Draft: 23 September 2017

You Say You Want a (Rose) Revolution? The Effects of Georgia's 2004 Market Reforms

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Abstract: After Georgia declared its independence from the Soviet Union, it experienced civil war and strife for several years. In late 2003, the peaceful Rose Revolution installed a new government that began a series of radical market-liberal reforms. The effectiveness of these reforms is a matter of controversy. This study sheds light on the debate by using the synthetic control method to create a credible counterfactual to examine the impact of these liberalizations on Georgia's subsequent socio-economic performance. We conclude that the reforms enacted after the Rose Revolution led to significant improvements in the Georgia's social and economic development, with only temporary side effects and argue that this case provides some support for the idea of rapid, multidimensional reform.

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Keywords: Georgia, Synthetic Control, Liberalization, Rose Revolution, Reform

JEL Codes: P1, P2

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I. Introduction

During the late eighteenth and early nineteenth centuries, the Russian Empire annexed much of the region south of the Caucasus Mountains, including the Kingdom of Georgia. After a brief period of independence during the Bolshevik Revolution, Georgia fell back into Russian hands in 1921 and eventually was organized as the Georgian Soviet Socialist Republic. Ultimately, the Russians controlled Georgia for the better part of two centuries. Georgia achieved independence on April 9, 1991, just before the political collapse of the Soviet Union.[1]

The immediate post-Soviet experience was chaotic featuring a bloody coup d'état and violent ethnic conflicts in the Georgian regions of Abkhazia, South Ossetia, and Adjara. Economically, things were little better. The breakup of the Soviet Union eliminated the established, if economically irrational, Soviet centralized economic plan. Many state-owned enterprises now owned by the Georgian government floundered as the patterns of specialization and trade within the old Soviet Union collapsed. Without stable tax revenue or state-owned enterprise earnings, the government resorted to printing money, which resulted in periods of hyperinflation. Shortages of basic items such as food, fuel, and electricity became the norm thanks to price controls and frequent supply disruptions.

In late 2003, after more than a decade of civil war, political uncertainty, and economic collapse, the Rose Revolution peacefully deposed Eduard Shevardnadze,

[1] See Burakova and Lawson (2013) for a more detailed treatment of the political economy of Georgia.

the former Soviet official who had ruled autocratically for most of the post-Soviet period. In January 2004, a Columbia University-educated lawyer, Mikheil Saakashvili, was elected to lead the new government, and Kakha Bendukidze, was tapped by Saakashvili to lead the reform process. Although the issues related to the separatist regions and hostile relations with Russia remained, the Rose Revolution ultimately ushered in a period of rapid economic liberalization.

The purpose of this study is to examine the impact of these reforms. In order to do this we need a reasonable counterfactual. That is, we need to know what would have happened in Georgia absent the reforms. To that end, we employ the Synthetic Control Method (SCM) that allows us to compare Georgia's socio-economic performance after the Rose Revolution against a weighted average of comparable countries with similar characteristics. We will describe the method in detail in a later section.

To summarize our findings we find large positive and significant effects of reform on incomes and large negative and significant effects on infant mortality relative to our statistical counterfactual. Inequality increases and employment declines and then recovers but the effects are not statistically significant when compared to the time path of our synthetic control. We conclude that the Rose Revolution on balance was quite positive for the country of Georgia.

In what follows below, we provide a brief overview of Georgia's experience with liberalization, explain how the SCM method works, and then present our results on the effect of the Rose Revolution on per-capita income, infant mortality, income inequality, and employment.

II. Liberalization in Georgia

The market-liberal reforms unleashed in Georgia have earned the country a reputation as one of the fastest-reforming nations in the former Soviet bloc, if not the entire world. Simeon Djankov, founder of the World Bank's Doing Business project and former minister of finance of Bulgaria, said Georgia's reforms were "unprecedented," (USAID, 2009: 43) with the closest analogues being Singapore in the 1960s, South Korea in the 1970s, Ireland in the 1980s, and Estonia in the 1990s. USAID (2009: 3) claims Georgia has made "the broadest, deepest, fastest business climate reforms of any country in the last fifty years."

Evidence of the rapid pace of reform can be found in various measures of the policy and institutional environment. Figure 1 shows the 2004-2014 ratings for Georgia for the Economic Freedom of the World Index (Gwartney, Lawson, and Hall, 2016), the Doing Business for Enforcing Contracts (World Bank, 2017), and the Corruption Perception Index (Transparency International, 2016). Each data series begins with a starting value of zero, and the data are expressed in standardized units. The Economic Freedom of the World rating increased by 0.90 standard units. The rating for enforcing contracts improved by 0.74. Finally, the Corruption Perception Index improved by an impressive 1.46 standard units. All three indicators agree that Georgia has experienced significant improvement in its policy environment.

Burakova and Lawson (2013) list and describe 28 distinct reform initiatives undertaken between 2004 and 2007 during the heyday of the reform process under

Saakashvili's and Bendukidze's leadership. Major tax reforms included both reducing the levels and number of taxes. The income tax was initially set at a flat 12% but was later combined with the payroll tax at a 20% flat rate. Aggregate government spending is capped at 30% of GDP; annual deficits are capped at 3% of GDP; the national debt is limited to 60% of GDP; and any new taxes have to be approved by referendum. Privatization of vast numbers of state-owned assets was achieved mainly through open and transparent highest-bidder auctions with very little apparent favoritism. The new labor code was only a few pages long and offered few guarantees to workers; unions, though perfectly legal, were given no special legal status – this of course was a major departure from the old Soviet system. Interestingly, Georgia abolished anti-monopoly laws while simultaneously opening to external trade as most goods can be imported tariff free. So-called "de-bureaucratization" efforts resulted in 95% reductions in executive branch staffing and the elimination of 6 entire ministries and 18 agencies. To combat corruption at the local level, Saakashvili's government shocked the nation by firing the nation's entire police force of over 30,000 officers.

There is virtually no scholarly literature on the economic effects of the Rose Revolution or the market liberal reforms that ensued. Papava (2005, 2013, and 2014) does offer highly critical accounts of the post-Rose Revolution period, paradoxically calling it "a symbiosis of neoliberalism and neobolshevism" (Papava, 2013: 51), but there is essentially no data analysis in these papers. Most of the rest

of the scholarly literature deals with the political and international relations situation (see for example, Mitchell, 2008) and is similarly anecdotal. [2]

The sheer scale and scope of these reforms and the speed with which they were implemented was quite astounding. The question is did they matter? That is, were these rapid, multidimensional reforms, "shock treatment" if you will, a good thing for the country?

III. Creating the Synthetic Control

We want to estimate the impact of the market-liberal reforms unleashed by the Rose Revolution in Georgia on various socio-economic outcomes. Ideally we would like to observe what happened to Georgia in the absence of the reforms. Of course, this is impossible as there is only one Georgia and it experienced the reforms, and there is no Georgia that did not experience the reforms. Instead, we use pre-revolution data to create a "synthetic Georgia", a weighted average of control countries similar to Georgia. This synthetic control is designed to track pre-revolution Georgian outcomes and also to match actual Georgia on the values of several indicator variables as well. To the extent the synthetic Georgia accurately represents the actual Georgia, it can serve as the counterfactual we need.

Abadie and Gardeazabal (2003) developed the synthetic control method in order to identify the effect of terrorism in the Basque Country in Spain. Abadie et al. (2010) explain the technique in detail and analyze the effect of a change in

[2] Tangiashvili and Slade (2014) do offer an interesting and quite critical data-driven analysis of Georgia's zero-tolerance policies related to school violence in Saakashvili's two terms in office.

California's tobacco regulations. Abadie et al. (2015) further refine the method and apply it to the economic effects of German reunification. Gautier et al. (2009) and Montalvo (2011) provide additional applications to the analysis of terrorism. Synthetic control methods have been used to study affirmative action (Hinrichs, 2012), compulsory voting (Fowler, 2013), economic liberalization (Billmeier and Nannicini, 2013), natural disasters Cavallo et al. (2013), and the impact of Hugo Chavez in Venezuela (Grier and Maynard, 2016).

The most important aspects of the method are the selection of the countries, the indictor variables, and what weights to assign to the countries comprising the synthetic Georgia. Our goal is to create a synthetic version of Georgia from among a list of potentially similar countries that mimics the conditions in Georgia leading up to the Rose Revolution. Thus, in order to create the synthetic control, we need to find a set of countries and country-weights that minimizes the pre-Rose Revolution differences in socio-economic conditions between actual Georgia and the synthetic control Georgia.

In addition to similar socio-economic conditions leading up to 2004, we also want our synthetic control countries to be economically and structurally similar to Georgia. To that end, we also use various indicator variables to minimize the difference between the weighted average of these variables for the synthetic control and Georgia. In the final analysis, countries with more similar indicators and more similar socio-economic outcomes will receive higher weights in creating the synthetic control. See the Appendix for the mathematical details of the process.

One issue economists often have with case studies is the lack of significance tests for the results. Abadie et. al. address this issue by means of permutation testing. Specifically, we want to see whether the deterioration in the ability of the control to match Georgia post 2004 is large relative to random deviations using the procedure where there was no intervention. That is, we conduct a synthetic control analysis as described above for all the countries in our control group. These tests are generally referred to as placebo tests. Since the other countries did not undergo the Rose Revolution in 2004, we would not expect to see significant changes in the predictability of their outcomes.

