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# FTA and Economic Growth: A Nonparametric approach

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# FTA and Economic Growth: A Nonparametric Approach

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**Abstract**

This paper assesses whether a bilateral FTA exerts a positive growth effect on the economies of the two countries engaging in the FTA. It employs a nonparametric matching approach, which is more faithful to questions posed by trade theories, imposes no specific functional forms on the relation, and can be applied to a broad range of data structures. Unlike the results from earlier linear regression model approaches, we find an insignificant effect of the FTA on total economic growth. In particular, we demonstrate that an FTA exerts no significant growth effects in the one-to-10-year period after its launch. Furthermore, we detect an upward trend in the gap between the growth rates of per capita real GDP within a bilateral FTA. This implies uneven FTA effects across countries within an FTA, which may explain, in part, the insignificant effects of the FTA on the total economic growth.

**Key Words:** Free trade agreement, Growth, Matching, Treatment effect

**JEL Classification:** F13, O24, C14, C21

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## I. Introduction

The number of bilateral Free Trade Agreements (FTA hereafter) has risen rapidly since the early 1990s, as is shown in Figure 1.[1] This phenomenon may imply that the majority of countries involved in FTAs anticipate increases in economic growth as the result of trade promotions resulting from the FTAs, and that policy makers and economists regard FTAs as important policy tools for economic development. International trade theories, from Ricardo's comparative advantage model through the two-country endogenous growth models developed by Grossman and Helpman (1991) and Feenstra (1996), can be considered rationales for the formation of FTAs.

However, although most international trade theories compare economic agents' welfare prior to and after the free trade agreement via two-country models, the mutual effect of free trade in two-country models has yet to be empirically investigated with sufficient rigor. Existing empirical studies have generally examined the correlation between an individual country's growth and the degree of openness of that country, whereas theoretical models usually hold that both countries will be better/worse off once they have removed all their trade barriers and implemented a free trade system than they would be without the free trade system. In addition to the discrepancy between theoretical models and empirical examinations, no consensus has yet been reached regarding the effects of free trade on economic growth among empirical studies. Whereas Dollar (1992), Sachs and Warner (1995), Edwards (1998), Frankel and Romer (1999), and Dollar and Kraay (2004) reported supportive evidence for a positive impact of free trade on economic growth by using a variety of measures of openness, Harrison (1996), Rodriguez and Rodrik (2000), Rodrik *et al*. (2004), and Wacziarg and Welch (2008) found that free trade had a negative or insignificant effect on

[1] Many economists have begun to pay attention to this new phenomenon, and have conducted research into a variety of FTA-associated issues. For example, Baier and Bergstrand (2004, 2007) evaluated the effects of FTAs on international trade flow, using a binary FTA dummy variable in the so-called "gravity models". Sohn and Lee (2006) evaluated the effects of an FTA on convergence in a simple neoclassical growth model.

economic growth. Recent contributions to the literature on empirical growth provide some examples of non-linear specifications. The studies of Freund and Bolaky (2008) and Chang *et al*. (2009) show that the growth effect of trade openness is significantly positive only if certain complementary domestic reforms are undertaken, including deregulations of business, financial developments, better education or rule of law, labor market flexibility, etc. Otherwise, the growth effects among rigid economies become negative.

In this paper, we also attempt to characterize empirically the effects of free trade on economic growth; however, our approach differs from those applied in previous studies in two important ways. First, the existing empirical literature relates an individual country's growth to the degree of openness of that country, and trade openness is frequently constructed as an index reflective of the trade liberalization regimes or policies of *that individual* country. However, the concept of openness is rather difficult to define, and the indices are generally highly correlated with other economic variables of that country, which makes it difficult to interpret results on the basis of trade theories (see Rodriguez and Rodrik (2000)). In addition to these problems, countries with the same levels of openness may experience different effects of that openness in terms of their economic growth, depending on the level of openness of their respective principal trade partners. In our paper, we focus on bilateral FTA systems among a variety of relevant trade policies to reduce mutual trade barriers and stimulate trade volume. Because a bilateral FTA is formed by a pair of countries, it can be considered an indicator of "mutual openness" for the countries specifically involved in the agreement. The direct effects of free trade can be identified more clearly in the context of mutual openness than from the perspective of individual trade openness referenced in previous empirical literature concerning economic growth and trade. In analyzing these effects, we utilize a binary dummy variable to indicate whether or not a country couple has an FTA, and then consider the growth rates of both economies engaged in the FTA. Although we do not deny the utility of the unilateral trade openness measures utilized in the existing literature, we believe that the mutual openness measure is a clearer measure and is more consistent with the actual question addressed by many trade theories, where the effects of free trade are generally discussed for both economies participating in a free trade arrangement.

Second, we consider engagement in an FTA as a “treatment” in the terminology of matching literature, and propose a nonparametric matching approach to evaluate the effects of FTAs on growth. The question addressed by the nonparametric matching approach is what would be the difference in the economic growth of a country couple when this couple has an FTA, as compared with the case in which this couple does not have an FTA. We believe that this question is more consistent with the question addressed by most international trade theories, and is more relevant in evaluating the effect of FTA than a simple comparison of the growth rates between countries with FTAs and countries without FTA, which is the question most often addressed by regression analyses. In fact, the majority of empirical studies, including the aforementioned ones, have adopted a parametric linear model using either cross-sectional or panel data. However, this linear regression approach not only has a conceptual problem in assessing the effects of free trade based on the basis of trade models, but is also subject to econometric issues. We demonstrate herein that the linear regression approach is subject to misspecification problems due to potential nonlinear relations among variables, as well as the non-random selection problem. However, the nonparametric matching approach imposes no parametric restrictions, and has been demonstrated to perform well even in the face of the non-random selection problem. Although this approach is popular in the field of labor economics, economists in the trade literature have recently begun to use this econometric approach. Relevant examples include Chang and Lee (2007) and Baier and Bergstrand (2009). To the best of our knowledge, however, this approach has never been utilized in the literature on trade and growth.[2] In summary, we apply the nonparametric matching approach to evaluate the effect of FTA because it avoids using arbitrary openness indices, is conceptually more consistent with trade theories, and performs better in the presence of non-random selection and misspecification problems.

Our paper is organized as follows. In Section II, we provide a brief description of the dataset used in this study. After demonstrating that an FTA exerts a significantly positive effect on economic growth under the usual linear panel regression, we present evidence suggesting that this linear panel regression model suffers from non-random selection and misspecification problems. Section III briefly discusses the econometric methodology used in this study—namely, the nonparametric matching approach. In Section IV, our main findings are presented via nonparametric matching analysis, showing that FTAs exert no statistically significant effects on total economic growth from one to 10 years period after launch. Furthermore, we also report our finding of an upward trend in the gap between the growth rates in per capita GDP among countries participating in an FTA. This finding implies that some countries may enjoy a positive FTA effect on economic growth, while their counterparts in the FTA experience a negative FTA effect on economic growth. This finding may explain, in part, the observed insignificant effects of FTA on the combined economic growth of countries involved in an FTA. We also discuss an additional issue related to this insignificant FTA effect. Section V presents our concluding remarks.

## II. Data and the Linear Regression Approach

We describe the dataset in this section and provide evidence of econometric problems occurring in linear regressions even if the trade openness index is replaced with the FTA dummy variable.

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[2] Imbens (2004) provides an excellent survey of the nonparametric matching approach.

1. Dependent Variable or Response Variable

In order to estimate the effects of FTAs on the growth performance of a country couple engaging in an FTA, we utilize the growth rate of the real gross domestic product (GDP) per person of a country couple for the dependent variable in the regression analysis, or for the response variable in the matching analysis. The per capita GDP for a couple composed of Country A and Country B is constructed as follows:

$$\frac{GDP_A + GDP_B}{Population_A + Population_B} = w_A \frac{GDP_A}{Population_A} + w_B \frac{GDP_B}{Population_B}$$

where $w_A = \frac{Population_A}{Population_A + Population_B}$ and $w_B = \frac{Population_B}{Population_A + Population_B}$.

