North-South Technology Diffusion, Regional Integration, and the Dynamics of the "Natural Trading Partners" Hypothesis*

Maurice Schiff[a]

Yanling Wang[b]

Abstract

Based on static analysis, a number of studies argue that forming a regional trade agreement (RTA)is more likely to raise welfare if member countries are "natural trading partners," while other studies claim that the opposite is true. This paper looks at the argument from a dynamic viewpoint by examining the impact of North-South trade on technology diffusion and total factor productivity (TFP) in the South. Specifically, it examines the impact on TFP in the Republic of Korea, Mexico, and Poland of trade with Japan, Canada plus the United States (North America) and the European Union (EU). Using industry-level data, we find that i) technology diffusion and productivity gains tend to be regional: Korea benefits mainly from trade with Japan, Mexico with the United States, and Poland with the European Union; and ii) though these results suggest that the dynamic version of the "natural trading partners" hypothesis holds for all three countries, careful analysis shows that it holds for Korea and Mexico but not necessarily for Poland.

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a. Corresponding author. International Trade Unit, DECRG, World Bank. Email Mschiff@worldbank.org.
b. The Norman Paterson School of International Affairs, Carleton University. Email Yanling_Wang@carleton.ca.

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North-South Trade-Related Technology Diffusion and the Dynamics of the "Natural Trading Partners" Hypothesis

1. Introduction

A number of studies claim that if two countries or regions are "natural trading partners," they are less likely to generate trade diversion and are more likely to gain from forming a regional trade agreement (RTA) between them. Two versions of the hypothesis exist, referring either to the large volume of trade between potential partners in an RTA or to the small distance and low transport costs between them. Both the volume-of-trade and the distance versions of the hypothesis are relevant to our analysis.

Adherents of the "natural trading partners" hypothesis include Lipsey (1960), Wonnacott and Lutz (1989), Summers (1991), Krugman (1993), Deardorff and Stern (1994), and the EU Commission (1995). Opponents of the hypothesis include Bhagwati (1993), Bhagwati and Panagariya (1996), Krishna (2003), Panagariya (1997), Schiff (1997) and Michaely (1998). Schiff (2001) shows that neither the analysis of the adherents nor that of the opponents is correct because of a failure to take the relationship between the partner country and the rest of the world into account, and that no conclusion can be drawn one way or the other about the impact of being natural trading partners on the benefits of forming an RTA.

The studies listed above were carried out in a static framework. This paper examines the "natural trading partners" hypothesis in a dynamic framework. Specifically, it examines the impact of trade on North-South technology spillovers and on TFP in the South. Given our interest in examining the differential impact of trade between natural and "non-natural" trading partners (whether in terms of volume of trade or in terms of distance), we divide the main developed countries of the OECD into three groups, namely Japan, Canada plus the US (denoted by ‘North America’) and the EU, and select three countries in the South that are “natural trading partners” (NTP) of one of the three OECD regions: the Republic of Korea as an NTP of Japan, Mexico as an NTP of North America, and Poland as an NTP of the EU.

Korea is closest to, as well as trades the most with, Japan, Mexico with North America, and Poland with the EU. We find that, in terms of productivity gains, Korea benefits mainly from trade with Japan, Mexico from trade with North America, and Poland from trade with the EU. These estimation results would seem to provide support for the dynamic version of the “natural trading partners” hypothesis for North-South RTAs. Careful analysis shows that this seems to be the case for Korea and Mexico but not necessarily for Poland.

The remainder of the paper is organized as follows. Section 2 sets forth a brief analytical framework, Section 3 describes the data used, and Section 4 presents the empirical results. Section 5 provides an interpretation of the results, Section 6 examines their implication for the NTP hypothesis, and Section 7 concludes.

2. Analytical Framework

In the last decade, a literature has developed that examines the impact of trade on international technology diffusion and productivity. The theoretical basis for the approach used here is the work of Grossman and Helpman (1991) on endogenous growth in the open economy. The basic idea is that goods embody technological know-how and therefore countries can acquire foreign knowledge through imports.

Coe and Helpman (1995) provide an empirical implementation of Grossman and Helpman's (1991) theory. They construct an index of "trade-related foreign R&D" consisting of the trade-weighted sum of trading partners' R&D stocks. They estimate the impact of the index of foreign R&D on total factor productivity (TFP) for OECD countries plus Israel, and conclude that foreign R&D does have a large impact on TFP.

