A Tale of Two Crises: Argentina and Greece

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Abstract

Argentina and Greece faced many similar circumstances in the lead-up to their sovereign debt defaults in 2001 and 2012 respectively. After defaulting, however, their paths diverged as Argentina recovered and Greece remained stuck in recession. Given this context, I analyze Argentina's recovery compared to Greece's continued struggles, seeking to determine the extent to which Argentina's path can be applied to Greece. Despite the many similarities, it becomes clear that a direct comparison cannot be made between the two countries, and thus Greece cannot simply mirror Argentina's post-default actions to achieve recovery.

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1. Introduction

In 2008, after many years of rapid growth, Greece's economy tipped into recession; in 2012, Greece defaulted on its sovereign debt in what is the world's largest default to date. Since then, Greece's economy has remained deep in recession, failing to progress toward recovery despite receiving multiple bailouts and implementing measures of fiscal austerity. As the financial situation in Greece continues to worsen, the question of how to reverse this trend and restore financial stability becomes more and more pressing.

More than a decade before the onset of the crisis in Greece, Argentina faced similar circumstances leading up to its 2001 default. However, after defaulting, Argentina's economy reversed its downward trend and managed to recover relatively quickly. The similarities surrounding the onset of each crisis—including general timeline, monetary policy, and struggles with competitiveness—provide an interesting lens through which to look at the crisis still unfolding in Greece: What allowed Argentina to recover and why has this not happened for Greece?

Despite the similarities, key differences exist between the circumstances surrounding each crisis. In fact, many of the imbalances troubling the Greek economy are unprecedented in scale. These factors must also be accounted for in considering the validity of a comparison and projecting solutions for the Greek economy.

Comparing the two countries proves useful in elucidating some of the key issues in the Greek economie and thus, answering the question of Greece's stunted recovery. However, I ultimately conclude that the differences win out and prevent the measures taken in ending the crisis in Argentina from being directly applied to Greece.

The first section of this paper provides background and details the circumstances leading up to the onset of the crisis in each country, starting the comparison about a decade prior to default when each country gave up free monetary policy. The next section examines how the paths of Greece and Argentina diverged after default and proposes reasons for Argentina's recovery and why Greece has not been so fortunate. The third section describes the synthetic counterfactual method used to develop predictions for Greece's path had it not entered the European Union, and the next section provides results and interpretations from this method while the following section discusses the robustness of these results.

Next, I turn the semi-small open economy to further evaluate the crises. After setting up this model, I examine Argentina and evaluate causes and solutions of the 2001 crisis through a comparison of model predictions and empirical data. I then return to Greece, using the model to continue exploring the validity of a comparison between the two countries and to further speculate on what would be necessary for a Greek recovery.

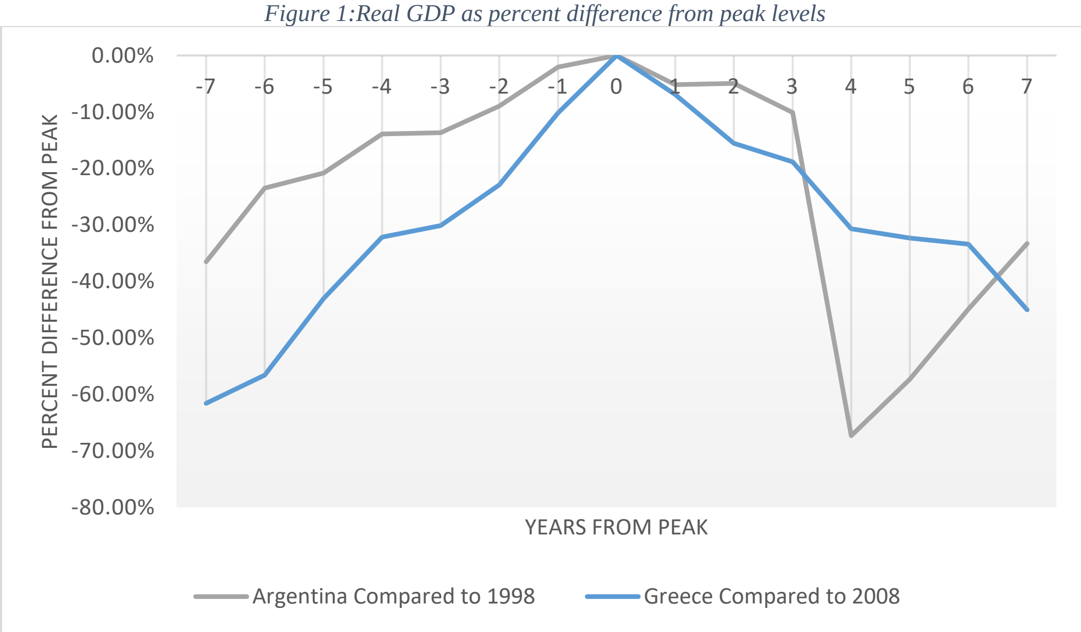
2. Similarities Leading up to the Crisis

Despite happening more than a decade apart and in very different regions, Argentina and Greece faced many similar circumstances in the years leading up to their respective defaults. The nature of these similarities can provide insight in evaluating the ongoing crisis in Greece.

Approximately one decade prior to their respective defaults, Argentina and Greece both adopted new currencies and, in doing so, forfeited their free monetary policy. In attempt to combat chronic hyperinflation, Argentina introduced a currency board known as Convertibilidad in 1991 (Baer, Margot and Montes-Rojas 2010). Convertibilidad introduced the peso as a new currency that was perfectly convertible and pegged the exchange rate of one peso to one U.S. dollar. Additionally, it restricted the central bank to issuing new pesos only against new foreign exchange reserves. While Argentina maintained its own currency, this policy equated closely to dollarization. Similarly, Greece adopted the euro as part of the European Monetary Union in 2001.

Additionally, Argentina and Greece share a long financial history as serial defaulters. Prior to the 2001 incident, Argentina had defaulted five times since 1824, spending roughly 25% of its time in a state of restructuring debt or default (Campos, Coricelli and Moretti 2014), and Greece had defaulted five times in the modern era leading up to its default in 2012 (Gourinchas, Philippon and Vayanes 2016). Despite this reputation of financial instability, Greece and Argentina both enjoyed temporary credibility in the years after forfeiting their monetary independence. In this time, both countries experienced rapid growth in GDP and investment that can be seen in the first seven years captured by Figure 1.

Figure 1:Real GDP as percent difference from peak levels



Data are from IMF World Economic Outlook Database. GDP is measured in terms of constant US dollars and expressed as a percent difference from year zero. Year zero represents the peak year before the crisis: 1998 for Argentina and 2008 for Greece.

However, as this rapid growth came to an end, major problems that had been looming under the mask of prosperity emerged in both countries. Argentina and Greece both suffered from deteriorating competitiveness as unit labor costs increased relative to international standards, causing exports to drop and current account deficits to worsen. In terms of magnitude, however, the countries differed in severity as Greece's current account deficit equated to about five times that of Argentina. Additionally, the two countries differed in the underlying causes for their rising labor costs. While Argentina's difficulties primarily stemmed from a strengthening currency—a result of the peso's connection to the U.S. dollar—Greece's problems were more structural, resulting from a combination of wasteful government employment and public and private wages rising faster than productivity (Kiguel 2011). Additionally, unemployment soared in both countries as levels in Greece rose from 7.5% in 2008 to 21.7% by 2012, and those in Argentina increased from 13.2% in 1998 to 21.5% in 2002. Both countries also faced high levels of debt in both the private and public sectors—an issue exacerbated in both by high levels of tax evasion. Once again, the magnitude of the problem in Greece was much more extreme with public debt levels equating to about 155% of GDP compared to 50% in Argentina.

The crises in Greece and Argentina share very similar time frames. Figure 1 compares the changes in real GDP for both countries. In both cases, GDP is measured as a percent difference from its peak value achieved in year zero—2008 for Greece and 2001 for Argentina. Thus, year -7 corresponds to 1991 for Argentina and 2001 for Greece—the years in which they both gave up free monetary policy. Rapid growth from year -7 to year 0 can be seen for both countries as investor confidence boomed in the wake of their new currencies, but the trend reverses after that. Year 4 corresponds to 2002 for Argentina and 2012 for Greece and marks their respective defaults and the year in which Argentina de-pegged the peso. While Argentina's GDP fell much more drastically than Greece's in that year, it started a rapid recovery for the remaining three years while Greece's continued to fall.

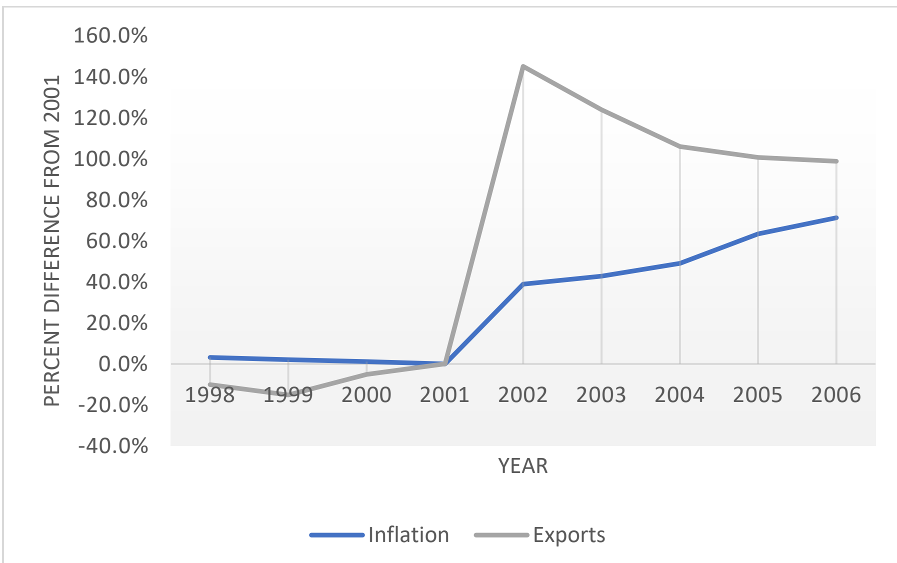
Ultimately changes in international circumstances—to which both countries were particularly sensitive to due to their lack of an independent currency—triggered the recessions in Greece and Argentina. In the case of Argentina, the onset of the 1997 Asian financial crisis caused capital to flow out (Baer, Margot and Montes-Rojas 2010). Additionally, in early 1999 Brazil devalued its currency 66% against the U.S dollar (and thus, the peso), leading to a reduction in exports that worsened the current account deficit and reverberated through the Argentine economy. Greece's descent into recession began in late 2007, coinciding with the Global Financial Crisis.

As the situations in Greece and Argentina worsened, both countries turned to third parties for support. Argentina received a bailout package from the IMF and Greece received funds from both the IMF and the European Central Bank. In exchange for assistance, the IMF required Greece and Argentina to implement harsh measures of fiscal austerity that led to social and political unrest. These measures were felt particularly hard due to the inability of both countries to devalue their currency and offset some of the blow through inflation. In both cases, austerity failed to lead to recovery, deepening the recessions by perpetuating a cycle that lowered investor confidence and caused debt premiums to soar, further reducing the countries' ability to pay. Ultimately, in 2001 and 2012 respectively, both Argentina and Greece chose to default.

3. Circumstances after Default

After defaulting, the countries' paths diverged. Argentina quickly de-pegged the peso from the U.S. dollar, freeing up monetary policy and allowing for rapid devaluation. This led to rapid inflation which initially reduced real wages and crushed the standard of living, sending 57.5% of Argentina's population below the poverty line in 2002. However, this devaluation helped to correct Argentina's struggle with deteriorating competitiveness and, combined with a fortunately timed increase in demand for the nation's products, led exports to rise dramatically in the period from 2003 to 2006. The boom in exports combined with a decrease in demand for imports—a result of the depressed state of the economy—corrected the current account balance which rose rapidly from deficit to surplus. The increase in exports in turn strengthened the government through increased tax revenues, allowing for an increase in expenditure that helped to pave the way for economic expansion.

Figure 2: Inflation and export value in Argentina as percent difference from 2001 levels



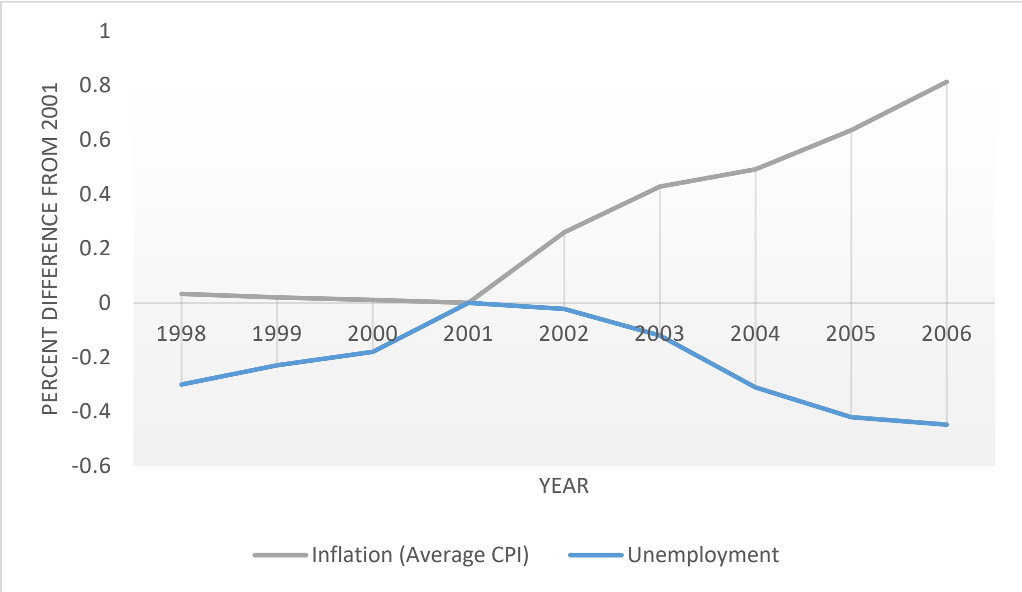
Export data are expressed as total value in constant US dollars is from the World Bank's World Development Indicators. Inflation data is expressed as average consumer prices from IMF World Economic Outlook Database. Exports and inflation are measured as percent difference from 2001.