We use these placebo tests to create a unique p-value for each post-treatment period, allowing us to see how the significance of the estimated effect changes over time. To calculate the p-values for time i, we collect each placebo's estimated treatment effect for the ith period and divide them by their respective pre-treatment RMSPE. This division minimizes the potential problem of poor pre-treatment fit driving an estimated effect in a post-treatment period. Since we conduct a two-sided test, it is also necessary to calculate the absolute value of each effect. Once the statistics are collected, we generate period i's p-value estimate by counting the number of placebos with greater effects than that of Georgia and divide by the number of total countries (donors and Georgia). The process is repeated for all post-treatment periods.[3] We use the "Synth_Runner" software (Galiano & Quistorff, 2016) to implement this significance testing in Stata.

[3] We also report result from a second method that yields a single p-value for the entire post intervention period. The process for calculation is nearly identical to the by-period method. However, rather than taking each period's estimated effect, this technique uses the overall

IV. The Experiments

We conduct four quasi-experiments in this paper. Each compares the post-Rose Revolution experience from 2004 onward of the actual Georgia with its synthetic Georgia counterpart. The outcome variables to be considered are per-capita GDP, infant mortality, income inequality, and the employment/population ratio. In each separate case, a synthetic Georgia will be constructed that mirrors the actual Georgia's pre-Rose Revolution record from 1995-2003 for that outcome variable.[4] Table 1 provides descriptive statistics for both the indicator variables and the outcome variables used. The first column of Table 2 lists all the potential donor countries included in the study. This list includes former Soviet republics and Communist-bloc nations, Russia itself, as well as a few countries from the region such as Turkey, Israel, and Egypt. All of these countries share either Communist backgrounds or similar regional influences.[5] The last four columns of Table 2 list the

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post-treatment RMSPE for each donor, which is divided by pre-treatment RMSPE. We use the absolute values for a two-sided test like the former technique, and use an identical rank system to calculate a p-value. This produces what Cavallo et al (2013) call "pseudo t-statistics"

[4] Data for Georgia begin in 1991, but a severe hyper-inflation in '92-'93 make it impossible for us to find a synthetic that looks at all like Georgia in terms of macroeconomic and social indicators for those years. Thus we begin the analysis in 1995.

[5] We do not claim that none of these countries experienced any type of economic reform. We are claiming that the extent and rapidity of Georgia's reform experience is unique in this group over the 2004-2014 period. Of all the countries in our list, Georgia's experience on the three reform indicators listed in the text is the largest. The next closest countries are Poland and Serbia. Interestingly, neither of these two countries makes it into any of the estimated synthetic controls in the paper. To the extent that countries in the synthetics have experienced similar reforms to Georgia, our results on the impact of Georgia's reforms will be understated.

country weights generated by the synthetic control method to create a synthetic Georgia for each of the four experiments we consider.

A: Per-Capita GDP Results

The first experiment looks at per-capita GDP. Six indicator variables, found in Table 3, were used to minimize the differences between per-capita GDP in Georgia and synthetic Georgia, which is comprised of 26% Armenia, 21% Bosnia and Herzegovina, and 54% Moldova. When comparing Georgia's per-capita GDP with that of its synthetic control counterpart during the pre-Rose Revolution era, we find a RMSPE of 48.015. This calculation highlights the value of creating a synthetic control using a weighted average of similar nations instead of just a single comparison nation. The closest single country to Georgia's pre-Rose Revolution per-capita GDP performance was Armenia, but the RMSPE between Armenia's and Georgia's per-capita GDP was 321.402 during the pre-treatment period, nearly seven times larger than it was for the synthetic control.

As Figure 2 shows, the pre-Rose Revolution actual Georgia and synthetic Georgia performed very similarly, but after the Rose Revolution, per-capita GDP grew substantially faster in actual Georgia relative to its synthetic control. This suggests that the impact of the Rose Revolution and the market liberal reforms gave per-capita GDP a boost in Georgia over what would have happened otherwise. And not just a small boost: by the end of our study period actual income is over 33% higher than predicted by the control! And remember, the control was very accurate in predicting Georgian income before the revolution.

Figure 3 presents significance tests for each year and shows that the large estimated differences between Georgia's actual post-Rose Revolution experience and its synthetic control were frequently statistically significant, especially by the end of the period.[6]

B: Infant Mortality Results

The second experiment looks at infant mortality. Six indicator variables, found in Table 4, were used to minimize the differences between infant mortality in Georgia and the synthetic control Georgia. For infant mortality, the synthetic Georgia was made up of 30% Albania, 23% Armenia, 33% Moldova, 9% Slovenia, and 4% Ukraine. The pre-Rose Revolution RMSPE of predicting Georgia by its synthetic control was only about $1/25^{th}$ as great as the RMSPE for predicting Georgia by its best single comparison country, Turkey. The synthetic control version of Georgia closely tracks Georgia's infant mortality prior to the Rose Revolution.

As Figure 4 illustrates, the pre-Rose Revolution actual Georgia and synthetic Georgia performed very similarly, but after the Rose Revolution infant mortality fell substantially faster in actual Georgia compared with its synthetic control. Infant mortality improved after the Rose Revolution faster than it would have without the intervention. Again, the effect is substantial. At the end of the period, infant mortality is almost 25% lower in Georgia compared to its synthetic control.

[6] It is true that the significance levels do not often hit 0.05, but the size of the effects coupled with their marginal significance means we should take them seriously. For a good discussion of economic vs. statistical significance, see Goldberger (1991) or McCloskey & Ziliak (1996). The overall p-value as calculated by our second method is 0.14 for the entire period.

Figure 5 presents our significance tests by year for the effect of the Rose Revolution on infant mortality. All are statistically significant at conventional levels. Similarly, the aggregate p-value is 0.069, further demonstrating the statistical significance of the results. This lends support to the idea that the reduction in infant mortality in Georgia was in fact attributable to the Rose Revolution and its policy reforms. The bottom line is that we see a large and significant improvement in infant mortality beginning in 2004 in Georgia, i.e., after the Rose Revolution relative to the prediction of the "business as usual" synthetic control.

C: Income Inequality Results

Liberalizations are often accused of sacrificing equity for growth. This third experiment is designed to assess this argument by examining income inequality as measured by the GINI coefficient provided by Solt (2016).[7] Three indicator variables, found in Table 5, were used to minimize the differences between the GINI in Georgia and the synthetic control Georgia. For the GINI coefficient experiment, synthetic Georgia was comprised of 27% Macedonia, 32% Turkey, and 41% Turkmenistan. Again, the method does an excellent job of finding a synthetic version of Georgia that matches Georgia's income inequality before 2004. The RMSPE between Georgia and its synthetic control was just 0.228, which is less than one-tenth as much as the RMSPE with Turkmenistan, Georgia's closest single comparison with respect to income inequality.

[7] We use Stata's "ipolate" command to fill in missing data. The command uses the following formula to estimate missing y values: $y = \frac{y_1 - y_0}{x_1 - x_0}(x - x_0) + y_0$, such that $x_0 < x$ and $x_1 > x$, where y_0 and y_1 are observed.

Figure 6 shows that the pre-Rose Revolution actual Georgia and synthetic Georgia performed very similarly, but after the Rose Revolution the GINI increased in actual Georgia compared with its synthetic control. It appears income inequality worsened after the Rose Revolution faster than it would have without the intervention. We should note though that the estimated effect is very small. At its peak in 2008, the difference between the two series was only around 5%.

Figure 7 presents our significance tests, and shows that the effect is not significant in any of the years from 2004 on. The aggregate p-value is also completely insignificant, at 0.414. Georgia's post-Rose Revolution GINI was indeed slightly higher than expected when compared with its synthetic control, but the variation was not much different that what we see in the control countries. Georgia's Rose Revolution did not materially affect the evolution of Georgian income inequality.

D: Employment Results

The final experiment examines employment, specifically the employment/population ratio. We study employment because we know the Rose Revolution had a direct and dramatic impact on government employment. In a country of fewer than 5 million people, 95% force reductions in various government ministries and firing tens of thousands of police officers seems likely to impact aggregate employment numbers. In this case our statistical procedure chooses a synthetic control comprised of Albania (33%), Azerbaijan (5%), Israel (8%), Kazakhstan (34%), and Romania (20%). Table 6 shows the indicators variables used and that this synthetic control again outperforms the closest single country

(Tajikistan) in mimicking Georgia's employment/population ratio leading up to 2004. After 2004, we find a large initial drop in Georgian employment relative to its synthetic control and then a sharp rebound around 2009 as shown in figure 8. Figure 9 contains the year by year significance tests and shows the effect of the Rose Revolution on employment was not statistically significant.[8]

Again, given the size of these effects, there is little question that liberal reforms can cause short run labor market disruptions as employees in the government itself and in newly privatized state-owned enterprises lose their jobs. We absolutely find this in the case of Georgia's Rose Revolution. The good news is that the new liberal labor code along with the acceleration in economic growth appears to have allowed these workers the opportunity to find new employment within a reasonable time frame so that the negative effects were temporary.

V. Conclusion

By all accounts, Georgia experienced one of the world's fastest and deepest economics liberalizations during the years immediately following its Rose Revolution in late 2003. However, it is misleading to measure the effect of the reforms simply by looking at changes in Georgia's socio-economic performance. The relevant comparison is to what would have happened in Georgia if the reforms had not occurred.

