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Estimating the Effects of the Totalization Agreements

Abstract

This paper quantifies the effects of the totalization agreements that coordinate the United States Social Security program with the comparable programs of other countries. For each treated country that has signed an agreement with the U.S., we construct a synthetic control country by properly weighting other countries that have not signed a totalization agreement with the U.S. to make sure that the resulting synthetic control mimics the behavior of the treated country before the totalization agreement entered into force. Using the synthetic country to approximate what would happen to the treated country after the agreement, we find, on average, that totalization agreements reduce U.S. exports significantly and increase U.S. imports and U.S. foreign direct investment in the fifth year after the agreement. Moreover, we find the effects are quite heterogeneous across countries/agreements, with some agreements increasing U.S. exports and others decreasing U.S. imports, both of which are the opposite of the average effects. In future work, we will investigate why the effects vary across countries by relating the estimates in this paper to the bilateral trade patterns between the U.S. and the treated countries, as well as the number and composition of beneficiaries of the totalization agreements.

Citation

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Introduction

Beginning in the late 1970s, the United States established a network of Social Security agreements that coordinate the U.S. Social Security program with the comparable programs of other countries.[1] These international Social Security agreements, often called the "totalization agreements," have three main purposes. First, they eliminate dual Social Security taxation, the situation that occurs when a worker from one country works in another country and is required to pay Social Security taxes to both countries on the same earnings. Second, the agreements help fill gaps in benefit protection for workers who have divided their careers between the U.S. and another country. Finally, totalization agreements permit unrestricted payment of benefits to residents of the two countries.

Conceptually, by reducing the tax and increasing benefit protection for U.S. citizens working in other countries and vice versa, the totalization agreements should have a positive effect on U.S. citizens working in countries that have signed such an agreement with the U.S., as well as the citizens from those countries working in the U.S. By promoting international labor mobility, the totalization agreements could also affect foreign direct investment (FDI) and bilateral trade.

Theoretically, however, it's not clear whether the trade effects will be positive or negative. On the one hand, the totalization agreements may increase bilateral trade if increased international labor mobility helps reduce the transaction cost of international trade. On the other hand, however, the totalization agreements may reduce trade if

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[1] This introductory paragraph draws from the description by the Social Security Administration. https://www.ssa.gov/international/agreements_overview.html

factor mobility and trade are substitutes, as shown by Mundell (1957) in a standard Heckscher-Olin model. For example, if the totalization agreement between Italy and the U.S. makes it easier for Boeing to send its engineers to Italy and produce airplanes there, it may reduce the number of airplanes exported from the U.S. to Italy. A reduction in U.S. exports is often perceived as contributing to fewer U.S. jobs, but this view ignores the fact that Boeing's physical presence in Italy might mean more airplane sales for Boeing and fewer for Airbus. Factor mobility and trade may also be complements. Additionally, FDI is generally associated with higher domestic employment (Grimm and Kim 2016).

Wong (1986) studies the conditions under which international trade and factor mobility are substitutes versus complements. Empirically, Gould (1994) estimates a positive effect of the number of immigrants from a country in the U.S. on the bilateral trade between the two countries, a finding supported by many subsequent studies. As most of the immigrants live in the host country permanently, the estimates may not apply to the totalization agreements, which mainly promote temporary international migration.

Quantitatively, the potential effects of a totalization agreement depend on at least three factors: the size of the population considering working abroad, the size of the Social Security taxes and benefits relative to other costs and benefits affecting their decisions, and the sensitivity of FDI and bilateral trade to international labor mobility. In 2016, the total number of beneficiaries of the totalization agreements was 226,924.[2] This is an approximate lower-bound estimate of the total number of workers previously

[2] Table 5.M, Annual Statistical Supplement, 2017. Social Security Administration. https://www.ssa.gov/policy/docs/statcomps/supplement/2017/index.html

employed under a totalization agreement. The economic impact of a totalization agreement at a particular point of time depends on the number of U.S./foreign workers currently participating in the agreement.

This paper estimates the effects of the totalization agreements empirically. We use the synthetic control method developed recently by Abadie and Gardeazabal (2003) and Abadie, Diamond and Hainmueller (2010, 2015), among others. As described in more detail later, for each country that has ever signed a totalization agreement with the U.S., referred to as the "treated country," this method constructs a synthetic control country as the weighted average of other countries that have not signed a totalization agreement with the U.S. The weights are chosen such that the synthetic control country mimics the behavior of the treated country in terms of the outcome variable of interest before the totalization agreement entered into force. The totalization agreement's effects are then measured by the differences in the outcome variable between the treated and the synthetic country since the agreement entered into force. Once we have a synthetic control for each treated country, we pool the pairs of countries together and estimate a totalization agreement's average effects by running difference-in-differences (DID) type regressions.

Relative to DID, the synthetic control method has at least two advantages. First, instead of simply assuming that the treated country shares the same trend with the control countries in the absence of a totalization agreement, the synthetic control method weights the control countries properly to explicitly ensure that the resulting synthetic control country does share the same trend with the treated country before the totalization agreement entered into force. Secondly, in addition to the average effect,

the synthetic control method can estimate the effect for each treated country/agreement. This allows us to study whether and how the effect varies across countries/agreements.

Empirically, we find that, on average, the totalization agreements reduce U.S. exports and increase U.S. imports and FDI. The effect on exports are more significant both economically and statistically, while the effects on imports and FDI are not significant statistically until the fifth year after an agreement entered into force.

Specifically, the U.S. exports to treated countries increase by about 50% on average in the six years between the year leading to the agreement and the fifth year after the agreement. In the absence of the agreement, the estimates suggest that the U.S. exports to those countries would double. This implies the totalization agreements reduce the growth of U.S. exports during the six years by about 50% on average.

Moreover, we find the effects are quite different across countries/agreements. For example, although most of the totalization agreements are estimated to reduce U.S. exports, the estimates suggest an increase in U.S. exports due to the totalization agreements with Finland, Ireland, and the Czech Republic. Similarly, contrary to the average effect that sees an increase in U.S. imports, the estimates suggest a decrease in U.S. imports due to the totalization agreements with countries such as Italy, Germany, Norway, Sweden, Portugal, South Korea, and Australia.