Figure 2 plots Argentina's inflation and total export value as the percent difference from their 2001 levels. Argentina allowed inflation to rapidly increase in the year following its default, and this correlated closely to a rapid increase in exports. By the end of 2002, just one year after defaulting, inflation had increased by almost 40% while exports rose by more than 140%. This increase in exports reflected an increasingly competitive Argentina and improved the trade balance, helping to pull Argentina's economy out of recession and reduce debt levels. Inflation levels continued to rise after 2002 but grew at a much slower rate. Exports fell after 2002 but stabilized and remained at elevated levels more than 100% above their pre-2002 value, suggesting an enduring improvement to Argentina's ability to compete.

A reduction of real wages also resulted from the devaluation of the peso. While this was initially a painful adjustment for the Argentines as the poverty rate rose to 57.5% in 2002, it helped to correct the issues with rising unit costs of labor that had hurt Argentina's competitiveness in the years before default. Thus, the reduction of wages from devaluation contributed to the resolution of many of the issues that played a role in the crisis including the current account deficit and high levels of unemployment.

As seen in Figure 2, the devaluation of the peso is closely correlated with an expansion in exports. Figure 3 shows another side of the benefits stemming from devaluation and plots Argentina's inflation and unemployment as the percent difference from their 2001 levels. Again, the rapid increase in inflation can be seen following 2001, but now inversely correlated with a sharp decline in unemployment. This relationship is likely due to the reduced cost of labor that resulted from a devalued peso, allowing for the creation of more jobs and thus helping to alleviate the recession and push Argentina towards recovery.

Figure 3:Inflation and unemployment in Argentina as percent difference from 2001 levels

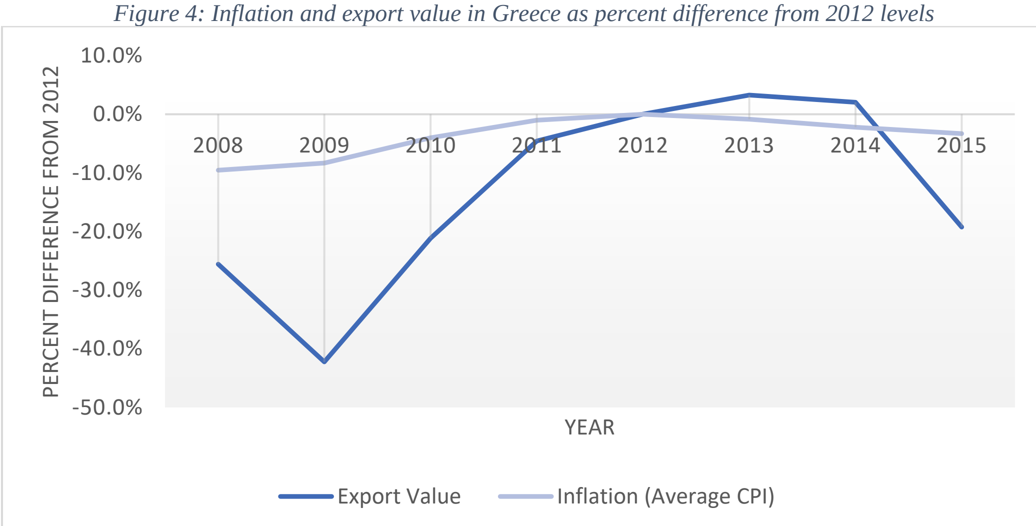


Unemployment data are expressed as percent of total labor force and taken from World Bank's World Development Indicators. Inflation data are expressed as average consumer prices and taken from IMF World Economic Outlook Database. Unemployment and inflation are measured as the percent difference from 2001 levels

In contrast, Greece has remained a member of the European Union and, consequently, has been unable to utilize monetary policy as a tool in its recovery. As Greece faced many of the same issues as Argentina in the lead-up to its default, it likely needs to make many of the same changes to achieve recovery. Specifically, Greece's failing competitiveness needs to be addressed. However, unlike in Argentina, this process cannot be assisted through devaluation. Rather, Greece would have to achieve this through some combination of reducing real wages and boosting productivity, but in an environment of declining aggregate demand, this burden would fall largely on real wages—a process which would be incredibly long and painful to the people of Greece, likely leading to further political and social unrest (Levy and Kretzmer 2012). Further, even if Greece does manage to restore competitiveness in this manner, its export base is much smaller than Argentina's, and consequently it is improbable that Greece would see a surge to the same extent, thus making for a much slower recovery.

Figure 4 replicates the plot of export value and inflation for Greece. As part of a large monetary union, the value of the euro has remained stable since Greece's default. Additionally, unlike Argentina, Greece has experienced much less volatility in exports. While export value increased slightly between 2009—when the economy first entered recession—and 2013, it has dropped since then, showing that Greece has made no real progress in improving competitiveness. Additionally, while exports in Argentina dropped almost 80% from the year of its peak GPD (1998) to its default, Greece's increased about 25% in its equivalent window from 2008 to 2012. While Argentina endured a huge drop in exports leading up to the crisis, this volatility hinted at the potential for an equally large rebound once competitiveness was restored. The lack of a huge drop in exports before the onset of the crisis in Greece, however, suggests the economy has less room for growth in exports even if devaluation allowed for improved competitiveness.

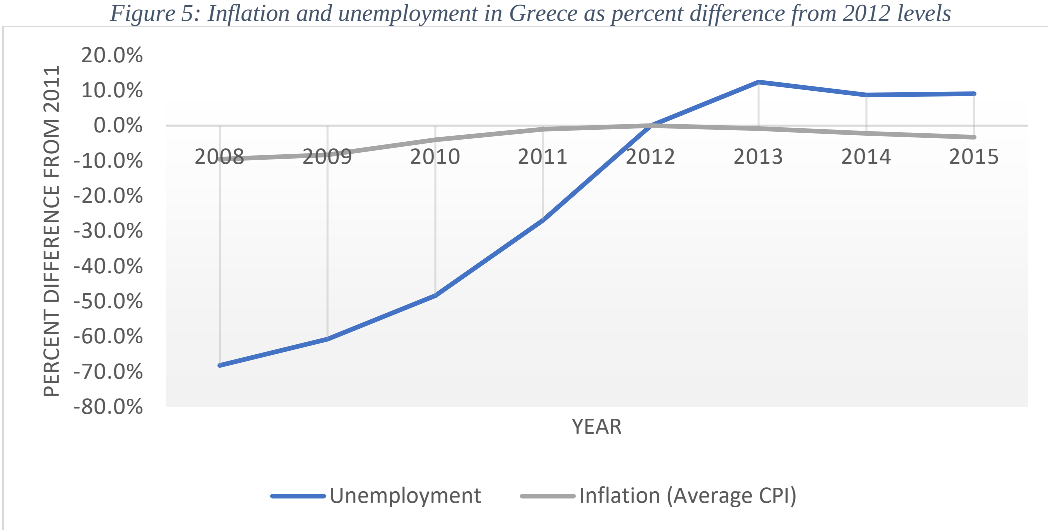
Figure 4: Inflation and export value in Greece as percent difference from 2012 levels



Export data are expressed as total value from the World Bank's World Development Indicators. Inflation data are expressed as average consumer prices from IMF World Economic Outlook Database. Exports and inflation are measured as percent difference from 2001.

Again in line with Argentina, Greece faces major problems with unemployment. Figure 5 plots inflation and unemployment as a percent difference from their 2012 levels. Clearly, the unemployment levels have increased dramatically since the economy entered recession, going up nearly 70% between 2008, when Greece reached its peak GDP, and 2012. The increase in unemployment levels continued into 2013 and, despite tapering off since then, unemployment remained at 26.4% of the total labor force in 2015. Once again, these high levels of unemployment likely stem from the relatively high unit cost of labor and thus require a reduction of wages to resolve—a blow which Greece cannot soften through inflation.

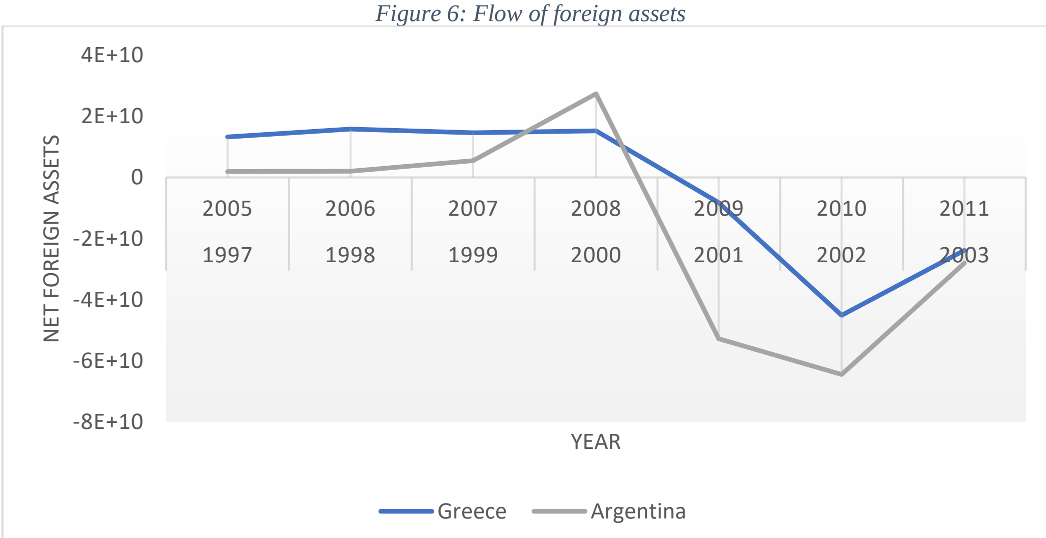
Figure 5: Inflation and unemployment in Greece as percent difference from 2012 levels



Unemployment data are expressed as percent of total labor force and taken from World Bank's World Development Indicators, Inflation data are expressed as average consumer prices and taken from IMF World Economic Outlook Database. Unemployment and inflation are measured as the percent difference from 2012 levels

As the economies in Argentina and Greece tipped into crisis, previously over-confident investors realized the magnitude of the situation and started to pull out. Consequently, both countries experienced a sudden stop of credit flows. Figure 6 plots the net foreign assets of Greece and Argentina in terms of 2010 U.S. dollars. In Argentina, the sudden stop occurred right before the default in 2001 when net foreign assets dropped by nearly 300% from 2000. In Greece, the sudden stop occurred around 2010 when net foreign assets fell over 150% from the year before.

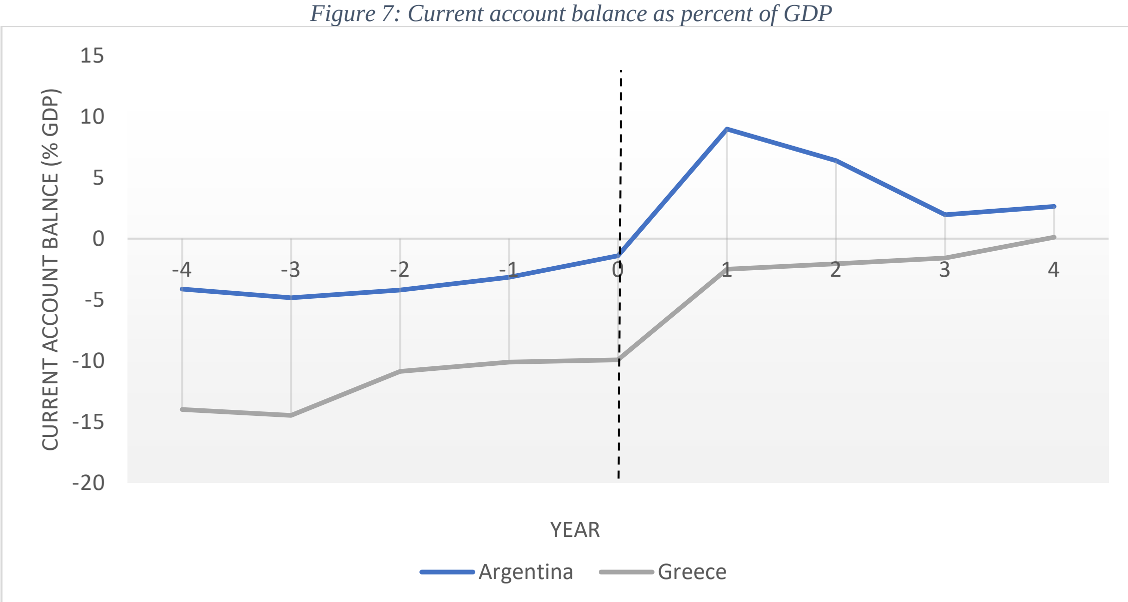
Figure 6: Flow of foreign assets



Net foreign asset data are expressed in terms of 2010 U.S. dollars and taken from the World Bank's World Development Indicators. On the horizontal axis, the top year corresponds to Greece and the bottom year corresponds to Argentina.

As in many other countries, rapid reversals of the current account balance accompanied the sudden stops in Greece and Argentina. Figure 7 plots the current account balances as a percent of GDP for each country. In Argentina, the current account balance moved from a deficit at -1.5% of GDP in 2001 to a surplus of almost 9% the next year. In Greece, the current account deficit was initially much larger, and thus did not shift to surplus, but still decreased nearly 7.5% between 2011 and 2012 as the current account balance moved from -10% of GDP to -2.5%. Despite investors rapidly pulling out of Greece as the economy worsened, an influx of emergency funds from the IMF and the European Central Bank allowed Greece to continue as a net borrower. In 2012—the same year Greece's current account deficit decreased by 7.5%—the Greek parliament approved a new package of austerity measures in exchange for a 130-billion-euro bailout from the European Central Bank (Levy and Kretzmer 2012).