[8] Appendix Tables 2and 3 report the employment experiment again, but with the addition of per-capita GDP as a predictor variable. This inclusion worsens the covariate balance, but creates a closer pre-treatment fit. The Georgian employment declines are greater, and statistically significant in some years in this specification. Qualitatively, though, the picture is similar with employment rebounding by the end of the period.

This study uses the SCM to estimate how Georgia performed compared to a synthetic control version of Georgia, a weighted average of similar countries, that did not experience the same reform process. The results suggest that the per-capita GDP and infant mortality improvements that Georgia experienced after the Rose Revolution were much greater than would have been expected in the absence of the reforms. In contrast, there is no evidence supporting the notion that the Rose Revolution's market-liberal reforms caused any significant increase in income inequality. Finally, the liberalizations do appear to have caused large employment losses in the years immediately following the Rose Revolution, though the dislocated workers were mostly able to find new employment by the end of the period perhaps thanks to the newly liberalized labor market.

In sum, the Rose Revolution generated large and significant increases in per-capita incomes (33%) along with large and significant declines in infant mortality (-25%) relative to the synthetic control, without worsening inequality. The employment ratio initially fell, but recovered by the end of our period of study.

These finding should provide reform advocates with some hope. The Rose revolution greatly improved economic and health outcomes in Georgia with fairly short-lasting negative employment side effects and no significant exacerbation of inequality. Shock treatment can work.

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TABLE 1: SUMMARY STATISTICS

Variable	Mean	Standard Deviation	Observations	Description
GDP per Capita	12,812.23	(7,874.97)	630	GDP per capita, PPP (constant 2011 international $)
Infant Mortality	19.33	(17.07)	630	Mortality rate, infant (per 1,000 live births)
GINI	33.31	(5.83)	630	GINI inequality index (SWIID)
FDI	4.97	(5.84)	625	Foreign direct investment, net inflows (% of GDP)
Employment Ratio	51.40	(7.22)	630	Employment to population ratio, 15+ total (%)
Urban	57.43	(13.82)	630	Urban population (% of total)
Investment	24.61	(6.76)	622	Gross capital formation (% of GDP)
Life Expectancy	71.61	(3.97)	596	Life expectancy at birth, total (years)
Military	2.26	(1.52)	586	Military expenditure (% of GDP)
Inflation	22.58	(80.13)	623	Inflation, GDP deflator (annual %)

Note. This table contains summary statistics for all variables in all analyses. The statistics are calculated using all countries, donors and Georgia, for all periods of the analyses, 1995-2015. There are 630 observations in the panel data. For the descriptions, we draw directly from the metadata of the respective sources. *Source.* World Bank's World Development Indicators, Standardized World Income Inequality (SWIID) and authors' calculations.

TABLE 2: ESTIMATED SYNTHETIC CONTROL WEIGHTS BY OUTCOME VARIABLE

	Outcome Variable			
	Income	Infant Mortality	Inequality	Employment
Albania	0.00	0.30	0.00	0.33
Armenia	0.26	0.23	0.00	0.00
Azerbaijan	0.00	0.00	0.00	0.05
Belarus	0.00	0.00	0.00	0.00
Bosnia and Herzegovina	0.21	0.00	0.00	0.00
Bulgaria	0.00	0.00	0.00	0.00
Croatia	0.00	0.00	0.00	0.00
Czech Republic	0.00	0.00	0.00	0.00
Egypt	0.00	0.00	0.00	0.00
Estonia	0.00	0.00	0.00	0.00
Hungary	0.00	0.00	0.00	0.00
Israel	0.00	0.00	0.00	0.08
Kazakhstan	0.00	0.00	0.00	0.34
Kyrgyz Republic	0.00	0.00	0.00	0.00
Latvia	0.00	0.00	0.00	0.00
Lithuania	0.00	0.00	0.00	0.00
Macedonia	0.00	0.00	0.27	0.00
Moldova	0.54	0.33	0.00	0.00
Poland	0.00	0.00	0.00	0.00
Romania	0.00	0.00	0.00	0.20
Russian Federation	0.00	0.00	0.00	0.00
Serbia	0.00	0.00	0.00	0.00
Slovakia	0.00	0.00	0.00	0.00
Slovenia	0.00	0.00	0.00	0.00
Tajikistan	0.00	0.09	0.00	0.00
Turkey	0.00	0.00	0.32	0.00
Turkmenistan	0.00	0.00	0.41	0.00
Ukraine	0.00	0.00	0.00	0.00
Uzbekistan	0.00	0.04	0.00	0.00

Note. Columns show the estimated weight for the synthetic Georgia. Each column represents an outcome variable, labelled at the top of the column. Values are in percentage points. Donors that receive a positive weight are in bold for the reader to more easily identify. Values are rounded, so the columns may not sum to one.

TABLE 3: AVERAGE INCOME PREDICTOR MEANS

Variables	Actual Georgia	Synthetic Georgia	Armenia
Avg. GDP per Capita	3,181	3,180	2,920
FDI	5.43	4.06	4.67
Urban	52.94	49.38	65.01
Investment	23.54	23.35	19.92
Life Expectancy	71.33	69.17	70.73
Military	1.12	1.82	3.40
Inflation	27.60	17.75	24.32
RMSPE	--	48.015	321.402

Note. This table shows the values of indicator variables for different comparison groups. In doing so, it illustrates the strenghts of the synthetic control, which better fits the behavior of actual Georgia in the pre-treatment period (1995-2004). We compare the synthetic to Armenia, which is the best single-country comparison (identified by selecting the single country that minimized pre-treatment RMSPE). Variables are averaged across the pre-treatment period. Please refer to table 1 for a description of the variables. The final row gives the root mean square prediction error for the unit of comparison.

TABLE 4: AVERAGE INFANT MORTALITY PREDICTOR MEANS

Variables	Actual Georgia	Synthetic Georgia	Turkey
Infant Mortality	32.43	32.39	34.44
GDP per Capita	3,181	3,186	12,542
Urban	52.94	46.89	64.28
Investment	23.54	23.61	20.83
Life Expectancy	71.33	69.46	69.36
Military	1.12	1.61	3.79
Inflation	27.60	29.52	66.62
RMSPE	--	0.100	2.445

Note. This table shows the values of indicator variables for different comparison groups. In doing so, it illustrates the strenghts of the synthetic control, which better fits the behavior of actual Georgia in the pre-treatment period (1995-2004). We compare the synthetic to Turkey which is the best single-country comparison (identified by selecting the country that minimized pre-treatment RMSPE).. Variables are averaged across the pre-treatment period. Please refer to table 1 for a description of the variables. The final row gives the root mean square prediction error for the unit of comparison.

TABLE 5: AVERAGE GINI PREDICTOR MEANS

Variables	Actual Georgia	Synthetic Georgia	Turkmenistan
GINI	39.57	39.60	41.27
FDI	5.43	3.20	5.01
Urban	52.94	55.16	45.69
Investment	23.54	27.19	36.59
RMSPE	--	0.228	2.541

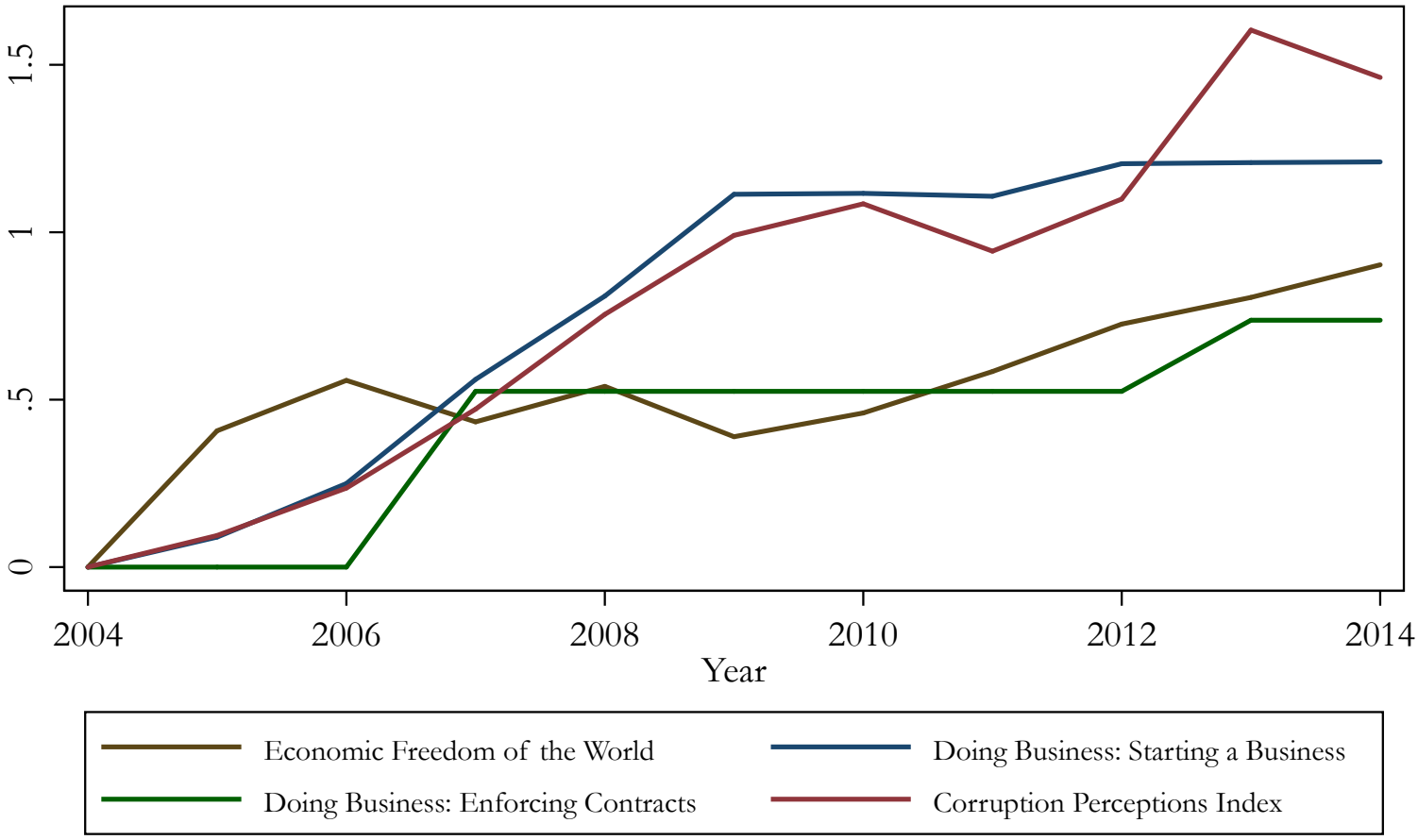
Note. This table shows the values of indicator variables for different comparison groups. In doing so, it illustrates the strenghts of the synthetic control, which better fits the behavior of actual Georgia in the pre-treatment period (1995-2004). We compare the synthetic to Turkmenistan which is the best single-country comparison (identified by selecting the single country that minimized pre-treatment RMSPE). Variables are averaged across the pre-treatment period. Please refer to table 1 for a description of the variables. The final row shows the root mean square prediction error for the unit of comparison.

