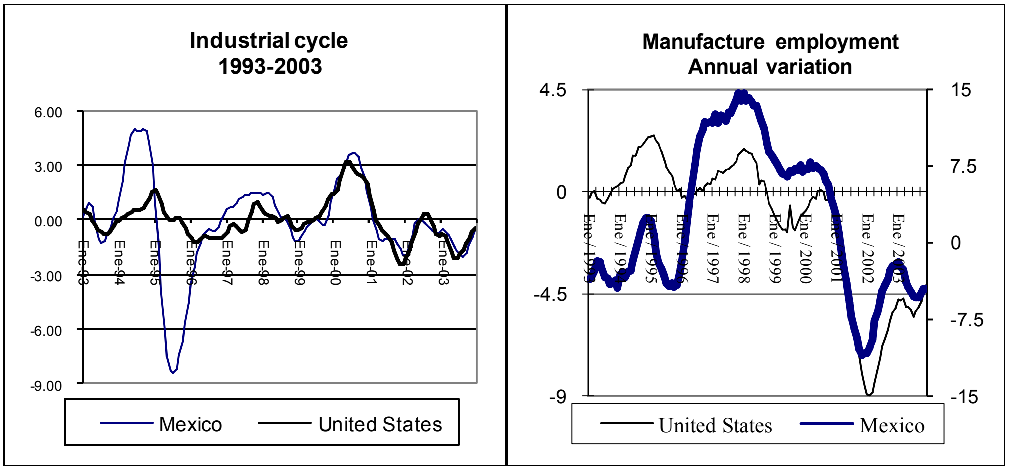
As we have mentioned, the data are organized in two samples. The first of these allows us to construct the first vector error correction model: VECM 1. Statistical tests on VECM 1 suggest us that significant (5 percent) weak exogeneity exists for all the variables (see Appendix D). This finding implies that, in the sample of countries included in each VECM, the information and evolution of US FDI in every two Latin-American countries and the GDP of US allow us to understand the dynamics of US FDI in every third Latin-American country. Thus US FDI in each country is conditioned by the American business cycle, and by investment flows into other Latin-American countries.

The existence of weak exogeneity is a necessary but not a sufficient condition for the purposes of the economic analysis. Thus, even though, as a whole, the information provided by this set of the variables allows us to explain US investment in each particular Latin American country, we need to analyze the role of historical information. This information, captured by the lags of each VECM, allows us to explain the individual trends of US investment in each country of the Latin American region. Using this procedure, it is possible to explain statistically how the lagged variables influence other dependent variables, and to determine whether causality is uni or bidirectional.

Statistical tests show that in all the cases where causality is observed in VEC 1, the causality test is positive (see Appendix E). US GDP seems to be the main explanatory variable of investment flows to the Latin-American countries. Looking at our results in more detail, it becomes apparent that investment flows to Brazil depend on lags in investment in other South American countries and on US GDP. It also seems that the closest relationships for Venezuela are with the flows of investment to Brazil and the state of the US economy. Furthermore it seems that bidirectional causality exists between Argentina and Brazil and also between Brazil and Venezuela. Such bidirectional causalities suggest that there are long-run economic interrelationships among these countries. Interestingly US investment in Mexico seems to depend only on US economic performance.

We analyze the cases of Chile, Colombia and Mexico with a second VECM: VECM 2. This vector confirms that the observed causality between US economic performance and investment flows to Latin America is positive and that the performance of the US economy is the main explainanation of such flows. Thus, US investment in Chile, Colombia and Mexico are explained by the US GDP. This result means that long-run investment to the Latin American region mainly depends on the economic situation prevailing in the US economy; this is particularly true for the Mexican economy. Such conclusion is supported with empirical evidence that shows there are close ties between employment and production in both countries (see Graph 3). Moreover, this conclusion is reinforced by the fact that 90 percent of Mexican exports go to US markets.

Graph 3
The Economies of United States and Mexico



Source: Bureau of Labor Statistics, FED and INEGI.

