Do Girls Play Nicer Than Boys?
The Effect of Gender of State Chief Executive on State Military Spending

Abstract

This paper combines a two-way fixed effects model with synthetic control to explore whether presence of a female chief executive decreases state military spending. The results are mixed. Overall, we cannot conclude that there exists a causal relationship between female chief executive and military spending.

1. Introduction

There exists a growing body of political science literature exploring the relationship between gender and conflict. In the past decade, scholars have found strong empirical relationships between greater inclusion of women in society and reduction of political violence (Caprioli, 2000). Large-N quantitative studies have demonstrated the link between female participation and state-perpetrated human rights abuses (Melander, 2005). Female participation has also been found to reduce the likelihood of a state engaging in or relapsing into violence (Caprioli and Boyer, 2001; Caprioli, 2005; Demeritt, Nichols and Kelly, 2014). Including women in peace processes has also been shown to increase the durability of peace (Shekhawat, 2015; Krause, Krause and Bränfors, 2018).

Other research in the field has explored gender differences in attitudes towards conflict and motivations for violence (Tessler and Warriner, 1997; Goldstein, 2004; McDermott, 2015); the effects of female representation in political institutions on political agenda setting and national spending (Koch and Fulton, 2011; Greene and O'Brien, 2016); as well as the factors that lead to women holding positions of political leadership (O'Brien and Rickne, 2016; Barnes and O'Brien, 2018).

A common rationale among much of this research is that women's preference for peace and aversion to political violence reduces conflict. In particular, Koch and Fulton (2011) find that increases in women's legislative representation decreases conflict behavior and defense spending. In line with Koch and Fulton's study (2011), this paper investigates the causal impact of the gender of a state's chief executive on a country's military spending, but instead uses Barnes and O'Brien's (2017) cross-national data from the post–Cold War era. I apply a two-way fixed effects method and combine it with synthetic control. I posit that female executives decrease state military spending.

2. Data

To analyse the relationship between the gender of a state's chief executive on a country's military spending, this paper uses a reduced version of Barnes and O'Brien's (2017) cross-national dataset of 164 countries between 1991-2011, the unit of analysis being the country-year. This dataset was chosen because of the large sample size as well as the recency of the observations. While Koch and Fulton (2011) also

The dataset begins in 1991 to reflect the shift in defence priorities and greater emphasis on peacebuilding in many states after the Cold War (Barnes and O'Brien, 2018). Far more women were also present in positions of political leadership after 1991, thus extending the dataset backwards in time would not have yielded many additional examples of female executives (ibid). Yet given the relatively high number of female executives that hold office today, this study would have benefitted from having collected additional data for the time period between 2011-present (for example Chancellor Angela Merkel, President Salome Zourabichvili and Prime Minister Jacinda Ardern, to name but a few). However, due to limited time constraints, this was not feasible.

The treatment indicator is the gender of a state's executive, a binary variable (`female_exe1`) coded as 1 if a female executive serves in the year and 0 otherwise. This variable was created by Barnes and O'Brien (2017) using data from Jalalzai (2013) (see appendix A for a table of the count of female chief executives worldwide per country, 2009-2011). The outcome variable measures logged military spending in US dollars (millions) (`mil_spend`), compiled using data from the Stockholm International Peace Research Institute and the COW National Material Capabilities Dataset (Barnes and O'Brien, 2017).

The dataset controls for a variety of factors that could affect military spending in a given country-year. Binary covariates include the following: whether a female defence minister was serving (1 if female); the country's involvement in peacekeeping (1 if involved); OECD membership (1 if member); the occurrence of a fatal dispute in the previous year (1 if occurred); whether the executive is from a "left party" (1 if left); whether the country is a democracy (1 if democracy); whether the country is involved in an interstate conflict (1 if involved); whether the country is within ten years of an internal or internationalized conflict (1 if within ten years); whether the country has a military dictator (1 if dictator); whether the political regime is parliamentary (1 if parliamentary); whether the political regime is mixed (1 if mixed); whether the country is an authoritarian regime (1 if authoritarian); and EU membership (1 if member). Continuous covariates include the proportion of women serving in parliament; women's involvement in the labour force; and the percentage of female ministers in the cabinet. See Barnes and O'Brien's (2017) codebook describing variables and data sources.

3. Methodology

This study aims to assess the casual impact of state female chief executive on state logged military spending. A basic approach to assessing this relationship would be a bivariate regression model. However, this will not provide a causal effect as there would be confounding factors. Similarly, we could use a multiple regression model to try and control for potential confounders. The results are shown in table 1.