Assuming that this variable is a proxy measure of a representative agent's welfare in two countries engaged in an FTA, we compare the growth rates of this variable before and after FTAs, as theories in international trade usually compare a representative agent's welfare before and after free trade via a two-country setting. As we mentioned in the Introduction section, this variable is more faithful to international trade theories than the ones utilized in previous empirical literature.

2. Control Variables or Covariates

As we wished to estimate the treatment effect of a bilateral FTA via the nonparametric matching approach, we required covariates that render a treated couple (countries engaged in a bilateral FTA) and an untreated couple comparable in terms of their potential growth performance and the likelihood of their forming a bilateral FTA. Similarly, we also required variables to control factors that may affect the growth performance and the possibility of forming a bilateral FTA in the regression analysis. Among many variables that have been reported in previous empirical studies to be strongly correlated with growth, we utilized 18 variables that were significantly and robustly correlated with growth in the study of Sala-i-Martin, Dopplehofer, and Miller (2004). In addition to these 18 variables, we included 7 variables demonstrated by Baier and Bergstrand (2004) and Egger and Larch (2008) to affect the possibility of forming a bilateral FTA.[3] The list of these variables, their brief descriptions, and the data sources are provided in Table 1. These 25 variables were available for 88 countries, and these countries are listed in Table 2. In addition to these variables, year dummies for $t$ = 1971,…, 2003 are also included in the analysis.

We attempted to construct a panel dataset of these variables for individual countries from 1971 to 2003, with an annual frequency. Variables that can be considered constant over time, such as the East Asia dummy, fraction of tropical area, sub-Saharan African dummy, Latin American dummy, Spanish colony dummy, and ethno-linguistic fractionalization are taken directly from the work of Sala-i-Martin, Dopplehofer, and Miller (2004).[4] However, variables such as the population density in coastal areas, prevalence of malaria, fraction of Confucians, fraction of Muslims, and fraction of Buddhists could all vary over time, but are not available in the annual frequency dataset. We thus assumed steady trends in these variables, and interpolated and extrapolated those variables using their values at two time points – one in the 1960s and the other in the 1990s – after obtaining the data for these variables from the sources described in Table 1. All other variables were taken with annual frequency from the data sources provided in Table 1.

After obtaining the panel dataset for 88 countries, we re-constructed these covariates for all 3828 (=(88 x 87)/2) couples over the sample period. For the majority of variables with

[3] Due to the large number of countries employed in our analysis, we could not use the same definition of the variables as was used by Baier and Bergstrand (2004). Rather, we decided to borrow the similar, but more relaxed, definitions utilized by Egger and Larch (2008). This enabled us to increase the number of countries to be analyzed to 88.

[4] http://www.econ.cam.ac.uk/faculty/doppelhofer/research/bace.htm is the web address from which the data were obtained.

continuous values, the newly rebuilt covariates for a couple of countries were the weighted averages of the counterparts in that couple, like the above combined per capita GDP. For the binary dummy variables, the values of the dummy variables for individual countries were added for a couple. Thus, in cases in which both countries (one country) in a couple are (is) located in Latin America, then the Latin American dummy variable for this couple (country) is two (one). If neither country in a given couple is located in Latin America, then the dummy variable for that couple is set to zero. Finally, the FTA dummy variable for a pair of countries was collected and re-arranged, on the basis of the WTO's report of *Regional Trade Agreements Notified to the GATT/WTO by Date of Entry into Force* for the 1958-2003 period. In Table 2, we also provide the list of Regional Trade Agreements (RTAs) that we utilized for the bilateral FTA dummy variable. The RTAs we used in the analysis were only free trade agreements and customs unions that are listed in the WTO. We excluded service agreements and preferential partial agreements. We also excluded RTAs for the countries that are not in the list in Table 2. Among the 88 countries on the list, the number of countries belonging to at least one RTA is 50.

## 3. Misspecification Test of the Linear Regression

In this sub-section, we regress the growth rate of a country couple on the above-mentioned covariates and FTA, similarly to existing studies. In order to determine the effects of free trade, the majority of existing studies focus on whether or not the coefficient of FTA in the regression is significant. However, the coefficient of the FTA dummy variable shows the overall average difference in growth rates between country couples with FTA and without FTA, whereas international trade theories generally compare the growth rates of a country couple when this couple has an FTA with the growth rate when this same couple does not have an FTA. This subtle difference arises from whether or not country couples which have no FTA but extremely different characteristics are included in the comparison. In order to remain faithful to international trade theories that compare the growth rate of a country couple with an FTA with the growth rate of the same country couple if this couple does not have an FTA, it seems more plausible to include country couples with FTAs and country couples which have no FTAs but very similar characteristics to those with FTAs in the analysis. However, the linear regression utilizes all the observations regardless of their characteristics, which implies a discrepancy between theoretical studies and empirical studies.

This conceptual problem is related closely with the non-random selection problem in the field of econometrics. It has been established that linear regressions may suffer from a non-random selection problem, in which the covariates are correlated systematically with the FTA (the treatment variable). Two primary sources can induce this non-random selection problem. First, the treatment variable, FTA, may exert a more profound effect under certain covariate values. For example, two countries that were previously colonized by the Spanish may see a larger effect from FTAs because the similar legal system, common language, and cultural characteristics between these countries can be expected to amplify the effects of FTAs on growth. Second, the treatment variable may pick up omitted non-linear relations between the dependent variable (the growth rate of combined GDP) and the covariates. Regardless of the source of this non-random selection problem, the existence of this problem also induces a bias in the estimates acquired from the linear regressions.

Table 3 shows a list of variables for which the null hypotheses that the means of covariates across two groups (one which has an FTA and the other one which has no FTA) are equal have been rejected at the 5% significance level. As is shown in Table 3, country couples with FTA systems report significantly higher primary school enrollment rates, higher per capita GDP, smaller tropical area, lower prevalence of malaria, longer life expectancy, and lower weight of the mining industry in GDP. They are also less likely to be located in sub-

Saharan Africa or Latin America, have higher openness measures, and also evidence less profound ethno-linguistic fractionalization. The results shown in Table 3 indicate that country couples with FTA evidence characteristics very different from those of country couples without FTA, and that we need to extract country couples with no FTA but very close characteristics to those with FTA, in order to estimate correctly the effects of FTA on economic growth.

In addition to this problem, we also demonstrate that the linear regression approach is subject to the econometric misspecification problem. First, we evaluate the fixed effect models and summarize the results in Table 4. As shown, the estimated coefficient of the FTA variable under the fixed effect model is significantly positive, which implies that FTA raises the annual growth rate of the combined per capita GDP by 0.4% per year after controlling for important factors that may affect growth and FTA formation. However, this regression suffers from some potential econometric problems, as the relation between the growth rate and the FTA membership may not be linear.[5] The regression equation specification error test of Ramsey (1969) is employed to determine whether nonlinear transformations of the control variables have any explanatory power in regard to the dependent variable. The square of the fitted value of the dependent variable is added to the original regression, and a significant coefficient for this newly added variable can be interpreted as indicative of the potential misspecification problem of the original linear regression. As can be seen in the second column of Table 4, the estimated coefficient of this new variable differs significantly from zero, thus suggesting that the original linear regression has evidence for misspecification at a conventional level of significance. We also re-run the model with interaction terms between the FTA variable and other control variables. We show in the third column of Table 4 that the

[5] Freund and Bolaky (2008) and Chang *et al.* (2009) showed a non-linear relationship between growth rates and trade openness. The source of this non-linearity varies due to the effects of business regulations, financial developments, education, or rule of law on labor market flexibility.

effect of the FTA is significantly negative and many interaction terms with the FTA are significant; this can be considered another piece of evidence that supports misspecification.