3.2 US– Latin America –China Relationships

In the second phase of our study, we include the US investment flows to China as a new variable in each of the previous data samples and VECM vectors. As in the previous analysis, the estimations show that weak exogeneity prevails in VECM 1 and VECM 2 (see Appendix F). Significant (5 percent) weak exogeneity exists for all the variables in both vectors. Therefore our previous interpretation can be extended to include China. Thus US FDI in each analyzed country is conditioned to the business cycle of the American economy and by the performance of other Latin American and Asian countries.

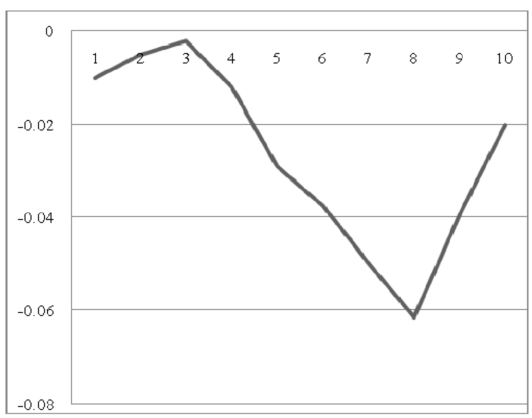
Econometrically, it is interesting to point out that the statistical analysis of causality shows that a negative unidirectional relationship exists from China to most Latin-American countries (See Appendix G). Specifically, according to the sample of countries included in VECM 1, this relationship exists with respect to Brazil, Mexico and Venezuela. In the sample of countries included in VECM 2, such relationship also is found with respect to Mexico. These findings, in addition to the previous ones, suggest the existence of competition between the Latin American countries and China for US investment flows. Indeed, the analyses based on the methodology of Toda and Yamamoto (1995), confirm the previous results. The causality tests show the same negative causal relationships from China to the most important Latin American countries (See Appendix F).

We believe that the explanation of these econometric findings lies at least in part on the existence of manufacturing export competition between China and the Latin American economies. Chinese manufacturing exports to the rest of the world have increased extraordinarily, and China has become the second leading exporter to the US, including such items as electronics, computers and electrical equipment. Exports and FDI are closely related in emerging economies [see, among others, Kung (2004) and De la Cruz and Nuñez (2006)]. We believe that our findings regarding the determinants of investment flows to Latin America can be explained in terms of this relationship and the existence of competition between Latin America and China.

Historically, Asian and Latin American economies used to export different goods, but now the situation is different. According to García-Herrero and Santabárbara (2005), a type of FDI substitution effect occurs among export-oriented emerging economies. Such substitution effect occurs when the economies produce the same goods and compete in the same markets. Thus, according to this idea, a rise in FDI inflows in an emerging economy, like the Chinese, can reduce investment flows to other, similar ones. We believe that some Latin American economies are experiencing this type of substitution effect, especially the exporters of manufactured goods, such as Brazil and Mexico.

The FDI substitution effects between the Chinese and Latin American economies may have a negative impact on the economic performance of the latter. Here we assess this impact for the Mexican economy with an impulse-response analysis (see Graph 4). According to the impulse-response function, a change in US investment in China reduces the corresponding amount in Mexico. This prediction is consistent with the fact that some substitution of manufactured exports has occurred in recent years. Mexican economic growth shows a positive relationship with FDI and exports (see De la Cruz and Nuñez, 2006). Thus our assessment provides some support to those who claim that an increase in Chinese manufacturing sectors may have negative growth effects on the Latin American economy.

Graph 4.
Response of Mexico to China



Our evidence suggests the existence of competition and substitution for FDI exists between China and some Latin American economies. However, we must recognize that China does not necessarily reduce FDI flows to the region. In recent years, Chinese investment flows to Latin America have increased. Usually such investment focuses on primary sectors, mainly into the production of commodities [see Rosales and Kuwayama, 2007]. In addition, the Chinese economy also demands the oil, copper and steel produced in the region. Such requirements explain the direct associations of China with economies like Argentina, Brazil, Chile, Colombia or Venezuela. Furthermore, these allow us to understand why some of those economies do not experience the FDI substitution effect.