In future work, we will investigate why the effects vary across countries by relating the estimates in this paper to the bilateral trade patterns between the U.S. and the treated countries as well as the number and composition of the totalization agreements' beneficiaries.

Data

The date that each totalization agreement entered into force is obtained from the Social Security Administration.[3] The basic characteristics of each country are obtained from the Penn World Table (PWT).[4] We use PWT version 9.1, the most recent version with information on relative levels of income, output, input, and productivity, covering 182 countries between 1950 and 2017. For FDI, we use the database from the Bureau of Economic Analysis.[5] It provides annual FDI position by country from 1980. We obtain annual trade (imports and exports) between the U.S. and other countries from the UN Comtrade Database.[6]

Empirical strategy

We use the synthetic control method developed recently by Abadie and Gardeazabal (2003) and Abadie, Diamond and Hainmueller (2010, 2015), among others. Suppose there is a sample of $I + 1$ countries indexed by i, among which $i = 1$ is the only country with which the U.S. has established a totalization agreement which entered into force in year T_i. The synthetic control estimator of the agreement's impact between the U.S. and country $i = 1$ on outcome variable y in year t is

$$y_{1t} - \sum_{i>1} w_i y_{it} \qquad (1)$$

where w_i is the weight of country i such that $\sum_{i>1} w_i = 1$ and each w_i is between 0 and 1.

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[3] https://www.ssa.gov/international/agreements_overview.html

[4] https://www.rug.nl/ggdc/productivity/pwt/

[5] https://www.bea.gov/international/di1fdibal

[6] https://comtrade.un.org/data/

Let X_i be a vector of pre-agreement, i.e., before the year T_i, characteristics of country i, and let X_{im} be its mth element. The optimal weight w_i is chosen by minimizing the following criterion function

$$\sum_m v_m \left(X_{1m} - \sum_{i>1} w_i X_{im} \right)^2 \qquad (2)$$

where v_m is the relative importance of the mth element. An optimal choice of v_m minimizes the mean squared error of the synthetic control estimator.

Essentially, for the treated country $i = 1$, the method constructs a synthetic control by properly weighting each of the potential control countries such that the resulting synthetic control country mimics the behavior of the treated country before the totalization agreement entered into force. The totalization agreement's effects are then measured by the differences in the outcome variable between the treated and the synthetic country since the agreement.

Because the synthetic control country is meant to approximate the counterfactual of the treated country $i = 1$ in the absence of the totalization agreement, it's important to restrict the pool of potential controls to countries similar to the treated country $i = 1$ in the sense that the outcome variable y is driven by the same structural process in both the treated country and the potential control countries. For example, in evaluating the effect of the totalization agreements on trade, Zimbabwe may not be a good control for Italy if the trade patterns between Zimbabwe and the U.S. are significantly different from those between Italy and the U.S. On the other hand, France may be a better control if its trade patterns with the U.S. are similar to those between Italy and the U.S.

Given that the bilateral totalization agreement between the U.S. and other countries entered into force at different times, a natural group of potential controls for a

particular treated country are countries that signed the totalization agreement with the U.S. in later years. For example, the first totalization agreement signed between the U.S. and Italy entered into force on November 1, 1978. Countries that have signed a totalization agreement with the U.S. since then are arguably better controls for Italy in estimating the totalization agreement's effect than other countries that have never signed a totalization agreement with the U.S.

By definition, however, a potential control should not have a totalization agreement with the U.S. during the evaluation period. We thus exclude the countries that have signed a totalization agreement with the U.S. before the end of the evaluation period, and only use the countries that have signed a totalization agreement with the U.S. afterward as potential controls. For example, if we want to estimate the totalization agreement's effects between Italy and the U.S. from 1978 to 1983, we would exclude Germany and Switzerland, which signed totalization agreements with the U.S. in 1979 and 1980, respectively, and use other countries that signed a totalization agreement with the U.S. since 1984 as potential controls.

Once we obtain a synthetic control for each treated country of interest, we pool these pairs of countries together and use the following event-study framework to estimate the average effect of the totalization agreements

$$y_{it} = \sum_{n} \beta_n D_{it}^{n} + d_j + d_t + \epsilon_{it} \qquad (3)$$

where D_{it}^{n} is a dummy that equals one if country i has been in the agreement with the U.S. for n years by year t, d_j and d_t are country pair and year fixed effects, respectively, and ϵ_{it} is the error term. β_n measures the average effect of a n-year

agreement. This is essentially a modified DID framework with the synthetic instead of actual countries as controls.

Implementation

For each country of interest that has signed a totalization agreement with the U.S., we use 11 years of data: the year when the agreement entered into force, which is normalized to be year zero $\mathrm{t} = 0$ in the results reported below, and five years before $-5 \leq \mathrm{t} \leq -1$ and after $1 \leq \mathrm{t} \leq 5$ that. We use countries that have signed a totalization agreement with the U.S. five years after the country of interest as potential controls, and choose the weights such that the resulting weighted average (the synthetic control) mimics the behavior of the country of interest in the five years leading to the totalization agreement. This is operationalized using equation (2) where X_i includes real GDP, population, and distance from the U.S., as well as the outcome variable of interest described below. v_m is chosen to minimize the mean squared prediction error over the five years before the agreement, i.e., $\sum_{t=-5}^{-1}(y_{1t} - \sum_{i>1} w_i y_{it})^2$.[7] With the synthetic control given by the weight for each country w_i, we then use equation (1) to estimate the effect of the totalization agreement for $\mathrm{t} \geq 0$.