That paper has inspired a lot of related research. Studies at the country level include Coe et al. (1997) for developing countries and Engelbrecht (1997), Keller (1998), Coe and Hoffmaister (1999), Lichtenberg et al. (1998) and Lumenga-Neso et al. (forthcoming) for OECD countries. Studies at the industry level include Schiff et al. (2002) for developing countries and Keller (2002a) for the OECD. A common finding in most of these studies is that trade promotes North-North and North-South technology diffusion.[1]

Coe and Helpman (1995) use aggregate import data. Such data include not only intermediate inputs and capital goods but also final consumer goods and agricultural commodities. The latter are unlikely to generate much, if any, technological knowledge diffusion. We use industry-level data, with all imports consisting of intermediate inputs and capital goods.

This paper expands on Coe et al. (1997). We divide our 14 major OECD countries into three distinct regions, and examine whether these regions have differential effects on technology diffusion and productivity in some of their trading partners in the South, and whether these differential effects might be based on geography.

The three OECD regions are denoted by *JPN* for Japan, *NA* for North America (Canada + US), and *EU*.[2] For a given industry *i* in country *c* in year *t*, we define the trade-related foreign R&D from one of the three OECD regions as follows:

$$NRD_{cit}^{N} \equiv \sum_{j} a_{cij} \overline{RD_{cjt}^{N}} = \sum_{j} a_{cij} \left[\sum_{k} \left(\frac{M_{cjkt}}{VA_{cjt}} \right) RD_{jkt}^{N} \right], \tag{1}$$

where *N* indexes the three OECD regions, *k* indexes the member countries of OECD region *N*, *c* indexes Korea, Mexico and Poland, *j* indexes industries and *t* for year.

The first part of equation (1) says that foreign R&D from region *N* in industry *i* in country *c*, NRD_{cit}^{N}, is a weighted sum over all industries *j* of $\overline{RD_{cjt}^{N}}$, with weights a_{cij} equal to the share of imports of industry *j* in country *c* that is sold to industry *i* (proxied by the input-output share in the empirical implementation). The second part of equation (1) says that $\overline{RD_{cjt}^{N}}$ is a weighted sum of R&D stocks RD_{jkt}^{N} in member country *k* of OECD region *N*, with weights M_{cjkt} / VA_{cjt}—imports of industry-*j* products from country k per unit of industry-*j* value added in country *c* (i.e., its import concentration ratio).[3]

Following Coe et al. (1997), we do not include domestic R&D stocks in the estimation equation. The reason is that R&D data at the industry level are not available for Korea, Mexico and Poland. As argued in Coe et al. (1997) and Schiff et al. (2002),

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[1] Keller (1998) argues that whether trade patterns matter for technology diffusion is an open question. Based on the concept of 'indirect' technology spillovers, Lumenga-Neso et al. (forthcoming) provide an interpretation of Keller's results which confirms the importance of trade for technological diffusion.

[2] The EU here includes Denmark, Finland, France, Germany, Italy, the Netherlands, Norway, Ireland, Spain, Sweden, and the United Kingdom.

[3] The trade weights here are similar to the ones in Lumenga-Neso et al. (forthcoming) and in Schiff et al. (2002), but different from those used in Coe and Helpman (1995) and Lichtenberg et al. (1998). Coe and Helpman use total imports as denominator in the trade weights in two regressions, the properties of which are discussed in Schiff et al. (2002). The latter use the ratio of imports over an industry's value-added in their industry-level analysis. Lichtenberg et al. (1998) use the exporting country's GDP as denominator while Lumenga-Neso et al. (forthcoming) use the importing country's GDP as denominator. In our view,

given that well over 90% of all R&D spending takes place in the OECD countries considered, this is unlikely to bias our results.[4] Also following Coe et al. (1997), we estimate the equations in the first difference (rather than in the level) of the log of the variables to capture the impact of trade on TFP.[5]

The estimated equation is:

$$\Delta \log TFP_{cit} = \beta_0 + \beta_{JPN} \Delta \log NRD_{cit}^{JPN} + \beta_{NA} \Delta \log NRD_{cit}^{NA}$$
$$+ \beta_{EU} \Delta \log NRD_{cit}^{EU} + \sum_c \beta_c E_c + \sum_t \beta_i I_i + \sum_i \beta_t D_t + \varepsilon_{cit}, \quad (2)$$

where Δ denotes first differences, NRD^{JPN}, NRD^{NA} and NRD^{EU} are defined in equation (1), E_c (I_i) (D_t) denotes country (industry) (year) dummies capturing country (industry) (year) fixed effects, and ε_{cit} is a white noise error term. We would expect β_{JPN}, β_{NA} and β_{EU} to be nonnegative, and if there is strong regional knowledge diffusion, β_{JPN} to be the largest for Korea, β_{NA} the largest for Mexico, and β_{EU} the largest for Poland.