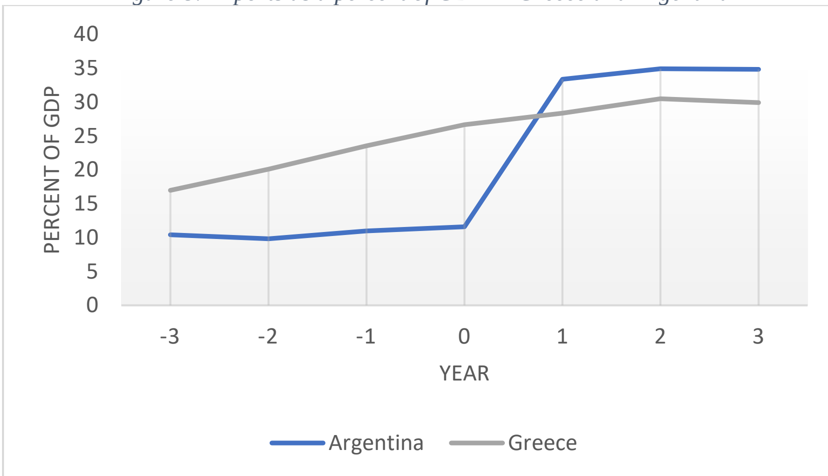
Figure 7: Current account balance as percent of GDP



Data from World Bank's World Development Indicators and are expressed as a percent of GDP. Year zero corresponds to year of default: 2001 and 2012 for Argentina and Greece respectively

Despite both enduring sudden stops and current account reversals, Argentina's economy transitioned into recovery while Greece's did not. Calvo and Talvi (2005) suggest that closed economies require a larger change in the real exchange rate to accommodate a sudden stop of capital flows than more open economies and thus take longer to recover. Figure 8 compares the openness of Greece and Argentina in terms of their export to GDP ratios in the three years before and after their respective defaults. Initially, Argentina appears significantly more closed than Greece with exports sticking around 10% for the three years before default. However, after defaulting, Argentina's exports shot up and surpassed Greece's by the next year. Despite liberalizing trade in the early 1990s, exports represented only a small portion of Argentina's GDP in the years prior to default due to the appreciation of the peso. Once Argentina defaulted and de-pegged their currency, however, the peso devalued, allowing exports to rise and thus opening up the economy to facilitate recovery.

Figure 8: Exports as a percent of GDP in Greece and Argentina



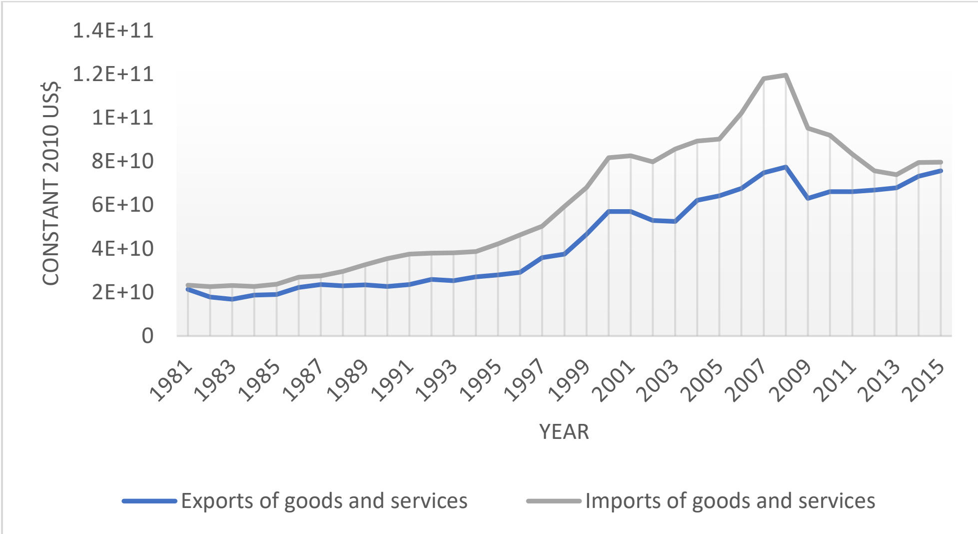
Data reflect exports of goods and services as a percent of GDP and are taken from the World Bank's World Development Indicators. Year zero indicates the year of default—2001 for Argentina and 2012 for Greece.

Despite its membership in the European Union—the world's wealthiest free trade area, Greece's economy has long remained surprisingly closed. Figure 9 plots the exports of Greece and the European Union as share of GDP alongside Greece's trade balance. Since joining the European Union in 1981, Greece has lagged far below the average in terms of exports. Despite reducing its trade deficit in recent years, Figure 10 shows that this predominately results from a decrease in imports—likely resulting from the depressed state of the economy— rather than an increase in exports. Figure 11 reveals that Greece has the smallest average export share of any country in the European Union. Greece's lack of openness stands out even more when controlling for the size of the economy. Figure 11 allows for this distinction by shading the bars associated with economies below the median size of European Union in darker color. Small economies are typically more open; while this trend holds true for most of the EU member countries, Greece appears to be an anomaly.

Figure 9: Exports of Goods and Services: Greece and EU

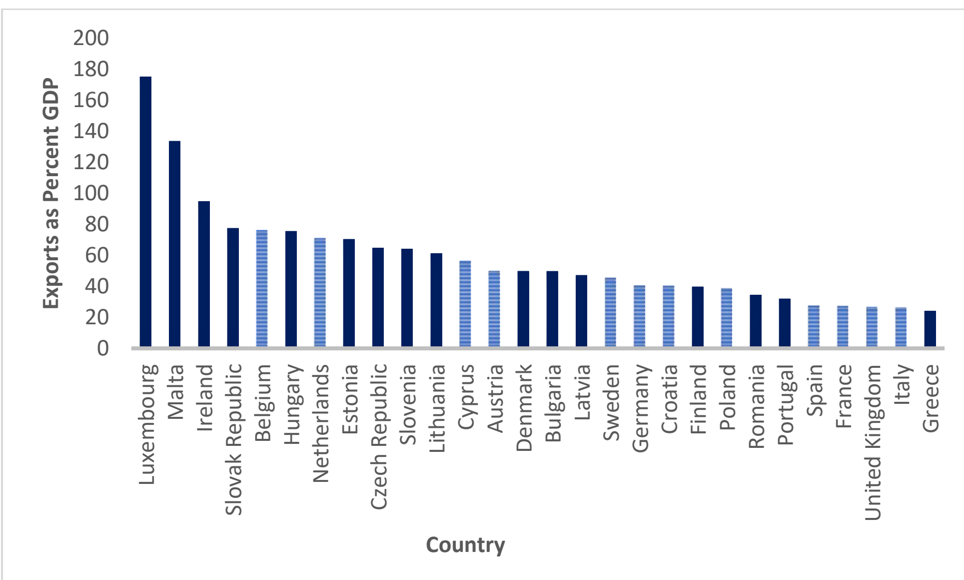
Data are from World Bank's World Development Indicators. Exports and trade balance measured as percent of GDP in each year. Trade Balance calculated as exports minus imports.

Figure 10: Exports and imports of goods and services in Greece



Data from World Bank World Development Indicators. Exports and Imports are measured annually as total value of goods and services in terms of constant 2010 US dollars.

Figure 11: Average export to GDP ratio of EU countries



Data from World Bank's World Development Indicators where exports are measured as the total value of goods and services. Average taken over period from 2001 to 2015. Dark shading indicates an economy below median size.

Given its small size and membership in a wealthy free trade area, Greece should, by all logic, be significantly more open than it is. Bower, Michou, and Ungerer (2014) predict that Greece exports one-third less than what regular international trade patterns would suggest based on Greek GDP, the size of its trading partners, and geographical location. Further, they estimate that between one-half and three-fourths of this discrepancy results from Greece's weak institutional quality.

Thus, while like Argentina, Greece likely needs to boost exports to recover, this cannot be achieved through currency devaluation alone, but rather must be accompanied by deep rooted institutional reform.

While the similarities between Argentina and Greece in the circumstances surrounding the leadup to their crises are numerous, many complicating differences emerge in the period after default, clouding the ability to make a direct comparison. While freeing up its currency and allowing for devaluation would likely help Greece to restore competitiveness, it is unlikely that the benefits from this would be as large or as rapid as those in Argentina. Given that an exit from the European Union would likely be accompanied by a myriad of social, economic, and political consequences, it is unclear if following Argentina's path would be ultimately beneficial for Greece. One way or another, however, Greece must mirror Argentina's growth in exports to correct mounting imbalances and pull its economy out of crisis. Whether Greece attempts this process in the European Union or out, it is likely to be slower than in Argentina and, predictably, quite painful for the citizens of Greece.

4. Synthetic Counterfactual Method

In evaluating the extent to which Argentina's recovery can be applied to Greece, I would ideally make predictions about what would result if Greece left the Euro today. However, this process is complicated by the degree of integration associated with European Union membership. Despite this limitation, one can make predictions as to what the situation in Greece would look like today had it never joined the European Union and thus, shed some light on the role of its membership in the current crisis. Through the synthetic counterfactuals method developed by Abadie, Diamond, and Hainmueller (2010) and used to evaluate the impact of joining the European Union on its members by Campos, Coricelli, and Moretti (2014), it is possible to estimate how GDP per capita would have behaved for Greece had it never joined the European Union.

The synthetic control method estimates the effect of a given intervention (in this case, European Union membership) by comparing the trends of an aggregate outcome variable (per capita GDP) for a country affected by the intervention to the evolution of the same aggregate outcome variable for a synthetic control group. The synthetic control group is created by searching for a weighted combination of other countries, unaffected by the treatment, that are chosen to match the country in question before the intervention occurs for a set of predictors for the outcome variable. The evolution of the outcome for the synthetic control group provides a predictor for the behavior of the outcome variable had the treated country in question not been subjected to the intervention. Specifically, the outcome of the synthetic control region estimates the evolution of per capita GDP in Greece had it not joined the European Union.

Formally, Equation 1 represents the estimation of the average treatment effect on the treated unit where Y_{it}^{I} is the outcome of a treated unit *i* at time *t*, and Y_{it}^{C} is country *i*'s outcome at time *t* had it not been subjected to the treatment. Thus, Y_{it}^{I} can be directly observed while Y_{it}^{C} cannot.

Equation 1: Estimation of average treatment effect

$$\tau_{it} = Y_{it}^{I} - Y_{it}^{C}$$

The synthetic counterfactual method (Abadie, Diamond and Hainmueller 2010) provides a way to identify and estimate the dynamic treatment effect through the general model provided in Equation 2 where Z_i is a vector of independent predictor variables at country level, θ_t is a vector of parameters, λ_t is an unknown common factor, ω_{it} is a country specific unobservable term, ε_{it} is a zero-mean transitory shock, and $\alpha_{it}D_{it} = \tau_{\tau it}$ where D_{it} is a dummy variable that equals one when a country is exposed to the treatment and zero otherwise.

Equation 2: General model for estimating dynamic treatment effect

$$Y_{it}^{I} = \delta_t + \alpha_{it}D_{it} + v_{it}$$

$$Y_{it}^{C} = \delta_t + v_{it}$$

$$v_{it} = \theta_t Z_i + \lambda_t \omega_i + \varepsilon_{it}$$

Consider an outcome Y_{it} and a set of determinants Z_{it} of the outcome for N+1 countries where $i = 1$ represents the treated country and $i = 2, .., N + 1$ are the untreated control countries for each period $t \in (1, T)$. Assume $t < T_0$ where T_0 is the period in which the treatment takes place. Then, to construct a counterfactual, I estimate a weighted average of Y_{it} for the untreated control countries to approximate Y_{1t} for $t < T_0$. The set of weights is given by $W = (w_2, \dots, w_{n+1})$ such that all ω_i are greater than or equal to zero and $\sum_{i=2}^{N+1} w_i = 1$ so that in the pre-treatment period, both parts of Equation 3 hold true.

Equation 3: Pre-treatment conditions

$$\sum_{i=2}^{N+1} w_i \, Y_{it} = Y_{1t}$$

$$\sum_{i=2}^{N+1} w_i Z_i = Z_1$$

To achieve accuracy, the optimal set of weights, W^* must be found by solving the minimization problem given in Equation 4. In matrix notation, $X_1$is the (K x 1) vector of the treated country's characteristics in the pre-treatment period, and X_c is the (K x N) matrix of the same characteristics for the control countries. V is a (K x K) positive and semi definite matrix which measures the relative importance of the characteristics included in X. Through this process, I select W^* to minimize the pre-treatment distance between the vector of the treated country's characteristics and that of the potential synthetic control countries and to minimize the mean squared error of the pre-treatment outcomes.

Equation 4: Optimal vector of weights

$$\min(X_1 - X_c W)' V (X_1 - X_c W)$$

$$s.t.\ w_i \geq 0\ \forall\ i = 2, \dots, N+1\ and\ \sum_{i=2}^{N+1} w_i = 1$$

Given the optimal vector of weights, the treated country's outcome at time t had it not been subjected to the treatment can now be estimated by Equation 5. From this follows an estimate for the effect of the treatment at time t for all $t \geq T_0$. The accuracy of the estimation depends on the pre-treatment distance of the synthetic control from the treated country, and all else equal, a longer pre-treatment period allows for a more accurate estimate.

Equation 5: Synthetic control

$$Y_{it}^{C} \approx \sum_{i=2}^{N+1} W_i^{*} Y_{it}$$

$$\mathrm{T}_{it} \approx Y_{1t} - \sum_{i=2}^{N+1} W_i^{*} Y_{it}$$

The synthetic control method requires two main assumptions: The pre-treatment variables should be characteristics which can approximate the path of the treated country without anticipating the effects of the intervention, and the countries weighted in developing the synthetic control must not be affected by the treatment.

5. Greek Counterfactuals

Applying the synthetic control method to Greece's membership in the European Union, the treatment date can be evaluated at either 1981 when Greece became a full member of the European Economic Community or at 2001 when Greece adopted the euro. In both cases, anticipation effects were most likely present in the years leading up the event, and thus, the synthetic counterfactual method generates a lower-bound estimate.

In the first case when the treatment date is 1981, the pre-treatment period in which the optimal weights are derived spans 10 years from 1970 to 1980. I consider five indicator variables, as selected by Campos et al. (2014), in determining the optimal weights for the synthetic control: per capita GDP, investment share of per capita GDP, and population growth (all from Penn World Tables 7.0) along with secondary gross school enrollment and tertiary gross school enrollment (both from the World Bank's World Development Indicators). The pool of donor countries comes from a list of 25 identified by Campos et al. (2014) and consists of Albania, Argentina, Australia, Brazil, Canada, Chile, China, Colombia, Egypt, Hong Kong, Iceland, Indonesia, Israel, Japan, Korea, Malaysia, Mexico, Morocco, New Zealand, the Philippines, Switzerland, Thailand, Tunisia, Turkey, and Uruguay.

Table 1 provides the average of the predictor variables in the pre-treatment period for both Greece and the synthetic region, and Table 2 reports the weights of the control countries from the donor pool for which w_i does not equal zero. Figure 12 plots the both the actual outcome for Greece following its decision to join the European Economic Community in 1981 and that of synthetic Greece which represents an estimate of Greece's outcome through 2010 if it had not. The gap between the two plots represents the treatment effect.

