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Manufacturing Exports Determinants across Mexican States, 2007-2015*

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Abstract: This article examines manufacturing export determinants across Mexican states and regions from 2007 to 2015, paying particular attention to the role of FDI. The analysis considers internal and external determinants of manufacturing exports under static and dynamic panel data methods, obtaining three main results. First, the ratio of manufacturing to total GDP is the most consistent determinant explaining exports performance, regardless of the econometric specification employed. Second, static panel data estimations under GMM techniques suggest different sensitivity to FDI across regions, with the Mexico-U.S. border region observing the strongest short-term effect of FDI on manufacturing exports. Finally, using dynamic panel data methods, we observe a significant persistence and similar long-term effects of FDI across most of the regions on the exporting manufacturing sector.
Keywords: Exports, Foreign Direct Investment, Panel Data, Mexico
JEL Classification: F16, F36

Resumen: El trabajo examina los determinantes de las exportaciones manufactureras en los estados y regiones de México para el periodo 2007-2015, con especial atención al papel de la inversión extranjera directa (IED). El análisis considera factores internos y externos usando métodos de datos panel estático y dinámico, obteniéndose tres resultados principales. Primero, la razón de PIB manufacturero a PIB total resultó ser el determinante más consistente que explica el desempeño de las exportaciones manufactureras, independientemente de la especificación econométrica empleada. En segundo lugar, las estimaciones mediante técnicas de datos panel estático (MGM) sugieren diferentes grados de sensibilidad respecto a la IED entre las regiones, con la norte experimentando el efecto más fuerte de corto plazo de la IED sobre las exportaciones manufactureras. Finalmente, al usar métodos de panel dinámico, se observa un efecto persistente y significativo de largo plazo similar para todas las regiones de la IED sobre el desempeño exportador del sector manufacturero.
Palabras Clave: Exportaciones, Inversión Extranjera Directa, Datos Panel, México

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This paper was written while René Cabral was working as an Economist at Banco de México.

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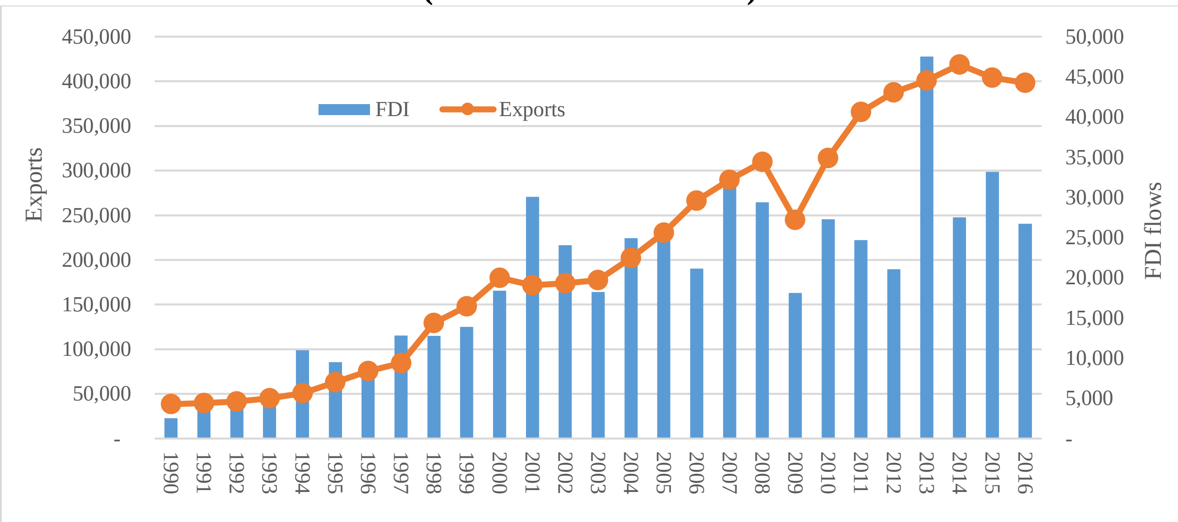
1. Introduction

Over the last three decades, the Mexican economy has undertaken significant structural changes in terms of its relationship with the rest of the world. The country shifted its strategy of economic development from an import-substitution industrialization and an oil-dependent economy to an open and export-oriented economy, especially with respect to manufactured goods (Williamson, 1990; Ten Kate, 1992). Following its insertion into the World Trade Organization (formerly known as General Agreement on Tariffs and Trade) in 1986, and the enactment of the North America Free Trade Agreement (NAFTA) in 1994, Mexico's trade and capital flows rose significantly (Figure 1). Moreover, since then Mexico has strategically promoted free trade by signing twelve free trade agreements with 46 countries and 32 agreements for the promotion and reciprocal protection of investments.

Figure 1
Mexico's Total Exports and FDI Flows
(Millions of U.S. dollars)



Source: Prepared with data from the World Bank, World Development Indicators.

Today exports and FDI flows are two crucial engines for the Mexican economy, especially those associated with the manufacturing sector. Figure 1 presents the evolution of total Mexican exports and FDI inflows between 1990 and 2016. Since the period before the starting of NAFTA to the most recent years, exports and FDI have experienced remarkable increases of about nine-fold and six-fold in value, respectively. Although the rise in exports and FDI has been significant, its effect has not been homogeneously felt across all Mexican states and regions. While manufacturing activity and its corresponding exports have become a central element for the economies of some states, others hardly participate, being largely absent from export-related businesses (Figure 2).