3. <u>Data Description</u>

The data set consists of three importing countries in the South—Korea, Mexico and Poland, 16 manufacturing industries, 14 OECD trading partners, and covers 21 years (1977-1997) for Korea and 19 years (1990-1998) for Mexico and Poland. The selection

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Lumenga-Neso et al.'s measure for country-level analysis and Schiff et al.'s measure for industry-level analysis are more adequate for the analysis of the productivity effect of trade-related R&D.

[4] In 1990 (1995), 96% (94.5%) of the world's R&D expenditures took place in industrial countries. Moreover, recent empirical work has shown that much of the technical change in individual OECD countries is based on the international diffusion of technology among OECD countries (Eaton and Kortum, 1999; Keller 2002a). For instance, Eaton and Kortum (1999) estimate that 87% of French growth is based on foreign R&D. Since developing countries invest much fewer resources in R&D than OECD countries, foreign R&D must be even more important for developing countries as a source of growth.

[5] Education variables (such as the share of the population with a given level of education) are available and can be used as proxy for countries' absorption capacity. However, this variable does not vary across industries (is correlated with industry dummies). Also, variations over time are small (and are zero in some

of the manufacturing industries, the OECD trading partners, and the year coverage is determined by data availability. The 16 manufacturing industries are either at the two- or three-digit level according to the International Standard Industry Classification (ISIC), revision 2.[6]

Data on total factor productivity (TFP), R&D stocks at the industry level for the 14 OECD countries, bilateral trade shares and input-output tables are taken from Schiff et al. (2002), which is available at http://www.worldbank.org/research/trade. That paper provides detailed documentation on the construction of the above variables and some summary statistics. The summary statistics provided in this paper (Table 1) are the average bilateral trade shares and trade-related foreign R&D.

Table 1 shows that each developing country imports more from its Northern neighbor than from more distant OECD regions. On average over the period 1981-1998, out of its total imports from the three OECD regions, Poland imported 91% from the EU and Mexico imported 82% from North America, while Korea imported about 43% from Japan, 36% from North America and 21% from Europe.

Thus, both in terms of trade volume and in terms of distance, Korea (Mexico) (Poland) is a "natural trading partner" of Japan (North America) (the EU). As for trade-related R&D stocks, each developing country gets access to more of the technology from its Northern neighbor than from more distant OECD regions.

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cases), and given that our estimation is in first differences, we decided not to include that variable in the estimation.

[6] They are: (1) 31 Food, Beverage & Tobacco; (2) 32 Textiles, Apparel & Leather; (3) 33 Wood Products & Furniture; (4) 34 Paper, Paper Products & Printing; (5) 351/2 Chemicals, Drugs & Medicines; (6) 353/4 Petroleum Refineries & Products; (7) 355/6 Rubber & Plastic Products; (8) 36 Non-Metallic Mineral Products; (9) 371 Iron & Steel; (10) 372 Non-Ferrous Metals; (11) 381 Metal Products; (12) 382 Non-Electrical Machinery, Office & Computing Machinery; (13) 383 Electrical Machinery and Communication Equipment; (14) 384 Transportation Equipment; (15) 385 Professional Goods; and (16) 39 Other Manufacturing.

4. Empirical Results

We now proceed with the estimation of the impact of trade-related technology diffusion from each OECD group on the TFP of each of the three Southern countries and examine whether these impacts vary by country and by OECD group. Estimation is carried out in first differences and with the White heteroskedasticity-consistent estimator.

Tables 2, 3 and 4 report, for Korea, Mexico and Poland, respectively, the impact on TFP of trade-related technology diffusion from each OECD region. Columns (i) to (vi) report the impact on TFP from *NRD* from individual OECD regions, while columns (vii) and (viii) report the joint impact on TFP from *NRD* from all three OECD regions. Coefficients for the constant and for the time and industry fixed effects are not shown. F-tests indicate that year (industry) dummies need to (need not) be included in the regressions. The results are robust with respect to whether or not industry fixed effects are included.