Table 1: Predictor balance for 1981 entry to EEC

Predictor	Treated	Synthetic
Rgdpch	15438.97	15445.26
Ki	30.68624	26.87622
Popgr	.00864	.0181887
Ter	14.91807	26.01254
Sec	74.83133	75.14615

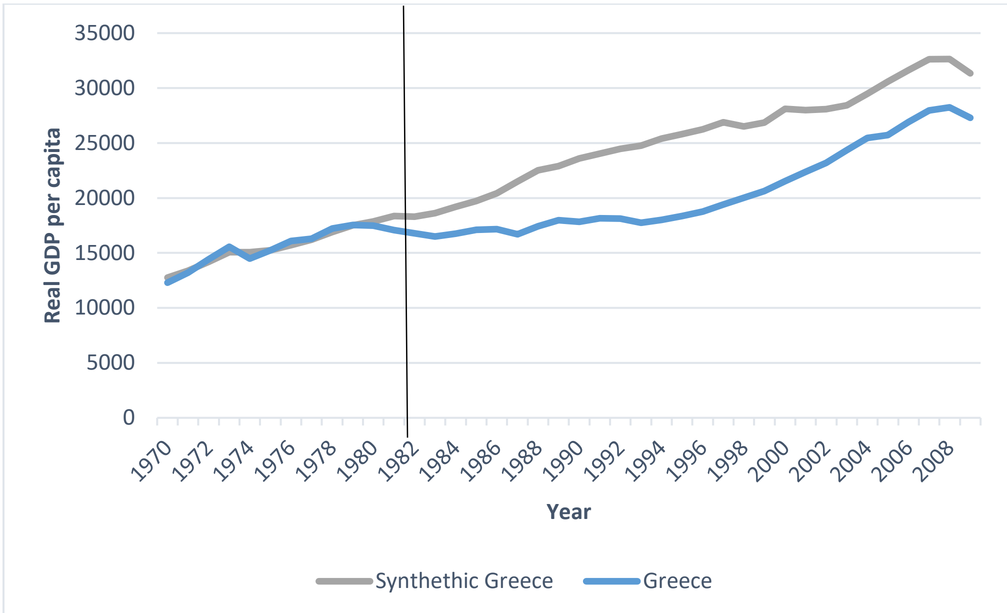
The predictors used are the pre-treatment (annual) GDP per capita PPP converted at 2005 constant prices (rgdpch), the pre-treatment average of the investment share of per capita GDP PP converted at 2005 prices (ki), population growth (popgr), secondary gross school enrollment (sec), and tertiary gross school enrollment (sec). Data for the first three predictors all come from Penn World Tables 7.0, and data for the final two come from the World Bank's World Development Indicators. The values listed for treated represent the pre-treatment averages for each indicator for the treated country while those for synthetic do the same for the synthetic region.

Table 2: Predictor country balance 1981 entry to EEC

Country	Weight
Canada	.252
Hong Kong	.221
Israel	.188
Japan	.274
Turkey	.065

The synthetic region is formed by the weighted average of donor countries taken from the pool of 25 countries suggested by Campos, Coricelli and Moretti (2014). The table reports the countries with non-zero weights used and their corresponding values.

Figure 12: Synthetic counterfactual for 1981 joining of EEC



The series for Greece plots the actual real GDP per capita of the country. The series for synthetic Greece plots the synthetic counterfactual results which proposes an estimate for what the real GDP per capita would have been in Greece had it not become a member of the EEC in 1981. The dark vertical line represents the year in which the treatment took place and the estimate begins.

As Figure 12 reveals, the synthetic control method predicts that membership in the European Economic Community has had an overall negative effect on Greece's GDP. The GDP per capita in the untreated synthetic region remains higher than that of Greece throughout all years in the post-treatment period. However, the gap between the two decreases overtime and GDP begins to decline around 2008 in both cases. Thus, while the synthetic control method predicts a negative treatment effect, I cannot conclusively determine if abstaining from the EEC would have prevented the crisis in Greece. The negative effect, if valid, likely results from exposing weak domestic industries to an influx of imports. As Figure 10 revealed, after joining the EEC in 1981, Greece's import to GDP ratio increased much faster than that for exports. Thus, it is possible the Greek economy simply was not ready to compete when it joined the EEC, resulting in negative blow to GDP.

Given that one of the main concerns relating to Greece's membership in the European Union is its inability to use monetary policy as a tool in recovery, I also consider the treatment date as 2001—the year in which Greece adopted the euro. The pre-treatment period again ranges ten years—this time from 1990 to 2000. I restrict the pool of donor countries to the same 25 used to develop the 1981 estimator, and the indicator data remain the same, aside from the per capita GDP which now comes from the World Bank's World Development Indicators due to data availability.

Table 3 reports the average of the predictor variables in the pre-treatment period for both Greece and the synthetic region, and Table 4 provides the weights of the control countries from the donor pool for which w_i does not equal zero. Figure 13 plots both the actual outcome for Greece following its decision to join to adopt the Euro in 2001 and that synthetic Greece which represents an estimate of its outcome had it not. The gap between the two plots represents the treatment effect.

Table 3: Predictor balance for 2001 adoption of euro

Predictor	Treated	Synthetic
Rgdpcap	11941.35	11944.95
Ki	20.41499	40.43323
Popgr	.0046833	.0046704
Ter	39.95093	39.95915
Sec	92.60362	92.57502

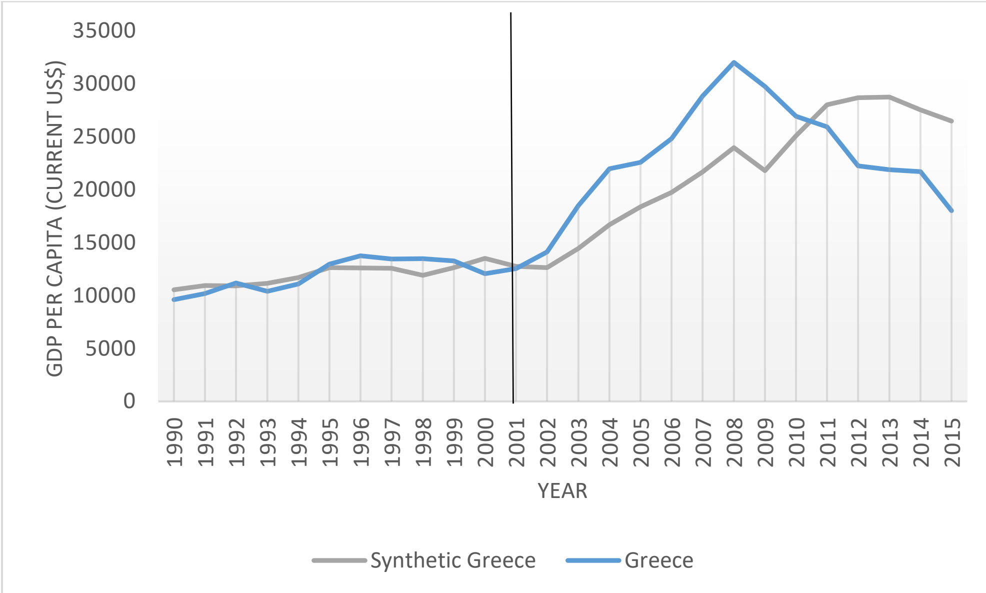
The predictors used are the pre-treatment average of the investment share of per capita GDP PP converted at 2005 prices (ki), population growth (popgr), GDP per capita expressed in current U.S. dollars (rgdpcap) secondary gross school enrollment (sec), and tertiary gross school enrollment (sec). Data for the investment share of per capita GDP come from Penn World Tables 7.0, and data for all other indicators come from the World Bank's World Development Indicators. The values listed for treated represent the pre-treatment averages for each indicator for the treated country (Greece), while those for synthetic do the same for the synthetic region.

Table 4: Predictor country weights for 2001 adoption of euro

Country	Weight
Albania	.44
Australia	.093
Canada	.274
Japan	.096
Uruguay	.097

The synthetic region is formed by the weighted average of donor countries taken from the pool of 25 countries suggested by Campos, Coricelli and Moretti (2014). The table reports the countries with non-zero weights and their corresponding values.

Figure 13: Synthetic counterfactual for 2001 adoption of the euro



The series for Greece plots the actual real GDP per capita of the country. The series for synthetic Greece plots the synthetic counterfactual results which proposes an estimate for what the real GDP per capita would have been in Greece had it not become a member of the European Union in 2001. The dark vertical line represents the year in which the treatment took place and the estimate begins.

In Figure 13, the plot for Greece is significantly above that of the synthetic estimator for the first 10 years post-treatment, indicating positive effects from European Union membership. This is likely due to the rapid growth Greece initially experienced after adopting the euro—fueled by increased investor confidence. However, in 2008 Greece's per capita GDP began to decline as the economy fell into recession while the synthetic region continued to grow aside from a smaller drop of its own around 2009. By 2011, a year before Greece's default, the per capita GDP of the synthetic control region overtook that of Greece, continuing to grow while the Greek economy plummeted. From here on, the estimated treatment effect of adopting the euro is negative. The per capita GDP of the synthetic region does decline slightly starting in 2013. However, this decline is small and gradual, particularly compared to that of Greece starting from 2008. Thus, it does not seem to be indicative of a looming crisis but rather, a minor recession after a long period of growth.

This counterfactual suggests that the crisis in Greece could have been avoided had it not adopted the euro in 2001. If valid, this result likely emerges from the switch to the euro causing Greece to enter an unstainable period of growth. This growth was fueled by appearances of financial stability stemming from the confidence instilled in investors by a multi-nationally backed currency. This illusion of prosperity allowed for major imbalances to build in the Greek economy. Had Greece not been a member of the Eurozone, this bubble would have burst far before debt levels and other imbalances reached unprecedented magnitudes seen today. Without the security of the European Central Bank as a lender of last resort, investors would have pulled out significantly sooner and lines of credit would have been cut off, forcing Greece to address the structural issues in its economy before they exploded into the massive problems they are today.

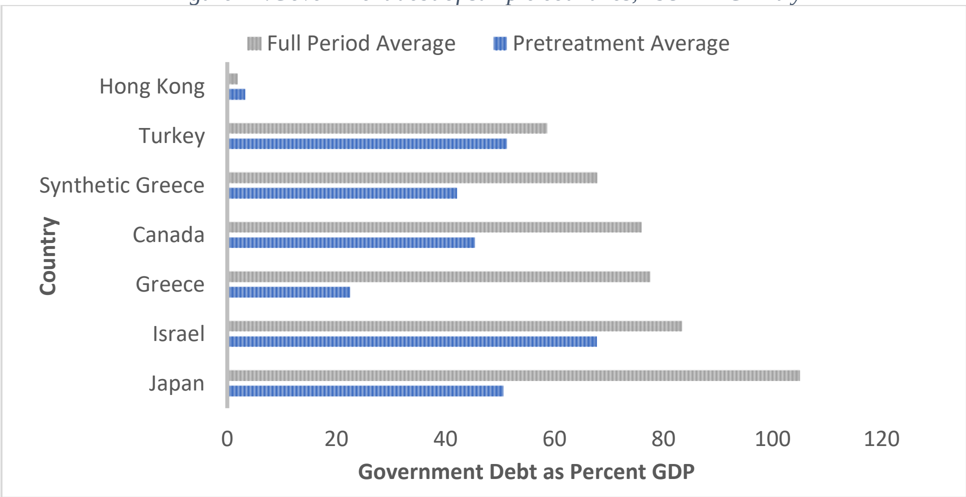
While the synthetic counterfactuals suggest Greece would have been better off had it never adopted the euro, this does not necessarily indicate that leaving the European Union now would be a beneficial move. Monetary policy is a valuable tool in financial recovery, and all else equal, the ability to devalue its currency would definitely help Greece cope with the many battles it faces in recovery. However, given the differences in its export base, the underlying issues related to its failing ability to compete internationally, and the unprecedented magnitude of its imbalances, it is highly unlikely that Greece could see a recovery as rapid as Argentina's even if it could devalue and inflate its currency. Furthermore, by leaving the European Union, Greece would forfeit an important source of financial assistance and stability and would additionally restrict its access to a valuable market for trade. On top of this, further consequences could emerge not just economically, but politically and socially, leading to unrest in an already highly volatile Greece. Thus, while European Union membership appears to have played a role in Greece's descent into crisis, it remains difficult to say whether an exit would prove beneficial.

6. Robustness of Counterfactuals

While the synthetic control method provides an interesting picture for what Greece's path would have looked like had they never joined the European Union, it is only a prediction; since Greece cannot go back in time and reverse its decisions to enter the European Economic Community or adopt the euro, it is impossible to know exactly what would have happened and thus, to verify the accuracy of the counterfactuals. Many variables aside from those used to select the predictor countries can impact the growth path of a country. An imbalance between the predictor countries and the country exposed to the treatment in one of these unincluded variables could compromise the reliability of the prediction. While options for such variables are vast, I choose to select two which have played a major role in Greece's descent into crisis: sovereign debt levels and openness to trade.

Starting with the counterfactual for Greece's 1981 joining of the European Economic Community, Figure 14 compares the sovereign debt levels of Greece, synthetic Greece, and each of the non-zero weighted predictor countries used to develop the synthetic estimator. Averages of government debt levels are given for both the pre-treatment period (1970-1980) and the entire period spanned by the counterfactual (1970-2007). In the pre-treatment period, Greece had not yet begun its unsustainable accumulation of debt, and thus it has the lowest average of all the sample countries aside from Hong Kong, with the average debt levels of the synthetic estimator around 10% higher than those of Greece. Thus, synthetic Greece entered the post-treatment period in a worse position in terms of sovereign debt than actual Greece did which would, if anything, have had a negative effect on its growth path, causing membership in the EEC to appear more beneficial than it was.