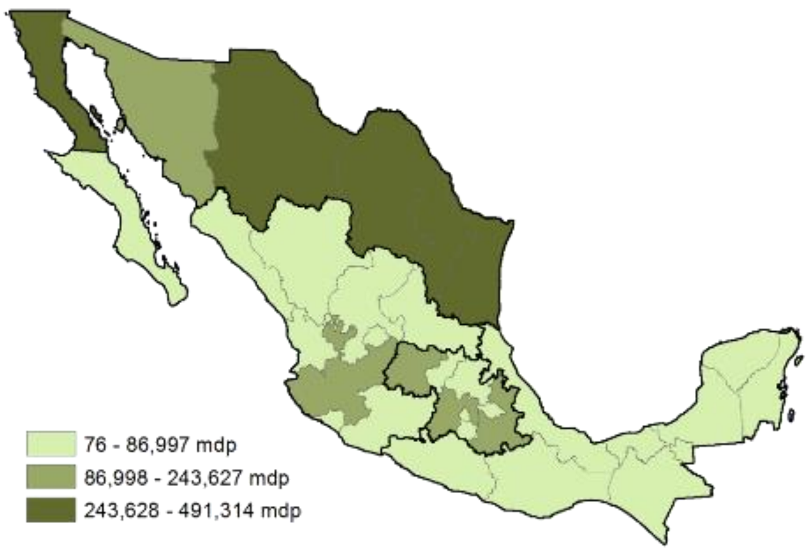
Figure 3 shows the ratio of manufacturing exports to GDP for the different states and the four regions of Mexico.[1] The figure gives account of a very dissimilar pattern of trade across the country, with a significant concentration of exports along the Northern region, where every state performs well above the national average (22.7%) and some states have exports that exceed the size of its GDP (e.g., Chihuahua with 113%). Meanwhile, the Southern region is similar to trade with rest of the world, none of its states exceeds the national average and for some of them manufacturing exports represent less than 1% of GDP (e.g., Campeche, Quintana Roo, and Guerrero). Although FDI is more volatile in nature, in recent decades it has registered significant growth, showing a geographical distribution similar to that of exports.[2]

[1] We employ the regionalization proposed by Banco de México (2011): Northern (Baja California, Chihuahua, Coahuila, Nuevo León, Sonora, and Tamaulipas), North-Central (Aguascalientes, Baja California Sur, Colima, Durango, Jalisco, Michoacán, Nayarit, San Luis Potosí, Sinaloa, and Zacatecas), Central (Ciudad de México, Estado de México, Guanajuato, Hidalgo, Morelos, Puebla, Querétaro, and Tlaxcala), and Southern (Campeche, Chiapas, Guerrero, Oaxaca, Quintana Roo, Tabasco, Veracruz, and Yucatán).

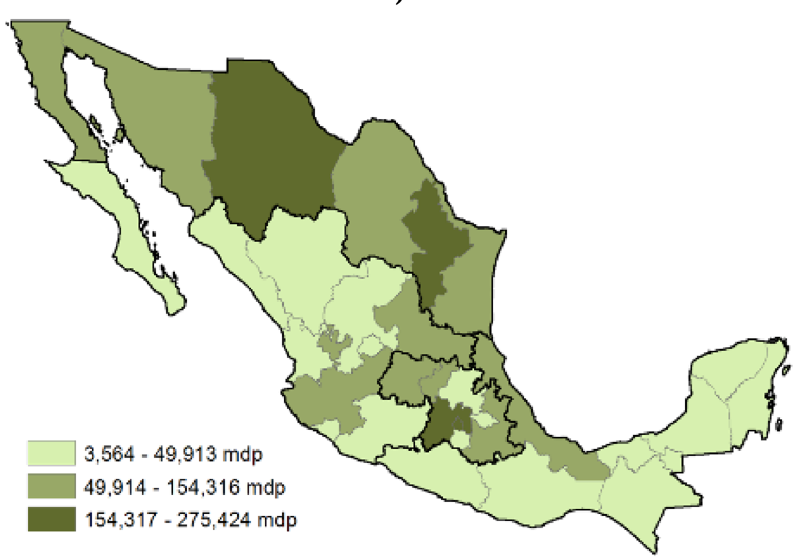
[2] The Northern and Central regions of Mexico have attracted the highest proportion of FDI stock (38.8 and 38.0 percent, respectively), followed by the North-Central and Southern regions (16.7 and 6.4 percent, respectively).

Figure 2
Average Annual Manufacturing Exports and FDI Flows, 2007–2015
(Real pesos of 2008)