Table 1: Bivariate and multivariate linear regressions

	Model 1	**Model 2**
(Intercept)	6369.53***	1001.93
	(644.93)	(3872.55)
female_exe1	-1787.85	-3291.90*
	(2513.21)	(1326.38)
FFL_lead1		622.45
		(2881.99)
deaths_any		519.68
		(1501.61)
dictator1		-2243.48
		(3627.40)

prop_female		-120.00**
		(43.22)
left_exe1		-1103.83
		(757.56)
involveTRUE		-4702.13***
		(731.52)
oecd		5655.25***
		(1311.25)
labor_full		66.27**
		(20.45)
recovery		3027.70
		(1952.91)
internal_recovery		-4509.08*
		(2029.12)
dems		-652.01
		(3646.13)
dics		-4633.75
		(3744.75)
parliamentary_c1		-7364.27***
		(1135.81)
mixed_c1		-844.54
		(1184.40)
eu		-1889.02
		(1391.45)
both.conflicts		-1393.54
		(1124.56)
pwomenmin_int		40.01
		(35.05)
gdpppp		0.00***
		(0.00)
R^2	0.00	0.77
Adj. R^2	-0.00	0.77
Num. obs.	3356	3085
***$p < 0.001$; **$p < 0.01$; *$p < 0.05$		

The coefficient of `female_exe1` in model 1 (bivariate regression) illustrates that having a female executive is associated with a decrease of 1787.85 log military spending, while in model 2 (multivariate regression) the coefficient is associated with a decrease of 3291.90 log military spending. Though the coefficient in model 2 is statistically significant at the 95% confidence interval, neither of the coefficients are substantial and neither model can be interpreted causally as omitted variable bias (OVB) is a problem in both cases. The adjusted R^2 for model 2 tells us that the covariates explain 77% of the variation in military spending - even after accounting for covariates in model 2, some of the variation in military spending remains unexplained. Particularly as this is an observational study, it is difficult - if not impossible - to measure or impossible to observe all confounders.

We can mitigate OVB by using a two-way fixed effects (2FE) model, which eliminates selection bias by simultaneously adjusting for unobserved unit-specific (but time-invariant) and time-specific (but unit-invariant) confounders (Imai and Kim, 2020) and allowing for the calculation of an average treatment effect (ATE). The 2FE model is expressed as follows:

$$Y_{it} = \gamma_i + \alpha_t + \partial D_{it} + \epsilon_{it}$$

whereby:

- Y_{it} is the observed outcome, i.e., logged military spending in U S dollars (millions) for unit i (1, 2, …, N) at time t (1, 2, …, N).
- D_{it} is the binary treatment indicator, i.e., the presence of a female chief executive for unit i at time t.
- γ_i and α_t are unit and time fixed effects, respectively. In this study, 2FE controls for unit-specific (but time-invariant) confounders such as culture, as well as time-specific (but unit-invariant) confounders such as GDPPPP.
- ϵ_{it} is the error term.

Under certain assumptions, this can produce valid estimates of causal effects. The validity of 2FE rests on the "parallel trends" assumption. Hence, we assume that if treated units did not receive the treatment (i.e., if countries with female executives had not had a female executive in a given year), they would have followed the same trend as the control units, since selection bias is time-invariant.

While 2FE allows us to examine the relationship between the gender of a state's chief executive and military spending, the ATE does not provide insight into the specificities of countries or allow us to compare between countries. Thus, to compliment the 2FE, two countries from the treated sample are modelled using synthetic control (SC) to examine whether the SC results conform with those of the 2FE.

In this case, it is interesting to use SC is gain insight into whether a treated country (i.e., a country that has had a female executive) would have followed the same military spending trend had it not had a female executive. SC allows for the synthesis of a control group by finding the weighted counterfactual that minimises the distance, in terms of time-invariant characteristics and pre-treatment outcomes, between the treated unit and the synthetic control.

The SC model is expressed as follows:

$$Y_{1,t} \approx \sum_{J=2}^{J+1} \widehat{w}_j Y_{j,t}$$

$$\text{for all } t \in 1, \dots, T_0$$

whereby $Y_{1,t}$ refers to the observed outcome, which is approximately equal to the weighted outcome of the donor pool in the same period. Essentially, it is the observed outcome of the treated unit minus the synthetic control for the treated unit. The difference between the treated and SC units should be the presence of a female executive.

4. Results

4.1 Two-way fixed effects

Table 2: Bivariate, multivariate and 2FE regressions

	Model 1	**Model 2**	**Model 3**
(Intercept)	6369.53***	1001.93	-1447.45
	(644.93)	(3872.55)	(3055.33)
female_exe1	-1787.85	-3291.90*	219.18
	(2513.21)	(1326.38)	(1150.39)
FFL_lead1		622.45	
		(2881.99)	
deaths_any		519.68	
		(1501.61)	
dictator1		-2243.48	
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prop_female		-120.00**	
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		(731.52)	
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		(3646.13)	
dics		-4633.75	
		(3744.75)	
parliamentary_c1		-7364.27***	
		(1135.81)	
mixed_c1		-844.54	
		(1184.40)	
eu		-1889.02	
		(1391.45)	
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		(1124.56)	
pwomenmin_int		40.01	
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gdpppp		0.00***	
		(0.00)	
R^2	0.00	0.77	0.87
Adj. R^2	-0.00	0.77	0.87
Num. obs.	3356	3085	3356
***$p < 0.001$; **$p < 0.01$; *$p < 0.05$			

As illustrated in table 2, the coefficient of the treatment indicator `female_exe1` in model 3 (the 2FE model) indicates an ATE of 219.18. Thus, in comparison to model 1 (bivariate regression) and model 2 (multivariate regression), we can see that once we control for unobserved unit-specific and time-specific, model 3 demonstrates that a female chief executive is associated with an increase of 219.18 log military spending, or 1.544061e+95, which is an extremely unsubstantial value. The adjusted R^2 increases from 0.77 in model 2 to 0.87 in model 3, meaning that the unobserved unit-specific and time-specific confounders adjusted for in the 2FE model accounts for 87% of the variation in logged military spending. Moreover, the t-value for model 3 is 0.1905, which is far from significant. Therefore, we cannot reject the null hypothesis that a female executive does not affect military spending.