4.1. Korea

Columns (i) to (vi) of Table 2 show that the elasticity of TFP with respect to *NRD* from Japan is .51 with industry fixed effects and .47 without their effects, both significant at the 5 percent level. The elasticity with respect to *NRD* from the EU is about .20 but is not significant. Perhaps somewhat surprisingly, given that it accounts for 36.5% of Korea's imports (Table 1), the elasticity with respect to *NRD* from North America is small and not significant.

Columns (vii) and (viii) report effects of *NRD* from the three OECD regions simultaneously. The elasticity of TFP with respect to *NRD* from Japan is about .47, significant at the 5 percent level, while the elasticity of TFP with respect to *NRD* from North America and from the EU are small and not significant. The results in columns (vii) and (viii) confirm those in columns (i) to (vi).

4.2. Mexico

We first describe the results in columns (i) to (vi) of Table 3. The elasticity of TFP with respect to *NRD* from North America is equal to .55, significant at the 10 percent level, while that with respect to *NRD* from Japan is not significant, and neither is that with respect to *NRD* from the EU.

Columns (vii) and (viii) confirm the results obtained in columns (i) to (vi). The elasticity of TFP with respect to *NRD* from North America is .59, significant at the 10 percent level, while that with respect to *NRD* from Japan is not significant, and neither is that with respect to *NRD* from the EU.

4.3. Poland

Starting with columns (i) to (vi) of Table 4, the elasticity of TFP with respect to *NRD* from North America is about 3.18, significant at the 5 percent level, that with respect to *NRD* from the EU is about 8.5, also significant at the 5 percent level, and that with respect to *NRD* from Japan is not significant. The elasticity with respect to *NRD* from the EU is close to 3 times larger than that from North America.

Results in the last two columns confirm those in columns (i) to (vi), though with somewhat smaller elasticities for the EU and North America. The elasticity of TFP with respect to *NRD* from North America is equal to about 2.25 (significant at the 5% level), about 6.4 with respect to *NRD* from the EU (significant at the 1% level), and not significant with respect to *NRD* from Japan. The elasticity with respect to *NRD* from the EU is again close to 3 times larger than that with respect to *NRD* from North America.

4.4. Structural and Policy Changes

A number of structural and policy changes occurred over the sample period. NAFTA was formed in 1994, the EU signed an FTA with Poland (Europe Agreement) in 1994, and the former Soviet Union collapsed in 1989. Dummy variables were interacted with the relevant *NRD* variables to examine whether the elasticity of Mexico's TFP with respect to North America's *NRD* changed after 1994 and whether that of Poland's TFP with respect to EU's *NRD* changed either after 1989 or after 1994 or both. None of the variables were found to be significant.

5. Interpretation of the Results

The empirical results described above are striking. For each of the three countries in the South, the largest and most precisely estimated elasticity of TFP is the one with respect to *NRD* from its neighboring OECD region or "natural trading partner." For Korea (Mexico), the only significant elasticity is the one with respect to *NRD* from Japan (North America). In the case of Poland, the elasticities with respect to *NRD* from both the EU and North America are significant, but the former is close to 3 times as large as the latter. Thus, our results indicate that North-South trade-related technology diffusion exhibits a regional pattern.

Why is the impact of *NRD* from the neighboring OECD region so much bigger than that from the distant regions? One possibility is that trade between each country in the South and its OECD neighbor involves more than just a simple exchange of goods. It is likely to entail more personal interaction, including sub-contracting relationships where firms in the South import intermediate goods from firms in the neighboring OECD regions and export finished products back to the same firms. In that case, knowledge diffusion is associated not only with the knowledge-content of the imported goods but also with the close contacts associated with trade. These hands-on relationships are more likely to hold with neighboring OECD regions than with the more distant ones where arms-length relationships are more likely to prevail.

A paper that is relevant to our analysis and supports our findings is Keller (2002b). He shows that knowledge is geographically localized in the sense that the impact of international technology diffusion on TFP declines with distance. This is precisely what we found in the case of North-South trade-related technology diffusion.

6. Implications for the "Natural Trading Partners" Hypothesis

The question examined here is as follows: assuming that Korea, Mexico and Poland have decided to form an RTA with one of the three OECD regions and that they are free to form an RTA with whatever OECD region they prefer, which one should they choose? Our empirical results suggest that each Southern country should form an RTA with its neighboring OECD region. However, careful analysis shows that, though this is likely to be true for Korea and Mexico, it is less likely for Poland.