Second, although the fixed effect model has been shown to provide more consistent estimates in the presence of omitted couple-specific factors, we should exclude time-invariant variables (e.g. East Asia dummy, sub-Saharan Africa dummy, etc.) from this analysis. Considering this problem, we also evaluate the potential presence of non-linearity in the random effect model without excluding the time-invariant variables, and the results are shown in the fourth column of Table 4. As is the case in the fixed effect model, we find a significantly positive FTA effect on growth in the original random effect model. However, the Ramsey test again points to a possible nonlinearity problem in the original regression, when the square of the fitted value of the dependent variable is added. The inclusion of the interaction terms between the FTA variable and the other control variables are also suggestive of a potential non-linearity problem in the original regression, as we were able to find several significant interaction terms.

In summary, the econometric problems arising from non-random selection and nonlinearity appear to warrant serious consideration. Previous studies regarding the relationship between trade and growth may not have been able to reach a consensus because the linear regression approach remains susceptible to these problems. As a result, we employ the nonparametric matching approach in subsequent sections to estimate the treatment effect of bilateral FTAs. The nonparametric matching approach is conceptually close to the comparative static analyses conducted in many theoretical models to derive the effects of free trade. The nonparametric matching approach has been shown to perform better in the presence of the non-random selection problem, as it compares observations with similar characteristics. The nonparametric matching approach is free from the potential nonlinear problem, as it imposes no specific functional forms between variables.

## III. Econometric Methodology

Suppose that there are $N$ countries in the dataset and those countries are indexed by $i$ = 1, 2, …, $N$. $Y_{ijt}$ denotes the combined per capita GDP for countries $i$ and $j$ in year $t$, which is the population-size weighted average of per capita real GDP between the two countries. The growth rate of $Y_{ijt}$ is $y_{ijt} = \ln(Y_{ijt}) - \ln(Y_{ijt-1})$, and $y_{ijt}$ is the response variable in the terminology of the matching literature. A vector of covariates containing information regarding the characteristics of a country couple ($i$, $j$) is denoted as $x_{ijt}$.[6] The FTA dummy variable $d_{ijt}$ is one in cases in which a country couple ($i$, $j$) has a bilateral FTA at time $t$, and is zero in all other cases. Hence, observations with $d_{ijt}$ = 1 belong to the treatment group, whereas observations with $d_{ijt}$ = 0 belong to the control group. Each observation in our dataset can be written as the triple ($y_{ijt}$, $x_{ijt}$, $d_{ijt}$) for $i$ = 1,…, $N$, $j$ = $i$+1,…, $N$, and $t$ = 1,…, $T$.

Suppose that a country couple ($i$, $j$) has formed a bilateral FTA. Then, the bilateral FTA effect on the growth of the per capita GDP for the couple ($i$, $j$) is defined as the difference in the growth rates when the couple forms the bilateral FTA, and when the couple does not form the bilateral FTA.[7] Hence, assuming that the potential untreated response is independently of the treatment, the average FTA effect can be written as follows:

$$E(y|d=1) - E(y|d=0) = E(y^1|d=1) - E(y^0|d=0)$$
$$= E(y^1|d=1) - E(y^0|d=1) = E(y^1 - y^0|d=1)$$

where $E(\cdot)$ is the expectation operator, $y^1$ denotes the potential treated response, and $y^0$ is the potential untreated response. However, as we are unable to observe $E(y^0|d=1)$, we need a counterfactual potential untreated response of the treated couple. The counterfactual

[6] In this paper, the word ‘couple’ refers to an observation unit that consists of two countries in which the response variable and covariates are combined. The word ‘pair’ means two observation units (couples) that are conditionally matched on the covariates.
[7] In terms of the terminology of the matching literature, we are interested in estimating ‘the effect on the treated’. The method in this paper can also be applied to estimate ‘the effect of the untreated’.

potential untreated response of the treated couple is acquired via matching methodology. In other words, a couple from the control group, which is the closest to the couple of the treatment group in terms of the function of the vector of covariates ($x$), is selected as the counterfactual potential untreated response of the treated, under the assumption that the potential untreated response occurs independently of the treatment conditional on the covariates. This assumption implies that a treated couple and an untreated couple are comparable in terms of their potential untreated growth performance and the probability of their forming bilateral FTA if they exhibit the same covariates.

When we select a couple $(y_{i'j't'}, x_{i'j't'}, d_{i'j't'})$ from the control group as the counterfactual for a given couple $(y_{ijt}, x_{ijt}, d_{ijt})$ from the treatment group, we employ two functions of covariates as criteria. The first function of covariates is the Mahalanobis metric, which is defined as $(x_{ijt} - x_{i'j't'})' X_N^{-1} (x_{ijt} - x_{i'j't'})$ where $X_N^{-1}$ is the sample variance matrix of covariates in the pooled sample. The Mahalanobis metric is a scale-normalized distance between $x_{ijt}$ and $x_{i'j't'}$, and the couple $(y_{i'j't'}, x_{i'j't'}, d_{i'j't'})$ from the control group which minimizes this scale-normalized distance is selected as the counterfactual potential untreated response of the treated couple ($i$, $j$). The second function is the propensity score function, which can be interpreted as the estimated probability of FTA formation as a function of the covariates of a country couple. The probit model is utilized to estimate the propensity score. For each treated couple ($i$, $j$), only one untreated couple with the closest estimated propensity score is selected as the counterfactual. While searching for the most appropriate untreated couple for each treated couple, we use some control couples more than once in matching.[8]

Once each treated couple is matched with its corresponding untreated couple by

[8] We use the 'psmatch2' command developed by Leuven and Sianesi (2003).

either of these functions, the average effect on the treated is estimated nonparametrically. That is, without assuming any particular functional form, the estimated average effect of the FTA is computed as the average difference of the response variable (the growth rate of combined GDP per capita) across matched pairs. We select an untreated couple that minimizes the scale-normalized distance or has the nearest propensity score to a given treated couple as a matching partner; however, the minimized distance or the nearest propensity score can in certain cases prove to be rather large, which means that there might be no good matches for a certain treated couple. In an effort to avoid such cases, we can discard the matched pairs that fall within the worst $\delta\%$ of all matched pairs.[9]

This setup in the nonparametric matching analysis is consistent with the theoretical models wherein the effect of free trade is shown as the difference in economic growth rates when a country couple has an FTA and when the same country couple does not have an FTA. Unlike the linear regression approach which uses all the observations, the nonparametric matching analysis does not use observations of country couples which have no FTA and different characteristics in terms of the Mahalanobis metric or the propensity score; this is because those cannot be regarded as a counterfactual of a country couple with an FTA.

## IV. Empirical Results

1. FTA Effect on Economic Growth

This section provides empirical results regarding the effects of FTA on the growth of the per capita GDP of treated couples using the matching method. For each treated couple (a country couple that has an FTA), one country couple from the control group (country couples which

[9] The cost of discarding the matched pairs whose distance falls within the worst $\delta\%$ of all matched pairs is the reduction in the number of observations. However, the results reported in subsequent sections are robust when we utilize all matched pairs and when we further restrict the sample by discarding the worst 20% of all matched pairs in terms of the distance or propensity score.

have no FTA) is matched. The matching criterion involves the selection of the one with the minimum Mahalanobis metric or the nearest propensity score among couples in the control group. Using these matched pairs, we then estimate the effects of FTA on the growth of the treated couples.