Briefly, it is interesting to note that in model 2, when all other covariates are held at zero, the coefficient for `parliamentary_c1` is associated with a 7364.27 decrease in military spending, statistically significant at the 99.9% confidence interval. Similarly, the coefficient for `oecd` is associated with a 5655.25 increase in military spending, also statistically significant at the 99.9% confidence interval. This suggests that having a parliamentary system, as well as being an OECD member state are both significant confounders in the model.

4.2 Synthetic control

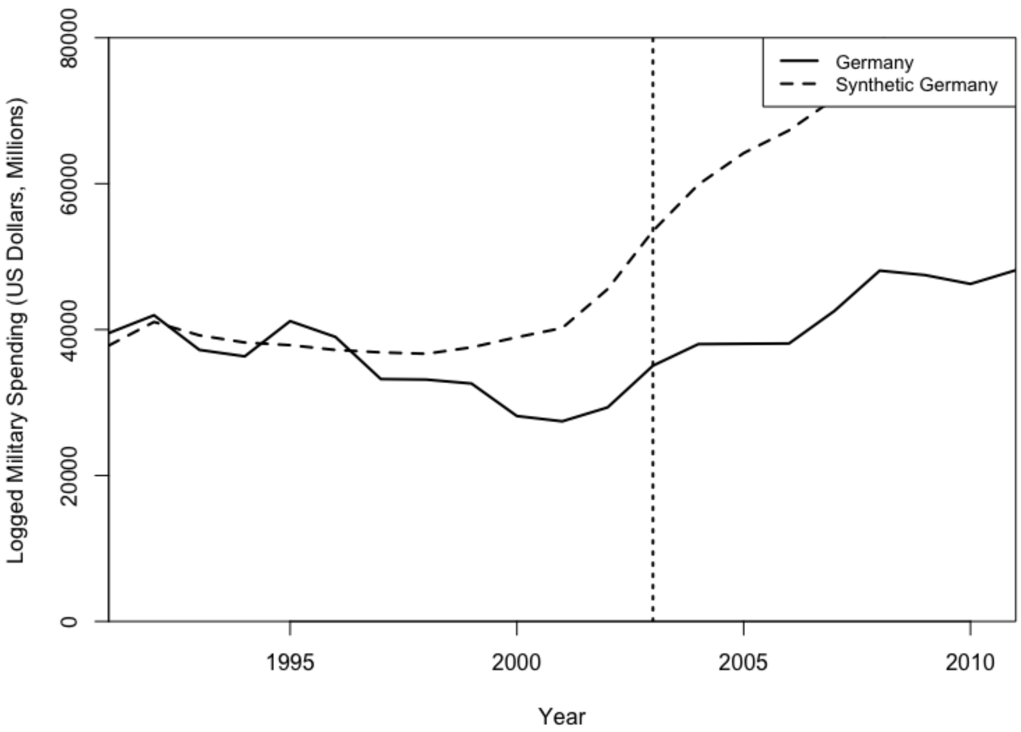

Figure 1: Military spending trajectories for Germany and Synthetic Germany

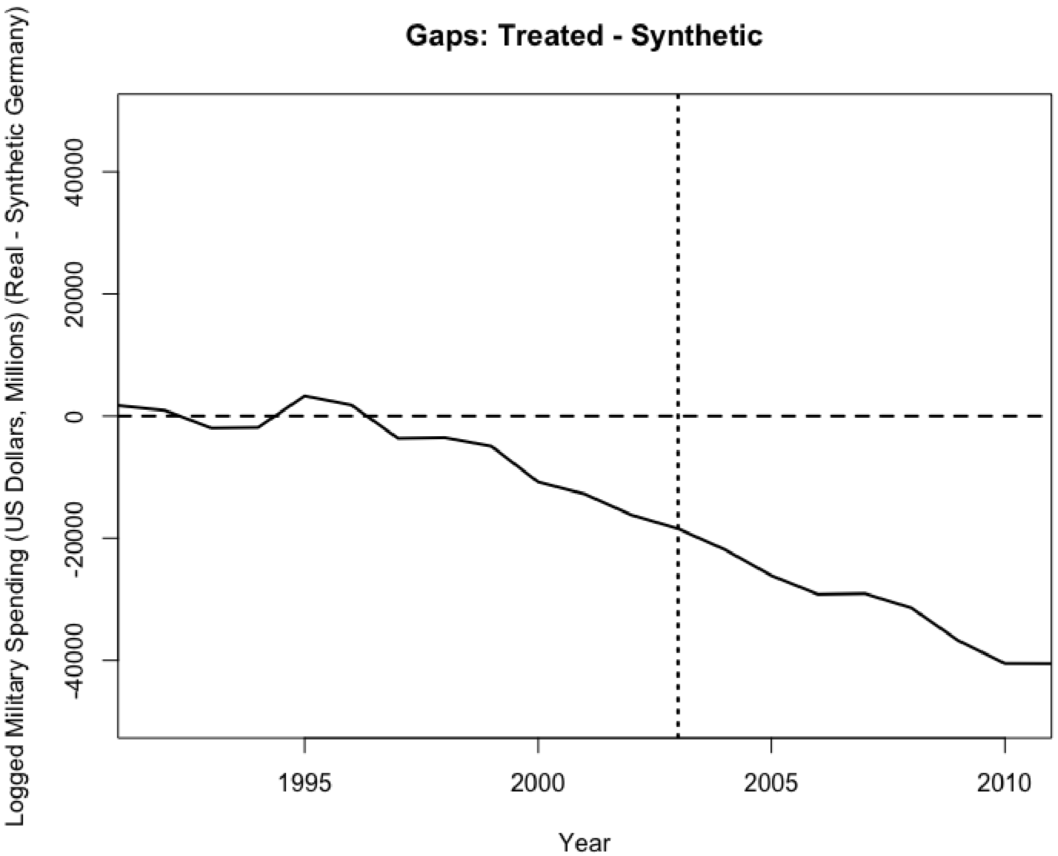

Figure 2: Gap in the trajectory of military spending for Germany and synthetic Germany