4. Conclusions and comments

The Chinese development strategy to entice foreign firms into investing in the country has been a huge success. This strategy depended on a mix of external and domestic policies. The Chinese "open door" external policies are complementary to those that internally seek the privatization of the economy. But is China diverting foreign direct investment away from the Latin American economies? This is the paramount question on the mind of many academic researchers as well as policymakers in Latin America.

Here we have explored this question by using a time series study based on causality tests. The econometric outcomes suggest that long-run investment inflows to the Latin America region mainly depend on the economic situation prevailing in US economy and the specific relationships that each Latin American economy has with other economies of the region. Furthermore, the outcomes also suggest that there is competition between the Chinese and the Latin American economies for US foreign investment. FDI substitution effects may occur as consequence. Thus, at least for some economies of the region, increases in US FDI flows to China may reduce US investment in Latin America and, eventually, the economic growth perspectives of the region.

We have derived such conclusions by applying two different methodologies for different country-data samples. According to our estimations, US FDI in each country is conditioned to the business cycle of the American economy. Our estimations also suggest that competition for FDI exists between emerging economies. Specifically they suggest that Brazil, Mexico and Venezuela compete (have a negative causal relationship) with China. Moreover, they suggest that the causation of such flows goes from China to Latin America. In addition, on the basis of an impulse-response analysis, we have provided evidence to support the claim that an increase in the production of Chinese manufactures may have negative growth effects to the Latin-American economies.

The Mexican economy deserves special attention in our analysis, since it is very likely that Mexico will be the country most affected by FDI competition and FDI substitution effects. De la Cruz, Gonzalez and Canfield (2008) show that the economic performance of Mexico relies mainly on its industrial and foreign trade sectors. Moreover, US investment flows to this economy are almost completely oriented to these sectors. Thus, overall, the behavior of FDI inflows is essential for the Mexican economy and its performance. Consequently, any change in the US economy may have a double-impact in this emerging economy through changes in exports and FDI inflows. In this context, FDI competition may be particularly stressful because US investment inflows do not seem to depend on the Mexican economy.

This study can be extended in several directions. Further exploration into the determinants of US FDI flows to the Latin-American economies may include variables like exports, imports, domestic investment and employment. In fact, wider economic frameworks seem to be necessary to improve our understanding. In addition, the role of government policies must be analyzed. Since the nineties, economic reforms associated to privatization, financial and trade liberalization may have an important role to explain the financial flows in the Latin American region. Finally a third extension of this research has to do with the analysis of Chinese FDI outflows to the Latin American region, the understanding of which is necessary for the assessment of the net effects of the Chinese economy on Latin America.

Finally, we think that the impact of the Chinese economy on the Latin American region has been unnecessarily overestimated. Financial competition is important, but the Chinese economy *per se* is not *the* most important determinant of the flows of foreign direct investment into Latin America. Indeed, we believe that the reorganization of domestic conditions must play a bigger role in encouraging investment inflows. Such conditions may include regulation of markets, fostering of adequate corporate and fiscal practices, and liberalization reforms. However, we should not dismiss the notion that Chinese competition may force the emerging economies of Latin America to improve their productive sectors and to defend their position in the international capital markets.

APPENDIXES

Appendix A. Causality Methodology

a) VAR(*p*+*d*)

In the Toda and Yamamoto proposal, the causal relationship test does not include additional lags, i.e., *d.* Gunduz and Hatemi-J (2005) define the Toda and Yamamoto test statistic in a compact way,

$$Y = \hat{D} Z + \hat{\delta} \tag{1}$$

Where

$$Y = (y_1, y_2, \ldots\ldots, y_T) \ (n \times T) \text{ matrix}$$

$$D = (\hat{v}, \hat{A}_1, \ldots, \hat{A}_p \ldots, \hat{A}_{p+d}) \ (n \times (1+n(p+d))) \text{ matrix}$$