TABLE 6: AVERAGE EMPLOYMENT RATIO PREDICTOR MEANS

Variables	Actual Georgia	Synthetic Georgia	Tajikistan
Employment Ratio	57.52	57.52	58.77
Age Dependency Ratio	53.12	55.67	87.35
FDI	5.43	5.43	1.78
Urban	52.94	52.94	27.20
Inflation	27.60	27.62	117.20
Trade	61.99	68.37	148.92
RMSPE	--	0.62	1.53

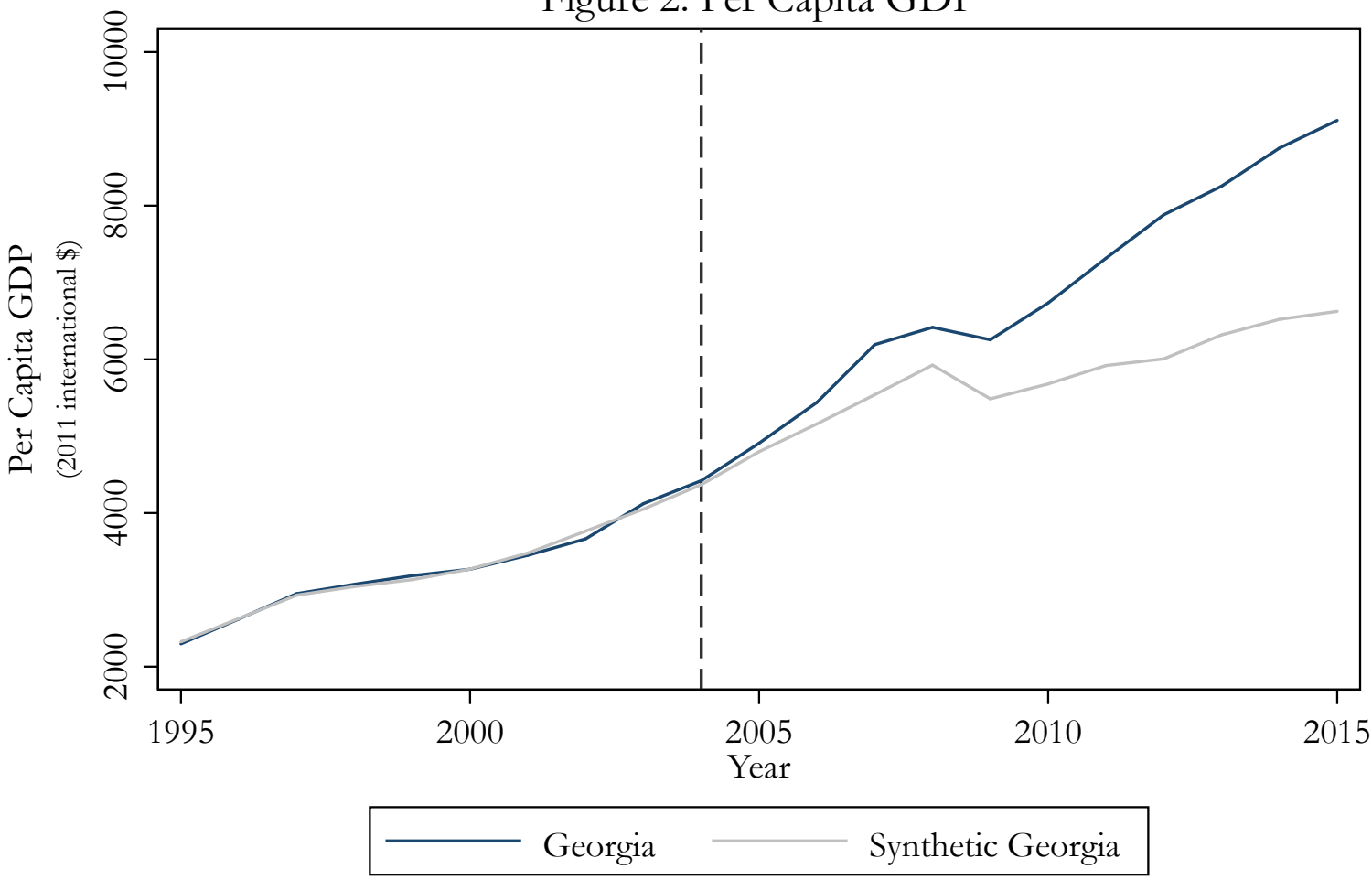
Note. This table shows the values of indicator variables for different comparison groups. In doing so, it illustrates the strenghts of the synthetic control, which better fits the behavior of actual Georgia in the pre-treatment period (1995-2004). We compare the synthetic to Tajikistan which is the best single-country comparison (identified by selecting the single country that minimized pre-treatment RMSPE). Variables are averaged across the pre-treatment period. Please refer to table 1 for a description of the variables. The final row shows the root mean square prediction error for the unit of comparison.

Figure 1: Measures of Institutional Quality in Georgia



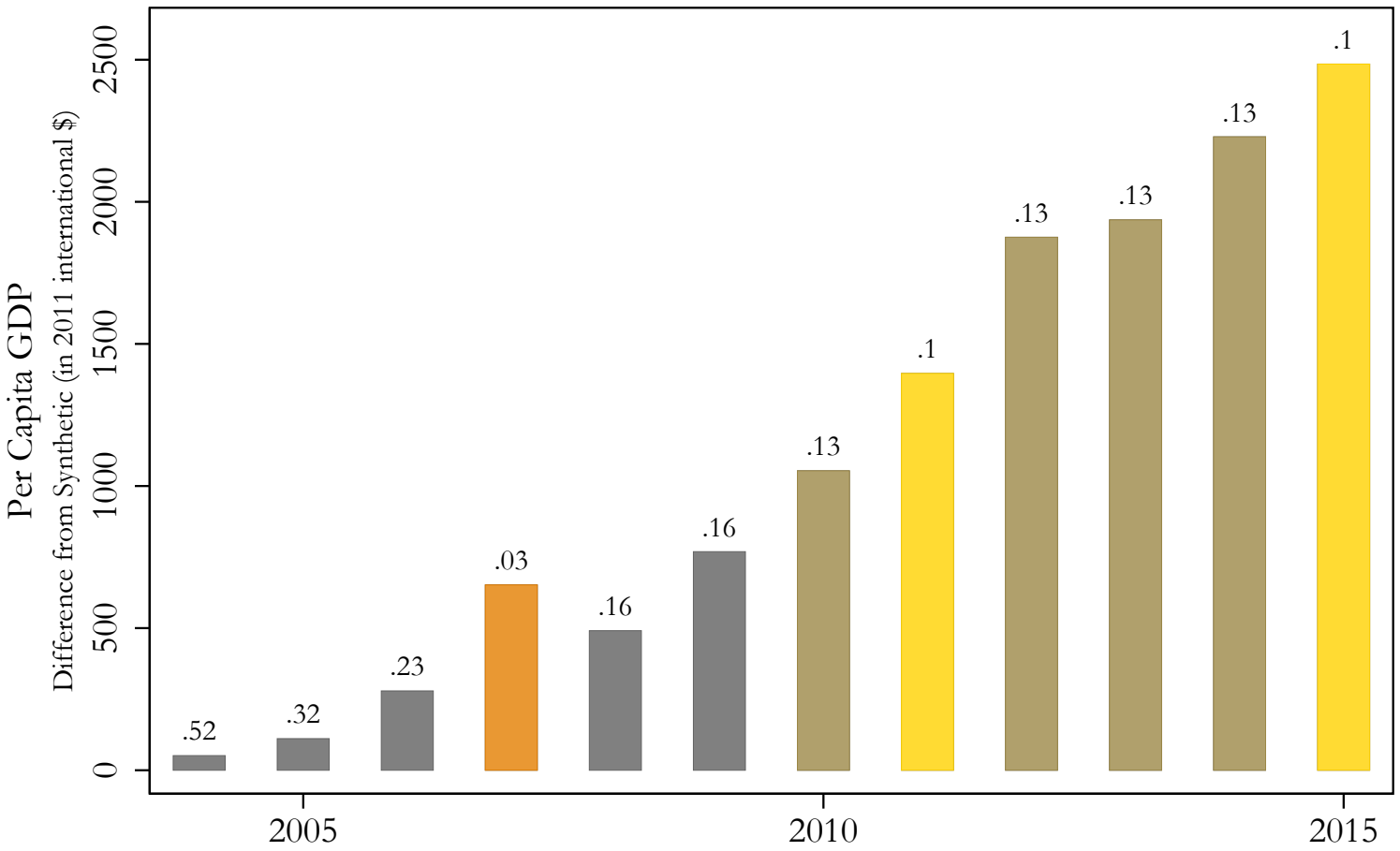
Note. Following the Rose Revolution, Georgia's reform led to improvements in various institutional quality measures. This figure demonstrates the increases experienced by four different indeces, listed in the figure's key. Each data series begins with a starting value of zero, and the units are expressed in standardized terms. A one unit increase along the y-axis represents a one standard deviation in the respective index.
Source. Gwartney, Lawson, and Hall, 2016. World Bank Group, 2017. Transparency International, 2016. Authors' calculations.