a) Exports

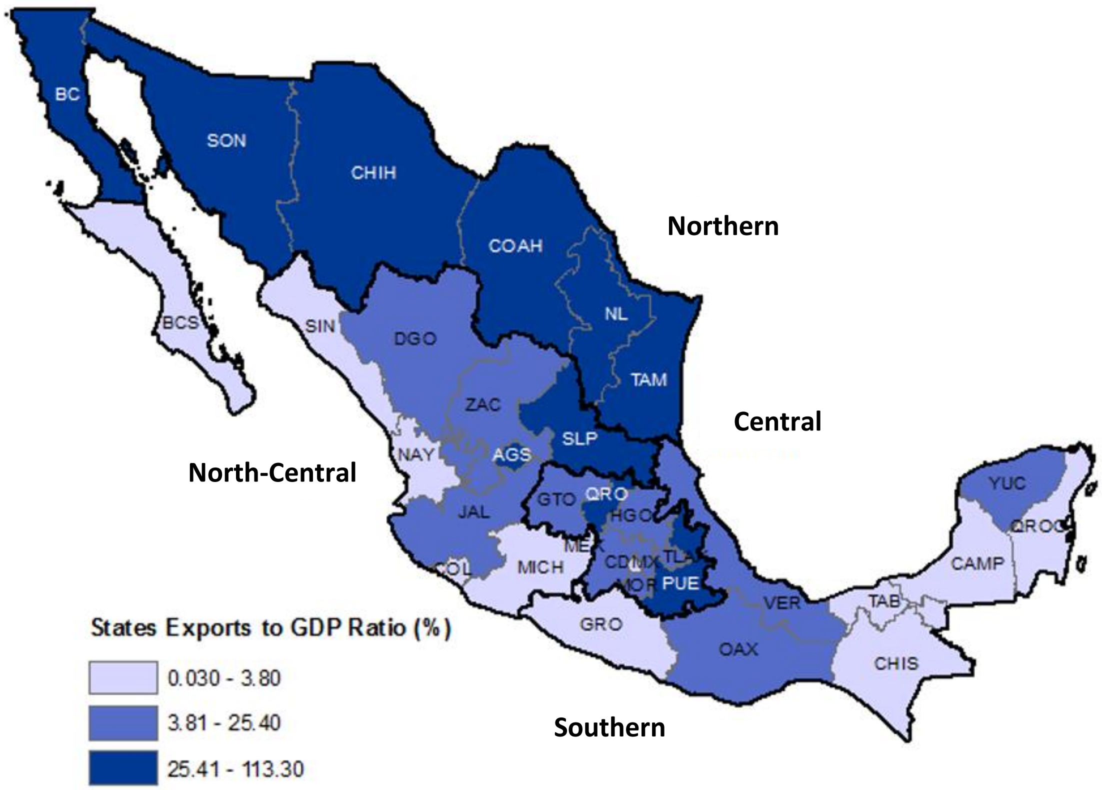


b) FDI



Source: Own estimations with data from INEGI and Secretaría de Economía.

Figure 3
Average State Exports to GDP Ratio 2007–2015 (%)



Northern	North-Central	Central	Southern
Baja California (BC)	Aguascalientes (AGS)	Ciudad de México (CDMX)	Campeche (CAMP)
Chihuahua (CHIH)	Baja California Sur (BCS)	Estado de México (MEX)	Chiapas (CHIS)
Coahuila (COAH)	Colima (COL)	Guanajuato (GTO)	Guerrero (GRO)
Nuevo León (NL)	Durango (DGO)	Hidalgo (HGO)	Oaxaca (OAX)
Sonora (SON)	Jalisco (JAL)	Morelos (MOR)	Quintana Roo (QROO)
Tamaulipas (TAM)	Michoacán (MICH)	Puebla (PUE)	Tabasco (TAB)
	Nayarit (NAY)	Querétaro (QRO)	Veracruz (VER)
	San Luis Potosí (SLP)	Tlaxcala (TLAX)	Yucatán (YUC)
	Sinaloa (SIN)		
	Zacatecas (ZAC)		

Source: Own estimations using data from INEGI.

Considering the above patterns of trade and FDI, this paper studies the determinants of manufacturing exports across Mexican states while paying special attention to the impact of foreign capital flows. A number of papers have studied the determinants of exports in industrial and emerging economies. A first strand of literature mainly examines the casual relationship between exports and FDI. Overall, studies analyzing causality report mixed results. For instance, Boubacar (2016) employs annual data on U.S. FDI to 25 OECD countries between 1999 and 2009. He uses spatial econometrics panel data techniques and finds a complex bidirectional causality between FDI and exports. Goswami and Saikia (2012) also analyze causality making use of aggregate data for India's exports, FDI, GDP and gross fixed capital formation. Estimating a vector error-correction model, they report the presence of bidirectional causality between exports and FDI. Ahmed et al. (2011) analyze causality for Ghana, Kenya, Nigeria, South Africa and Zambia, employing an error-correction model to test for Granger causality. Their findings show bidirectional causality between exports and FDI in Ghana and Kenya, Granger causality from FDI to exports in South Africa and from exports to FDI in Zambia. Similarly, Hsiao and Hsiao (2006) analyze causality in China, Korea, Hong Kong, Singapore, Malaysia, Philippines and Thailand using time series for 1986–2004. Finally, in estimating panel data Granger causality test between GDP, exports and FDI, they report individual direct causality from exports to FDI only in China, but from FDI to exports in the cases of Taiwan, Singapore and Thailand. For the eight countries in the sample analyzed together, they only observe direct causality from FDI to exports.[3]

[3] For more studies with mixed evidence of causality between exports and FDI, see for instance, Chowdhury and Mavrotas (2006), Baliamoune-Lutz (2004), Dritsaki et al. (2004), and Zhang and Felmingham (2001).

In a second strand found in the literature, several other studies have followed a multivariate approach that not only looks at causality between exports and FDI but also at other relevant determinants of exports. Many of those studies have made use of industry- or firm-level data. For instance, Franco (2013) employed data pertaining to U.S. FDI on sixteen OECD countries from 1990 to 2001 separating assets seeking from asset exploiting FDI. Employing panel data techniques, she addresses endogeneity problems caused by FDI and exports, and observes that market seeking FDI influences export intensity more than other forms of FDI. Rahmaddi and Ichihashi (2013) analyze Indonesia's manufacturing exports by industry from 1990 to 2008 using fixed effects panel data methods. They find that higher levels of FDI enhance the performance of manufacturing exports and that FDI effects on exports varies across manufacturing industries with capital-intensive, human capital-intensive and technology-intensive exporting industries gaining the most from FDI inflows. Karpaty and Kneller (2011) analyze manufacturing firms in Sweden with at least 50 employees during the years 1990-2001. Using the two-stage probit procedure proposed by Heckman (1979), they find that FDI has positive effects on Swedish exports.[4]