By now, the U.S. has signed a totalization agreement with 30 countries. The last one, with Iceland, entered into force on March 1, 2019. Because we need five years of data after the agreement to evaluate its effect and at least one similar country that has signed an agreement afterward to construct the synthetic control, we cannot evaluate

[7] Given a value of v_m, equation (2) is used to solve for the optimal weight w_i, which results in a particular value of the mean squared prediction error $\sum_{t=-5}^{-1}(y_{1t} - \sum_{i>1} w_i y_{it})^2$. The process is repeated until the mean squared prediction error is minimized, and the resulting v_m and w_i are used to construct the synthetic control estimator in equation (1).

the effect of the agreements signed recently, which, in practice, includes the six agreements signed since 2014. This leaves us with 24 agreements entered into force between November 1, 1978 (Italy), and March 1, 2009 (Poland). In practice, however, the sample size is slightly smaller because of missing data. For example, because the trade data for Luxembourg was combined with that of Belgium around the year (1993) when the totalization agreement between the U.S. and Luxembourg entered into force, we cannot evaluate the effect of this totalization agreement on trade. Additionally, because our data on FDI starts from 1980, we cannot evaluate the effect on FDI of the totalization agreements signed before 1985.

Intuitively, the direct effect of the totalization agreements should be on international labor mobility. Theoretically, we could calculate the number of immigrants by country from the Current Population Survey's Annual Social and Economic Supplement (ASEC), which has been collecting information on country of birth since 1994, or from the annual American Community Survey (ACS) since 2000. However, as a majority (17 out of the 24 used in this paper) of the totalization agreements entered into force in or before 1994, and the number of immigrants calculated from survey data like ASEC and ACS is likely measured with error, such measures are less accurate than official statistics on FDI and trade. We choose not to evaluate the effect on international labor mobility in this paper, but will pursue it in the future with other data such as the annual number of visas issued to each country by the U.S. Department of State.

We present results for three outcome variables—exports, imports, and FDI—all measured from the perspective of the U.S. That is, exports and imports are the U.S. exports to and imports from another country, respectively, and FDI is the FDI position

that the U.S. holds in another country. For each outcome variable, we normalize its value in the year before the agreement entered into force to be one. The values in other years are relative to the year before the agreement entered into force. We first present the average effect estimated from equation (3), and then report the results for each individual agreement to highlight the heterogeneity. As discussed above, the effect of a totalization agreement is measured by the difference between the treated and the synthetic country, under the assumption that the synthetic country represents how the treated would have behaved in the absence of the totalization agreement. That is, the approach assumes factors other than the totalization agreement, e.g., changes in exchange rates and the adoption of the Euro, have exactly the same effects on both the treated and the synthetic country, and thus their effects would be differenced out.

Results

Table 1 reports the average effects of an n-year agreement β_n estimated from equation (3). Each column uses a different outcome variable as indicated by the column title. Each row reports the estimate for a different year since the totalization agreement entered into force.

The first column shows that, on average, the totalization agreements reduce U.S. exports to the treated country. The estimated effect increases (in absolute value) over time and is statistically significant two years after the agreement entered into force. The estimates suggest that a totalization agreement reduces the growth in U.S. exports to the treated country by about 50% in the first five years since the agreement entered into force. More precisely, as shown later in Figure 2, the U.S. exports to treated countries increased by about 50% between the year leading to the agreement and the fifth year

after the agreement. In the absence of the agreements, we estimate that the U.S. exports to those countries would double during the same period.

The second column shows that, on average, a totalization agreement increases U.S. imports, but the effect is relatively small and only marginally significant statistically in the fifth year after the agreement entered into force. The estimates suggest that a totalization agreement increases the growth in U.S. imports from the treated country by about 13% in the first five years since the agreement entered into force. More precisely, as shown later in Figure 4, the U.S. imports from treated countries increased by about 67% between the year leading to the agreement and the fifth year after the agreement. In the absence of the agreements, we estimate that the U.S. imports from those countries would only increase by about 54%.

Finally, the last column shows that, on average, a totalization agreement has no significant effect on U.S. FDI until five years after the agreement entered into force. The estimates suggest that a totalization agreement increases the growth in U.S. FDI in the treated country by about 192% in the first five years since the agreement entered into force. More precisely, as shown later in Figure 6, the U.S. FDI in the treated countries increased by about 541% between the year leading to the agreement and the fifth year after the agreement. In the absence of the agreements, we estimate that the U.S. FDI in those countries would only increase by about 349%.

Table 1. Average Effects of the Totalization Agreements

	Exports	**Imports**	**FDI**
Year 0	-0.046	0.069	-0.266
	(0.090)	(0.076)	(0.794)
Year 1	-0.084	0.068	-0.050
	(0.090)	(0.076)	(0.794)
Year 2	-0.233***	0.037	-0.194

	(0.090)	(0.076)	(0.794)
Year 3	-0.308***	0.005	-0.128
	(0.090)	(0.076)	(0.794)
Year 4	-0.339***	0.039	1.119
	(0.090)	(0.076)	(0.794)
Year 5	-0.505***	0.134*	1.924**
	(0.090)	(0.076)	(0.794)
N	506	506	374

* p < 0.1, ** p < 0.05, *** p < 0.01. Standard Errors are in the parentheses.

As mentioned above, relative to traditional methods such as DID, one advantage of the synthetic control method is that it allows us to estimate the effect separately for each treated country/agreement, making it possible to study whether and how the effect varies across countries/agreements. For each treated country/agreement, Figures 1, 3, and 5 report the effects on U.S. exports, imports and FDI, respectively. The figures reveal two important messages. First, for each treated country and each outcome variable, the synthetic control country matches the behavior of the treated country very well before the agreement entered into force. This suggests that the synthetic control is doing a good job approximating the counterfactual of what would happen to the treated country in the absence of the totalization agreement.

Second, for each outcome variable, the estimated effect varies significantly across countries/agreements. Consistent with the average effects estimated in Table 1, most panels in Figure 1 suggest a totalization agreement reduces the growth of U.S. exports to the treated country, although the size of the effect varies significantly across countries/agreements. However, for U.S. exports to countries such as Belgium, Canada, France, and the Netherlands, the estimates suggest a zero effect of the totalization agreements. Moreover, the estimates suggest an increase, although relatively small, in U.S. exports to countries such as Finland, Ireland, and the Czech

Republic due to the totalization agreements. Similarly, contrary to the small increase in the growth of U.S. imports from the treated countries estimated in Table 1, Figure 3 suggests a decrease in the growth of U.S. imports following the totalization agreements with countries such as Italy, Germany, Norway, Sweden, Portugal, South Korea, and Australia, and a zero effect of the agreements with countries such as the Netherlands, Austria, Greece, and Chile. Finally, Figure 5 shows the estimated effect on U.S. FDI also varies significantly across countries/agreements. In future work, we will investigate why the effects vary across countries by relating the estimates in this paper to the bilateral trade patterns, e.g., the balance of trade prior to the totalization agreement, between the U.S. and the treated countries.