Figure 2: Per Capita GDP



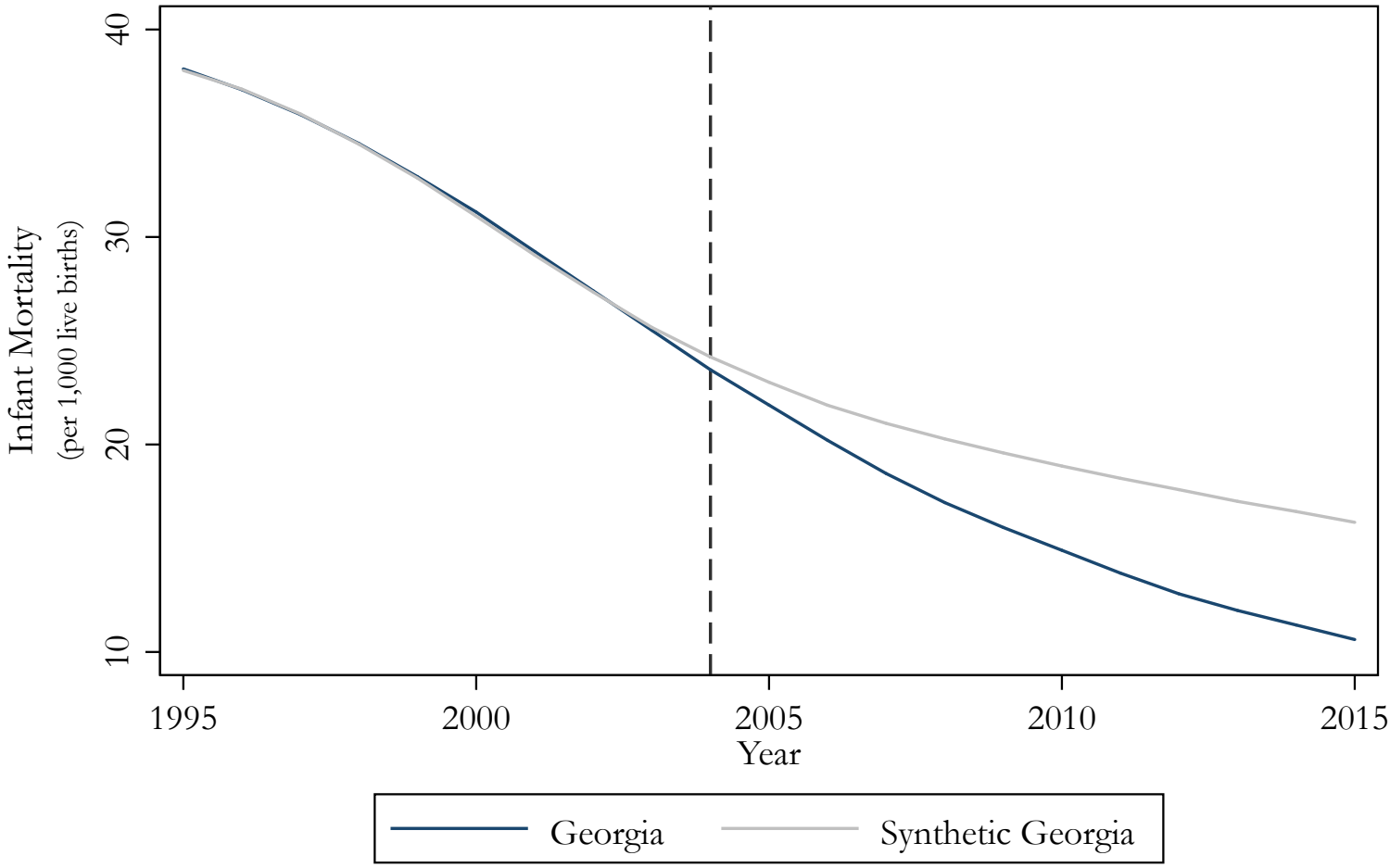
Note. This figure demonstrates the behavior of per capita GDP for Georgia and synthetic Georgia, pre- and post-treatment. The dashed vertical line indicates the treatment period.

Figure 3: The Effect of Rose Revolution on per Capita GDP



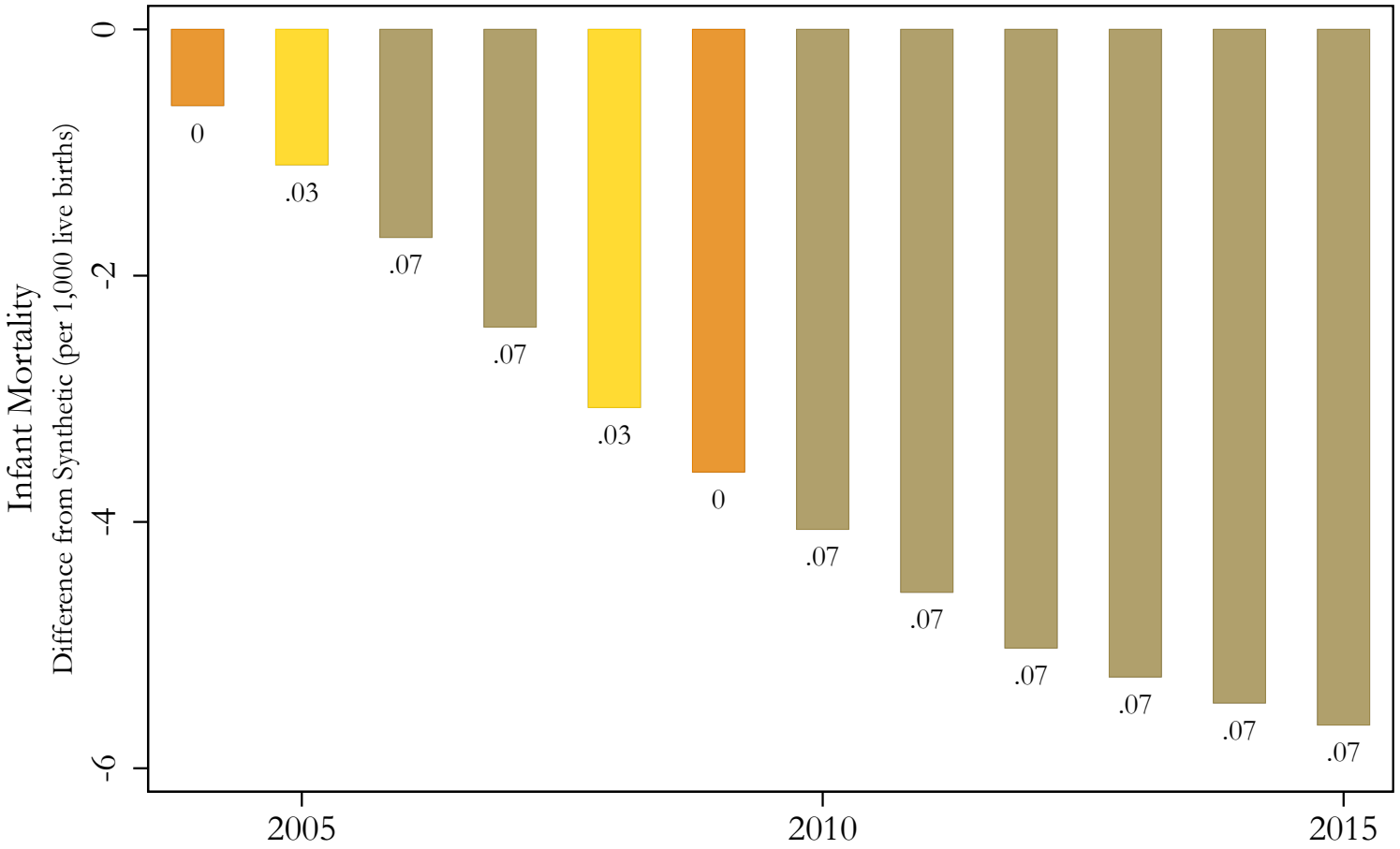
Note. This figure shows the estimated treatment effect upon per capita GDP for each period following the Rose Revolution. Effects in orange are significant at the .04 level, effects in gold at the .10 level, in brown at the .13 level. Effects in grey are insignificant. Each period's p-value is indicated at the top of each bar. The p-value for the entire experiment is 0.148. The method of p-value calculation for each method is described on page 9.