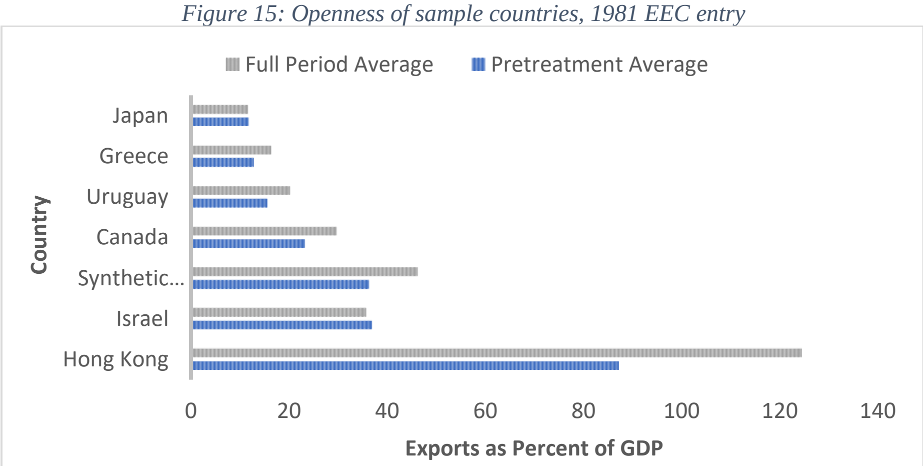
Figure 14:Government debt of sample countries, 1981 EEC Entry



Data are from IMF World Economic Outlook Database. The pretreatment average spans the period from 1970-1980 and the full period average spans from 1970-2007. Synthetic Greece represents the weighted average previously developed by the synthetic control method.

Greece's relatively closed economy has also played a role in many of its economic challenges. Figure 15 compares the openness of Greece with that of synthetic Greece and each of the non-zero weighted predictor countries in terms of the average ratio of exports to GDP. Aside from Japan, Greece has the lowest average ratio of exports to GDP of the 5 predictor countries in the pre-treatment period (1970-1980), leaving the ratio of the synthetic estimator over 23% higher than that of Greece. As higher export rates can contribute to faster growth, this discrepancy suggests that the synthetic estimator for Greece might grow faster than Greece actually would have had it not joined the European Economic Community in 1981. If this is the case, the negative treatment effect predicted by the synthetic region would be overstated and perhaps unreliable.

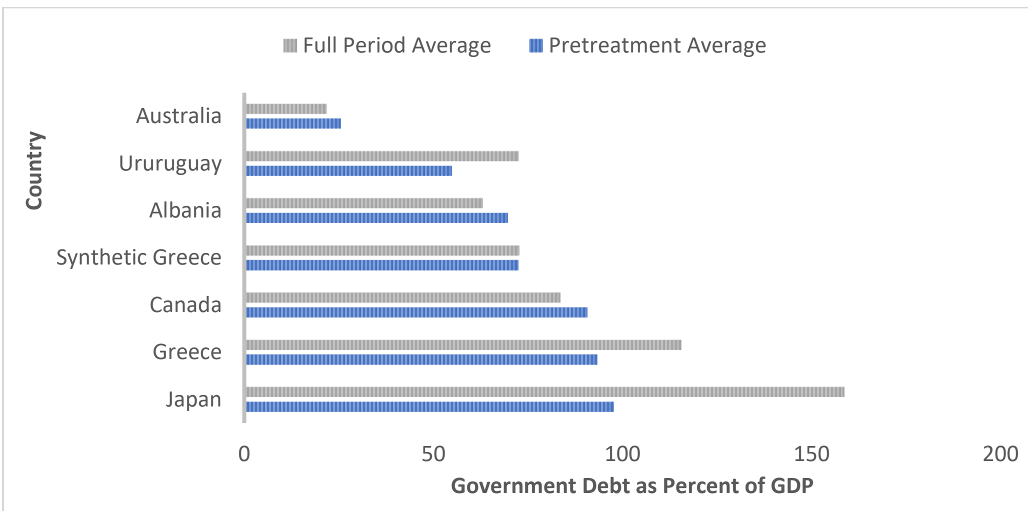
Figure 15: Openness of sample countries, 1981 EEC entry



Data from World Bank's World Development Indicators. Exports reflect both goods and services and are expressed as percent GDP. The pretreatment average spans the period from 1970-1980 and the full period average spans the period from 1970-2007. Synthetic Greece represents the weighted average previously developed by the synthetic control method.

Moving to Greece's 2001 adoption of the Euro, Figure 16 compares the sovereign debt levels of Greece, synthetic Greece, and each of the non-zero weighted predictor countries used to develop the synthetic estimator. I provide averages of government debt levels as a percent of GDP for both the pre-treatment period (1990-2000) and the entire period spanned by the counterfactual (1990-2015). In the pre-treatment period, Greece's average government debt is over 20% higher than that of the synthetic estimator. Given its sovereign debt imbalances played a large role in triggering the crisis, Greece might have faced a downturn even if it had not adopted the euro, contrary to what the path of the synthetic estimator suggests. However, adopting the euro provided investors with a false sense of security which allowed Greece to continue to accumulate debt and generate larger and larger imbalances. Without this inflated confidence, investors likely would have pulled out much sooner, forcing Greece to address its imbalances before they grew to the present scale. Thus, while some of the predicted negative effect of adopting the euro might be inflated due to the lower debt ratios of the predictor countries, at least a portion of it is likely accurate.

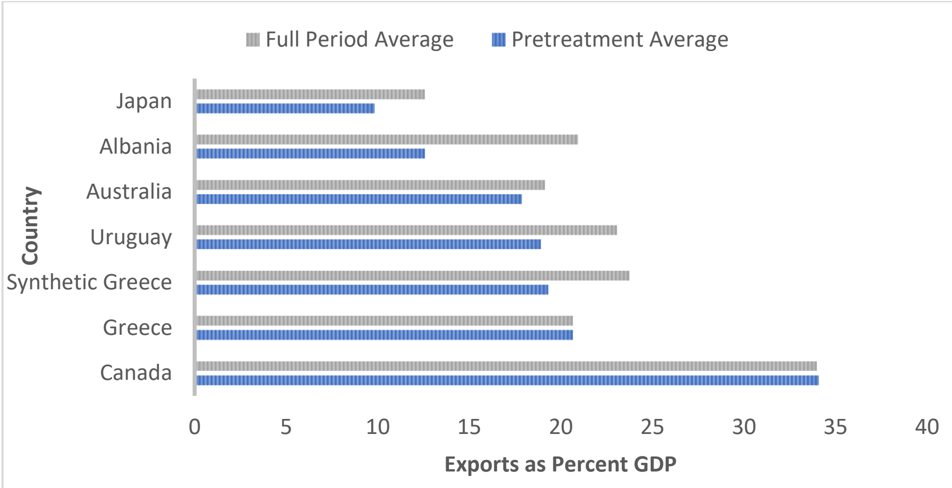
Figure 16:Government debt of sample countries, 2001 adoption of euro



Data are from IMF World Economic Outlook Database. The pretreatment average spans the period from 1990-2000 and the full period average spans the period from 1990-2015. Synthetic Greece represents the weighted average previously developed by the synthetic control method.

Figure 17 compares the openness to trade of Greece and each of the predictor countries in terms of average ratio of exports to GDP. Unlike the estimate for EEC membership, 4 of the 5 predictor countries are more closed than Greece with the synthetic estimator having an average export to GDP ratio 3% lower than Greece in the pre-treatment period. Given the closeness of this match, it is unlikely that differing degrees of openness would have played a significant role in making the prediction inaccurate.

Figure 17: Openness of Sample Countries, 2001 Adoption of Euro



Data from World Bank's World Development Indicators. Exports reflect both goods and services and are expressed as percent GDP. The pretreatment average spans the period from 1970-1980 and the full period average spans the period from 1970-2007. Synthetic Greece represents the weighted average previously developed by the synthetic control method.

The Greek debt crisis resulted from many complex events and imbalances beyond just openness to trade and sovereign debt. While it is unlikely that imbalances between the predictor countries and Greece in either of these areas resulted in any major flaws in the predictive abilities of the synthetic control method, the results, as with any counterfactual, should be interpreted with caution.

7. The Model

Next, I turn to a semi-small open economy model[2]. The model will be used to make comparisons with the empirical patterns of both crises as well as to further aid in the comparison of Greece and Argentina. I calibrate the model separately for both Greece and Argentina to incorporate the various aspects of their economies. A representative household, a representative producer, a representative wholesaler, and a representative retailer populate the semi-small open economy model. In accordance with Kehoe and Ruhl (2009), the economy is small in the sense that it takes world bond prices as exogenous but not small in the goods market: The price of its exported goods changes to clear the market.

Households

Households choose their state-contingent consumption sequences c_t and labor sequences L_t to maximize the expected discounted sum of future period utilities subject to a sequence of budget constraints. At date 0, Equation 6 represents the expected discounted sum of the future period utilities for the representative household where $\beta < 1$ is the subjective time discount factor, c_t is the household's consumption, and L_t is its labor input.

[2] The semi-small open economy model used in this paper is based on Proebsting (2017). I rely heavily on his theoretical model as well as his generously provided MATLAB code.

Equation 6: Discounted future utilities

$$\sum_{t=0}^{\infty}\sum_{s^t}\pi(s^t)\beta^t U(c_t, L_t)$$

The model considers utility functions consistent with Greenwood et al. (1988) (written GHH hereafter) in assuming that consumption and labor are complements for the household. Equation 7 specifies the GHH utility function where σ is the intertemporal elasticity of substitution for consumption, η is the Frisch Labor supply elasticity and k is a weight on the disutility of labor.

Equation 7: GHH utility function

$$U(c, L) = \frac{1}{1-\frac{1}{\sigma}}\left(c - k\frac{L^{1+\frac{1}{\eta}}}{1+\frac{1}{\eta}}\right)^{1-\frac{1}{\sigma}}$$

A hand-to-mouth restriction is imposed on a fraction χ of the consumers. These consumers receive income proportionate to their consumption share of total income and spend the entirety on current consumption. Hand-to-mouth consumption in each period is given by $c_t^{htm} \equiv \frac{\bar{C}}{\bar{Y}} Y_t$ where the bars indicate steady state values. Thus, Equation 8 gives aggregate consumption.

Equation 8: Aggregate consumption

$$C_t = (1-\chi)c_t + \chi c_t^{htm}$$

Households supply labor to the producers and, in return, earn nominal wages net of labor taxes equal to $(1-\tau_t)W_t L_t$. The household also receives lump-sum transfers $\mathbf{T}_t$ which include nominal profits from producers and wholesalers Π_t, nominal lump-sum taxes T_t, and the nominal amount consumed by hand-to-mouth consumers $P_t c_t^{htm}$, where P_t represents the date t nominal price of the final good.

In addition to direct wage income, the household may receive payments from both state contingent and state non-contingent bonds. All bonds pay off in units of the world currency (taken here to be U.S. dollars). State non-contingent bonds pay interest at rate i_t^*. The quantity of state non-contingent bonds purchased by the household at time *t* is denoted by S_t, and the quantity of state contingent bonds purchased by the household at nominal price $a_t(s_{t+1})$ after history s^t is denoted by $b_t(s_{t+1})$. The nominal exchange rate to convert the economy's currency into the world currency is $E_t = \frac{e_t}{P_t}$, where e_t is the real exchange rate. Equation 9 gives the nominal budget constraints for the representative household.

Equation 9: Nominal budget constraint

$$P_t c_t + \frac{S_t}{E_t} + \sum_{s^{t+1}} \frac{a_t(s_{t+1}) b_t(s_{t+1})}{E_t} = (1-\mathrm{T}_t)W_t L_t + \frac{(1+i_{t-1}^*)S_{t-1}}{E_t} + \Pi_t - \mathrm{T}_t - P_t c_t^{htm}.$$

Equation 10 provides the first order conditions for an optimum. The first equation gives the optimizing household's Euler equation for purchases of state non-contingent bonds, the second equation gives the domestic Euler equation, and the final equation represents the labor supply condition. Let U_j denote the derivative of the utility function $U(.)$ with respect to its j^{th} argument.

Equation 10: First order conditions

$$\frac{U_{1,t}}{e_t} = \beta(1 + i_t^*)E_t\frac{U_{1,t+1}}{e_{t+1}}$$

$$U_{1,t} = \beta(1 + i_t)E_tU_{1,t+1}$$

$$-\frac{U_{2,t}}{U_{1,t}} = (1 - \tau_t)\frac{W_t}{P_t}$$

Firms

Three types of firms populate the semi-small open economy model: producers, wholesalers, and retailers. Producers behave in monopolistically competitive manner and employ labor to produce an intermediate good variety. The prices of these varieties are potentially sticky. Perfectly competitive wholesalers purchase these varieties and combine them to produce an intermediate good. Wholesalers can ship some of these intermediate goods overseas and sell the remaining goods to perfectly competitive retailers who combine them with imports from overseas to produce a final, non-tradeable good. Retailers then sell this final good to either households or the government. I discuss the production chain in reverse order, starting with the retailers.

Retailers

Perfectly competitive retailers purchase intermediate goods from domestic wholesalers, y_t, at the nominal price $\varphi_t = p_tP_t$, where p_t is the real price of the intermediate good in terms of the final good, priced at P_t. Retailers also purchase intermediate goods from overseas, y_t^*, whose price in foreign currency is fixed and normalized to unity. Converted into domestic currency, $\frac{P_t}{e_t}$ gives the price of imported intermediate goods, where e_t is the real exchange rate and $\frac{e_t}{P_t}$ is the nominal exchange rate. Retailers then assemble the non-tradeable final good, Y_t, that they sell at price P_t to either households or the government.

Equation 11 gives their maximization problem where ψ denotes the elasticity of substitution between domestic and imported intermediate goods.

Equation 11: Retailer's maximization problem

$$max_{y_t,y_t^*}\left\{Y_t - p_ty_t - \frac{1}{e_t}y_t^*\right\}$$

$$s.t.\ Y_t = (\omega^{\frac{1}{\psi}}y_t^{\frac{\psi-1}{\psi}} + (1-\omega)^{\frac{1}{\psi}}(y_t^*)^{\frac{\psi-1}{\psi}})^{\frac{\psi}{\psi-1}}$$

Equation 12 gives the demand for intermediate goods where the first and second equations represent domestic intermediate goods and imported intermediate goods respectively.

Equation 12: Demand for intermediate goods

$$p_t = (\frac{\omega Y_t}{y_t})^{\frac{1}{\psi}}$$

$$\frac{1}{e_t} = (\frac{(1-\omega)Y_t}{y_t^*})^{\frac{1}{\psi}}$$

Wholesalers

The wholesales in the semi-small open economy are perfectly competitive and purchase intermediate good varieties $Q_t(\xi)$ from producers at price $\varphi_t(\xi)$ to produce a tradeable intermediate good, Q_t. They then sell this good at price φ_t either to retailers or overseas. Optimizing wholesalers maximize profits according to the maximization problem given by Equation 13 where the constraint comes from the CES production function and ψ_p represents the elasticity of substitution between the varieties.