Table 5 shows the results with regard to the effects of FTA on the annual growth rates of treated country couples. Results based on both the Mahalanobis metric and the propensity scores are provided. As is shown in Table 5, we estimate the effect with two caliper choices: 100% and 80%. A caliper choice of 100% means that we have utilized all matched pairs to estimate the effect, whereas a caliper choice of 80% means that we estimate the effect after discarding the worst 20% of matched pairs in terms of the Mahalanobis metric or the propensity score. The total number of matched pairs for the 100% caliper choice is 4113. The results shown in Table 5 differ markedly from those generated by the linear panel regression shown in Section II. The results based on the Mahalanobis metric state that the estimated effect of FTA on the growth of treated couples is insignificantly negative, regardless of the caliper choice. The results based on the propensity score are also insignificant.

As the results in Table 5 demonstrate the average difference in the annual growth rate of per capita GDP between country couples with and without an FTA, the observations include the FTA effect in the very short-run (e.g. the difference in the annual growth rate one year after the FTA has started) as well as the FTA effect in the very long-run (e.g. the difference in the annual growth rate more than 20 years after the launch of the FTA). However, the short-run FTA effect might differ substantially from the long-run effect, although the theoretical comparative statistics do not address how long it would take for an FTA to exert its full impact. For example, it may take a relatively long time for some industries to realize the benefit of an FTA, whereas it may take a relatively short time for other industries to be negatively affected by the FTA. Hence, the effect of the FTA in the short-run tends to be negative or insignificant. However, as workers and resources gradually migrate to industries that have been positively affected by the FTA, the FTA effect may, in the long-run, become more positive. As the number of country couples engaged in FTAs has increased rapidly since the mid-1990s, the results shown in Table 5 might be biased toward the short-run effect. In order to overcome this problem and to understand better the dynamics of the FTA effect over time, we assess the cumulative growth rates of matched pairs, since the time at which the treated couple in a given pair formed their FTA. The number of matched pairs is greatly reduced and varies from 326 (the number of matched pairs one year after the launch of FTA) to 122 (the number of matched pairs 10 years after the launch of the FTA) when the caliper choice is 100%.

Figure 2 shows the average difference in the cumulative growth rates of matched pairs since the time at which the treated couple in a given pair forms an FTA. Although the caliper choice in Figure 2 is 80%,[10] the results are quite similar to the other caliper value choice (100%).[11] Figure 2 shows the 95% confidence interval for the FTA effect. As is shown in the left panel of Figure 2, the FTA effect on cumulative growth rates is positive in most years, from one to 10 years period after the beginning of the FTA on the basis of the Mahalanobis metric, but is consistently insignificant. Furthermore, no upward sloping trend whatsoever was noted with the progression of the time horizon. The results based on the propensity score are generally consistent with those based on the Mahalanobis metric, except that the estimated effect fluctuates more profoundly and this effect becomes marginally and briefly significant at the nine-year horizon. In summary, the results in Figure 2 show that the formation of an FTA does not significantly stimulate the growth performance of the involved countries, at least up to a 10-year horizon.

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[10] When the caliper choice is 80%, the number of matched pairs for one year (ten years) old FTA is 261 (98).

[11] The results with the 100% caliper value are available upon request.

## 2. FTA Effect on Growth Rate Convergence

Although many countries have recently formed FTAs or have begun to consider forming FTAs, the results shown in Table 5 and Figure 2 imply that the average effect of FTA on the growth rate of per capita GDP for country couples with FTAs is insignificant. In this sub-section, we attempt to determine whether this insignificant effect is the consequence of the convergence of the per capita GDP growth rates of individual countries in a treated couple, or of the divergence of per capita GDP growth rates of individual countries in a treated couple. Put another way, we attempt to determine whether the gap in the per capita GDP growth rates of two countries with an FTA has grown or shrunk since the inception of the FTA.

While some previous studies—most notably those of Sachs and Warner (1995) and Ben-David (1996)—have reported that growth convergence is currently observed only among open countries engaging in international trade, others like Slaughter (2001) reported the opposite result—namely, that trade liberalization induced income divergence among open countries. Our investigation in this sub-section is also anticipated to make a contribution to this debate over the relationship between free trade and growth convergence via the nonparametric matching approach.

The nonparametric matching approach is used to compare differences in the growth rates between country couples with and without an FTA, after switching the response variable from the growth rate of combined per capita GDP to the difference in per capita GDP growth rates across two countries within a couple. The results are shown in Figure 3. As is shown in Figure 3, the gap of the growth rates between members of a country couple with an FTA is initially lower (on average) than that between members of a country couple without an FTA immediately following the launch of the FTA by both matching methods. That is, an FTA seeks to reduce the gap in the growth rates between member countries in a couple engaging in an FTA, as compared with that between member countries in a couple without the FTA, and this effect is shown to be significant according to the propensity score criterion. As time elapses, however, the gap in the growth rates between member countries in a couple rises relatively more rapidly since these two countries have formed an FTA. The gap between countries with an FTA becomes significantly larger than that between countries without an FTA beginning five years (nine years) after the launch of the FTA, on the basis of the Mahalanobis metric (the propensity score). The vivid upward trend and significantly positive gap shown in Figure 3 suggest that the effects of FTAs on economic growth may not prove symmetrical between within-FTA country members. Some countries appear to enjoy a positive FTA effect on economic growth, whereas their FTA partners appear to experience a negative FTA effect on economic growth.

3. The Behavior of Growth Rates Before FTAs

One may surmise that we found an insignificant FTA effect on the combined growth rate of GDP because the GDP growth rates for couples from the treatment group were lower than the matched couples from the control group prior to the inception of the FTAs. In other words, when we match a couple from the treatment group with a couple from the control group on the basis of the Mahalanobis metric or the propensity score, we implicitly assume similar growth behaviors between the matched couples before the inception of the FTAs; this assumption may, however, not prove to be true. To evaluate this possibility, we attempt to determine whether any significant difference exists in the behavior of combined GDP growth rates between matched couples during the period prior to FTA formation.

As approximately one or two years are generally required for countries to complete their FTA negotiations and to put their FTA into effect, we compare three- to five-year cumulative growth rates prior to the launch of FTAs for matched couples in order to assess whether those growth rates were comparable before the FTAs were formed. The T-statistics of the difference in the cumulative growth rates of combined GDP are shown in Table 6 and the caliper choice in Table 6 is 80%. As shown in Table 6, the differences in the cumulative growth rates of combined GDP between matched couples are insignificant in all cases, except that the difference in the five-year cumulative growth rates is significant at the 5% level when the propensity score is employed as the matching criterion. These results indicate that the insignificant effect of the FTA on combined growth rates does not appear to be attributable to any systematic difference in the combined growth rates between matched couples prior to the inception of FTAs.

## V. Concluding Remarks

In this paper, we utilize an alternative trade openness measure, which implies 'mutual' trade liberalization and the nonparametric matching approach, in order to determine whether an FTA exerts an effect on the growth of the two countries involved in the FTA. Whereas linear panel regressions, which are common in both the growth literature and the FTA literature, are found to be vulnerable to econometric problems including misspecification and non-random selection, the nonparametric matching method imposes no specific functional form in the relation, and can thus be applied to a broad range of data structures.

The principal finding of this paper is that FTAs appear to exert an insignificant effect on growth performance from the nonparametric matching approach. An FTA has an insignificant effect in the one-to-10-year period after the launch of the FTA. Furthermore, we find an upward trend in the gap between the growth rates of per capita GDP among countries within an FTA. This is suggestive of uneven FTA effects across countries within an FTA, which may partially explain the insignificant effects of FTAs on the economic growth of both countries engaging in an FTA. This also shows that policy makers should not consider FTAs as a strategy that guarantees rapid development. Thus, caution should be exercised in the design of FTAs in order to ensure the FTA's positive effects.