Figures 2, 4, and 6 plot the average profiles of the treated and the synthetic countries in Figures 1, 3, and 5, respectively. They provide another way to visualize the average effects of the totalization agreements. In each case, we see that there is essentially no difference between the treated and synthetic countries before the totalization agreement entered into force. Afterward, however, we clearly see that, on average, a totalization agreement reduces the growth of U.S. exports over time, and the effects on U.S. imports and FDI are mostly small and statistically insignificant until the very end.

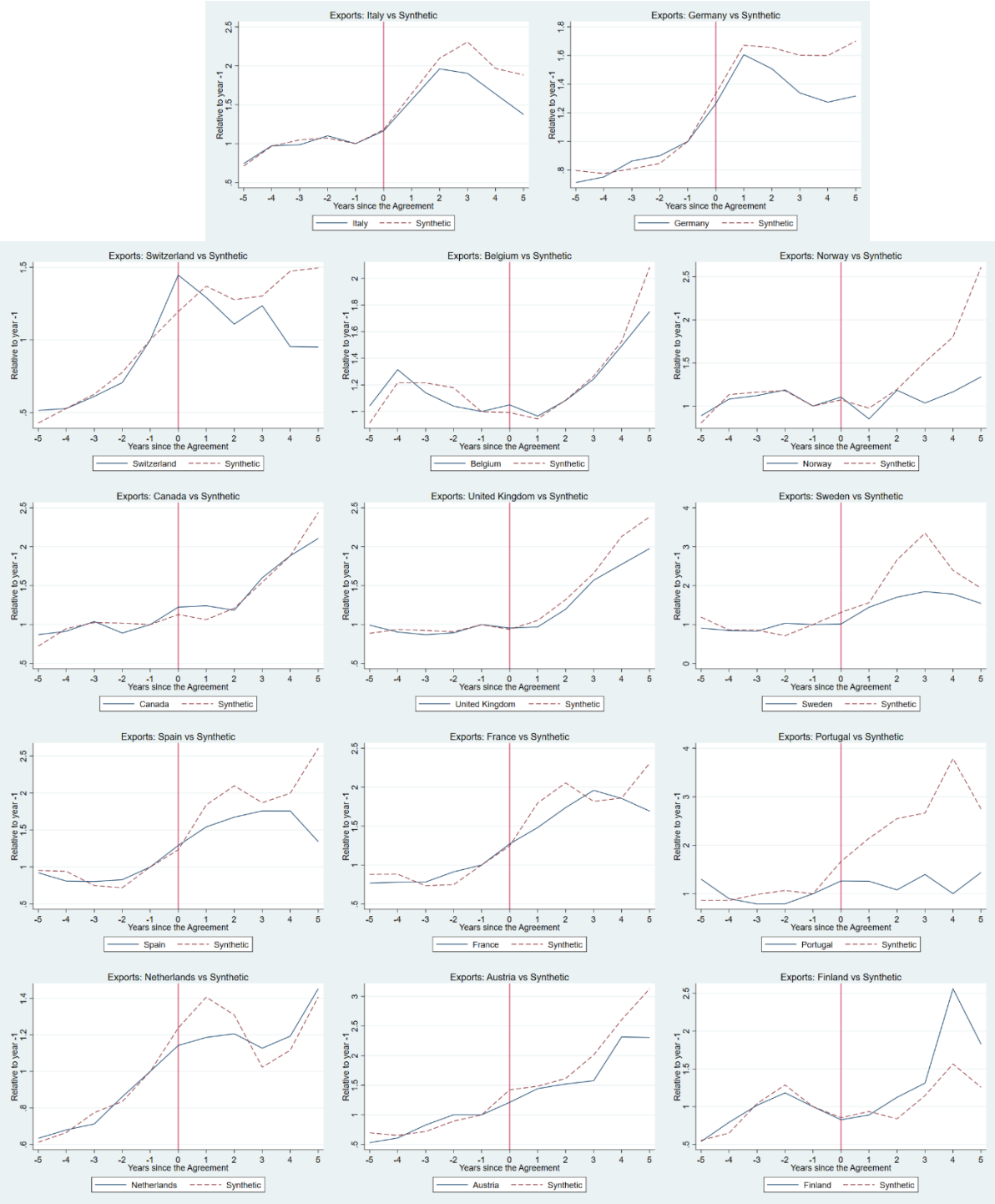
Specifically, Figure 2 shows the U.S. exports to treated countries grow by about 50% on average in the six years between the year leading to the agreement and the fifth year after the agreement. In the absence of the agreement, the estimates suggest that the U.S. exports to those countries would double. This implies the totalization

agreements reduce the growth of U.S. exports during the six years by about 50% on average.

Figure 4 shows the U.S. imports from treated countries grow by about 67% on average in the six years between the year leading to the agreement and the fifth year after the agreement. In the absence of the agreement, the estimates suggest that the U.S. imports from those countries would only grow by about 54%. This implies the totalization agreements increase the growth of U.S. imports during the six years by about 13% on average.

Figure 6 shows the U.S. FDI in treated countries grow by about 541% on average in the six years between the year leading to the agreement and the fifth year after the agreement. In the absence of the agreement, the estimates suggest that the U.S. FDI in those countries would only grow by about 349%. This implies the totalization agreements increase the growth of U.S. FDI during the six years by about 192% on average.