Figure 4: Infant Mortality



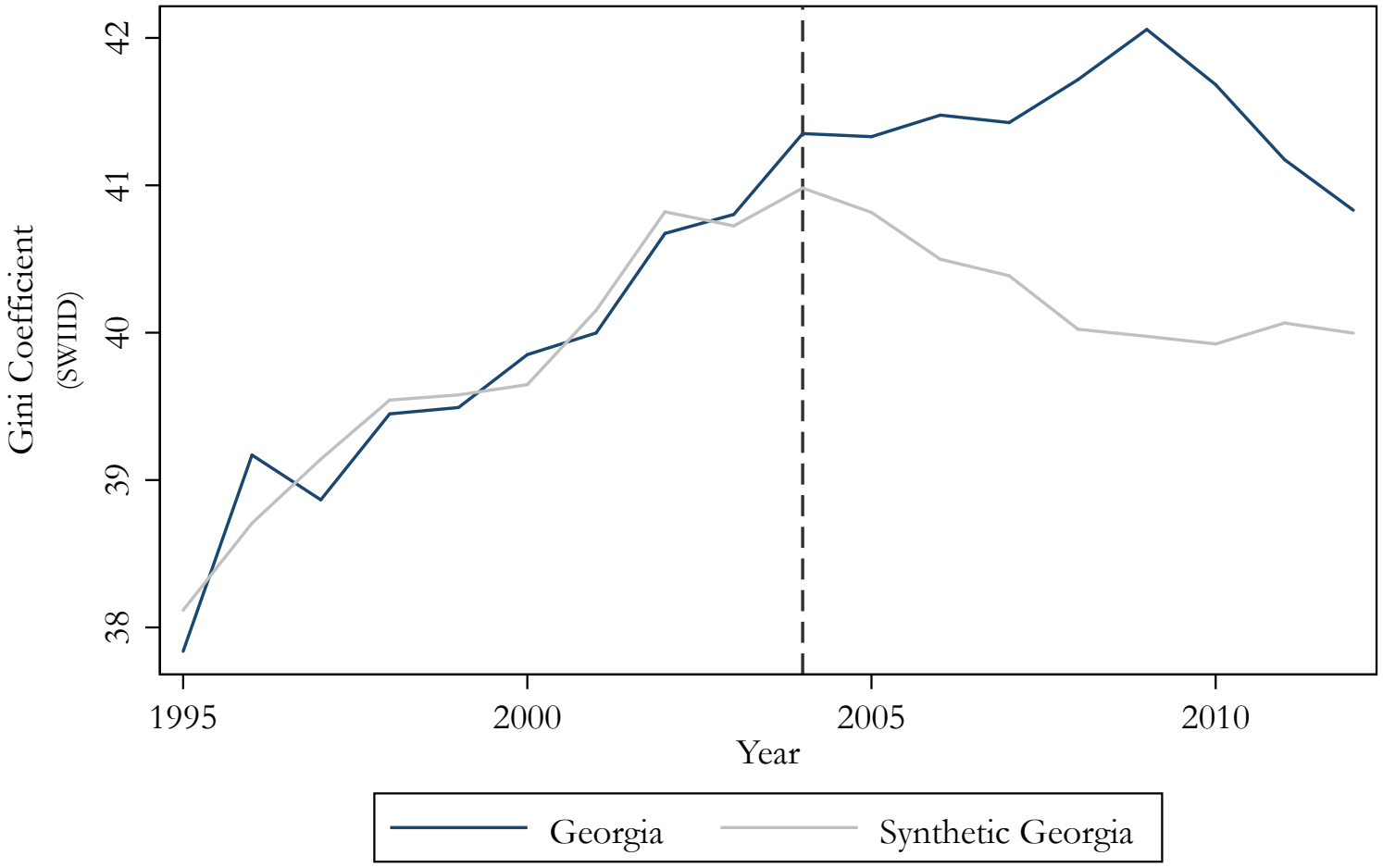
Note. This figure demonstrates the behavior of infant mortality for Georgia and synthetic Georgia, pre- and post-treatment. The dashed vertical line indicates the treatment period.

Figure 5: The Effect of Rose Revolution on Infant Mortality



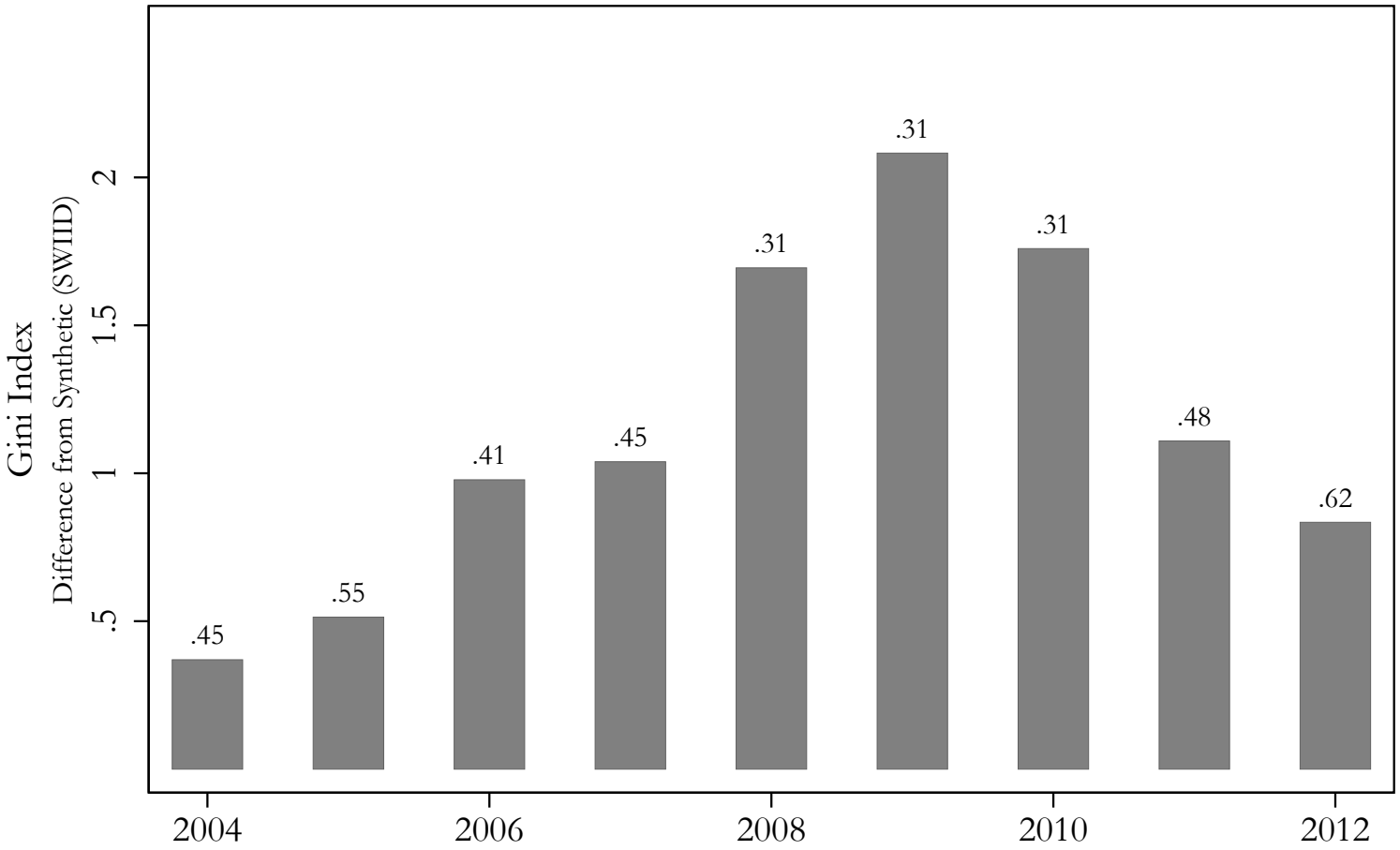
Note. This figure shows the estimated treatment effect upon infant mortality for each period following the Rose Revolution. Effects in orange are significant at the .00 level, effects in gold at the .03 level, and brown at the .07 level. Effects in grey are insignificant. Each period's p-value is indicate at the bottom of each bar. The p-value for the entire experiment is 0.069. The method of p-value calculation for each method is described on page 9