Equation 13: Wholesaler profit maximization

$$max_{Q_t(\xi)}\{\varphi Q_t - \int_0^1 \varphi_t(\xi)Q_t(\xi)d\xi\}$$

$$S.T.\ Q_t = [\int_0^1 Q_t(\xi)^{\frac{\psi_p - 1}{\psi_p}} d\xi]^{\frac{\psi_p}{\psi_p - 1}}$$

Equation 14 then gives the demand for each variety $Q_t(\xi)$, and Equation 15 gives the nominal price of the intermediate good φ_t—a combination of the prices for each of the varieties.

Equation 14: Demand for intermediate good varieties

$$Q_t(\xi) = \ Q_t(\frac{\varphi_t(\xi)}{\varphi_t})^{-\psi_p}$$

Equation 15: Nominal price of intermediate good

$$\varphi_t = (\int_0^1 \varphi_t(\xi)^{1-\psi_p} d\xi)^{\frac{1}{1-\psi_p}}$$

Additionally, wholesalers face the demand curve given by Equation 16 for their exports where Y_t^* acts as a demand shifter and $\varphi_t \frac{e_t}{P_t} = p_t e_t$ yields the price of the intermediate good in foreign currency.

Equation 16: Export Demand

$$y_{*,t} = Y_t^*(p_t e_t)^{-\psi}$$

Producers

Producers of intermediate goods varieties are perfectly competitive in the input market, but monopolistically competitive in the output markets. Each producer, indexed by ξ, sells its output at price $\varphi_t(\xi)$ to a set of wholesalers. Here, $\varphi_t(\xi)$ is the nominal price of the variety made by producer ξ. Production of the intermediate good varieties requires only labor. Thus, Equation 17 gives a producer's production function.

Equation 17: Production function

$$Q_t(\xi) = Z_t L_t(\xi)^{1-\alpha}$$

Since they are monopolistically competitive, producers typically charge a markup for their products. The desired price naturally depends on the demand curve given in Equation 14. Each type of producer ξ freely chooses its inputs each period, but its nominal price $p_t(\xi)$ may be fixed to some exogenous level. In this case, the producers choose labor input to minimize costs taking their date-t output price $\varphi_t(\xi)$ as given. Cost minimization implies Equation 18 where $MC_t(\xi)$ is the marginal cost of production.

Equation 18: Optimal wages

$$W_t = MC_t(\xi)(1-\alpha)Z_t L_t(\xi)^{-\alpha}$$

The nominal prices of the intermediate good varieties are adjusted only infrequently according to the Calvo mechanism, and producers face a probability θ that they cannot change their price that period. When a firm can reset its price, it chooses an optimal reset price, denoted by $\varphi^*(\xi)$. Firms choose their reset price to maximize the discounted value of their profits, applying the stochastic discount factor of the household to all future income streams. Equation 19 gives the maximization problem of a producer that can reset its price at date.

Equation 19: Optimal reset price for producers

$$max_{\varphi_t^*}(\xi) \sum_{\tau=0}^{\infty} (\theta\beta)^\tau \sum_{s^{t+\tau}} \pi(s^{t+1}|s^t) \frac{U_{1,t+\tau}}{P_{t+\tau}} (\varphi_t^*(\xi) - MC_{t+\tau}) Y_{t+\tau} \left(\frac{\varphi_t^*(\xi)}{\varphi_{t+\tau}}\right)^{-\psi_p}$$

$$S.T.\ \varphi_t^*(\xi) = \frac{\psi_p}{\psi_p - 1} \frac{\sum_{\tau=0}^{\infty}(\theta\beta)^\tau \sum_{s^{t+\tau}} \pi(s^{t+\tau}|s^t) \frac{U_{1,t+\tau}}{P_{t+\tau}} \varphi_{t+\tau}^{\psi_p} MC_{t+\tau} Y_{t+\tau}}{\sum_{\tau=0}^{\infty}(\theta\beta)^\tau \sum_{s^{t+\tau}} \pi(s^{t+\tau}\,|s^t) \frac{U_{1,t+\tau}}{P_{t+\tau}} \varphi_{t+T}^{\psi_p} Y_{t+\tau}}$$

Since firms adjust their prices infrequently, the nominal price of the intermediate good is sticky and, using Equation 15, evolves according to Equation 20.

Equation 20: Nominal price of intermediate good

$$\varphi_t = [\theta(\varphi_{t-1})^{1-\psi_p} + (1-\theta)(\varphi_t^*)^{1-\psi_p}]^{\frac{1}{1-\psi_p}}.$$

Fiscal and Monetary Policy

The model includes both fiscal and monetary policy variables. Government purchases are assumed to be exogenous and financed by lump-sum taxes and labor taxes. Changes in labor taxes and government purchases are financed through changes in lump-sum taxes. Fiscal policy shocks to government purchases and taxes decay at a constant rate ρ and unfold according to Equation 21.

Equation 21: Fiscal policy shocks

$$G_t = (1-\rho)G + \rho G_{t-1} + \epsilon_t^G$$
$$\tau_t = (1-\rho)\tau + \rho \tau_{t-1} + \epsilon_t^\tau$$

The model considers two monetary regimes: In regime one, the monetary authority allows its currency to float and simply targets a nominal interest rate set by the Taylor rule (in log-linearized form) given by Equation 22. The Taylor Rule targets steady-state deviations of GDP (Q_t) and domestic inflation ($\pi_t + \overline{p}_t - \overline{p}_{t-1}$). In regime two, the monetary authority keeps its nominal exchange rate fixed so that $\frac{e_t}{P_t}$ remains unchanged.

Equation 22: Taylor rule

$$i_t = \phi_Q \tilde{Q}_t + \phi_\pi(\pi_t + \bar{p}_t - \bar{p}_{t-1})$$

Aggregation and Market Clearing

Production of the intermediate good and its market clearing condition are given by Equation 23 and Equation 24 respectively.

Equation 23: Production of intermediate goods

$$Q_t = Z_t {L_t}^{1-\alpha}.$$

Equation 24: Market clearing condition for intermediate goods

$$Q_t = Z_t {L_t}^{1-\alpha}.$$

Production of the final good by retailers and its market clearing condition are given by Equation 25 and Equation 26 respectively.

Equation 25: Production of final goods

$$Y_t = (\omega^{\frac{1}{\psi}}(y_t)^{\frac{\psi-1}{\psi}} + (1-\omega)^{\frac{1}{\psi}}(y_t^*)^{\frac{\psi-1}{\psi}})^{\frac{\psi}{\psi-1}}$$

Equation 26: Market clearing condition for final goods

$$Y_t = C_t + G_t$$

Equilibrium conditions

The model is solved under the conditions around the non-stochastic steady state. Exact calibration for the steady state is discussed in the next section. From the steady state, in various experiments, I subject the economy to shocks in total factor productivity and in export demand as defined in Equation 27. Here, $\tilde{X}_t$ denotes a deviation of variable X from its steady state at time t.

Equation 27: Shocks

$$\widetilde{Z}_t = (1-\rho)\widetilde{Z}_{t-1} + \epsilon_t^Z$$
$$\widetilde{Y}_t^{\;*} = (1-\rho)\widetilde{Y}_{t-1}^{\;*} + \epsilon_t^Y$$

Calibration

My benchmark calibration is summarized in Table 5.

Production: The capital share of production α is set to 0.512 for Argentina, consistent with the values found by Frankema (2010) and Guerriero (2012). The capital share is then assumed to be one minus this value. For Greece I set α to 0.35 in accordance with the capital share of Euro area countries as computed by Jones (2003).

Preferences: I set the subjective time discount factor β to 0.99, the intertemporal elasticity of substitution σ to 0.5, the Frisch elasticity of labor supply η to 1 and the share of hand-to-mouth consumers χ to 0.5. These values are consistent with the calibration in House, Proebsting, and Tesar (2017) and are comparable to findings in microeconomic literature (i.e. Barsky, et al., 1997).

Price Rigidity: I set the calvo price setting hazarad θ_p to 0.8 for both countries. This is consistent with the calibration in House, Proebsting and Tesar (2017) and with the findings of Alvarez, et al. (2006) who report average duration of prices in Europe is 13 months. It also fits well for Argentina according to Cavallo's (2015) computation of average duration of prices in Argentina at 13.5 months.

Fiscal and Monetary Policy: For Argentina and Greece, I set the share of governemnt purchases in GDP to 0.135 and 0.194 respectively. These values match emprically, reflecting the 1998-2001 average for Argentina and the 2001-2008 average for Grecce. I set The Taylor rule as standard (targeting both inflation and GDP) for Argentina and as a pegged nominal exchange rate for Greece. Argentina's free monetary policy reflects their depeggingof the peso in January of 2002 while Greece's peg reflectes their continued Euro area membership. I set the Taylor Rule inflation coeffiecint φ_π to be 1.5.

Trade: I set the home bias parameter ω to 0.78 for Argentina and 0.51 for Greece. These values represent the average trade share of GDP from 1998-2001 for Argentina and 2001-2008 for Greece. The elasticity of substitution between domestic and foreign goods is set to 0.5 for both countries, comparable to parameter values used in international business cycle models with trade and consistent with the benchmark parameterization used in House, Proebsting, and Tesar (2017)

Table 5: Benchmark calibration for semi-small open economy model

Parameter	Meaning	Argentina		Greece	
		Value	Source	Value	Source
Production					
$\boldsymbol{\alpha}$	Capital share	0.512	Guerriero (2012) Frankema (2010)	.35	Jones (2003)
Preferences					
$\boldsymbol{\beta}$	Discount factor	0.99	Standard value	0.99	Standard value
$\boldsymbol{\sigma}$	Coefficient of relative risk aversion	0.5	Standard value	0.5	Standard value
Pref	Preference type	GHH	--	GHH	--
$\boldsymbol{\eta}$	Frisch Elasticity	1	Barsky, et al. (1997)	1	Barsky, et al. (1997)
$\boldsymbol{\chi}$	Fraction of hand to mouth consumers	0.5	House, Proebsting, and Tesar (2017)	0.5	House, Proebsting, and Tesar (2017)
Price and Wage Stickiness					
$\boldsymbol{\theta_p}$	Price stickiness	0.8	House, Proebsting, and Tesar (2017) A. Cavallo (2015)	0.8	House, Proebsting, and Tesar (2017) Alvarez, et al. (2015)
Monetary Policy					
$\boldsymbol{\varphi_\pi}$	Taylor Rule inflation coefficient	1.5	--	1.5	--
Taylor Rule	--	Standard (targets GDP and inflation)	--	Nominal exchange rate peg	--
Fiscal Policy					
G	Share of government purchases in GDP	.135	World Bank WDI data set, 1998-2001 average general governemnt final expenditure	0.194	World Bank WDI data set, 2000-2008 average general governemnt final expenditure
Trade					
$\boldsymbol{\psi}$	Elasticity of substitution between domestic and foreign goods	0.5	House, Proebsting, and Tesar (2017)	0.5	House, Proebsting, and Tesar (2017)
$\boldsymbol{\omega}$	Home bias parameter	0.777	World Bank WDI data set, 1998-2001 average trade share of GDP	0.51	World Bank WDI data set, 2001-2008 average trade share of GDP

8. Argentina: Model and Data Comparison

Methodology

In attempting to model Argentina, I calibrate the model with the benchmark parameters described in Table 5 as the steady state. I consider the shocks as occurring at the end of 2001, making 2002 the first year of the impulse responses produced by the model. To simulate the crisis, I consider two types of shocks: a negative total factor productivity shock and a positive export demand shock both of which are defined by Equation 27.

Data on total factor productivity level at current purchasing power parities for Argentina are available through the FRED database[3] and shows Argentina suffered a 15% decline in TFP in 2001. Accordingly, I experiment with a TFP shock of -15% in the model. Export demand cannot be measured as concretely, but I propose a positive shock due to the boom in exports seen by Argentina immediately after de-pegging the peso. Prior to de-pegging, Argentina struggled with an overvalued peso that led Argentine goods to be more expensive than those of direct competitors such as Brazil. Consequently, once they allowed the peso to devalue, demand for exports increased. Since Argentina de-pegged in January of 2002—essentially immediately after their default in December of 2001—and their fall in GDP was sudden—dropping drastically in 2002—I present the shocks as occurring simultaneously in the model.

In matching the model to the data, I start by analyzing the shocks one at a time. For the negative total factor productivity shock, I focus on adjusting size and duration to match the fall in GDP. Fortunately, a negative shock of 15% works well here--and matches with the actual drop in total factor productivity experienced during this time—and I adjust the duration to 0.5 to account for the relatively rapid recovery in output. For the positive export demand shock, I focus on matching the projected increase in exports with the data. This ends up requiring a shock of size of 15% and a duration of 0.7. Having established the two shocks independently, I combine them to complete the model.

Benchmark Model Performance

Table 6 summarizes the results from the model as compared to the data. In assessing the model's accuracy, I select five key parameters due to their significance in the crisis: GDP, consumption, exports, imports, and inflation.

Starting by taking the negative total factor productivity shock in isolation, the model produces a good match in the response of GDP, projecting a fall of 18.1% from 2001 to 2002 relative to the actual fall of 18.3%. It also projects Argentina's rapid recovery fairly well, projecting the gap in output to have decreased to 1.1% below the steady state level by 2004, comparable to the actual trajectory where GDP rose to 0.5% below the steady state level by 2004.

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[3] University of Groningen and University of California, Davis, Total Factor Productivity Level at Current Purchasing Power Parities for Argentina [CTFPPPARA669NRUG], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/CTFPPPARA669NRUG, March 5, 2018.

The model projects a 27.2% drop in consumption in 200—too large relative to the data which marks only a 15.1% drop in consumption—and a 24.3% drop in imports—about half of the decline seen in the actual data. This shock alone fails to capture the export boom of 15.1% or rise inflation of 25.8% seen in the data in 2001, instead projecting a relatively steady path for both of these variables.