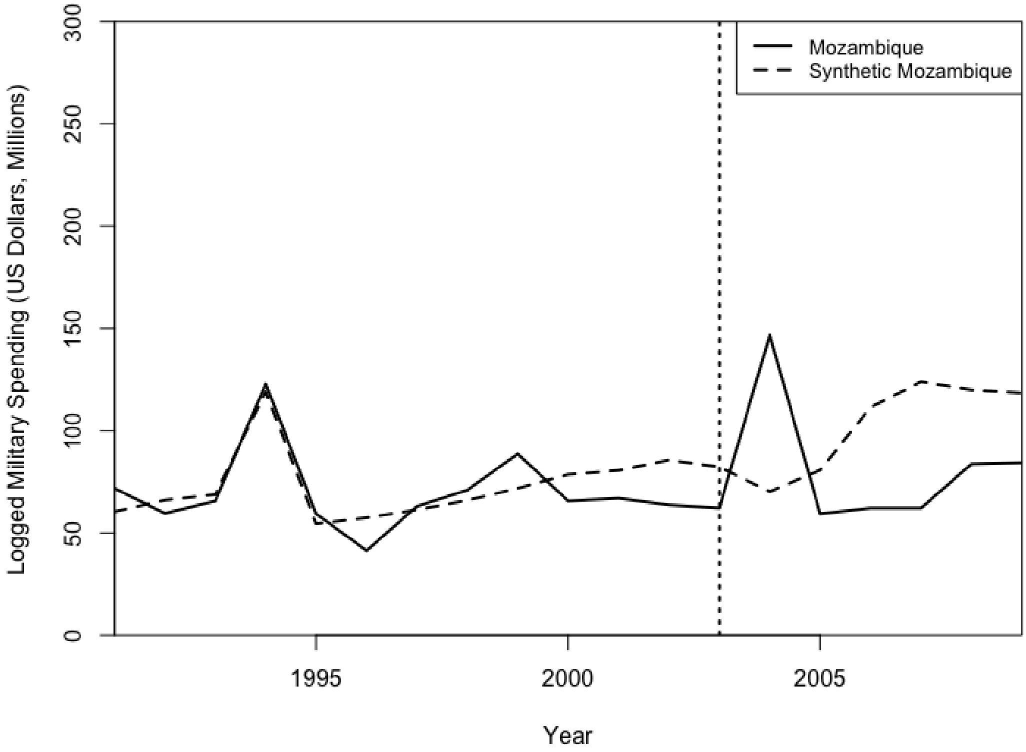

Figure 3: Military spending trajectories for Mozambique and Synthetic Mozambique

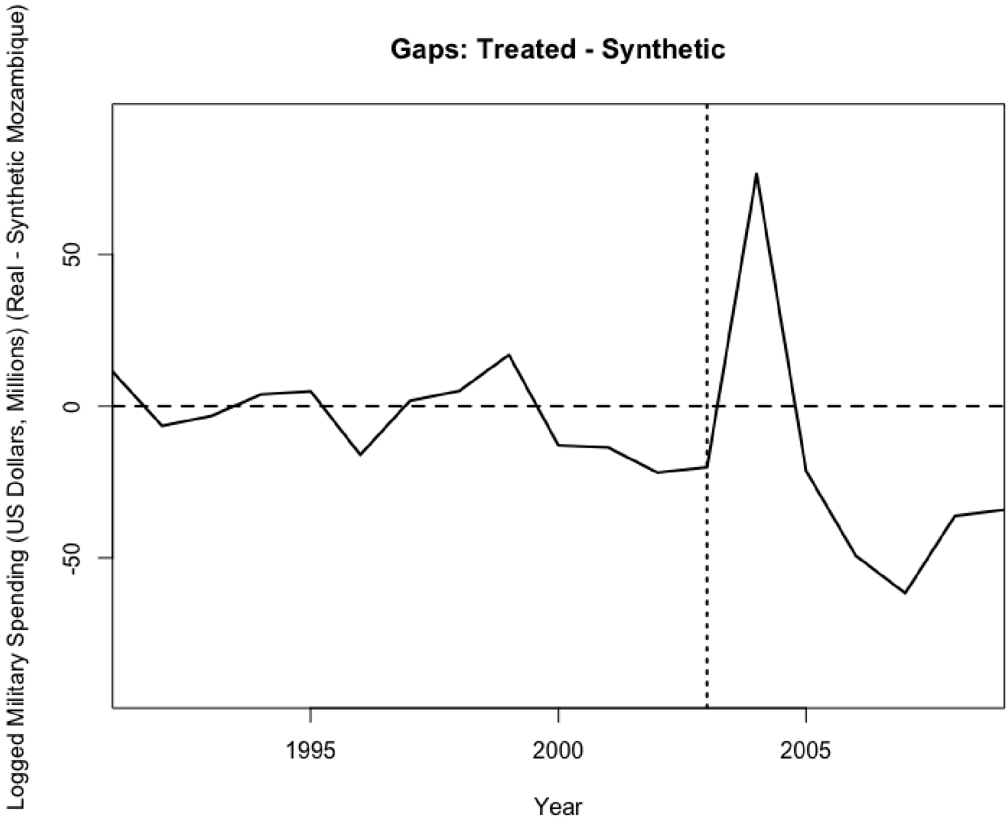

Figure 4: Gap in the trajectory of military spending for Mozambique and synthetic Mozambique

In SC figures 1-4, the pre-treatment period indicates the years in which there was no female executive in office. For both Germany and Mozambique, the post-treatment period begins in 2003, as there was a female executive in office between 2003-2011.

Figures 1 and 2 illustrate that synthetic Germany does not provide a particularly good approximation to the pre-treatment trend of Germany. Though logged military spending increases for synthetic Germany relative to real Germany in the post-treatment period, there is already a significant divergence between synthetic and real Germany beginning in approximately 1997.

Meanwhile, figures 3 and 4 illustrate that synthetic Mozambique provides a reasonably good approximation to the pre-treatment trend of Mozambique, as there are only small differences in logged military spending before 2003. (See appendices C-H for weights of synthetic Germany and Mozambique.)

Additionally, there is a reasonable divergence in the trajectory of Mozambique and its SC after a female executive was appointed in 2003. In particular, synthetic military spending increases more than the real military spending post-female executive appointment. This provides some empirical support for female executives' decrease a state's military spending, albeit quite weak, as it is only a single example.

The placebo test (see appendices I-J) supports the inference drawn from Mozambique's SC analysis, as the synthetic version of Algeria (the placebo) provides a reasonably good approximation to the pre-treatment trend of Algeria. There is, therefore, some effect of a female executive decreasing military spending.

When conducting permutation inference, we see that the test-statistic (root-mean-square-erros, or RMSEs) for Germany is 4.36. This is smaller than Algeria's (the placebo) RMSE (8.72). Thus, we can expect to be more confident that the effect of a female executive on logged military spending is different from zero. This contradicts results for Mozambique, however, as the Mozambique's RMSE (2.28) is larger than Algeria's RMSE (1.35), suggesting we should be less confident that the effect is zero.