In a third strand of literature, some studies have examined the effects of FDI on exports at either the subnational or regional level. Perhaps due to the absence of data on exports for other countries, the existing evidence studying the regional influence of FDI on exports seems to be concentrated on Chinese regions. For instance, Zhang (2015) employs data for 31 manufacturing sectors and 31 regions of China over 2005–2011. Using panel data fixed effects and instrumental variables techniques, he observed that FDI has exerted a

[4] Several other studies have used firm level data for the UK (Kneller and Pisu, 2007; Greenaway et al., 2004; and Girma et al., 2008) and for Belgium (Conconi et al., 2016), among other countries.

significant influence on China's export success and that absorptive capacity is reinforced through human capital availability. Similarly, Zhang and Song (2000) used data from 24 Chinese provinces for 1986–1997 and employed ordinary and generalized least squares techniques. Their paper provides evidence on the role of FDI in promoting Chinese exports and reports that a 1% increase in the level of FDI in the previous year is associated with a 0.29% increase in exports in the following one. Finally, Sun and Parikh (2001) analyze a panel of 29 provinces across three regions of China for a period of 11 years (from 1985 to 1995). They find that the strength of the impact of exports on GDP varies significantly across regions. Their results also implied that the relationship between exports (FDI) and economic growth depends on regional, economic and social factors.

Evidence on export determinants for Mexico is less abundant and mostly focuses on the causality between exports and FDI while employing aggregate data (see, for instance, Vasquez-Galán and Oladipo (2009), De la Cruz and Núñez Mora (2006), Pacheco-López (2005), Cuadros et al. (2004) and Alguacil et al. (2002), among others). A paper that uses a different approach to that of simple causality analysis is Aitken et al. (1997). They studied 2,104 Mexican firms for 1986–1990 employing a Probit specification that analyzed the probability that a firm exports. They found that foreign firms are a catalyst for domestic firms and the probability that a firm exports is positively correlated with its proximity to multinational firms.

In this paper, we take a regional approach to look at internal and external factors that affect manufacturing exports with special interest on the importance of agglomeration economics resulting from the presence of local manufacturing activity and the stock of foreign capital. With regard to the methodology employed for the analysis, we rely on static and dynamic panel data techniques that allow us to control for potential endogeneity problems and identify short- and long-term effects of FDI on manufacturing exports.

Several interesting findings are obtained in this paper. First, regardless of the method or specification employed, we observe that the most consistent determinant of exports is the ratio of manufacturing to total GDP. This result is consistent with the idea that agglomeration economies are necessary for the existence of a robust exporting platform in each state and region. Second, using GMM estimation techniques to control for endogeneity, two important results were obtained. On the one hand, estimating a dynamic panel specification, we observed significant export persistence but, most importantly, similar long-term effects coming from FDI across most regions—with only slightly less sensitivity to FDI in the Central region. The intuition for this result is that, once we consider long-term export dynamics, there seems to be little difference on how regions respond to FDI variations. On the other hand, under our static specification, the results suggest that, in the short-term, states show different sensitivities to FDI across regions, with the Northern region experiencing the strongest effect of FDI on manufacturing exports, followed by the North-Central, Central and Southern regions.

The rest of this paper is organized as follows. Section 2 describes the data used in the analysis and presents some descriptive statistics. Section 3, describes the static and dynamic models that are employed to study manufacturing exports determinants. Section 4 presents the results of the empirical estimations. Finally, section 5 concludes.

2. Data

Our sample comprises all 32 Mexican states (see Figure 3). For the purpose of our analysis, the country is divided into four large regions following the regionalization proposed by Banco de México (2011). The period of analysis is determined by the availability of information on manufacturing exports and extends from 2007 to 2015. Our data come from various sources. Exports, states' total and manufacturing GDP comes from Mexico's National Institute of Statistics INEGI (*Instituto Nacional de Estadística y Geografía*). Foreign Direct Investment flows were obtained from Mexico's Ministry of the Economy (*Secretaría de Economía*). The real exchange rate is from Mexico's Central Bank (*Banco de México*) and the U.S. index of manufacturing production came from the U.S. Federal Reserve Economic Data.

Table 1
Average Regional Indicators, 2007-2015[1/]
(Millions of 2008 pesos)

Region	Manufacturing Exports	Manufacturing FDI Stock[2/]	Manufacturing GDP	Total GDP	Manufacturing to Total GDP (%)
Northern	358,447	147,146	133,369	569,847	23.4
North-Central	47,335	37,960	46,672	272,833	17.1
Central	85,979	108,071	130,616	735,549	17.8
Southern	13,992	18,267	36,822	411,576	8.9
National	106,994	71,037	81,451	478,888	17.0

Source: Own calculations with data from INEGI and *Secretaría de Economía*.
1/ Average values by state within each region.
2/ Manufacturing FDI was considered the accumulated figure at 2015.

Since FDI flows are highly volatile, we build a stock of FDI using the perpetual inventory method.[5] In calculating FDI stocks, we take advantage of the fact that FDI data at

[5]According to the methodology, we stablish the flow of FDI in 1999 as the initial stock of FDI ($FDIS_0 = FDI_{t=1999}$). Then, subsequent flows are added on the basis of the traditional capital accumulation

the state level is available from 1999. In Table 1 we present some descriptive statistics for the full sample and each of our four regions. As can be observed, average states' exports are considerably more substantial in the Northern region, states at the Central region are the second most important average exporters followed by the states at the North-Central and Southern regions. Looking at the stock of FDI at the end of the sample period, in 2015, we observe that the stock of FDI at the Northern and Central regions is similar (38.8% and 38.0% of the total, respectively), with the latter surpassing the former just marginally. The North-Central region stock of FDI is less than half of the Northern region (16.7%), and the Southern region accounts only a small fraction of total stock (6.4%).[6] Figure 2 provides a picture of the geographical location of exports and FDI across states. It is clear from this picture that there is a close relationship in the distribution of exports and FDI, with a significant geographical concentration in the Northern and Central regions.