To address the issue of capturing exports, I reconsider the model with a positive export demand shock. In isolation, this shock provides a good match for exports, projecting an initial increase of 15.2%. However, it struggles to capture the long-term elevation of export value seen empirically, instead projecting a gradual return to the steady state. Similar to the negative TFP shock, this scenario accounts for about half of the drop in imports with a predicted decline of 23.9%. The positive export demand shock understates the total effect on consumption seen in the data, predicting an initial drop of 6.3% relative to the actual decline of 15.1%. This shock alone fails to capture the decline in GDP or increase in inflation, projecting a relatively stable trajectory for each.

Table 6: Argentina impulse responses

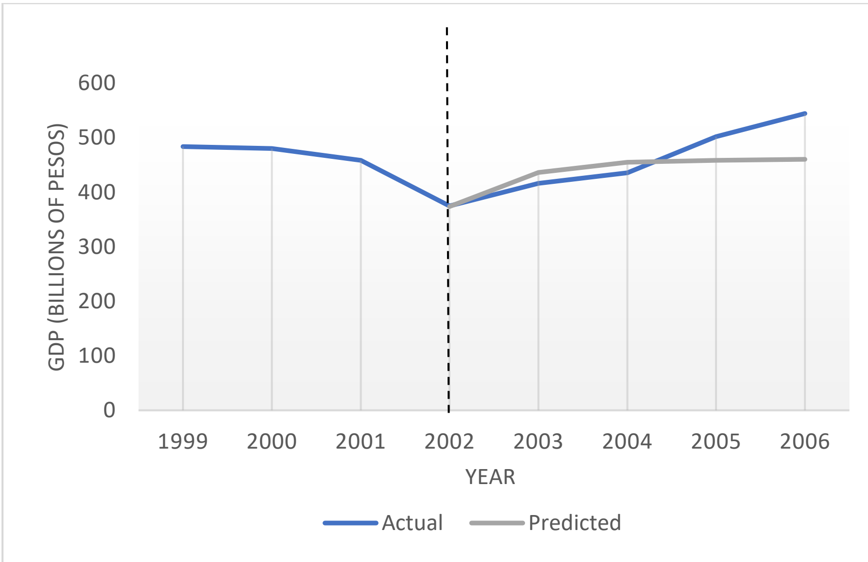
Source	Shocks	Measure	GDP	Consumption	Exports	Imports	Inflation
Data	---	% Change 2001-2002	-18.3%	-15.1%	15.1%	-50.1%	25.8%
		% Change 2001-2004	-0.5%	1.0%	18.1%	-3.7%	47.5%
TFP Shock Only	Size of Shock: Z=-15%	% Change 2001-2002	-18.1%	-27.2%	0.4%	-24.3%	2.5%
		% Change 2001-2004	-1.1%	-2.4%	0.4%	-2.8%	0.6%
Export Demand Shock Only	Size of Shock: Yst=15%	% Change 2001-2002	-0.4%	-6.3%	15.2%	-23.9%	3.9%
		% Change 2001-2004	0.2%	-0.8%	7.6%	-10.9%	1.8%
Both Shocks	Size of Shock: Z=-15% Yst=15%	% Change 2001-2002	-18.5%	-33.5%	15.6%	-48.2%	6.4%
		% Change 2001-2004	-0.9%	-3.2%	8.0%	-13.8%	2.4%

The first row reports the actual response of the Argentine economy. All data come from the World Bank's World Development Indicators. GDP, consumption, export and import data are taken in terms of constant local currency units. All other rows report the responses as predicted by the semi-small open economy model. The second and third rows report the predicted response to only a negative TFP shock and only a positive export demand shock respectively. The fourth row presents the combined effect of these two impulses. Z represents total factor productivity and YST represents export demand.

Having analyzed both shocks separately, I now turn to their combined effect and examine each parameter in detail one at a time. Looking first at GDP, the combined shocks accurately capture the collapse and recovery—predominately thanks to the negative TFP shock—predicting a fall of 18.5% in 2002 and a recovery to just 0.9% below the steady state value by 2004—just 0.2 percentage points and 0.5 percentage points off the empirical values respectively. Below, Figure 18 plots the model's projects compared to the actual data, using the impulse response to calculate

GDP by taking empirical level from 2001 as the steady state. Examining the figure, the model provides a good prediction of the trajectory of GDP through 2004; after 2004, the model fails to capture Argentina's continued growth as it projects a gradual return to the steady state. From the accuracy of the model through 2004, I conclude that the drop in total factor productivity played a prominent role in creating the recession in Argentina.

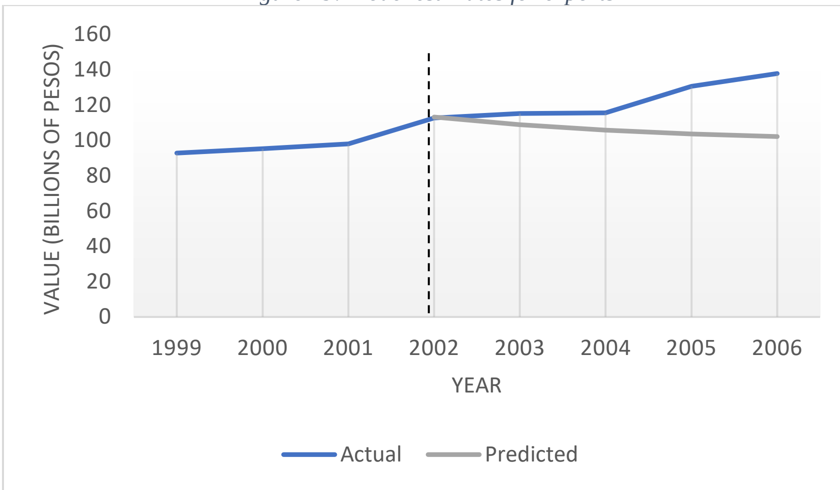
Figure 18: Model estimates for GDP



The figure plots Argentina's actual GDP in terms of constant local currency units from the World Bank's World Development Indicators and the GDP path predicted by the semi-small open economy model in responses to a negative shock to TFP and a positive shock to export demand. The model's predictions start in 2002 (as denoted by the dashed line) and can be assumed to follow the path of the actual data prior to this date.

The combined shocks—dominated by the positive shock to export demand—accurately capture the initial boom in exports, projecting an increase of 15.6% in 2001, just 0.5 percentage points larger than increase seen in the data. However, on a longer horizon, the model fails to accurately project the trajectory of export value. In the data, Argentina's exports continue growing to 18.1% above the steady state in 2004, and further increase after that. The model, however, projects a return to 2001 levels, with the gap in exports declining to 8% by 2004 and continuing a return to the steady state thereafter. These two trajectories can be seen in comparison as plotted in Figure 19 which displays the yearly export value both as realized in the data and as predicted by the model. The sustained increase in exports seen in the data suggests that the export boom resulted—at least partially—from permanent changes in the Argentine economy rather than a temporary shock like the one captured by the model.

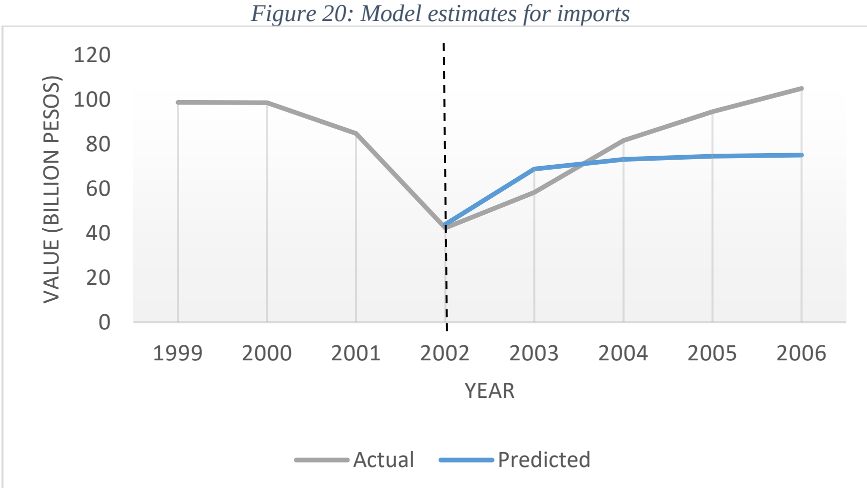
Figure 19: Model estimates for exports



The figure plots Argentina's actual export value in terms of constant local currency units from the World Bank's World Development Indicators and the export value path predicted by the semi-small open economy model in responses to a negative shock to TFP and a positive shock to export demand. The model's predictions start in 2002 (as denoted by the dashed line) and can be assumed to follow the path of the actual data prior to this date.

Next, turning to imports, the combined shocks project an initial drop of 48.2%--fairly in line with the actual drop of 50.1% in 2002. In this case, rather than being dominated by one shock, the negative TFP shock and the positive export demand shock play an equal role in creating the drop in import value. The model diverges slightly in predicting the recovery of imports in 2004, projecting a value of 13.8% lower than the steady state while the data reveals a value only 3.7% below the steady state. The difference between the model and the data continues to increase overtime as imports continue to grow despite leveling out in the model's projections. Despite the ultimate divergence, the two shocks provide an accurate assessment for the initial response of the Argentine economy.

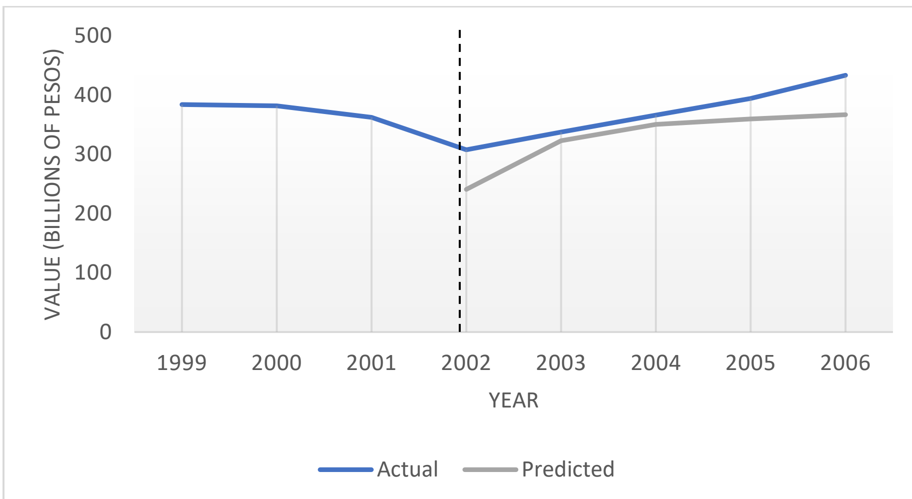
Figure 20: Model estimates for imports



The figure plots Argentina's actual import value in terms of constant local currency units from the World Bank's World Development Indicators and the import value path predicted by the semi-small open economy model in responses to a negative shock to TFP and a positive shock to export demand. The model's predictions start in 2002 (as denoted by the dashed line) and can be assumed to follow the path of the actual data prior to this date.

Departing from the previous results, I now consider consumption—a parameter poorly predicted by the model. The model largely overstates the effect of the crisis on consumption predicting an initial drop of 33.5% in 2002, more than twice the size of the actual decline. Here, the total factor productivity shock alone generates a larger drop in consumption than what was seen empirically, and this issue is further exacerbated by the positive export demand shock that creates a relatively small drop in consumption of its own. Despite its inaccuracy in magnitude, the model does capture the general pattern of consumption seen in Argentina following the crisis: a sharp initial drop followed by a rapid recovery. A year by year comparison of the model's prediction with the data can be seen below in Figure 21.

Figure 21: Model estimates for consumption

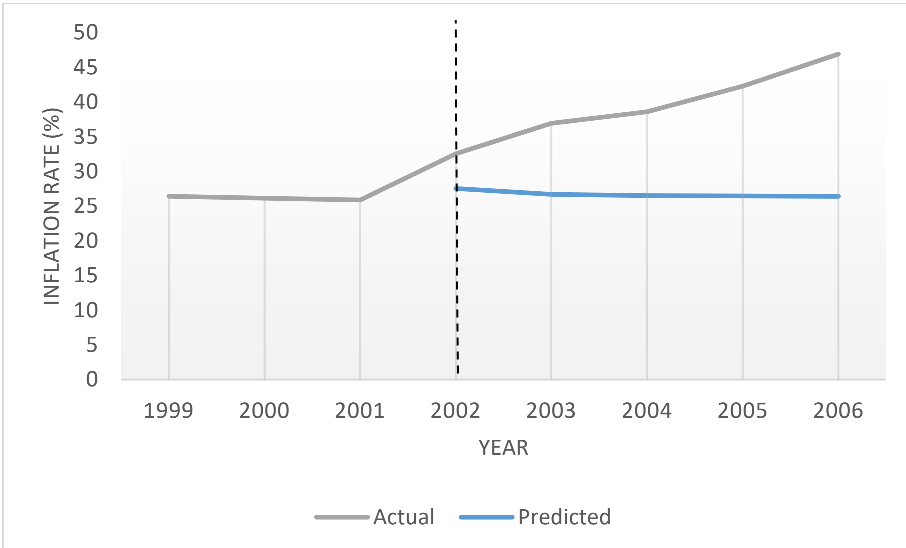


The figure plots Argentina's actual consumption value in terms of constant local currency units from the World Bank's World Development Indicators and the consumption value path predicted by the semi-small open economy model in responses to a negative shock to TFP and a positive shock to export demand. The model's predictions start in 2002 (as denoted by the dashed line) and can be assumed to follow the path of the actual data prior to this date.

As the final variable, I examine inflation. Of the five measures, the model performs the worst in this regard. Empirically, Argentina faced rapid inflation in 2002 with rates rising about 25.8%, and this inflation continued to grow in the following years, reaching levels 47.5% above the 2001 level by 2004. In the model, however, inflation remains stable over the trial period. Neither shock has a strong impact on inflation with the total factor productivity shock and export demand shock leading to an initial rise of only 2.5% and 0.6% respectively. The divergence continues to worsen as the model projects a gradual return to the steady state while actual inflation rates continue to grow. The contrast between predicted and actual trajectories of inflation can be seen in Figure 22 below.

Likely, the model's issues in projecting inflation stem from its inability to capture Argentina's change in monetary regime: In December of 2001 Argentina defaulted on their debt and in January they de-pegged the peso from the U.S. dollar, causing a rapid devaluation of the peso and, in turn, leading to inflation. Due to the proximity of these events, my model parameterization considers Argentina as having independent monetary policy to accurately project its path after 2001. However, as a consequence of this set up, the model cannot capture the results of the switch between these two regimes and thus misses the major driver of inflation in the aftermath of the default.