The calculation of the impact of an RTA on TFP requires a few steps. We start with Korea. Assume Korea forms an RTA with Japan, and that the increase in Korea's imports from Japan associated with trade creation is equal to X percent. Assume also that the proportionate increase in imports is the same for all industries. Then, from equation (1), the increase in TFP is equal to .48X percent (with the elasticity of .48 taken from column (vii) of Table 2).[7]

Assume the increase in Korea's imports from Japan associated with trade diversion is Y percent. This results in an increase in TFP of .48Y percent. Denote the value of the increased imports of Y percent by $YY. Under trade diversion, Korea's total imports remain unchanged, so that imports from other countries than Japan must decline by exactly $YY. Given that the RTA between Korea and Japan discriminates against both the EU and North America, we assume that Korea's imports from these two regions decline in the same proportion.[8] Korea's imports from Japan amount to 42.9 percent of its total imports (Table 1). Thus, the Y percent increase in imports from Japan equal .429Y percent of Korea's total imports, and equals (.429/.571)*Y or .75Y percent of Korea's imports from the EU plus North America.

Given the assumption that Korea's imports from the EU and North America decline in the same proportion, the decline in Korea's TFP from the fall in imports is .14*.75*Y or .105Y percent (where the elasticity for the EU is .14 and the elasticity for North America is zero (column (vii), Table 2)). The net impact on TFP from trade

[7] We choose the results of column (vii) rather than from column (viii) because of the higher adjusted R^2. However, whether we choose the results of column (vii) or (viii) has no impact on our conclusions. The same holds in the case of Mexico and Poland.
[8] This assumption does not affect our conclusion. Even if we assume that the EU, whose elasticity is larger than that from North America, is the source of the entire decline in imports, this would lead to a smaller TFP gain from trade diversion but would still not change our conclusions (see below).

diversion is .48Y - .105Y or .375Y percent. Thus, the impact on Korea's TFP of both trade creation (.48X) and trade diversion (.375Y) is positive, with the total impact on Korea's TFP equal to .48X + .375Y.

On the other hand, if Korea formed an RTA with the EU, it would result in a negative impact on TFP from trade diversion and a (most likely) smaller impact from trade creation (compare the TFP elasticity of .14 (zero) with respect to imports from the EU (North America) with that of .48 with respect to imports from Japan). With an RTA with North America, the impact of trade diversion would also be negative and there would be no impact of trade creation. These calculations indicate that the largest impact on Korea's TFP obtains from an RTA with Japan, and that the dynamic version of the "natural trading partner" hypothesis holds for Korea.[9]

What about Mexico? First, note that the coefficient of trade-related R&D from Japan is negative but not significant in the regressions for both Mexico and Poland. Given that an increase in trade with a Northern region is unlikely to reduce productivity in the South, we set the coefficient equal to zero for both countries in the simulations.

Now, assume Mexico forms an RTA with North America. Trade creation of X percent raises its TFP by .59X percent (column (vii), Table 3). The increase in imports associated with trade diversion of Y percent raises its TFP by .59Y percent. Given North America's share in Mexico's imports from the three OECD regions of 82 percent and that of the EU plus Japan of 18% (Table 1), the relative reduction in imports from the EU plus Japan is equal to (.82/.18)*Y = 4.56Y percent, and the decline in TFP due to the decrease in imports is .14*4.56*Y = 0.638Y percent, or an decrease in TFP of .638Y. The net impact of trade diversion on TFP is .59Y -.638Y = -.048Y percent. Thus, the total impact on TFP is .59X - .048Y percent. Hence, unless trade diversion is at least 12.3 (.59/0.048) times larger than trade creation—which is highly unlikely (see footnote 10)—we conclude that the impact on Mexico's TFP is positive.[10]

An RTA between Mexico and the EU or Japan would result in a negative impact on TFP from trade diversion and a (most likely) smaller impact from trade creation (compare the TFP elasticity of .59 with respect to imports from North America with one of .14 (zero) with respect to imports from the EU (Japan)). Thus, the dynamic version of the "natural trading partner" hypothesis seems to hold for Mexico as well.