In Table 2 we review the correlation between the main variables of our model. The first column shows the correlation between exports and the determinants considered in the model. As expected, we observed a positive correlation between exports and FDI, state GDP, the U.S. index of manufacturing activity, the real exchange rate, and the ratio of manufacturing to total GDP within each state. A potential problem of multicollinearity is only observed for the correlation between the stock of FDI and state's GDP (0.84). To assess this potential problem in more detail, we calculate the variance inflation factors (VIF) for the set of variables in Table 2. Jointly assessed, all variables present a mean VIF of 1.94 and

equation: $\Delta FDIS_{t+1} = FDIS_{t+1} - FDIS_t = FDIS_t - \delta FDIS_t$, δ is the rate of depreciation and is assumed to be equal to 5% as in the case of other papers in the literature.

[6] For the total FDI stock figures the values from Table 1 must be multiplied by the number of states in each region. Therefore, the final figures are 882,876; 379,600; 864,568; and 146,136 for the Northern, North-Central, Central and Southern regions, respectively. The total national FDI stock amounts to 2,273,184.

individually they are all smaller than 4, which suggests that our model is not beleaguered by multicollinearity problems.[7]

Table 2
Correlation Matrix, 2007-2015

Variables	Average manufacturing exports	FDI stock	State GDP	U.S. index of manufacturing production	Real exchange rate	Ratio of manufacturing to total GDP
Average manufacturing exports	1.0000					
FDI stock	0.6842	1.0000				
State GDP	0.5597	0.8361	1.0000			
U.S. index of manufacturing production	0.0516	0.0349	0.0503	1.0000		
Real exchange rate	0.0967	0.1063	0.0278	-0.1880	1.0000	
Ratio of manufacturing to total GDP	0.4612	0.2917	0.5026	0.0286	-0.0057	1.0000

Source: Own calculations.

3. The Model

The empirical model we use controls for traditional domestic and foreign determinants of exports. Defined in log terms, the empirical equation employed is given by:

$$ln(EXP_{it}) = \rho ln(EXP_{it-1}) + \beta ln(FDIS_{it}) + X\Gamma + \alpha_i + \mu_t + u_{it} \qquad (1)$$

where: EXP represents total manufacturing exports by state *i* at time *t*; FDIS is the stock of FDI and X is a vector of traditional control variables which includes domestic factors, states' GDP and the ratio of manufacturing to total GDP, as well as foreign factors that affect exports, the real exchange rate and the U.S. index of manufacturing production. The coefficient α_i is a time-invariant, unobserved fixed effect, μ_t is a state-invariant, unobserved time effect and u_{it} is the usual error term.[8] We expect each one of our control variables to

[7] We intended to include a proxy of domestic capital on the basis of data for construction spending at the state level. Nevertheless, this variable shows a high correlation with state GDP, and the average VIF exceeded the threshold of 10, implying that there were problems of multicollinearity when introducing this variable into the analysis. Because of that, we excluded it from the model.

[8] Notice that we do not include time effects in the model whenever state invariant regressors, such as the real exchange rate or the U.S. index of manufacturing production, are employed in the analysis.

exert a positive effect on manufacturing exports (i.e., $\beta > 0$ and $\Gamma > 0$). Two of our control variables, the stock of FDI and the ratio of manufacturing to total GDP, capture agglomeration economies that emerge from the presence of foreign capital and manufacturing activity across states.

In a dynamic specification like equation (1), the lagged dependent variable on the right-hand side would be correlated with the error term, invalidating the results obtained through traditional OLS panel estimations.[9] In addition, there are also some potential endogenous variables in our model (e.g., FDI stocks, state GDP, manufacturing to total GDP), which might bias the estimation of equation (1). To deal with these problems, we adopt two different approaches. The first approach consists of estimating a static version of equation (1), disregarding the persistence of exports ($\rho = 0$), which biases the estimation of the model using OLS, and fitting the first lag of all the potential endogenous variables in the model to avoid reverse and simultaneous causation. This allows us to avoid the use of potentially invalid or weak instrumental variables (Clemens et al., 2012). Thus, the empirical specification is the following:

$$ln(EXP_{it}) = \beta ln(FDIS_{it-1}) + X\Gamma + \alpha_i + \mu_t + u_{it} \quad (2)$$

The estimations then rely on the Hausman test to establish whether fixed or random effects methods are more appropriate. Moreover, to revise how these determinants change

[9] In this case, the variable associated with $EXP_{i,t-1}$ is correlated with $u_{i,t}$ because the error term of the reduced form equation (say, $v_{i,t}$) is a linear function of $u_{i,t}$, and $u_{i,t-1}$, and are not uncorrelated. See Wooldridge (2012) for details about simultaneity bias in OLS.

from one region to another, we partition our sample of 32 states in the four regions, Northern, North-Central, Central, and Southern, described above.

Recently, Bellemare et al. (2017) and Reed (2015) have criticized the use of lagged regressors to control for endogeneity. Henceforth, the second approach we follow to deal with endogeneity is the use of system generalized method of the moments (SGMM) techniques to solve the consistency problem of OLS in (1), as well as potential problems of reverse and simultaneous causation. Arellano and Bond (1991) and Blundell and Bond (1998) propose a model in which lagged differences are employed in addition to the lags of the endogenous variables, producing more robust estimations when the autoregressive processes become persistent. SGMM estimators are said to be consistent if there is no second order autocorrelation in the residuals by the AB (2) test and if the instruments employed are valid according to the Hansen-J test. To avoid overidentification problems, the instrument set is constrained to its minimum by employing the collapse procedure proposed by Roodman (2009), which restricts our specification to one instrument for each lag distance and instrumenting variable.