Figure 1. U.S. Exports to the Treated and Synthetic Countries



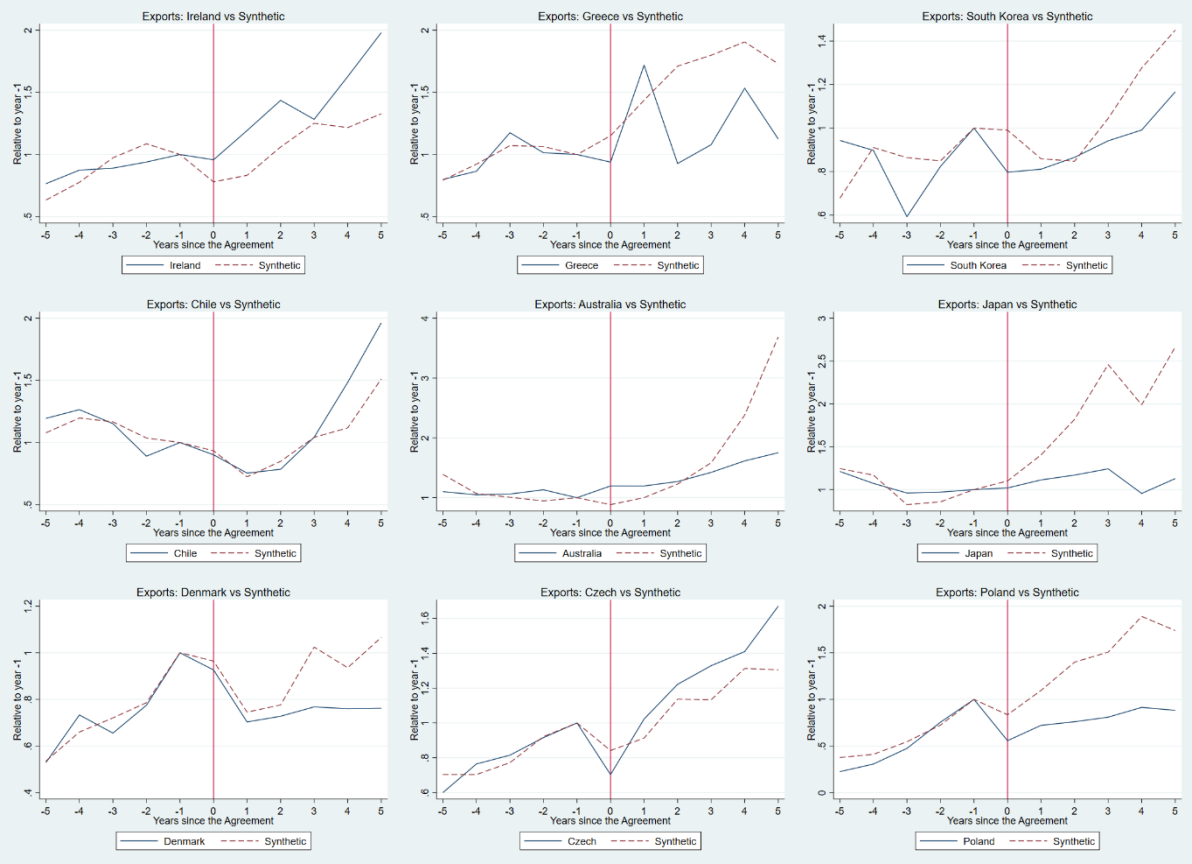

Exports: Ireland vs Synthetic
Relative to year -1
Years since the Agreement
Ireland
Synthetic
Exports: Greece vs Synthetic
Relative to year -1
Years since the Agreement
Greece
Synthetic
Exports: South Korea vs Synthetic
Relative to year -1
Years since the Agreement
South Korea
Synthetic
Exports: Chile vs Synthetic
Relative to year -1
Years since the Agreement
Chile
Synthetic
Exports: Australia vs Synthetic
Relative to year -1
Years since the Agreement
Australia
Synthetic
Exports: Japan vs Synthetic
Relative to year -1
Years since the Agreement
Japan
Synthetic
Exports: Denmark vs Synthetic
Relative to year -1
Years since the Agreement
Denmark
Synthetic
Exports: Czech vs Synthetic
Relative to year -1
Years since the Agreement
Czech
Synthetic
Exports: Poland vs Synthetic
Relative to year -1
Years since the Agreement
Poland
Synthetic