One may surmise that the insignificant effects of an FTA on the combined growth rate of GDP might be attributable to certain distortions induced by the FTAs. FTAs are basically preferential free trade agreements among member countries, and this preferential arrangement can exert a trade diversion effect against non-FTA member countries outside the FTA blocs. If the trade diversion effect—which reduces the welfare of FTA member countries—is relatively more dominant, then the effects of FTAs on growth rates might prove insignificant. This may explain why we detected an insignificant FTA effect. However, recent studies such as the work of Lee *et al*. (2008) have already demonstrated that not only insiders of FTAs, but also outsiders, increase their international trade. Based on this empirical finding, the trade diversion effect of FTAs cannot be adjudged a compelling reason for the insignificant effect of FTAs on economic growth.

Although our findings certainly appear remarkable in relation to the conventional view regarding the effects of free trade, our results can be considered consistent with some endogenous growth models that emphasize the relationship between trade and growth. For example, Grossman and Helpman (1991) and Feenstra (1996) have predicted that if a free trade system is formed under conditions in which technology transfer occurs between the involved economies, production efficiency can be improved, and free trade can therefore ultimately induce economic growth among FTA signatory countries. More specifically, Feenstra (1996) has demonstrated that the free trade system does not increase the growth rate of large countries, and can even retard the growth of small countries in the long run if technology transfer does not occur. These theoretical propositions imply an insignificant FTA effect on combined growth rates and an uneven FTA effect between the countries engaging in an FTA when technology transfer does not occur between FTA signatory countries; this is consistent with the empirical findings of this paper. Hence, an interesting future research topic would be to investigate empirically whether a technology transfer channel works well, or under what conditions FTA can provide benefits to all member countries.

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**Table 1: Data Descriptions and Sources**

| Variable | Description | Source |
|---|---|---|
| **East Asian dummy** | Dummy for East Asian Countries | Sala-i-Martin, Dopplehofer and Miller (2004) |
| **Primary schooling** | Annual enrollment rate in primary school | World Development Indicator |
| **Investment price** | Annual investment price | Penn World Table 6.2 |
| **Real GDP pc** | Real GDP per capita | Penn World Table 6.2 |
| **Fraction of tropical area** | Proportion of country's land area within tropics | Sala-i-Martin, Dopplehofer and Miller (2004) |
| **Population density in coastal area** | Coastal population per coastal area (interpolated) | Gallup et al. (2001) |
| **Malaria prevalence** | Index of Malaria prevalence (interpolated) | Gallup et al. (2001) |
| **Life expectancy** | Annual life expectancy | World Development Indicator |
| **Confucian** | Fraction of Confucian Population (interpolated) | Barro |
| **African dummy** | Dummy for sub-Saharan African countries | Sala-i-Martin, Dopplehofer and Miller (2004) |
| **Latin American dummy** | Dummy for Latin American countries | Sala-i-Martin, Dopplehofer and Miller (2004) |
| **Fraction of GDP in mining** | Fraction of GDP in mining | Sala-i-Martin, Dopplehofer and Miller (2004) |
| **Spanish colony** | Dummy for former Spanish colonies | Sala-i-Martin, Dopplehofer and Miller (2004) |
| **Openness**[12] | Openness variable | Penn World Table 6.2 |
| **Fraction of Muslim** | Fraction of Muslim population (interpolated) | Barro |
| **Fraction of Buddhist** | Fraction of Buddhist population (interpolated) | Barro |
| **Ethonoliguistic fractionalization** | Average of five difference indices of ethnolinguistic fractionalization | Sala-i-Martin, Dopplehofer and Miller (2004) |
| **Government consumption share** | Annual share of government consumption to GDP | Penn World Table 6.2 |
| **Natural** | Inverse of Distance | CIA World Fact Book |
| **Remoteness** | Remoteness of coupled countries from the rest of the world | CIA World Fact Book |
| **GDP sum** | $log\ (GDP_i + GDP_j)$ | Penn World Table 6.2 |
| **GDP sim** | $\lvert lo\ g(GDP_i) - \log\ (GDP_j) \rvert$ | Penn World Table 6.2 |
| **DKL** | $\lvert\ log(GDP_i/Pop_i) - log\ (GDP_j/Pop_j) \rvert$ | Penn World Table 6.2 |
| **SQDKL** | $\text{DKL}^2$ | Penn World Table 6.2 |
| **DROWKL** | $0.5\{\lvert A - log\ (GDP_j/Pop_j)\rvert + \lvert A - log\ (GDP_j/Pop_j)\rvert\}$ where $A = log\ (\frac{\sum_{k\neq i} GDP_k}{\sum_{k\neq i} Pop_k})$ | Penn World Table 6.2 |

The web address for the data source indicated as Sala-i-Martin, Dopplehofer and Miller (2004) is http://www.econ.cam.ac.uk/faculty/doppelhofer/research/bace.htm.

The web address for the data source indicated as Gallup *et al.* (2001) is http://www.cid.harvard.edu/ciddata/ciddata.html.

The data for religion is taken from Robert Barro's web site of which the address is http://www.economics.harvard.edu/faculty/barro/data_sets_barro.

'Penn World Table 6.2' can be found at http://pwt.econ.upenn.edu/php_site/pwt_index.php.

'World Development Indicator' can be found at the web site of the World Bank which is http://www.worldbank.org/.

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[12] The variable used by Sala-i-Martin, Dopplehofer and Miller (2004) is the number of years the economy has been open between 1950 and 1994. Since we need a variable with annual frequency for individual countries, we use the openness variable in the Penn World Table.

**Table 2**
**List of Regional Trade Agreements and Countries Used In the Analysis**

| **Regional Trade Agreements (FTA and Customs Union Only)*** | |
|---|---|
| 1958 | European Community (EC) |
| 1960 | European Free Trade Association (EFTA) |
| 1961 | Central American Common Market (CACM) |
| 1973 | EC-Switzerland and Liechtenstein; EC accession of Denmark, Ireland and United Kingdom; EC-Norway; Caribbean Community and Common Market (CARICOM) |
| 1976 | EC-Algeria |
| 1977 | EC-Syria |
| 1981 | EC accession of Greece |
| 1983 | Closer Trade Relations Trade Agreement (CER) |
| 1985 | United States-Israel |
| 1986 | EC Accession of Portugal and Spain |
| 1991 | Southern Common Market (MERCOSUR) |
| 1992 | EFTA-Turkey |
| 1993 | EFTA-Israel |
| 1994 | North American Free Trade Agreement (NAFTA) |
| 1995 | EC accession of Austria, Finland and Sweden |
| 1996 | EC-Turkey; |
| 1997 | Canada-Israel; Turkey-Israel; Canada-Chile; |
| 1998 | EC-Tunisia; Mexico-Nicaragua |
| 1999 | Chile-Mexico; EFTA-Morocco |
| 2000 | EC-South Africa; EC-Morocco; EC-Israel; Israel-Mexico; EC-Mexico; Southern African Development Community (SADC) |
| 2001 | EFTA-Mexico; India-Sri Lanka; United States-Jordan |
| 2002 | EFTA-Jordan; EC-Jordan; Chile-El Salvador |
| 2003 | EC-Chile; Panama-El Salvador |

| **88 Countries** |
|---|
| Algeria, Argentina, Australia, Austria, Belgium, Benin, Bolivia, Botswana, Brazil, Burkina Faso, Burundi, Canada, Chile, Colombia, Congo, Cote d'Ivoire, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, Finland, France, Gabon, Gambia, Germany, Ghana, Greece, Guatemala, Guinea, Guinea-Bissau, Honduras, Hungary, India, Indonesia, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Korea, Lesotho, Liberia, Madagascar, Malawi, Malaysia, Mali, Mauritania, Mexico, Morocco, Mozambique, Nepal, Netherland, New Zealand, Nicaragua, Niger, Nigeria, Norway, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Rwanda, Senegal, South Africa, Spain, Sri Lanka, Sudan, Sweden, Switzerland, Syria, Tanzania, Togo, Trinidad & Tobago, Tunisia, Turkey, United Kingdom, United States, Uruguay, Venezuela, Zambia, Zimbabwe |

Note: *We obtain the list from the WTO's report of *Regional Trade Agreements Notified to the GATT/WTO by Date of Entry into Force* for the period of 1958-2003. The RTAs that we used in the analysis are only the free trade agreements and customs unions listed in the WTO. We exclude service agreements and preferential partial agreements. We also exclude RTAs for the countries that are not in the country list.