The partition of our full sample with 32 states into regions would provide us with sub-samples in which the number of time periods (years) is larger than the number of units of analysis (states). Under this scenario, SGMM tends to suffer from problems of overidentification due to the proliferation of instruments. Because of that fact, rather than splitting our sample, we rely on the interaction between regional dummies and the stock of FDI to revisit the role of capital flows on the dynamics of manufacturing exports. Consequently, the model to be estimated is:

$$ln(EXP_{it}) = \rho ln(EXP_{it-1}) + \beta ln(FDIS_{it}) + X\Gamma + \sum_{i=1}^{3} \delta_i \, (region_i * ln(FDIS_{it})) + \alpha_i + \mu_t + u_{it} \qquad (3)$$

where $region_i$ is a set of dummy variables comprising the four regions defined above. We expect each of these interactions to present a positive sign ($\delta_i > 0$) and μ_t to appear in the model only when state-invariant regressors are not included in the model.

4. Empirical Results

4.1 Static Panel Data Estimations

Table 3 reports the estimations of equation (2) using random effects. According to the Hausman test (χ^2 = 9.15, p-value = 0.1031), random effects are preferred over fixed effects for the estimations of our static model specification.[10] The first column reports the results of the estimations for all 32 states, while the rest of the columns describe the results for each of the four regions. Looking at the whole sample of 32 states, we observe first that the stock of FDI does not appear to be a reliable determinant of exports. Meanwhile, state GDP, the real exchange rate and the ratio of manufacturing to total GDP yield the positive expected sign and are statistically significant at the 1% level.

[10] Fixed effects model assumes that exists unobserved time-constant factors (say, a_i) that affect the dependent variable and are correlated with some explanatory variables; while the random effect model supposes that the unobserved factors are uncorrelated with each explanatory variable.

Table 3
Static Model Estimations Employing Random Effects

Variables	National	Northern	North-Central	Central	Southern
FDI stock lagged	0.108	0.420**	0.114	0.407+	-0.376
	(0.140)	(0.190)	(0.164)	(0.254)	(0.464)
State GDP lagged	0.939***	0.116	1.001*	1.012**	0.523
	(0.267)	(0.282)	(0.592)	(0.494)	(0.479)
U.S. index of manufacturing production	0.159	1.002***	0.423	0.294	0.140
	(0.318)	(0.121)	(0.699)	(0.352)	(0.574)
Real exchange rate lagged	1.047***	0.672*	1.419***	1.353***	0.736
	(0.238)	(0.382)	(0.488)	(0.378)	(0.587)
Ratio of manufacturing to total GDP lagged	0.091***	0.019**	0.090***	0.088***	0.124***
	(0.018)	(0.008)	(0.022)	(0.025)	(0.039)
Constant	-9.863***	-1.690	-13.544*	-16.065***	-0.101
	(3.536)	(2.339)	(8.228)	(5.215)	(9.382)
Number of observations	288	54	90	72	72
R^2 within	0.115	0.655	0.254	0.723	0.022
R^2 between	0.719	0.382	0.843	0.514	0.661
R^2 overall	0.703	0.434	0.826	0.521	0.613

Note: Standard errors robust to heteroskedasticity are reported in parenthesis.
The symbols +, *, **, and *** refer to levels of significance of 12%, 10%, 5%, and 1%, respectively.

Moving to the estimation results for the regions, we observe that the ratio of manufacturing to total GDP is statistically significant for each of the four regions, with coefficients ranging from 0.02 in the Northern region to 0.12 in the Southern one. Considering the ratio of manufacturing to total GDP as a proxy of economies of agglomeration, it makes sense for this variable to be a relevant determinant which increases its magnitude as we move away from Mexico's northern border with the U.S., where perhaps other factors –such as transportation costs and economic integration with the U.S. economy– could be potentially more relevant.[11] The real exchange rate is statistically significant for

[11] Agglomeration economies is essentially the idea that firms can obtain productivity gains by concentrating in geographic areas or clusters in order to reduce transportation costs, have access to a specialized labor pooling, and take advantage of technological spillover effects (Combes and Gobillon, 2015). Some evidence of the effects of agglomeration economies on productivity can be found in Zhang (2014), Greenaway and Kneller (2008), Lall et al. (2004), and Hanson (1998) for the cases of China, United Kingdom, India and Mexico, respectively, among others.

each region, except the Southern. A possible explanation for this finding is that, since in the Southern region manufacturing exports are not substantial, those states tend to benefit less from the competitive gains that a depreciation of the real exchange rate can bring to the rest of the economy. The state GDP is statistically significant only for the North-Central and Central region but not for the Northern or Southern. Finally, concerning FDI stock, we observe that it is only statistically relevant for the Northern (coefficient of 0.42, significant at the 5% level) and Central (coefficient of 0.41, statistically significant at the 12% level) regions. We conjecture that this result responds to the fact that these two regions comprise the largest shares of manufacturing exports in the country: 63% and 20%, respectively; but also have the highest shares of FDI: 39% and 38% of the total stock.