Figure 2. U.S. Exports to the Treated and Synthetic Countries: Average

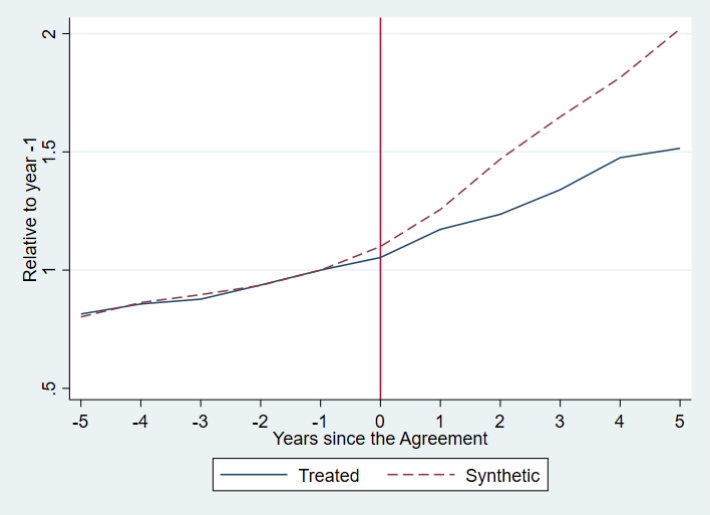
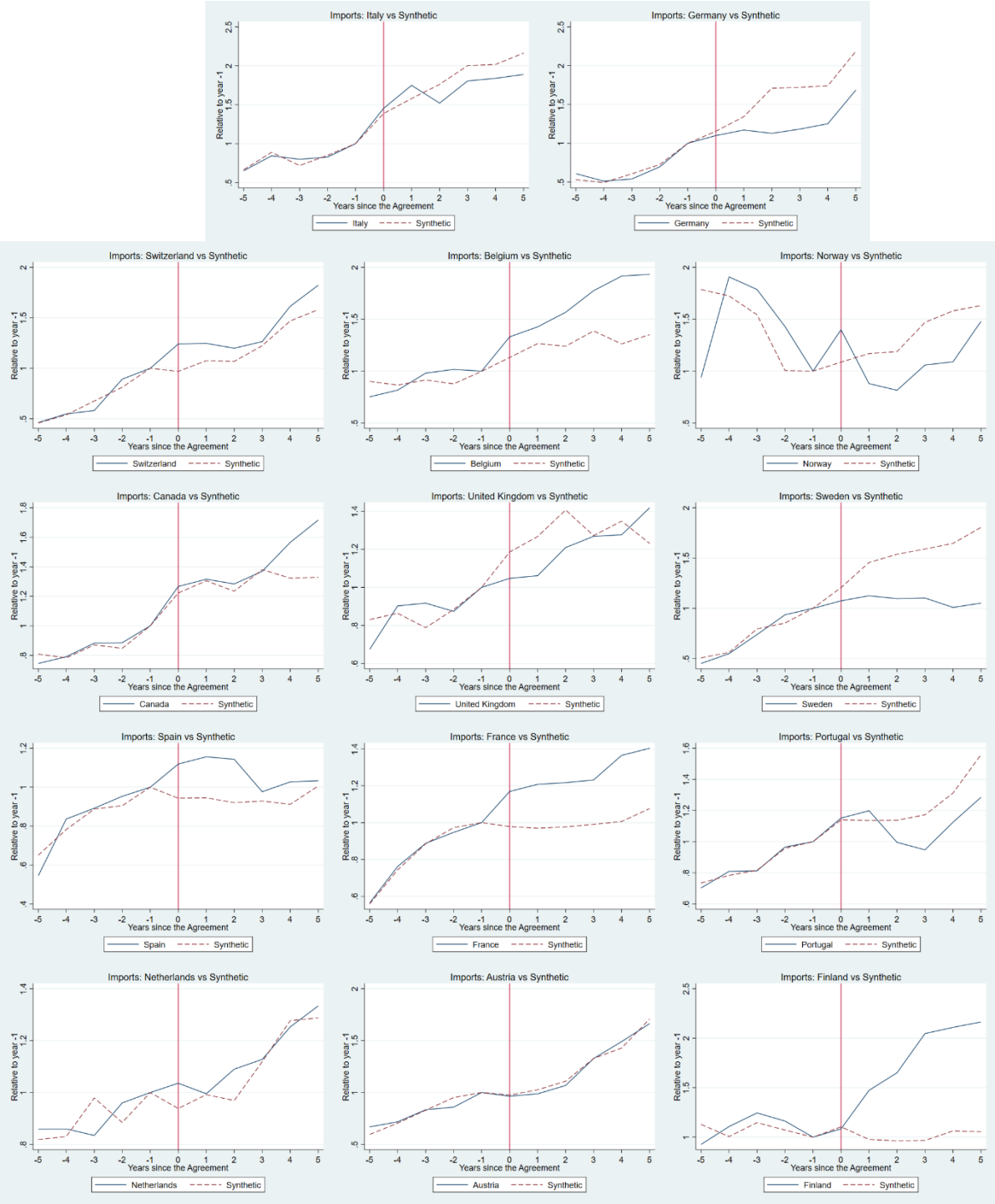