**Table 3: Distribution of Covariates**

| Variable | Non FTA couples | | | FTA couples | | |
|---|---|---|---|---|---|---|
| | Obs | Mean | Std. Dev | Obs | Mean | Std. Dev |
| **Primary Schooling** | 122211 | 75.23 | 23.73 | 4113 | 92.61 | 10.59 |
| **Investment Price** | 122211 | 86.17 | 39.38 | 4113 | 90.99 | 20.07 |
| **Real GDP pc** | 122211 | 7585.06 | 6342.57 | 4113 | 16423.44 | 6765.24 |
| **Fraction of tropical area** | 122211 | 0.5541 | 0.3798 | 4113 | 0.1088 | 0.2743 |
| **Malaria Prevalence** | 122211 | 0.6754 | 0.5917 | 4113 | 0.0427 | 0.2205 |
| **Life expectancy** | 122211 | 63.02 | 9.38 | 4113 | 73.46 | 7.09 |
| **African dummy** | 122211 | 0.7025 | 0.6649 | 4113 | 0.0681 | 0.3434 |
| **Latin American dummy** | 122211 | 0.4402 | 0.5775 | 4113 | 0.1821 | 0.5524 |
| **Fraction of GDP in mining** | 122211 | 0.0429 | 0.0483 | 4113 | 0.0239 | 0.0353 |
| **Spanish colony** | 122211 | 0.3471 | 0.5284 | 4113 | 0.1575 | 0.5048 |
| **Openness** | 122211 | 56.14 | 26.82 | 4113 | 65.79 | 24.11 |
| **Fraction of Muslim** | 122211 | 0.2171 | 0.2761 | 4113 | 0.1379 | 0.2429 |
| **Fraction of Buddhist** | 122211 | 0.0271 | 0.1032 | 4113 | 0.0017 | 0.0020 |
| **Ethonoliguistic fractionalization** | 122211 | 0.3496 | 0.2501 | 4113 | 0.1592 | 0.1428 |
| **Natural** | 122211 | -8.67 | 0.7202 | 4113 | -7.32 | 0.8007 |
| **Remoteness** | 122211 | 2.16 | 3.77 | 4113 | 6.25 | 3.95 |
| **GDP sum** | 122211 | 18.94 | 1.54 | 4113 | 20.13 | 1.19 |
| **GDP sim** | 122211 | 2.21 | 1.61 | 4113 | 1.40 | 1.06 |
| **DKL** | 122211 | 1.36 | 0.9456 | 4113 | 0.6500 | 0.6825 |
| **SQDKL** | 122211 | 2.75 | 3.22 | 4113 | 0.8877 | 1.57 |
| **DROWKL** | 122211 | 1.11 | 0.5122 | 4113 | 0.8641 | 0.2651 |

Note: The null hypothesis is that the means of covariates across two groups (one with an FTA and the other one without an FTA) are equal. With an assumption of unequal variances between the two groups, we rejected the null hypothesis at a significance level of 5% for all covariates used in the analysis.

**Table 4: Linear Panel Regression Models - Fixed Effect and Random Effect**

| | Fixed Effect Model | With Fitted Value term | With Interaction terms | Random Effect model | With Fitted Value term | With Interaction terms |
|---|---|---|---|---|---|---|
| **East Asian dummy** | (dropped) | (dropped) | (dropped) | -0.000(-0.45) | 0.000(0.00) | -0.000(0.36) |
| **Primary schooling** | 0.000(1.90) | 0.000(1.20) | 0.000(1.73) | 0.000(1.26) | 0.000(1.43) | 0.000(1.15) |
| **Investment price** | -0.000(-5.49) | -0.000(-5.07) | -0.000(-5.33) | -0.000(-8.51) | -0.000(-8.80) | -0.000(-8.23) |
| **Real GDP pc** | 0.000(6.13) | 0.000(7.13) | 0.000(5.67) | -0.000(-3.03) | -0.000(-3.73) | -0.000(-3.46) |
| **Fraction of tropical area** | (dropped) | (dropped) | (dropped) | -0.001(-1.53) | -0.001(-1.77) | -0.001(-1.33) |
| **Population density in coastal area** | -0.000(-2.99) | -0.000(-2.24) | -0.000(-2.97) | -0.000(-3.31) | -0.000(-4.01) | -0.000(-2.93) |
| **Malaria prevalence** | 0.022(8.39) | 0.021(8.25) | 0.021(8.32) | 0.003(5.30) | 0.003(5.88) | 0.003(5.16) |
| **Life expectancy** | -0.001(-10.50) | -0.001(-10.17) | -0.001(-10.43) | -0.000(-7.84) | -0.000(-8.58) | -0.000(-7.47) |
| **Confucian** | 0.958(12.12) | 1.123(16.90) | 0.964(12.15) | 0.058(31.24) | 0.076(29.09) | 0.058(31.14) |
| **African dummy** | (dropped) | (dropped) | (dropped) | -0.007(-13.24) | -0.008(-14.60) | -0.007(-13.02) |
| **Latin American dummy** | (dropped) | (dropped) | (dropped) | -0.003(-4.83) | -0.003(-5.24) | -0.003(-4.67) |
| **Fraction of GDP in Mining** | -0.083(-2.61) | -0.082(-2.50) | -0.085(-2.73) | 0.005(1.02) | 0.006(1.08) | 0.005(0.91) |
| **Spanish colony** | (dropped) | (dropped) | (dropped) | -0.003(-6.37) | -0.003(-7.12) | -0.003(-6.24) |
| **Openness** | 0.000(2.28) | 0.000(1.73) | 0.000(1.92) | 0.000(19.53) | 0.000(20.60) | 0.000(19.19) |
| **Fraction of Muslim** | 0.015(1.59) | 0.013(1.31) | 0.015(1.47) | 0.003(5.19) | 0.004(5.60) | 0.004(5.53) |
| **Fraction of Buddhist** | 0.224(19.66) | 0.289(22.30) | 0.226(19.54) | 0.018(11.42) | 0.020(13.26) | 0.018(11.17) |
| **Ethonoliguistic fractionalization** | 0.050(3.83) | 0.051(3.92) | 0.051(3.92) | -0.002(-2.60) | -0.002(-2.65) | -0.002(-2.84) |
| **Government consumption share** | -0.000(-5.64) | -0.000(-5.48) | -0.000(-5.72) | -0.000(-2.07) | -0.000(-2.16) | -0.000(-2.21) |
| **Natural** | (dropped) | (dropped) | (dropped) | -0.001(-4.48) | -0.001(-4.80) | -0.001(-3.98) |
| **Remoteness** | (dropped) | (dropped) | (dropped) | 0.000(2.79) | 0.000(3.12) | 0.000(2.23) |
| **GDPsum** | 0.039(21.25) | 0.040(22.21) | 0.039(21.08) | 0.003(14.01) | 0.003(14.97) | 0.003(13.87) |
| **GDPsim** | 0.001(1.30) | 0.001(1.40) | 0.001(1.22) | 0.003(20.53) | 0.003(22.14) | 0.003(20.20) |
| **DKL** | -0.002(-1.61) | -0.002(-1.92) | -0.002(-1.50) | -0.003(-6.19) | -0.003(-6.90) | -0.003(-5.92) |
| **SQDKL** | 0.001(3.16) | 0.001(3.09) | 0.001(3.11) | 0.000(0.69) | 0.000(0.66) | 0.000(0.51) |
| **DROWKL** | -0.006(-3.54) | -0.005(-2.71) | -0.006(-3.60) | -0.003(-5.97) | -0.003(-6.34) | -0.003(-5.73) |
| **FTA** | **0.004(5.40)** | **0.004(5.12)** | **-0.106(-2.54)** | **0.002(2.99)** | **0.002(3.36)** | **-0.001(-0.02)** |
| **(Fitted drgdp)$^2$** | | **-0.567(-13.25)** | | | **-4.089(-9.63)** | |
| **FTA × East Asian dummy** | | | (dropped) | | | (dropped) |
| **FTA × Primay Schooling** | | | -0.000(-1.81) | | | -0.000(-2.01) |
| **FTA × Investment price** | | | -0.000(-1.94) | | | -0.000(-2.90) |
| **FTA × Real GDP pc** | | | -0.000(-2.32) | | | -0.000(-1.47) |
| **FTA ×** | | | -0.035(-2.95) | | | -0.021(-3.25) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Fraction of tropical Area | | | | | | |
| FTA × Population density in coastal area | | | -0.000(-2.64) | | | -0.000(-3.70) |
| FTA × Malaria prevalence | | | 0.023(1.96) | | | 0.009(1.00) |
| FTA × Life expectancy | | | 0.000(1.21) | | | 0.000(0.76) |
| FTA × Confucian | | | (dropped) | | | (dropped) |
| FTA × African dummy | | | -0.015(-1.85) | | | -0.005(-0.65) |
| FTA × Latin American dummy | | | 0.007(1.05) | | | 0.003(0.77) |
| FTA × Fraction of GDP in Mining | | | 0.100(2.65) | | | 0.066(2.96) |
| FTA × Spanish colony | | | -0.004(-0.58) | | | -0.000(-0.07) |
| FTA × Openness | | | 0.000(4.38) | | | 0.000(0.50) |
| FTA × Fraction of Muslim | | | -0.007(-1.12) | | | -0.017(-3.41) |
| FTA × Fraction of Buddhist | | | -1.606(-5.22) | | | -0.321(-1.30) |
| FTA × Ethonoliquistic Fractionalization | | | 0.031(3.82) | | | 0.017(3.05) |
| FTA × Government consumption share | | | 0.001(2.62) | | | 0.000(1.75) |
| FTA × Natural | | | 0.001(0.68) | | | 0.000(0.24) |
| FTA × Remoteness | | | 0.000(0.80) | | | 0.000(0.40) |
| FTA × GDPsum | | | 0.004(2.72) | | | -0.000(-0.21) |
| FTA × GDPsim | | | 0.002(2.54) | | | -0.001(-2.23) |
| FTA × DKL | | | 0.002(0.46) | | | 0.002(0.45) |
| FTA × SQDKL | | | -0.002(-0.97) | | | -0.001(-0.70) |
| FTA × DROWKL | | | 0.004(0.68) | | | 0.004(1.05) |
| obs | 126,324 | 126,324 | 126,324 | 126,324 | 126,324 | 126,324 |
| $R^2$ | 0.1184 | 0.1198 | 0.1201 | 0.1012 | 0.1019 | 0.1026 |