5. Discussion

This study attempted to identify the causal effect of a female chief executive on military spending. Results are mixed. The 2FE model in table 2 demonstrated that having a female executive is associated with an extremely small increase in logged military spending. The result is not significant given the t-value 0.1905 so we cannot reject the null hypothesis that a female executive does not affect military spending.

This is somewhat aligned with Koch and Fulton's (2011) conclusions: that women in the executive branch oversee greater defence spending than men in the same positions, consistent with hypotheses that women must overcome stereotypes of being "weak" in foreign/security policy. However, Koch and Fulton only examine 22 democratic states between 1979-2000, while this study examines a larger sample and longer period, not limited to democracies.

Germany and Mozambique were chosen for the SC for various reasons. Some literature suggests that there are differences in military spending between regime types (Brauner, 2015;

Bove and Brauner, 2016). Germany was coded as a democracy in the dataset while Mozambique was coded as an authoritarian regime.

Moreover, both countries had a post-treatment period beginning in 2003 as both countries had female executives appointed in the same year. However, there is no structured way of choosing units for SC, making it a relatively weak model unless strongly justified.

While synthetic Germany did not provide a good approximation to the pre-treatment trend, synthetic Mozambique did provide a good approximation. This suggests some effect of a female executive decreasing military spending, supported by results from Algeria (the placebo). Similarly, the RMSE for Mozambique's RMSE (2.28) is larger than Algeria's RMSE (1.35), suggesting we should be less confident that the effect is zero. Given the contradiction of the results, however, these results are unconvincing.