Figure 3. U.S. Imports from the Treated and Synthetic Countries



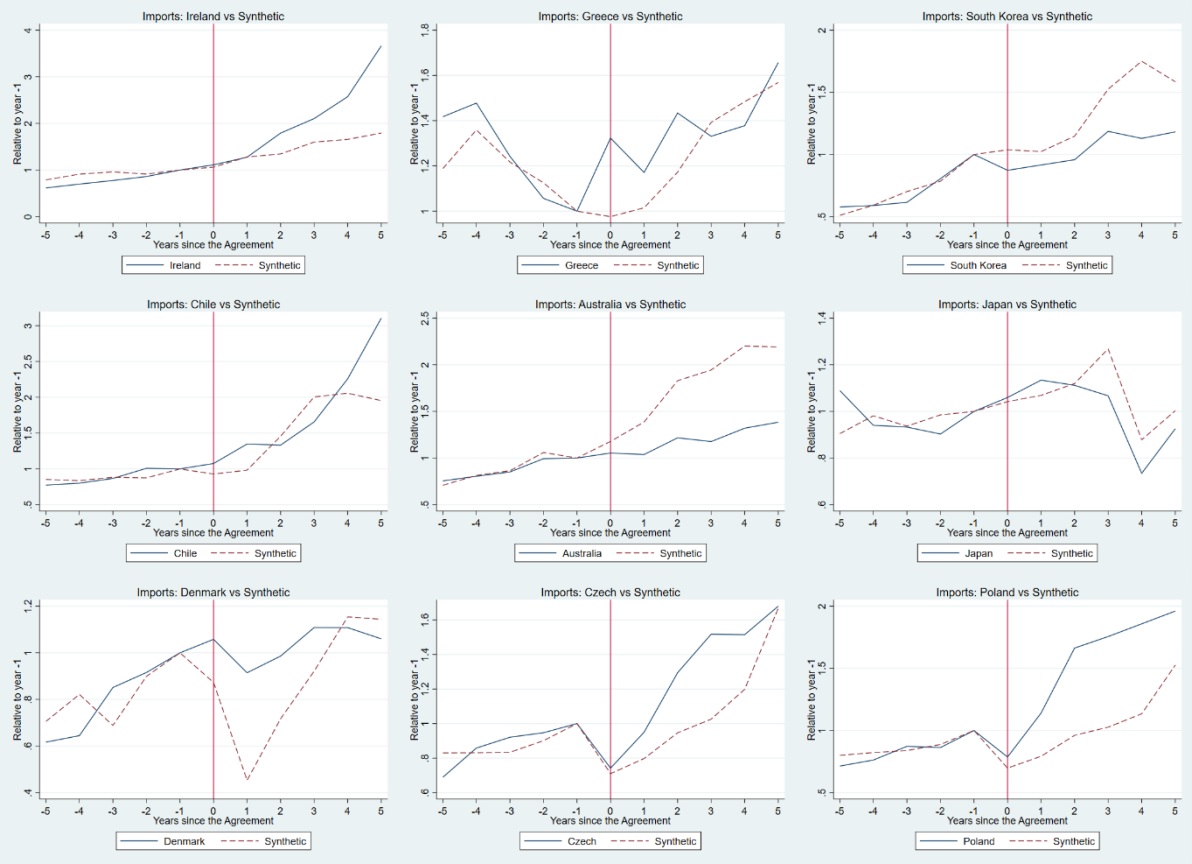

Imports: Ireland vs Synthetic
Relative to year -1
Years since the Agreement
Ireland
Synthetic
Imports: Greece vs Synthetic
Relative to year -1
Years since the Agreement
Greece
Synthetic
Imports: South Korea vs Synthetic
Relative to year -1
Years since the Agreement
South Korea
Synthetic
Imports: Chile vs Synthetic
Relative to year -1
Years since the Agreement
Chile
Synthetic
Imports: Australia vs Synthetic
Relative to year -1
Years since the Agreement
Australia
Synthetic
Imports: Japan vs Synthetic
Relative to year -1
Years since the Agreement
Japan
Synthetic
Imports: Denmark vs Synthetic
Relative to year -1
Years since the Agreement
Denmark
Synthetic
Imports: Czech vs Synthetic
Relative to year -1
Years since the Agreement
Czech
Synthetic
Imports: Poland vs Synthetic
Relative to year -1
Years since the Agreement
Poland
Synthetic

Figure 4. U.S. Imports from the Treated and Synthetic Countries: Average

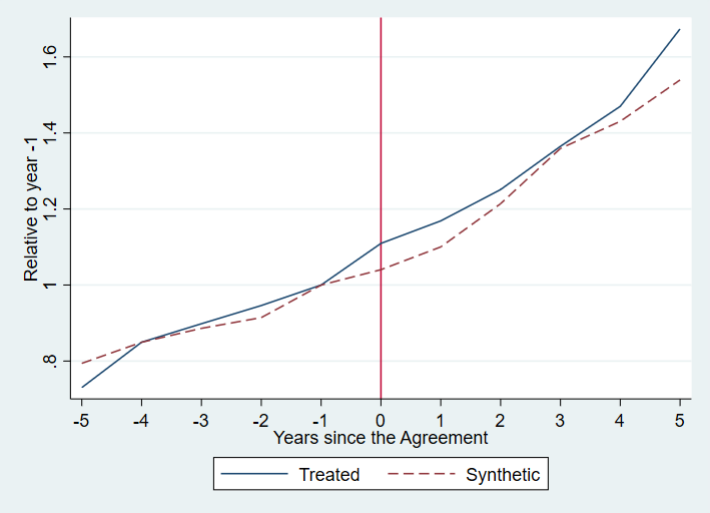
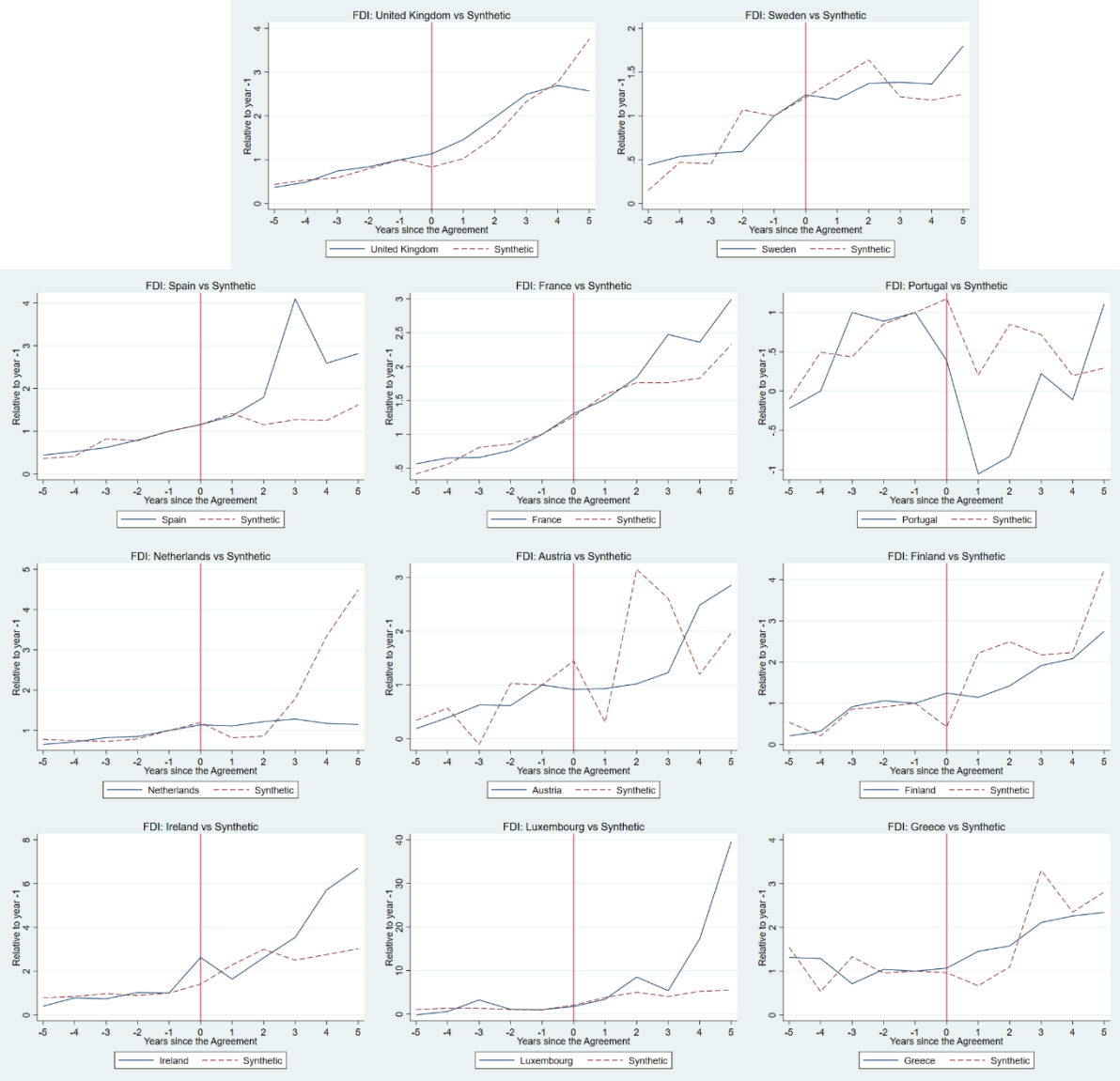