What about an RTA between Poland and the EU? The impact of trade creation of X percent on TFP is equal to 6.42X percent (column (vii), Table 4). The Y percent of trade diversion result in a positive impact on TFP of 6.42Y percent. The equi-proportional reduction in imports from Japan and North America results in a decrease in TFP equal to (90.7/9.3)*(2.26)*Y = 22.04Y percent. Thus, the net impact on TFP from trade diversion is –15.62Y percent, and the total impact is 6.42X – 15.62Y percent. Whether the total impact on TFP of an RTA with the EU is positive or negative is ambiguous and depends on the relative magnitude of trade creation X and trade diversion Y. It is positive (negative) for X > (<) 2.43Y.

What about an RTA between Poland and North America? The impact of trade creation of W percent is 2.26W percent. The impact of trade diversion of Z percent is 2.26Z – (6.2/93.8)*(6.42)*Z = 1.84Z percent, with the total impact equal to 2.26W +

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[9] If the entire trade diversion were due to an decrease in imports from the EU, the fall in TFP would be equal to .14*(.429/.206)*Y = .29Y, and the net effect would be equal to .48Y - .29Y = .19Y percent. In other words, the results would be qualitatively unchanged.

1.84Z percent. The impact of trade diversion is positive in this case, though the impact of trade creation is likely to be smaller than with an RTA with the EU. Whether the impact on TFP of an RTA between Poland and North America (6.42X – 15.62Y percent) is larger than that between Poland and the EU (2.26W + 1.84Z percent) is unclear. In conclusion, whether the dynamic version of the "natural trading partner" hypothesis holds in the case of Poland is ambiguous.

7. Concluding Remarks

This paper examined the impact of trade-related technology diffusion from three developed OECD regions on productivity in Korea, Mexico and Poland. Using industry-level data, the paper shows that trade-related technology diffusion and productivity gains in the three countries tend to be regional. In terms of productivity gains, Korea benefits mainly from trade with Japan, Mexico from trade with North America, and Poland from trade with the EU. These results would seem to provide support for the dynamic version of the "natural trading partners" hypothesis for North-South RTAs. However, careful analysis shows that this is likely to be the case for Korea and Mexico, though not necessarily for Poland.

[10] Schiff and Wang (2003) estimate that trade diversion from Mexico joining NAFTA is at most equal to 22% of trade creation.

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Table 1: Manufacturing Imports & Trade-related R&D from Each Region (1981-1998 average)

Country	**Trading Partner**	**Import Share (%)**	**Trade-related R&D**
	European Union	**20.57**	**7.47E+07**
Korea	**Japan**	**42.93**	**5.32E+08**
	North America	**36.50**	**3.73E+08**
	European Unoin	**12.92**	**1.04E+08**
Mexico	**Japan**	**5.11**	**8.96E+07**
	North America	**81.97**	**2.53E+09**
	European Union	**90.74**	**2.81E+08**
Poland	**Japan**	**3.07**	**3.21E+07**
	North America	**6.20**	**3.31E+07**

Note: For Korea, Mexico and Poland, Import share from each region is defined as imports for manufacturing industries from a Northern region over total imports from the three Northern regions. Figures reported are averages for 1981-1998. Trade-related R&D from each region is defined as in equation (1) and figures reported are averages for 1981-1998.

Table 2: Determinants of TFP – **Korea**
(Dependent variable: **ΔlnTFP, 1977-1997)**

Variable	**(i)**	**(ii)**	**(iii)**	**(iv)**	**(v)**	**(vi)**	**(vii)**	**(viii)**
$\Delta logNRD^{JPN}$	**0.51**	**0.47**					**0.48**	**0.46**
	(2.11)**	***(2.03)*****					***(2.01)*****	***(1.97)*****
$\Delta logNRD^{NA}$			**0.02**	**0.01**			**0.00**	**-0.02**
			(0.19)	***(0.08)***			***(-0.03)***	***(-0.19)***
$\Delta lnNRD^{EU}$					**0.20**	**0.18**	**0.14**	**0.12**
					(0.89)	***(0.80)***	***(0.63)***	***(0.58)***
Time effects	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Industry Effects	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
F-test								
No Time Effects	**17.23*****	**18.29*****	**17.65*****	**18.80**	**16.99*****	**18.13*****	**16.91*****	**18.01*****
No Industry Effects	**0.85**	**---**	**0.76**	**---**	**0.78**	**---**	**0.83**	**---**
Obs	**336**	**336**	**336**	**336**	**336**	**336**	**336**	**336**
Adjusted R2	**0.48**	**0.46**	**0.46**	**0.45**	**0.47**	**0.45**	**0.48**	**0.46**

Note: $\Delta logNRD^{Jpn}$, $\Delta logNRD^{NA}$ and $\Delta logNRD^{EU}$ are the first difference of the logs of trade-related technology from trading with Japan, North America, and the EU, respectively. Figures in parentheses are robust t-statistics. The data set consists of 16 manufacturing industries in Korea with 15 OECD trading partners, and covers 1977-1997. Regression results on constant, time and industry dummies are not reported.. F-tests reject (do not reject) that all the coefficients of time (industry) dummies equal zero.