Further, many units had to be removed from the SC due to missing data, reducing the sample size from 187 to 131. Of these countries, 44 had female executives, leaving only 87 to be used as controls. Had there not been missing data, the SC model would have had a larger donor pool and may have produced more accurate SCs.

Time constraints also limited this analysis. Firstly, the dataset used is not updated. There have been more female executives appointed post-2011 which could have affected the results, but it was not feasible to collect more data to create a more comprehensive dataset. Additionally, SC is insightful due to the long time period and many variables. Thus, replicating the study with a complete, updated dataset would contribute to the SC's validity and could be an avenue for future research.

It would also be interesting to investigate this question focusing specifically on OECD member states and states with parliamentary systems, as model 2 in table 2 illustrated the associated covariates, `oecd` and `parliamentary_c1`, respectively, were significant confounders.

Ideally, I would also conduct full permutation inferences by estimating placebo treatment effects for all of the control units and comparing them to Germany and/or Mozambique. This would require re-estimating the SC for every unit in the donor pool and comparing the distribution of these placebo treatment effects to the treatment effect for Germany/Mozambique. This was not feasible due to technical limitations. The code to calculate placebos for all control units is included in the replication data and also attached in appendix N. However, I was unable to run it as the code took too long and caused my computer to shut down.

References

Barnes, T. D. and O'Brien, D. Z. (2017) 'Barnes&OBrien_DefenseMinisters_Code Book.pdf', *Harvard Dataverse*. (Replication Data for: Defending the Realm: The Appointment of Female Defense Ministers Worldwide). doi: https://doi.org/10.7910/DVN/TR4OUK/JRQ3TB.

Barnes, T. D. and O'Brien, D. Z. (2018) 'Defending the Realm: The Appointment of Female Defense Ministers Worldwide', *American Journal of Political Science*, 62(2), pp. 355–368. doi: https://doi.org/10.1111/ajps.12337.

Bove, V. and Brauner, J. (2016) ‘The demand for military expenditure in authoritarian regimes’, *Defence and Peace Economics*, 27(5), pp. 609–625. doi: 10.1080/10242694.2014.925325.

Brauner, J. (2015) ‘Military spending and democracy’, *Defence and Peace Economics*, 26(4), pp. 409–423. doi: 10.1080/10242694.2014.960245.

Caprioli, M. (2000) ‘Gendered Conflict’, *Journal of Peace Research*, 37(1), pp. 51–68. doi: 10.1177/0022343300037001003.

Caprioli, M. (2005) ‘Primed for Violence: The Role of Gender Inequality in Predicting Internal Conflict’, *International Studies Quarterly*, 49(2), pp. 161–178. doi: 10.1111/j.0020-8833.2005.00340.x.

Caprioli, M. and Boyer, M. A. (2001) ‘Gender, Violence, and International Crisis’, *Journal of Conflict Resolution*, 45(4), pp. 503–518. doi: 10.1177/0022002701045004005.

Demeritt, J. H. R., Nichols, A. D. and Kelly, E. G. (2014) ‘Female Participation and Civil War Relapse’, *Civil Wars*, 16(3), pp. 346–368. doi: 10.1080/13698249.2014.966427.

Goldstein, J. S. (2004) ‘War and Gender’, in Ember, C. R. and Ember, M. (eds) *Encyclopedia of Sex and Gender: Men and Women in the World’s Cultures Volume I: Topics and Cultures A-K Volume II: Cultures L-Z*. Boston, MA: Springer US, pp. 107–116. doi: 10.1007/0-387-29907-6_11.

Greene, Z. and O’Brien, D. Z. (2016) ‘Diverse parties, diverse agendas? Female politicians and the parliamentary party’s role in platform formation’, *European Journal of Political Research*, 55(3), pp. 435–453. doi: https://doi.org/10.1111/1475-6765.12141.

Imai, K. and Kim, I. S. (2020) ‘On the Use of Two-Way Fixed Effects Regression Models for Causal Inference with Panel Data’, *Political Analysis*, pp. 1–11. doi: 10.1017/pan.2020.33.

Jalalzai, F. (2013) *Shattered, Cracked, or Firmly Intact?: Women and the Executive Glass Ceiling Worldwide, Shattered, Cracked, or Firmly Intact?* Oxford University Press. Available at: https://oxford.universitypressscholarship.com/view/10.1093/acprof:oso/9780199943531.001.0001/acprof-9780199943531 (Accessed: 11 May 2021).

Koch, M. T. and Fulton, S. A. (2011) ‘In the Defense of Women: Gender, Office Holding, and National Security Policy in Established Democracies’, *The Journal of Politics*, 73(1), pp. 1–16. doi: 10.1017/s0022381610000824.

Krause, J., Krause, W. and Bränfors, P. (2018) ‘Women’s Participation in Peace Negotiations and the Durability of Peace’, *International Interactions*, 44(6), pp. 985–1016. doi: 10.1080/03050629.2018.1492386.