Figure 6: Gini



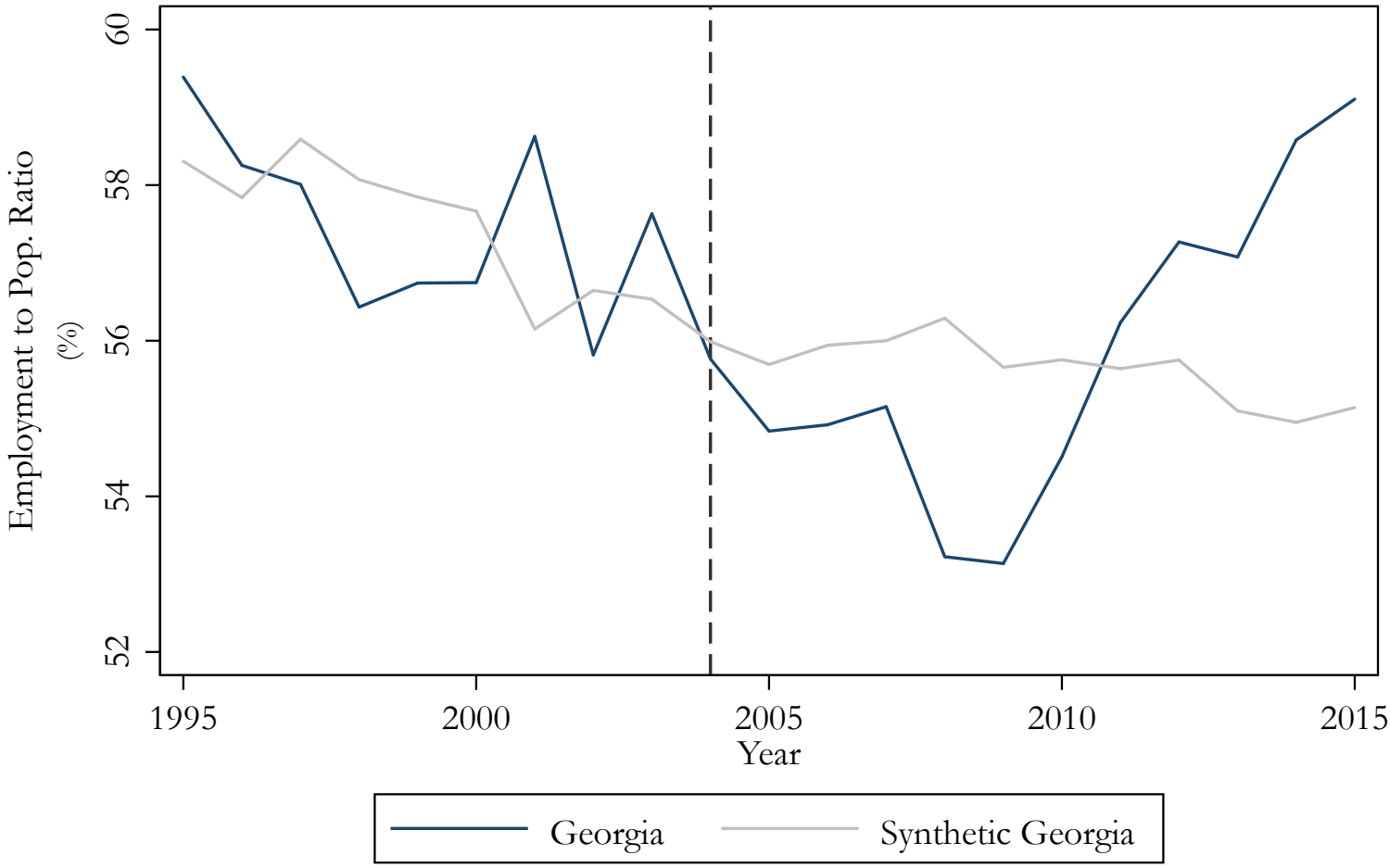
Note. This figure demonstrates the behavior of the Gini coefficient for Georgia and synthetic Georgia, pre- and post-treatment. The dashed vertical line indicates the treatment period.

Figure 7: The Effect of Rose Revolution on Inequality



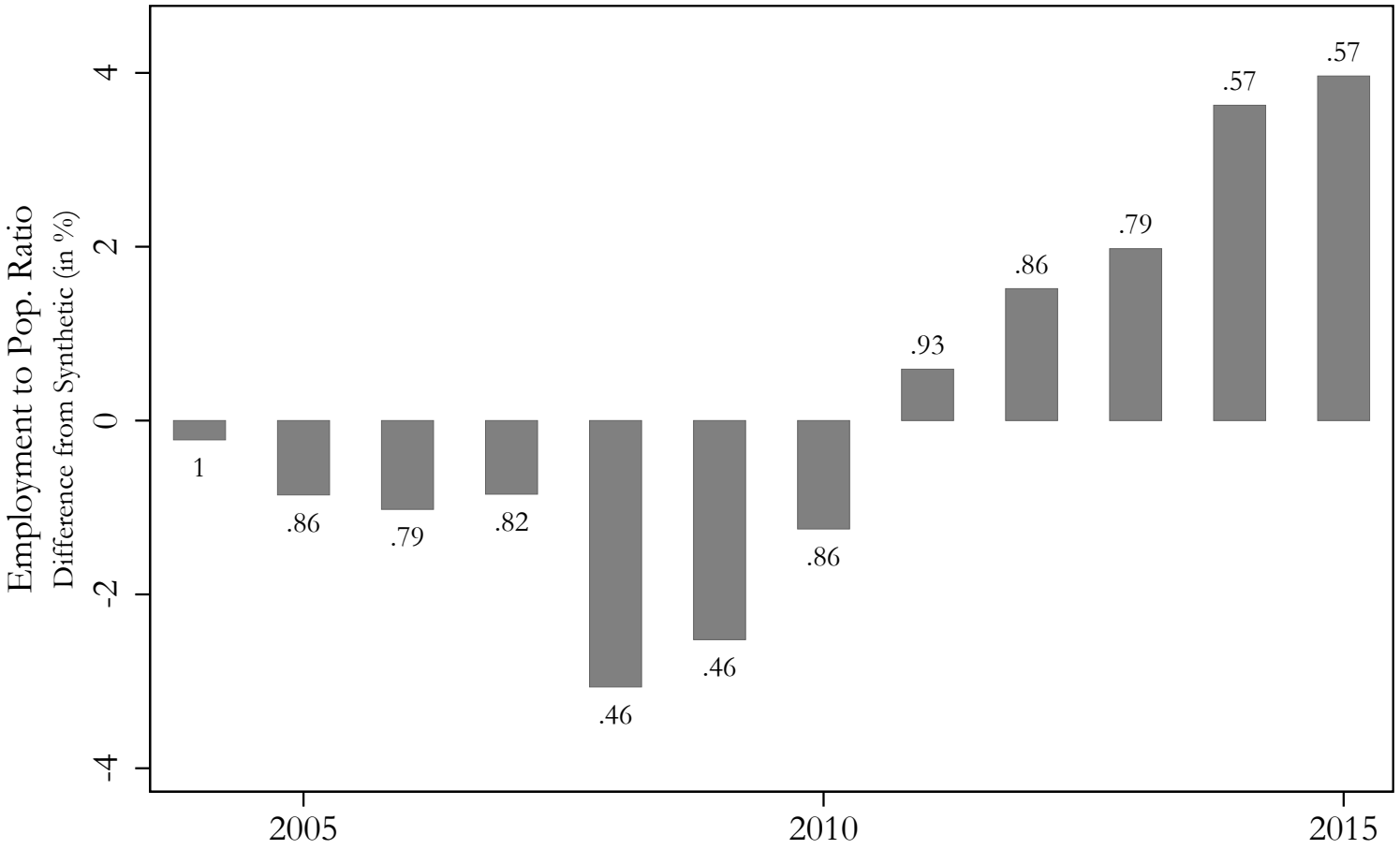
Note. This figure shows the estimated treatment effect upon inequality (Gini index) for each period following the Rose Revolution. Effects in grey ar are insignificant. Effects in grey are insignificant. Each period's p-value is indicated at the bottom of each bar. The p-value for the entire experiment is 0.414. The method of p-value calculation for each method is described on page 9.

Figure 8: Employment to Population Ratio



Note. This figure demonstrates the behavior of employment ratio for Georgia and synthetic Georgia, pre- and post-treatment. The dashed vertical line indicates the treatment period.

Figure 9: The Effect of Rose Revolution on Employment



Note. This figure shows the estimated treatment effect upon employment for each period following the Rose Revolution. Effects in grey are are insignificant. Effects in grey are insignificant. Each period's p-value is indicated at the bottom of each bar. The p-value for the entire experiment is 0.750. The method of p-value calculation for each method is described on page 9.

Appendix A: Synthetic Control Mathematics

Let j = 0, …, J be the number countries in our analysis, where Georgia is j=0 and J is the number of countries in the potential control country pool (J=29; see Table 1).

Let k = 1,…, K be the number of indicator variables (K varies by experiment).

Let n = 1, …, N be the number of years in the pre-Rose Revolution period (N=9 since the pre-Rose Revolution period is 1995-2003).

Let X_1 represent the Kx1 vector of the pre-Rose Revolution indicator variables for Georgia and Y_1 represent Georgia's Nx1 vector of pre-Rose Revolution outcomes.

Let X_0 be the KxJ matrix whose columns are vectors of the pre-Rose Revolution indicator variables for the potential control countries and Y_0 is the NxJ matrix whose columns are vectors of their pre-Rose Revolution outcomes.