Table 3: Determinants of TFP – **Mexico**
(Dependent variable: **ΔlnTFP, 1981-1998)**

Variable	**(i)**	**(ii)**	**(iii)**	**(iv)**	**(v)**	**(vi)**	**(vii)**	**(viii)**
$\Delta logNRD^{JPN}$	**0.26**	**0.27**					**-0.21**	**-0.20**
	(0.80)	***(0.89)***					***(-0.94)***	***(-0.90)***
$\Delta logNRD^{NA}$			**0.55**	**0.55**			**0.59**	**0.59**
			(1.64)*	***(1.67)****			***(1.64)****	***(1.66)****
$\Delta logNRD^{EU}$					**0.29**	**0.29**	**0.14**	**0.12**
					(0.95)	***(0.96)***	***(0.52)***	***(0.46)***
Time effects	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Industry Effects	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
F-test								
No Time Effects	**23.81*** **	**25.77** **	**23.54*** **	**26.34*** **	**25.46*** **	**28.68*** **	**21.08*** **	**22.98*** **
No Industry Effects	**0.83**	**---**	**0.38**	**---**	**0.38**	**---**	**0.43**	**---**
Obs	**272**	**272**	**272**	**272**	**272**	**272**	**272**	**272**
Adjusted R2	**0.44**	**0.44**	**0.50**	**0.50**	**0.45**	**0.44**	**0.51**	**0.50**

Note: $\Delta logNRD^{Jpn}$, $\Delta logNRD^{NA}$ and $\Delta logNRD^{EU}$ are the first difference of the logs of trade-related technology from trading with Japan, North America, and the EU, respectively. Figures in parentheses are robust t-statistics. The data set consists of 16 manufacturing industries in Mexico with 15 OECD trading partners, and covers the period 1981-1998. Regression results on constant, time and industry dummies are not reported. F-tests reject (do not reject) that all the coefficients of time (industry) dummies equal zero.

Table 4: Determinants of TFP – **Poland**
(Dependent variable: **ΔlnTFP, 1981-1998)**

Variable	**(i)**	**(ii)**	**(iii)**	**(iv)**	**(v)**	**(vi)**	**(vii)**	**(viii)**
$\Delta logNRD^{JPN}$	**-0.55**	**-0.50**					**-0.69**	**-0.80**
	(-0.76)	*(-0.75)*					*(-1.35)*	*(-1.56)*
$\Delta logNRD^{NA}$			**3.19**	**3.17**			**2.26**	**2.24**
			*(1.97)***	*(2.02)***			*(2.17)***	*(2.21)***
$\Delta logNRD^{EU}$					**8.57**	**8.38**	**6.42**	**6.34**
					*(2.08)***	*(2.12)***	*(2.56)****	*(2.60)****
Time effects	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Industry Effects	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
F-test								
No Time Effects	**21.36*****	**21.88*****	**6.58*****	**6.76*****	**3.94*****	**3.81*****	**2.99*****	**10.57*****
No Industry Effects	**0.38**	**---**	**0.19**	**---**	**0.25**	**---**	**0.21**	**---**
Obs	**288**	**288**	**288**	**288**	**288**	**288**	**288**	**288**
Adjusted R2	**0.15**	**0.15**	**0.44**	**0.44**	**0.43**	**0.42**	**0.57**	**0.56**

Note: $\Delta logNRD^{Jpn}$, $\Delta logNRD^{NA}$ and $\Delta logNRD^{EU}$ are the first difference of the logs of trade-related technology from trading with Japan, North America, and the EU, respectively. Figures in parentheses are robust t-statistics. The data set consists of 16 manufacturing industries in Poland with 15 OECD trading partners, and covers the period 1980-1998. Regression results on constant, time and industry dummies are not reported. F-tests reject (do not reject) that all the coefficients of time (industry) dummies equal zero.