Figure 22: Model estimates for inflation



The figure plots Argentina's actual inflation rate in terms of annual percent change in CPI from the World Bank's World Development Indicators and the inflation rate path predicted by the semi-small open economy model in responses to a negative shock to TFP and a positive shock to export demand. The model's predictions start in 2002 and can be assumed to follow the path of the actual data prior to this date.

Overall, the model is reasonably successful in projecting the crisis in Argentina. A negative total factor productivity shock seems to have been a major contributor to the collapse in GDP while a positive export demand shock can explain much of the shift in trade. However, certain concerns arise with the model: As discussed above, the model fails to capture the change in exchange rate regimes and the consequent surge in inflation. Further, due to the persistent nature of Argentina's increase in export value in the years following the crisis, this increase appears to be fueled by a more permanent shift in the economy rather than a shock. Additionally, in its simplification, the model cannot capture certain other key elements of the lead up to the crisis in Argentina, including elevated levels of sovereign debt and a sudden stop to investment—both of which are discussed in detail in previous sections.

Variations on the Benchmark model:

In addition to the benchmark calibration described in Table 5, I consider the following alternative cases:

i. No hand-to-mouth consumers: This scenario maintains the benchmark specifications, but the share of hand-to-mouth consumers is set to $\chi = 0$.
ii. No price rigidities: This scenario maintains the benchmark specifications by resetting the price rigidity parameter θ_p to zero.

iii. Wage rigidities: This scenario introduces sticky wages to the benchmark scenario and sets $\theta_w = 0.8$

iv. Pegged exchange rate: This scenario considers how the outcome might have been different had Argentina not de-pegged the peso after defaulting. It maintains the benchmark parameterization, but sets the Taylor rule to "Peg" instead of "Standard."

v. High trade elasticity: This scenario maintains the benchmark parameterization but sets the elasticity of substitution between domestic and foreign goods to $\psi = 5$. This adjustment makes foreign and domestic goods closer substitutes.

Table 7 summarizes the results of these experiments.

Table 7: Sensitivity Analysis

Case	GDP		Exports	
	% Change 2001-2002	% Change 2001-2004	% Change 2001-2002	% Change 2001-2004
Data	-18.3%	-0.5%	15.1%	18.1%
Benchmark	-18.5%	-0.9%	15.6%	8.0%
No hand-to-mouth consumers	-19.2% (-0.7%)	-1.3% (-0.4%)	16.4% (+0.8%)	8.8% (+0.8%)
No price rigidities	-19.6% (-1.1%)	-1.8% (-0.9%)	16.4% (+0.8%)	8.8% (+0.8%)
Wage rigidities	-18.1% (+0.4%)	-1.4% (-0.5%)	16.2% (+0.6%)	6.9% (-1.1%)
Pegged exchange rate	-26.4% (-7.9%)	-5.4% (-4.5%)	16.5% (+0.9%)	9.1% (+1.1%)
High trade elasticity	-16.5% (+2.0%)	-1.0% (-0.1%)	12.9% (-3.1%)	6.3% (-1.7%)

The table reports the impulse responses of the Argentine economy measured as deviation from equilibrium (here taken to be 2001). The first row reports the actual data, the second row reports the results from the benchmark calibration when exposed to a negative TFP and positive export demand shock. The remaining rows give the results for each of the 5 alternative cases in response to the same shocks as the original model. The figures in parenthesis report the difference between the outcome of the benchmark scenario and that of each of the alternative scenarios.

A comparison of the responses of GDP and exports across the different cases gives a sense of which features of the model are critical for matching the data. Reducing the fraction of hand-to-mouth consumers has little impact on the trajectory of GDP and exports compared to the base case. Similarly, flexible prices and the introduction of sticky wages create only small deviations in the predictions for these variables. Of the alternative cases, the pegged exchange rate scenario has the largest effect on GDP, creating a negative response 7.9 percentage points larger than that of the benchmark scenario. This impact suggests that had Argentina not de-pegged immediately after defaulting in 2002, the crisis could have been much worse, resulting in an even more severe drop in GDP. Introducing a high elasticity of trade has the largest impact on exports. In this case, the combined shocks lead to a 3.1 percentage point smaller increase in exports than in the benchmark scenario. The high elasticity of trade also leads to a slightly smaller decline in GDP, likely because a greater substitutability between home and foreign goods weakens the impact of a shock on domestic output and increases the spillover of these effects to trading partners.

9. Greece: Model Predictions

Methodology

In attempting to model Greece, I calibrate the model with the benchmark parameters described in Table 5 as the steady state. I consider the shocks as occurring at the end of 2008, making 2009 the first year of the impulse responses produced by the model. Unlike Argentina, the crisis in Greece is ongoing; thus, my approach is different, and instead of focusing on modeling the crisis, I focus on developing a comparison to Argentina and analyzing potential means for recovery.

First, to further explore a comparison between the two countries, I apply the same negative TFP shock used on Argentina to the model for Greece. Then, since unlike Argentina, Greece has not had the benefit of an export boom, I experiment with adding in an export demand shock of the same magnitude as Argentina's but in the opposite direction. I compare theses shocks to the data in Greece both in isolation and collectively and analyze to what extent the underlying causes of the crises can be compared.

Next, to explore pathways to recovery for Greece, I experiment with applying positive shocks. For these cases, I take the shocks as occurring in 2015 and explore the size and type of shock needed to shift Greece towards recovery. I also check to see how the required magnitude of the shocks changes when the monetary policy regime of the model changes from a pegged interest rate to the standard Taylor rule.

Results

Table 8 summarizes the results from comparative analysis of the causes of the Greek crisis with Argentina's. In assessing the crises similarity, I select four key parameters due to their significance: GDP, consumption, exports, and imports. As continued members of the European Monetary Union, high inflation has not been an issue in the Greek crisis and thus I omit it from this analysis.

Applying only a negative total factor productivity shock of the same magnitude as the one occurring in Argentina produces a poor fit for the Greek economy. Looking first at GDP, the model predicts an initial fall of -20.3% in 2009 and a recovery to 0.2% above 2008 levels by 2015. The data, however, reveal Greece suffered only a minor drop in GDP of 4.7% in 2009—much smaller than that of the model. Additionally, unlike the model, Greece's empirical drop in GDP is gradual but persistent, falling to 25.9% below 2008 levels by 2015. While the magnitude of the shock can be decreased to match the small initial drop or increased to match the total drop, this does not improve the overall fit: Either the model captures the small initial drop and then quickly recovers, or it captures the total drop but does so all in the span of a year or two rather than gradually over the 7-year period of the data. The gradual nature of Greece's drop in GDP makes the negative total factor productivity shock a poor model for the Greek crisis. While declining total factor productivity might be an issue in the Greek economy, it has likely happened as a consequence of the recession—likely exacerbating the situation overtime—rather than acting as a shock to start the crisis. This suggests a difference in cause from the Argentine crisis, creating a challenge to the feasibility of looking to Argentina for a model to recovery.

A quick examination of the other variables also shows the negative total factor productivity shock to be a poor model for the Greek crisis. The model's predictions for consumption suffer similar issues to those for GDP: It projects an initial drop of 47.8%--much larger than the actual decline of 0.8% in 2009—and then predicts a recovery to levels 1.7% above the steady state by 2015 while, in reality, values continued dropping to 24.2% below 2008 levels by 2015. The shock to total factor productivity has very little effect on exports or imports in the model and fails to capture the large drop in each seen empirically.

Table 8: Greece Impulse Responses

Source	Shocks	Measure	GDP	Consumption	Exports	Imports
Data	---	% Change 2008-2009	-4.7%	-0.8%	-18.5%	-20.3%
		% Change 2008-2015	-25.9%	-24.2%	-2.5%	-33.2%
TFP shock	Z=-15%	% Change 2008-2009	-20.3%	-47.8%	-0.4%	-3.8%
		% Change 2008-2015	0.2%	1.7%	-0.3%	1.7%
Export demand shock	Yst = -15%	% Change 2008-2009	-2.9%	14.6%	-18.0%	11.3%
		% Change 2008-2015	-0.8%	-0.9%	-1.3%	-1.2%
Combined	Z=-15% Yst=-15%	% Change 2008-2009	-23.2%	-33.2%	-18.4%	8.5%
		% Change 2008-2009	-0.6%	0.8%	-1.6%	0.5%

The first row reports the actual response of the Greek economy. All data come from the World Bank's World Development Indicators. GDP, consumption, export and import data are taken in terms of constant local currency units. All other rows report the responses as predicted by the semi-small open economy model. The second and third rows report the predicted response to only a negative TFP shock and only a negative export demand shock respectively. The fourth row is simply the sum of these two impulses. Z represents TFP and YST represents export demand.

In modeling Argentina, I considered a positive export demand shock in addition to the negative total factor productivity shock. However, Greece—under continued use of the euro—has not benefited from any of the exchange rate dynamics at play in Argentina and thus has suffered a drop in exports during the crisis rather than a boom. Consequently, I apply instead a negative export demand shock to Greece of the same magnitude as that used for Argentina. This shock produces a good match to Greece in terms of export levels, projecting an initial drop of 18.0%--well in line with the actual drop of 18.5% seen in Greece from 2008 to 2009—and then a recovery to 1.3% below steady state levels by 2015—again, similar to the empirical level. However, this shock alone has little impact on GDP and—contrary to the data—projects a positive response from consumption and imports. Thus, while a shock to export demand may have played a role in the crisis, it alone cannot explain Greece's path.

The results from combining the negative total factor productivity shock and export demand shock are also provided in Table 8 but, due to the concluded unsuitability of the total factor productivity shock, are not discussed in further detail. Overall, the results from the model suggest that the paths of the Greek and Argentine economies cannot be compared in terms of underlying shocks.

I turn next to consider a hypothetical Greek recovery. In assessing recovery, I choose to focus on consumption and GDP as they have the largest sustained negative effect of the four selected variables. Table 9 provides a summary of the minimum size and type of shock that would be required in 2015 to move GDP and consumption to their pre-crisis (2008) levels. In this analysis, I report results both for the benchmark calibration of Greece and for the same calibration but with the standard Taylor rule instead of a pegged exchange rate. These two scenarios are meant to capture how Greece's ease of recovery might be impacted if they left the euro and freed their monetary policy. However, this is an over simplification as membership in the European Monetary Union has a much broader impact than simply pegging a currency, and Greece's departure could have a multitude of negative effects not captured by the model.

Table 9: Shocking Greece to Recovery

Shock	GDP		Consumption	
	Peg	Standard	Peg	Standard
Total Factor Productivity	25%	20%	15%	10%
Export Demand	35%	55%	30%	65%

The table provides the minimum shock required to restore Greek GDP and consumption to pre-crisis (2008) levels in 2015. For ease of computation, the shocks are rounded to the nearest 5 percentage points. The categories "peg" and "standard" denote the monetary policy regime the model is parameterized with in the experiment: "Peg" establishes a pegged nominal exchange rate and is meant to represent continued EMU membership. "Standard" refers to a standard Taylor rule (independent monetary policy) and provides a simplified hypothetical for if Greece were to leave the EMU.

Looking first to total factor productivity, Greece requires a positive shock of 25% to restore GDP and 15% to restore consumption when a pegged exchange rate is retained. This requirement lowers slightly 20% and 10% respectively when monetary policy is freed. However, in either case, a shock to total factor productivity of this magnitude would be difficult to attain—likely requiring deep rooted structural change or major technical innovation. Additionally, while a shift to free monetary policy does ease the requirements for recovery slightly, the model cannot capture the unpredictable consequences of leaving the Euro and the risk of this would likely outweigh the slight benefit of de-pegging here.

In terms of export demand, Greece requires a positive shock of 35% and 30% to restore GDP and consumption respectively under a pegged currency regime. In contrast to total factor productivity, this requirement increases substantially when monetary policy is freed, reaching a magnitude of 55% for GDP and 65% for consumption. However, this disparity shrinks when considering the ease at which such a shock might be attained. If Greece had free monetary policy, they could offset some of this challenge through nominal means by devaluing their currency to better compete with trading partners. Conversely, leaving the euro could sever many of Greece's trade relationships, thus reducing demand for exports. In either case, shocks of this magnitude would once again be difficult to attain and would require significant structural reform in the Greek economy.

Overall, recovery through a positive shock to total factor productivity or export demand does not seem feasible for Greece. The required size of shocks necessitates strong structural reform which could not happen quickly. Additionally, at least from this perspective, leaving the euro does not appear to be particularly beneficial for Greece. While having a free monetary policy might ease certain challenges, it would almost certainly come with some sort of negative consequences and, regardless of the severity of these, would not be enough to push Greece towards a full recovery. Argentina's rapid collapse is suggestive of an underlying negative shock to the economy. While initially devastating, shocks eventually relent and, combined with a fortunately timed positive shock to export demand, this allowed the Argentine economy to recover relatively quickly. Greece, on the other hand has experienced a slower but relentless decline which cannot be captured by a simple shock. This is indicative of stronger fundamental issues in the Greek economy that cannot be easily fixed and will necessitate a great deal of time and reform before recovery can be achieved.

10. Conclusion

While Argentina and Greece move in symmetry through the period leading up to their crises, this comparison unravels as their paths diverge post-default. While Argentina's recovery can offer some insights for what needs to occur in Greece, a simple answer does not exist. The current imbalances in Greece are much greater in magnitude than those faced by Argentina or those faced by any other country in a sovereign debt default. While this alone would make Greece's issues harder to grow out of, Greece's struggles with competitiveness are also more deeply rooted than Argentina's, resulting largely from structural issues rather than an over-valued currency. Thus, Argentina's recovery cannot be directly translated to Greece.

Through the synthetic counterfactual model, I conclude that membership in the European Union has had a negative effect on the Greek economy, contributing to the scale of the current crisis. While this indicates that Greece—like Argentina—might benefit from a switch to free monetary policy, leaving the euro would unleash an unpredictable wave of consequences for Greece. Furthermore, even once it regained control of monetary policy, the devaluation of currency would not be enough for Greece to mirror the rapid growth of Argentina. The challenge of mirroring Argentina's actions is further reinforced through my analysis of the semi-small open economy model which suggests structurally different causes for each of the crises. One way or another, as measures of fiscal austerity continue to send the economy into deeper and deeper recession, Greece must find a way to boost competitiveness and begin outgrowing its problems.

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