(Â is the estimated parameters matrix)

$$Z = (Z_0, Z_1, \ldots\ldots, Z_{T-1}) \ ((1+n\ (p+d) \times T) \text{ matrix}$$

$$Z_t = \begin{bmatrix} 1 \\ y_t \\ y_{t-1} \\ . \\ . \\ y_{t-p+1} \end{bmatrix}$$

and

$$\hat{\delta} = (\hat{\varepsilon}_1, \ldots\ldots, \hat{\varepsilon}_T) \ (n \times T)$$

$\hat{\varepsilon}_t$ is defined as the estimated error term. Toda and Yamamoto introduced a modified Wald (MWALD) statistic for testing the null hypothesis of non-Granger causality.
According to Gunduz and Hatemi-J (2005), the MWALD test is defined as:

$$MWALD = (C\hat{\beta})' \left[C((Z'Z)^{-1} \otimes S_u) C \right]^{-1} (C\hat{\beta}) \sim \chi^2_p \tag{2}$$

Where C is a ($p \times n(1+n(p+d))$) selection matrix. That indicates whether a parameter has a zero value as the null hypothesis of non-Granger causality implies. *Su* is the estimated variance-covariance matrix of residuals in Equation 1. β *=vec(D)* where *vec* means the column-staking operator

b) VECM(*p*)

Without loss of generality, assume the existente of an autorregressive vector of p *order* (VAR(p)) (Quintos, 1998).

$$y_t^* = J(L)y_{t-1}^* + \varepsilon_t \qquad (3)$$

$$J(L) = \sum_{i=1}^{k} JL^{i-1} \qquad (4)$$

Where y_t^* is integrated of order one (I (1)). The corresponding VEC vector is

$$\Delta y_t^* = J_k^*(L)\Delta y_{t-1}^* + \Pi y_{t-1}^* + \varepsilon_t \qquad (5)$$

$$J_k^*(L) = \sum_{1}^{k-1} J_i^* L^{i-1} \qquad (6)$$

$$J_i^* = -\sum_{l=i+1}^{k} J_l \qquad (7)$$

with

$$\prod = (J(1) - I) \qquad (8)$$

If there are q cointegration relationships, the matrix $\prod$ can be written as

$$\Pi = \alpha\beta' \qquad (9)$$

From equation 9, it can be established that the short and long-run significance of the parameters can be studied, β_{ij} y α_{ij} respectively. Weak exogeneity can be studied by using zero constraints on α_{ij}. In the case of bidirectional causalita, Wald tests are applied on the lags of each variable included in the VEC (Liu, Burridge y Sinclair, 2002).

Appendix B. Unit root test

VARIABLE	ADF CRITICAL VALUE	SIGNIFICANCE LEVEL (%)	VALUE
Argentina	-1.95	5	1.35
Brazil	-1.95	5	1.29
Chile	-1.95	5	-0.53
China	-1.95	5	1.02
Colombia	-1.95	5	-0.49
Mexico	-1.95	5	2.84
Venezuela	-1.95	5	3.59
United States	-1.95	5	1.13

Appendix C. Cointegration test

VECM 1: Argentina, Brazil, Mexico, United States and Venezuela.

Cointegration Rank Test				
Hypothesis No. de CE(s)	Eigenvalue	Trace	5 % Critical Value	1 % Critical Value
None**	0.973400	148.3964	62.99	70.05
One**	0.694013	80.97977	42.44	48.45
Two	0.434595	23.00230	25.32	30.45
Three	0.163011	1.936102	12.25	16.26
Tour	0.034965	1.020344	8.94	12.94

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Trace test indicates 2 cointegrating equation(s) at the 5% level

VECM 2: Chile, Colombia, Mexico, United States

Cointegration Rank Test				
Hipótesis No. de CE(s)	Eigenvalue	Trace	5 % Critical Value	1 % Critical Value
None**	0.659304	67.48396	46.18	59.75
One**	0.294955	39.78295	30.47	38.23
Two	0.103485	7.295066	14.93	22.23
Three	0.010737	0.193574	3.69	5.38

*(**) denotes rejection of the hypothesis at the 5%(1%) level
Trace test indicates 2 cointegrating equation(s) at the 5% level