4.2 Dynamic Panel Data Estimations

There are several advantages of estimating the model in (3) using SGMM. The first is that, by introducing lagged exports on the right-hand side, we can control for the inertia or persistence of manufacturing exports over time and for more complete dynamics. The second advantage relates to the first and has to do with the fact that since lagged dependent variables perpetuate their effect into the infinite future, we could interpret the estimated coefficients and their significance as long- rather than short-term effects.[12] Assuming theoretically the economy is at the steady state, and thus that all variables growth at the same rate, the long-term coefficients for the FDI effects on exports are obtained as: $\beta_{LR} = \beta/(1-\rho)$. Obviously, these long term coeffcients, however, merits a word of caution, given that our period of

[12] With regard to this, our model is akin to the autoregressive panel distributed lag model (ARDL) propose by Afonso and Alegre (2011) with a ARDL(1,0) structure.

analysis (nine years) is relatively short.[13] Third, by using SGMM we do not need to lag all our potentially endogenous variables by one period. Instead, we can instrument those variables using lags and lagged differences of the those variables that we consider to be potentially endogenous.

Table 4
Dynamic Model Estimations Employing SGMM

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Lagged exports	0.656***	0.655***	0.639***	0.638***	0.633***	0.638***
	(0.104)	(0.117)	(0.093)	(0.103)	(0.093)	(0.098)
FDI stock	0.267**	0.217*	0.242***	0.221***	0.261***	0.218***
	(0.106)	(0.125)	(0.082)	(0.078)	(0.091)	(0.082)
State GDP	-0.106	0.120			0.076	0.169
	(0.594)	(0.727)			(0.352)	(0.355)
U.S. manufacturing production index	0.308	0.053				
	(0.868)	(0.750)				
Real exchange rate	-0.206	-0.157				
	(0.524)	(0.355)				
Manufacturing to total GDP ratio	0.046***	0.064**	0.050***	0.058***	0.050***	0.061***
	(0.016)	(0.026)	(0.016)	(0.022)	(0.016)	(0.017)
FDI stock * north-central region	-0.028	-0.023	-0.026	-0.040	-0.016	-0.021
	(0.073)	(0.087)	(0.026)	(0.034)	(0.034)	(0.045)
FDI stock * central region	-0.042	-0.060*	-0.045**	-0.059**	-0.043**	-0.056*
	(0.026)	(0.035)	(0.021)	(0.029)	(0.021)	(0.029)
FDI stock * southern region	-0.031	-0.018	-0.036	-0.035	-0.029	-0.026
	(0.056)	(0.050)	(0.038)	(0.034)	(0.034)	(0.032)
Constant	1.168	-0.549	0.679	0.834	-0.490	-1.412
	(5.596)	(7.179)	(0.763)	(0.885)	(3.946)	(4.045)
Number of observations	256	256	256	256	256	256
States	32	32	32	32	32	32
Number of instruments	31	31	26	26	29	29
Second order test of serial correlation	−0.442	−0.512	−0.455	−0.470	−0.419	−0.492
p-value	[0.659]	[0.609]	[0.649]	[0.638]	[0.675]	[0.622]
Hansen test	24.033	24.033	25.764	25.764	25.745	25.745
p-value	[0.291]	[0.291]	[0.137]	[0.137]	[0.216]	[0.216]

Note: Standard errors robust to heteroskedasticity are reported in parenthesis.
The symbols *, **, and *** refer to levels of significance of 10%, 5%, and 1%, respectively.
The Hansen test reports that under the null the overidentified restrictions are valid. Second order test of serial correlation corresponds to the Arellano-Bond test for serial correlation, under the null of no autocorrelation.

[13] See Mankiw et al. (1992) for an interesting discussion about the economy convergence and its steady state.

Table 4 presents estimations of the dynamics specifications in equation (3) by employing panel system-GMM techniques. In columns (1), (3) and (5) we consider as endogenous only the FDI stock and the real exchange rate along with lagged exports, while columns (2), (4) and (6) are additionally regarded as endogenous the states' GDP and the ratio of manufacturing to total GDP. The results of the model estimations considering all the control variables, analogous to the specification in Table 3, appear in columns (1) and (2). Notice that, to avoid perfect collinearity, one of the interactions, Northern*FDIS, is dropped from the regression. With this modification, the coefficient of FDI stock corresponds to the effect of the Northern region, and it is taken as the reference region. To calculate the effect of FDI on manufacturing exports of, for instance, the North-Central region, coefficient for the total FDI stock (corresponding to our reference region) must be added to that of the interaction for the FDI stock and the North-Central region (FDIS*North-Central), whenever such coefficients end up being statistically significant.

In Table 4, column (1), as expected, lagged exports are statistically significant at the 1% level. With respect to the effect of FDI stock, the coefficient is only statistically significant for the reference region, implying that the stock of FDI has the same impact on every region. In other words, in the long run, the effect of FDI stock on exports is the same across the country. This result, however, changes when we consider as endogenous state GDP and the ratio of manufacturing to total GDP in column (2). Here, the coefficient for the Central region is negative and statistically significant at the 10% level. Given this significant interaction, we would interpret that, in the long term, the effect of the Central region (coefficient of 0.455 = (0.217 – 0.060)/(1-0.655)) is smaller than for the Northern region (coefficient of 0.628).

A problem that we encounter in the regressions of columns (1) and (2) is that, due to the presence of the lagged dependent variable on the right-hand side, there are several variables which are not statistically significant and could be deemed as redundant. This drawback is particularly problematic when we are instrumenting some of those irrelevant regressors. To deal with this issue, we follow two different approaches. The first is to estimate the model in columns (3) and (4), omitting those variables that were not statistically significant. The second is to eliminate from the model, in columns (5) and (6), the time-invariant regressors (i.e., real exchange rate and the U.S. index of manufacturing production) and include time effects instead. The results from following those strategies are consistent with those described before in column (2). Overall, except for the Central region, all others observe a slightly larger impact from the stock of FDI on exports in the long run. For the Central region, the coefficient ranges from 0.447 to 0.594, while all other regions range from 0.602 to 0.711. A possible explanation why the Central region experiences less sensitivity in its exports to FDI than the rest of the country in the long term is that states in this region have traditionally attracted FDI that is primarily oriented toward serving the domestic rather than export market.