Let W represent the Jx1 column of country weights, with the weight assigned to country j equal to the j^{th} individual element of W. The process of selecting W is as follows:

Step 1. Select weights, W, to minimize the distance function:

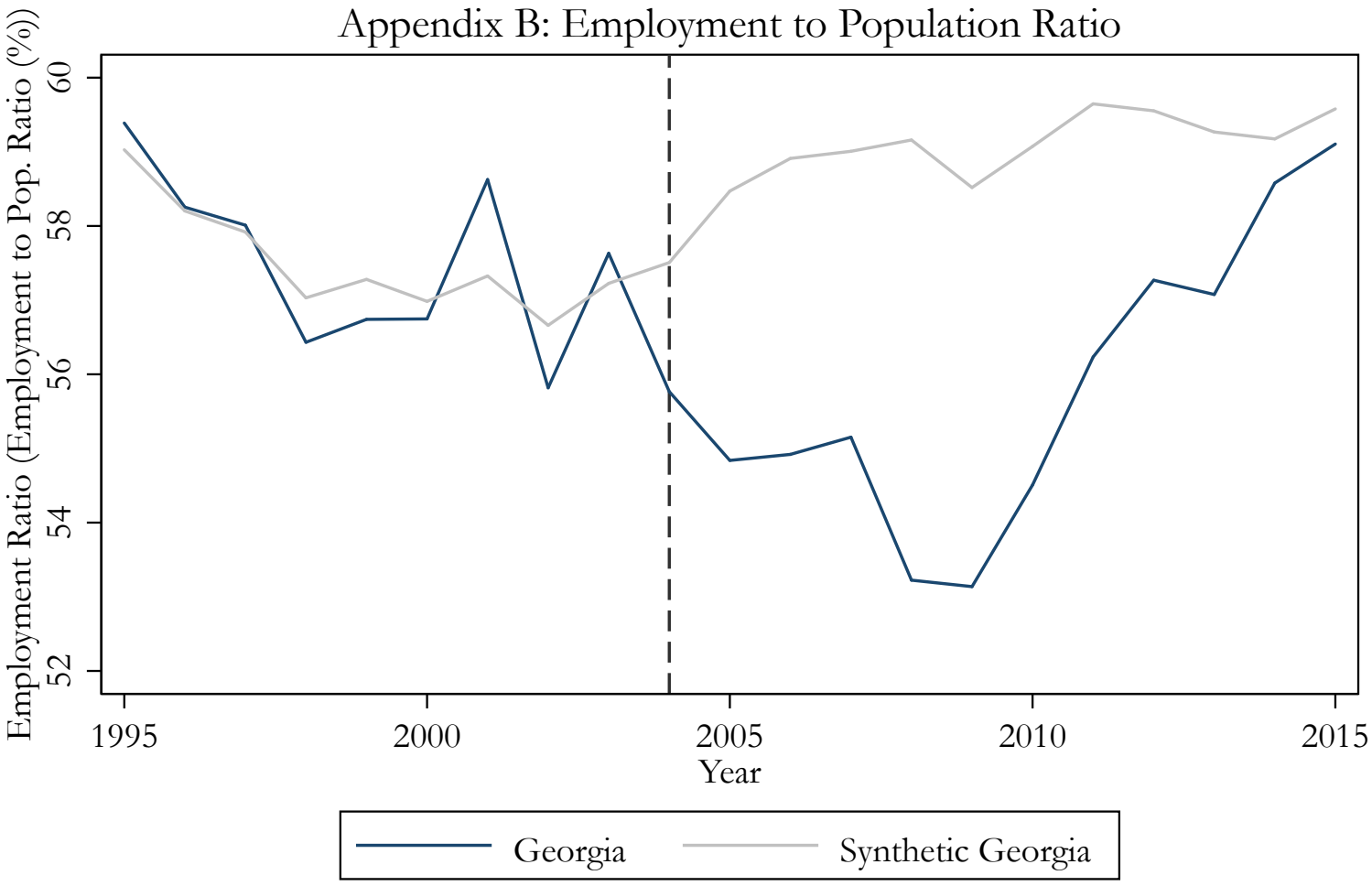
$$D = ((X_1 - X_0W)^T V(X_1 - X_0W))^{½},$$

where V is a KxK positive-definite diagonal matrix, initially set as an identity matrix. The distance-minimizing W vector is thus a function of the V matrix, W(V).

Step 2. Given the W matrix found in Step 1, calculate the mean squared prediction error in the outcome variable between Georgia and the potential controls countries over the pre-Rose Revolution period:

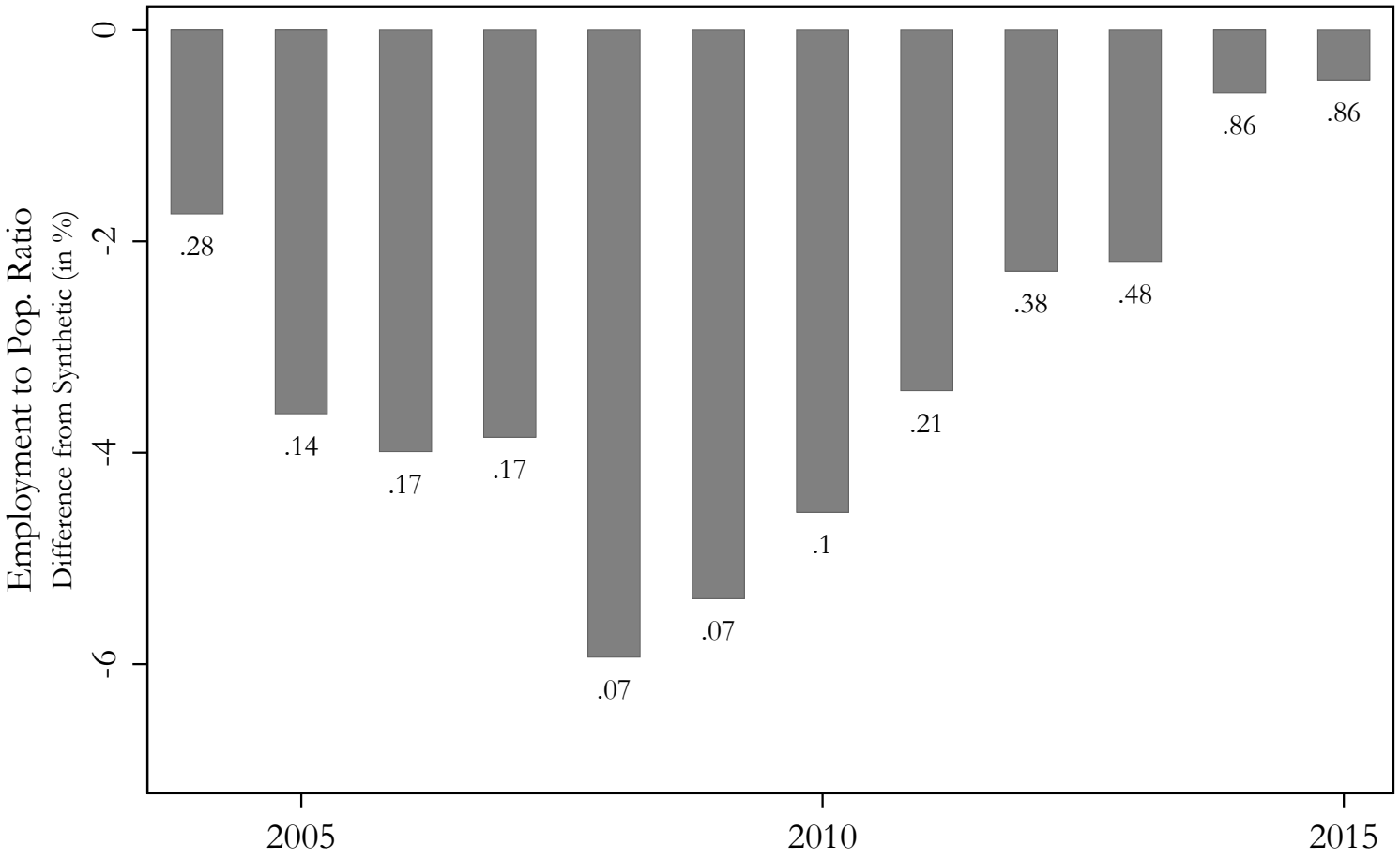
$$MSPE = (Y_1 - Y_0W(V))^T(Y_1 - Y_0W(V))$$

Step 3. Redo Steps 1 and 2 using all possible positive-definite diagonal matrices of V. Ultimately, $W^* = W^*(V^*)$ is the W vector that globally minimizes the MSPE of the outcome variables found in step 2 during the pre-Rose Revolution period.



Note. This appendix demonstrates the behavior of employment ratio for Georgia and synthetic Georgia, pre- and post-treatment. The dashed vertical line indicates the treatment period. This specification includes GDP per capita as a predictor variable. The inclusion worsens covariate balance, but creates a closer pre-treatment fit, which is why we include the results here.

Appendix C: The Effect of Rose Revolution on Employment



Note. This figure shows the estimated treatment effect upon employment for each period following the Rose Revolution. Effects in grey are are insignificant. Effects in grey are insignificant. Each period's p-value is indicated at the bottom of each bar. The p-value for the entire experiment is 0.750. The method of p-value calculation for each method is described on page 9.