Figure 5. U.S. FDI Positions in the Treated and Synthetic Countries



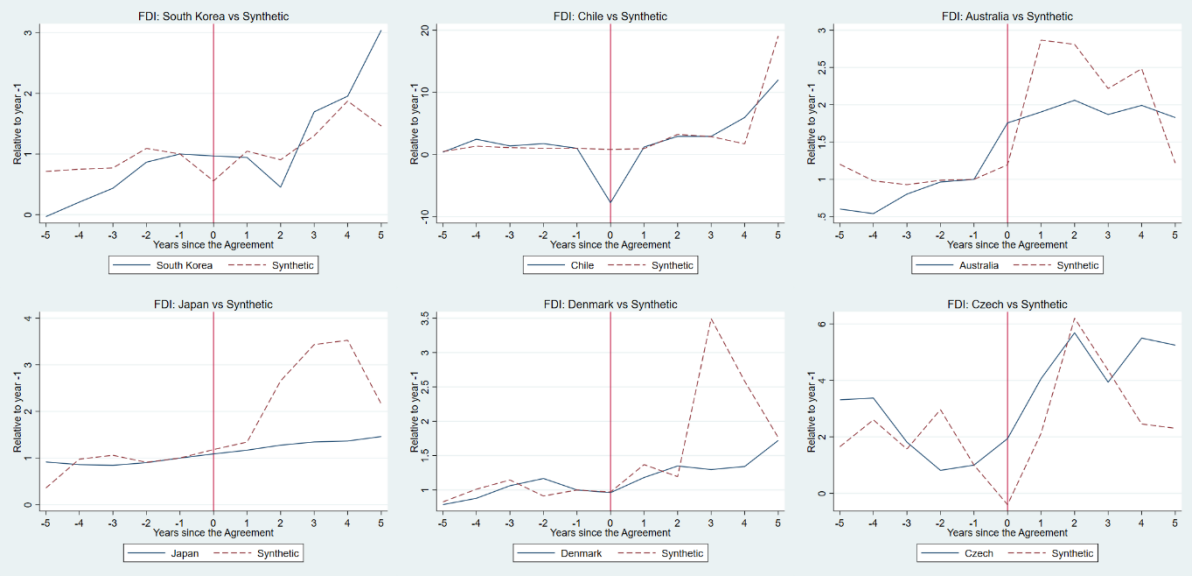
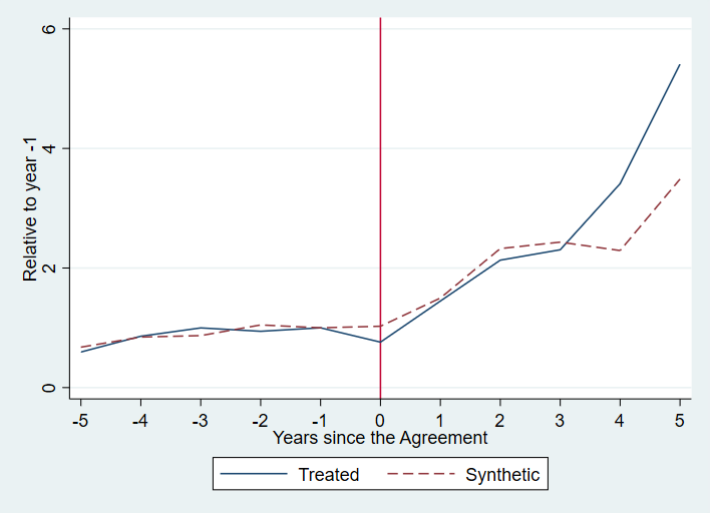

FDI: South Korea vs Synthetic
Relative to year -1
Years since the Agreement
South Korea
Synthetic
FDI: Chile vs Synthetic
Relative to year -1
Years since the Agreement
Chile
Synthetic
FDI: Australia vs Synthetic
Relative to year -1
Years since the Agreement
Australia
Synthetic
FDI: Japan vs Synthetic
Relative to year -1
Years since the Agreement
Japan
Synthetic
FDI: Denmark vs Synthetic
Relative to year -1
Years since the Agreement
Denmark
Synthetic
FDI: Czech vs Synthetic
Relative to year -1
Years since the Agreement
Czech
Synthetic

Figure 6. U.S. FDI Positions in the Treated and Synthetic Countries: Average



Summary and future work

Using the synthetic control method, we find that, on average, the totalization agreements reduce U.S. exports and increase U.S. imports and FDI. The effect on exports are more significant both economically and statistically, while the effects on imports and FDI are not significant statistically until the fifth year after an agreement entered into force.

Moreover, we find the effects are quite different across countries/agreements. For example, although most of the totalization agreements are estimated to reduce U.S. exports, the estimates suggest an increase in U.S. exports due to the totalization agreements with Finland, Ireland, and the Czech Republic. Similarly, contrary to the average effect that sees an increase in U.S. imports, the estimates suggest a decrease in U.S. imports due to the totalization agreements with countries such as Italy, Germany, Norway, Sweden, Portugal, South Korea, and Australia.

In future work, we will investigate why the effects vary across countries by relating the estimates in this paper to the bilateral trade patterns between the U.S. and the treated countries, as well as the number and composition of beneficiaries of the totalization agreements.

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