4.3 Robustness Checks

The advantage of the model estimated in (2) is that we are able to control for the persistence of FDI and instrument potentially endogenous variables. Nevertheless, if we are merely interested in short-term effects and take advantage of GMM, we can just omit from (2) the lag of manufacturing exports as a regressor and continue to tackle endogeneity issues as was done in Table 4. Given that we are now omitting the lagged dependent variable, in addition to the Hansen test, testing for first order serial correlation becomes necessary. In

Table 5 we replicate the estimation of Table 4 by employing the static specification in (1) using GMM and interpret the results as short-term effects.

Table 5
Static Model Employing GMM Estimations

Variables	(1)	(2)	(3)	(4)
FDI stock	0.618***	0.594***	0.533***	0.593***
	(0.162)	(0.146)	(0.154)	(0.110)
State GDP	0.986	0.668*	0.855*	0.892***
	(0.737)	(0.351)	(0.483)	(0.197)
U.S. manufacturing production index	-0.595	0.051		
	(0.958)	(0.626)		
Real exchange rate	-0.377	0.100		
	(0.592)	(0.374)		
Manufacturing to total GDP ration	0.061**	0.054**	0.061**	0.050**
	(0.030)	(0.026)	(0.025)	(0.022)
FDI stock * north-central region	-0.064	-0.087*	-0.096*	-0.088***
	(0.090)	(0.052)	(0.054)	(0.034)
FDI stock * central region	-0.108***	-0.081*	-0.116***	-0.099**
	(0.035)	(0.045)	(0.033)	(0.049)
FDI stock * southern region	-0.169**	-0.150**	-0.200**	-0.172***
	(0.083)	(0.061)	(0.095)	(0.056)
Constant	-4.376	-4.987*	-6.115	-7.027***
	(5.797)	(2.923)	(5.781)	(1.914)
Number of observations	288	288	288	288
States	32	32	32	32
Number of instruments	30	30	28	28
Second order test of serial correlation	−0.921	−0.202	−1.003	−0.421
p-value	[0.357]	[0.840]	[0.316]	[0.674]
Hansen test	17.14	17.14	18.178	18.178
p-value	[0.703]	[0.703]	[0.638]	[0.638]

Note: Standard errors robust to heteroskedasticity are reported in parenthesis.
The symbols *, **, and *** refer to levels of significance of 10%, 5%, and 1%, respectively.
The Hansen test reports that under the null the overidentified restrictions are valid. First and second order test of serial correlation corresponds to the Arellano-Bond test for serial correlation, under the null of no autocorrelation.

Columns (1) and (2) in Table 5 present the results for the model that includes all the original regressors. Except for column (1), where the interaction between the stock of FDI and the North-Central region is not statistically significant, we observe evidence suggesting that each region exports are affected differently by the stock of FDI. As before, there are again irrelevant variables that might best be omitted from the model. In columns (3) and (4) we excluded the state-invariant, irrelevant regressors that were not statistically significant in (1) and (2) and instead included time effects. This time the state GDP is positive and statistically significant along with the ratio of manufacturing to total exports. Moreover, the results suggest that the Northern region is the most sensitive to variations in the stock of FDI (coefficients of 0.533 and 0.593), followed by the North-Central (0.437 and 0.505), Central (0.417 and 0.494) and Southern (0.333 and 0.421) regions. Once again, we interpret the latter result as evidence that as we move away from Mexico's northern border with the U.S., the impact of FDI on manufacturing exports is less relevant in the short run. We think this evidence is consistent with Aitken et al. (1997)'s findings, since the presence of multinational firms and FDI is less important as one moves south—at least in the short run. The relevance of this factor for manufactured goods exports also diminishes as one moves away from Mexico's northern border.

5. Concluding Remarks

In this paper, we examined the determinants of manufacturing exports across Mexican states and regions. Our analysis considers internal and external determinants of manufacturing exports and pays particular attention to the role of FDI. We first make use of traditional static fixed-effect estimations, followed by dynamic and static panel techniques employing SGMM. Regardless of the method or specification employed in the estimations, the most reliable determinant of manufacturing exports is the ratio of manufacturing to total GDP. This result is consistent with the idea that agglomeration economies are necessary for the existence of a robust exporting platform in each state and region. This result is also consistent with the evidence reported by Jordaan (2012), who finds that new multinational firms have concentrated in a selected group of states in Mexico –mainly in the Northern and Central regions– due to the regional presence of agglomeration of manufacturing firms that provide knowledge spillovers and other externality-based productivity advantages.

Using GMM estimations techniques to control for endogeneity, we also obtain two important results. First, under our static specification, the results suggest that in the short run there exist dissimilar responses to FDI variations across Mexican states, with the Northern region observing the strongest effect of FDI on manufacturing exports, followed by the North-Central, Central and Southern regions. This result is consistent with Aitken et al. (1997)'s finding, which suggests that as we move further away from the U.S. Mexican border the sensitivity of exports to FDI diminishes as the states move to the south of the country. Second, by employing a dynamic panel specification, we observed significant export persistence, but most importantly, similar long-term effects of FDI across most of the regions –with only slightly less sensitivity to FDI in the Central region. The intuition for this result is that, once we take into account the long-term dynamics of manufacturing exports, there seems to be little difference on how responsive regions are to FDI variations. This fact has important economic implications, especially when considering promoting the less-developed regions and facilitating its economic integration into the rest of the country; for instance, through the attraction of foreign capital as a key element for developing an export platform.

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