McDermott, R. (2015) ‘Sex and Death: Gender Differences in Aggression and Motivations for Violence’, *International Organization*. Edited by A. Belkin et al., 69(3), pp. 753–775.

Melander, E. (2005) ‘Political Gender Equality and State Human Rights Abuse’. Available at: https://journals.sagepub.com/doi/abs/10.1177/0022343305050688 (Accessed: 26 December 2020).

O'Brien, D. Z. and Rickne, J. (2016) 'Gender Quotas and Women's Political Leadership', *American Political Science Review*, 110(1), pp. 112–126. doi: 10.1017/S0003055415000611.

Shekhawat, S. (2015) 'Introduction: Women in Conflict and Peace-Making', in Shekhawat, S. (ed.) *Female Combatants in Conflict and Peace: Challenging Gender in Violence and Post-Conflict Reintegration*. London: Palgrave Macmillan UK, pp. 1–19. doi: 10.1057/9781137516565_1.

Tessler, M. and Warriner, I. (1997) 'Gender, Feminism, and Attitudes toward International Conflict: Exploring Relationships with Survey Data from the Middle East', *World Politics*, 49(2), pp. 250–281.

Appendix

Appendix A: Count of female chief executives worldwide, 2009-2011

Country	Count of female chief executives
Argentina	1
Australia	3
Bangladesh	19
Bulgaria	2
Burundi	2
Chile	5
Croatia	3
Denmark	2
Ecuador	1
Finland	3
France	1
FRG/Germany	8
Gabon	1
Georgia	2
Guinea-Bissau	1
Haiti	4
India	6
Indonesia	4
Ireland	20
Israel	1
Jamaica	3
Kyrgyzstan	2
Latvia	9
Liberia	7
Lithuania	5
Macedonia	1
Mali	2
Moldova	2
Mongolia	1
Mozambique	7
New Zealand	12
Nicaragua	6

Norway	5
Pakistan	4
Peru	1
Philippines	11
Poland	2
Rwanda	2
South Africa	2
Sao Tome and Principe	4
Senegal	2
Serbia	3
Slovakia	3
South Korea	3
Sri Lanka	12
Switzerland	7
Turkey	4
Ukraine	5

Appendix B: Full output of bivariate regression (model 1), multivariate regression (model 2) and 2FE (model 3).

	Model 1	**Model 2**	**Model 3**
(Intercept)	6369.53^{***}	1001.93	-1447.45
	(644.93)	(3872.55)	(3055.33)
female_exe1	-1787.85	-3291.90^{*}	219.18
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		(757.56)	
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		(1311.25)	
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		(2029.12)	
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		(1135.81)	
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		(1184.40)	
eu		-1889.02	
		(1391.45)	
both.conflicts		-1393.54	
		(1124.56)	
pwomenmin_int		40.01	
		(35.05)	
gdpppp		0.00***	
		(0.00)	
as.factor(sname)Albania			-119.72
			(4057.04)
as.factor(sname)Algeria			2589.14
			(4057.04)
as.factor(sname)Angola			1172.90
			(4057.04)
as.factor(sname)Antigua and Barbuda			-138.74
			(4057.04)
as.factor(sname)Argentina			2487.62
			(4070.34)
as.factor(sname)Armenia			-73.47
			(4057.04)
as.factor(sname)Australia			11310.04**
			(4060.37)
as.factor(sname)Austria			2253.39
			(4057.04)
as.factor(sname)Azerbaijan			319.57
			(4057.04)
as.factor(sname)Bahamas			-197.51
			(4057.04)
as.factor(sname)Bahrain			247.00
			(4057.04)
as.factor(sname)Bangladesh			292.88
			(4188.43)
as.factor(sname)Belarus			418.56
			(4057.04)
as.factor(sname)Belgium			4135.68
			(4057.04)
as.factor(sname)Belize			-210.82
			(4057.04)
as.factor(sname)Benin			-185.57
			(4057.04)
as.factor(sname)Bolivia			-46.82
			(4057.04)
as.factor(sname)Bosnia-Herz			24.84

			(4107.78)
as.factor(sname)Botswana			15.41
			(4057.04)
as.factor(sname)Brazil			14856.20***
			(4057.04)
as.factor(sname)Brunei			66.15
			(4057.04)
as.factor(sname)Bulgaria			290.65
			(4058.52)
as.factor(sname)Burkina Faso			-164.10
			(4057.04)
as.factor(sname)Burundi			-203.38
			(4058.52)
as.factor(sname)C. Verde Is.			-167.86
			(4057.04)
as.factor(sname)Cambodia			-115.54
			(4057.04)
as.factor(sname)Cameroon			-21.95
			(4057.04)
as.factor(sname)Canada			11835.92**
			(4057.04)
as.factor(sname)Cent. Af. Rep.			-203.56
			(4057.04)
as.factor(sname)Chad			-74.04
			(4057.04)
as.factor(sname)Chile			2473.69
			(4066.28)
as.factor(sname)China			44162.83***
			(4057.04)
as.factor(sname)Colombia			4852.76
			(4057.04)
as.factor(sname)Comoro Is.			-228.27
			(4057.04)
as.factor(sname)Congo			-128.42
			(4057.04)
as.factor(sname)Cote d'Ivoire			-50.93
			(4057.04)
as.factor(sname)Croatia			730.24
			(4111.35)
as.factor(sname)Cuba			312.80
			(4057.04)
as.factor(sname)Cyprus			153.03
			(4057.04)
as.factor(sname)Czech Rep.			1340.96
			(4163.12)
as.factor(sname)Democratic Republic of the Congo			-22.77
			(4057.04)