Appendix D. Weak exogeneity results

VECM 1

Country	P-value
Argentina	0.0312
Brazil	0.0011
México	0.0275
Venezuela	0.0021
United States	0.0000

VECM 2

Country	P-value
Chile	0.0131
Colombia	0.0002
Mexico	0.0101
United States	0.0003

Appendix E. Granger causality

VECM 1 Simple: 1966 2006 Dependent variable: D(LOG(ARGENTINA))		
Independent	Df	Prob.
D(LOG(BRAZIL))	4	0.0130
D(LOG(MEXICO))	4	0.6293
D(LOG(USPIB))	4	0.0385
D(LOG(VENEZUELA))	4	0.7193
All	16	0.3113
Dependent variable: D(LOG(BRAZIL))		
Independent	df	Prob.
D(LOG(ARGENTINA))	4	0.0000
D(LOG(MEXICO))	4	0.1492
D(LOG(USPIB))	4	0.0183
D(LOG(VENEZUELA))	4	0.0505
All	16	0.0603
Dependent variable: D(LOG(MEXICO))		
Independent	df	Prob.
D(LOG(ARGENTINA))	4	0.1823
D(LOG(BRAZIL))	4	0.0451
D(LOG(USPIB))	4	0.0190
D(LOG(VENEZUELA))	4	0.2691
All	16	0.1537
Dependent variable: D(LOG(VENEZUELA))		
Independent	df	Prob.
D(LOG(ARGENTINA))	4	0.0501
D(LOG(BRAZIL))	4	0.0000
D(LOG(MEXICO))	4	0.0398
D(LOG(USPIB))	4	0.0271
All	16	0.0182

VECM 2 Sample: 1966 2006 Dependent variable: D(LOG(CHILE))		
Independent	Df	Prob.
D(LOG(COLOMBIA))	3	0.0915
D(LOG(MEXICO))	3	0.3891
D(LOG(USPIB))	3	0.0259
All	9	0.2162
Dependent variable: D(LOG(COLOMBIA))		
Independent	df	Prob.
D(LOG(CHILE))	3	0.1538
D(LOG(MEXICO))	3	0.5529
D(LOG(USPIB))	3	0.0419
All	9	0.3791
Dependent variable: D(LOG(MEXICO))		
Independent	df	Prob.
D(LOG(CHILE))	3	0.6129
D(LOG(COLOMBIA))	3	0.1872
D(LOG(USPIB))	3	0.0001
All	9	0.3010

VEC 1

Causality direction	Sign
Brazil→ Argentina	Positive
United States → Argentina	Positive
Argentina→ Brazil	Positive
United States → Brazil	Positive
Venezuela → Brazil	Positive
Brazil→ Mexico	Positive
United States →Mexico	Positive
Argentina→Venezuela	Positive
Brazil→Venezuela	Positive
Mexico→Venezuela	Positive
United States→Venezuela	Positive

VEC 2

Causality direction	Sign
United States → Chile	Positive
United States →Colombia	Positive
United States→Mexico	Positive

Appendix F. Weak exogeneity results when China is included.

VECM 1

País	P-value
Argentina	0.0101
Brazil	0.0000
México	0.0491
Venezuela	0.0170
United States	0.0016
China	0.0371

VECM 2

Country	P-value
Chile	0.0219
Colombia	0.0312
Mexico	0.0501
United States	0.0210
China	0.0032

Appendix G. Chinese causality effects over the Latin American countries.

VECM 1

Country	P-value
Argentina	0.0938
Brazil	0.0451
Mexico	0.0315
Venezuela	0.0373

VECM 2

Country	P-value
Chile	0.3129
Colombia	0.2844
Mexico	0.0113

Causality direction

VECM 1

Direction	Sign
China →Brazil	Negative
China→Mexico	Negative
China →Venezuela	Negative

VECM 2

Direction	Sign
China →Mexico	Negative

Appendix F. Toda and Yamamoto´s causality results

VAR 1

Direction	Sign
China →Brazil China→Mexico China →Venezuela	Negative Negative Negative

VAR(2)

Direction	Sign
China →Mexico	Negative

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