Note: Dependent variable, denoted by RGDP, is the sum of real GDP growth rates of a pair of countries. Estimates for constant and year effects are not reported. Robust t-statistics are in parentheses. Standard errors are adjusted for country-pair clusters.

**Table 5: Effect of FTA on the Growth of per capita GDP**

| caliper | Mahalanobis Metric | | |
|---|---|---|---|
| | Effect | Standard Errors | T-statistic |
| **100%** | -0.0006 | 0.0008 | -0.75 |
| **80%** | -0.0001 | 0.0008 | -0.16 |
| **caliper** | **Propensity Score** | | |
| | Effect | Standard Errors | T-statistic |
| **100%** | 0.0012 | 0.0010 | 1.23 |
| **80%** | -0.0005 | 0.0008 | -0.60 |

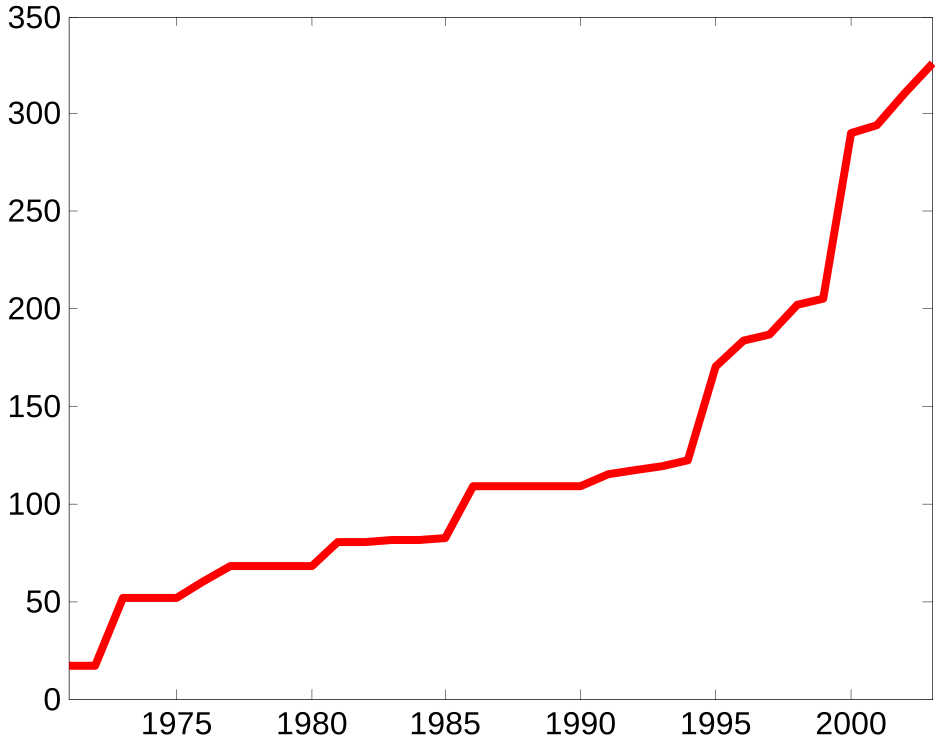
Note: This table shows the estimated FTA effect on annual growth rates for country couples with an FTA by the nonparametric matching approach.

**Table 6: Difference in the Growth Rates before the Formation of FTAs**

| caliper | T-statistics: Mahalanobis Metric | | |
|---|---|---|---|
| | -3 year | -4 year | -5 year |
| **80%** | 0.04 | 0.23 | -0.02 |
| **caliper** | **T-statistics: Propensity Score** | | |
| | -3 year | -4 year | -5 year |
| **80%** | -1.67 | -0.85 | -2.55 |

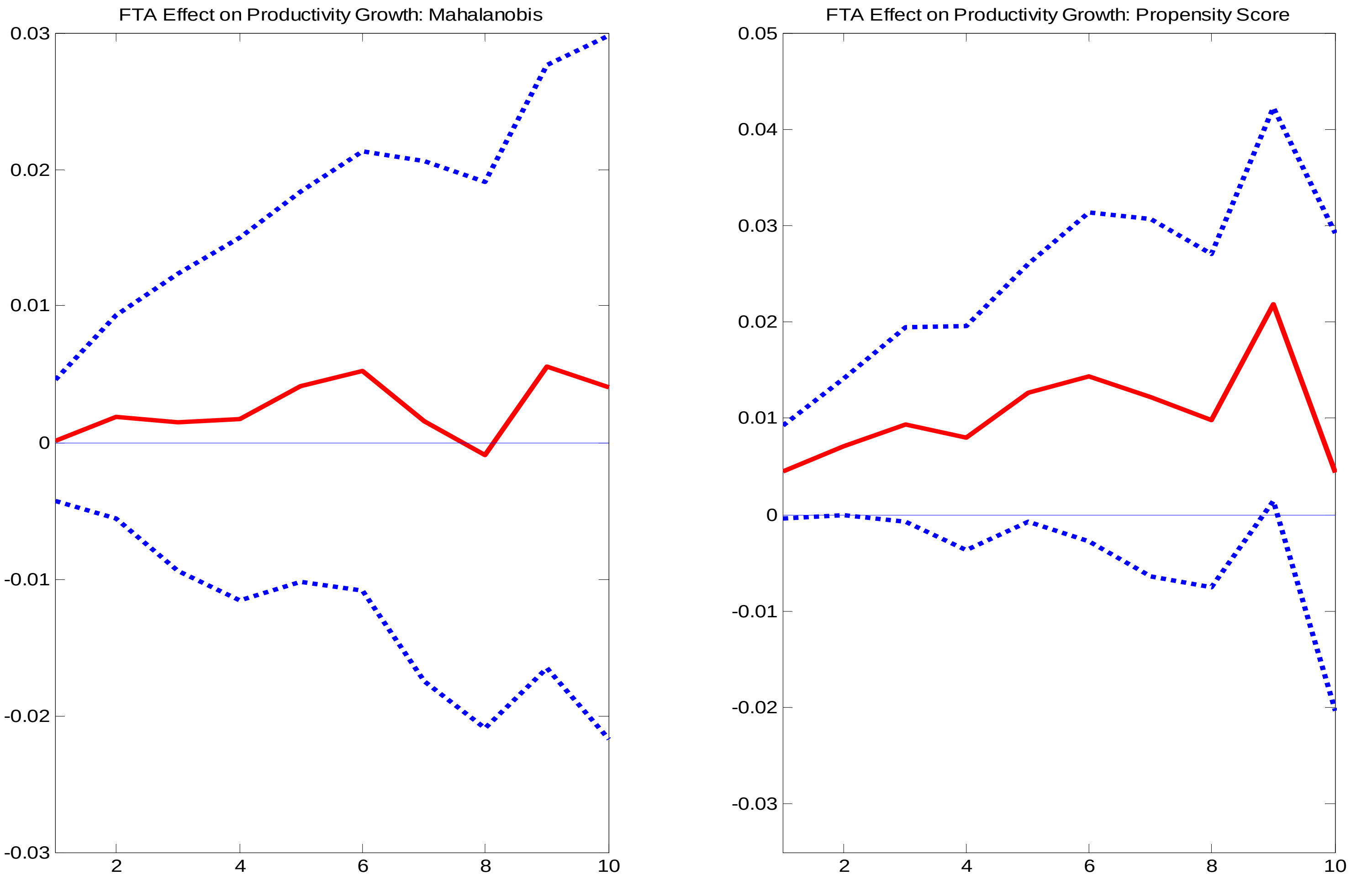
Note: This table shows T-statistics of the difference in the cumulative growth rates between country couples with an FTA and couples without an FTA before the start of FTAs.

**Figure 1: Cumulative Number of FTAs**



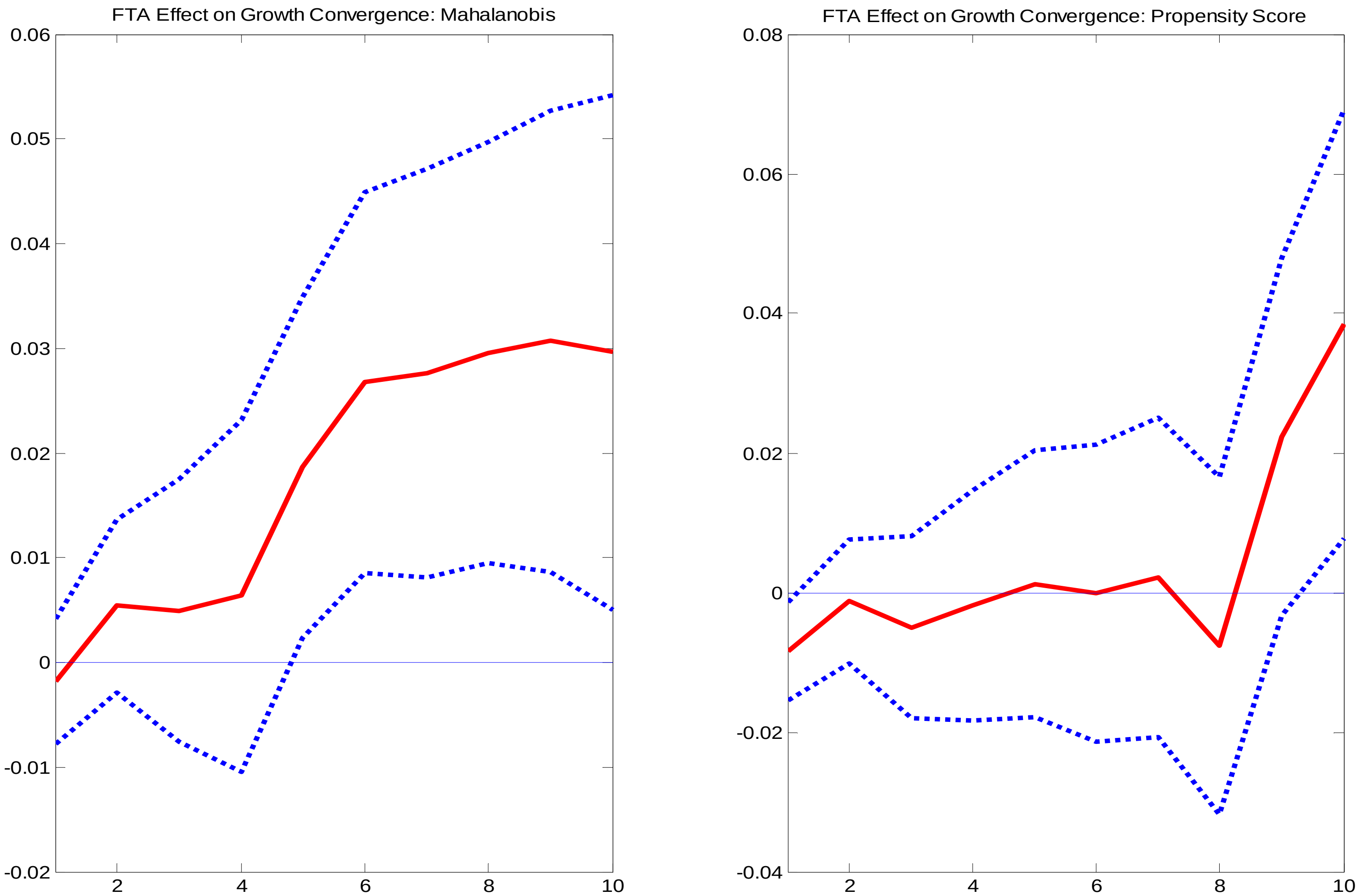

Notes: The data source is WTO's report of *Regional Trade Agreements Notified to the GATT/WTO by Date of Entry into Force* for the 1958-2003 period. This figure shows the cumulative number of a bilateral FTA, which is counted as one if a couple of countries engages in a free trade system such as a free trade agreement or customs union.

**Figure 2: FTA Effect on Economic Growth over Time**




Note: The solid lines show the estimated average FTA effect on the growth performance and the dotted lines show the 95% confidence interval of the effect.

**Figure 3: FTA Effect on Convergence over Time**




Note: The solid lines show the estimated average FTA effect on the growth performance, and the dotted lines show the 95% confidence interval of the effect.