as.factor(sname)Denmark			3056.73
			(4058.52)
as.factor(sname)Djibouti			-203.19
			(4057.04)
as.factor(sname)Dominican Rep			-42.95
			(4057.04)
as.factor(sname)Ecuador			559.78
			(4057.41)
as.factor(sname)Egypt			2638.53
			(4057.04)
as.factor(sname)El Salvador			-73.28
			(4057.04)
as.factor(sname)Eq. Guinea			-173.49
			(4057.04)
as.factor(sname)Eritrea			-273.38
			(4163.12)
as.factor(sname)Estonia			-136.27
			(4107.78)
as.factor(sname)Ethiopia			95.33
			(4057.04)
as.factor(sname)Fiji			-4821.67
			(13493.46)
as.factor(sname)Finland			2420.34
			(4060.37)
as.factor(sname)France			48272.06^{***}
			(4057.41)
as.factor(sname)FRG/Germany			37815.85^{***}
			(4080.64)
as.factor(sname)Gabon			-142.56
			(4057.41)
as.factor(sname)Gambia			-223.45
			(4057.04)
as.factor(sname)Georgia			92.02
			(4058.52)
as.factor(sname)Ghana			-146.69
			(4057.04)
as.factor(sname)Greece			5592.18
			(4057.04)
as.factor(sname)Guatemala			-89.41
			(4057.04)
as.factor(sname)Guinea			-175.87
			(4057.04)
as.factor(sname)Guinea-Bissau			-216.43
			(4057.41)
as.factor(sname)Haiti			-239.34
			(4062.96)
as.factor(sname)Honduras			-140.01
			(4057.04)

as.factor(sname)Hungary			1138.28
			(4057.04)
as.factor(sname)India			19383.08***
			(4070.34)
as.factor(sname)Indonesia			2157.07
			(4062.96)
as.factor(sname)Iran			7238.46
			(4057.04)
as.factor(sname)Iraq			2142.32
			(4057.04)
as.factor(sname)Ireland			493.77
			(4202.38)
as.factor(sname)Israel			10295.08*
			(4057.41)
as.factor(sname)Italy			27992.73***
			(4057.04)
as.factor(sname)Jamaica			-203.05
			(4060.37)
as.factor(sname)Japan			43114.45***
			(4057.04)
as.factor(sname)Jordan			466.41
			(4057.04)
as.factor(sname)Kazakhstan			638.06
			(4057.04)
as.factor(sname)Kenya			66.68
			(4057.04)
as.factor(sname)Kuwait			3743.99
			(4057.04)
as.factor(sname)Kyrgyzstan			-163.40
			(4058.52)
as.factor(sname)Laos			-188.27
			(4057.04)
as.factor(sname)Latvia			-126.50
			(4086.89)
as.factor(sname)Lebanon			648.30
			(4057.04)
as.factor(sname)Lesotho			-196.95
			(4057.04)
as.factor(sname)Liberia			-280.06
			(4075.12)
as.factor(sname)Lithuania			-76.89
			(4066.28)
as.factor(sname)Luxembourg			-47.33
			(4057.04)
as.factor(sname)Macedonia			-302.97
			(4163.54)
as.factor(sname)Madagascar			-168.98
			(4057.04)

as.factor(sname)Malawi			-201.83
			(4057.04)
as.factor(sname)Malaysia			2529.02
			(4057.04)
as.factor(sname)Maldives			-168.47
			(4057.04)
as.factor(sname)Mali			-173.59
			(4058.52)
as.factor(sname)Mauritania			-188.93
			(4057.04)
as.factor(sname)Mauritius			-208.60
			(4057.04)
as.factor(sname)Mexico			3324.96
			(4057.04)
as.factor(sname)Moldova			-283.59
			(4109.36)
as.factor(sname)Mongolia			-200.74
			(4057.41)
as.factor(sname)Montenegro			-3281.82
			(6096.20)
as.factor(sname)Mozambique			-228.05
			(4075.12)
as.factor(sname)Myanmar			9420.69^{*}
			(4057.04)
as.factor(sname)Namibia			-77.58
			(4057.04)
as.factor(sname)Nepal			-121.27
			(4057.04)
as.factor(sname)Netherlands			8394.54^{*}
			(4057.04)
as.factor(sname)New Zealand			874.25
			(4109.95)
as.factor(sname)Nicaragua			-247.77
			(4070.34)
as.factor(sname)Niger			-197.85
			(4057.04)
as.factor(sname)Nigeria			628.56
			(4057.04)
as.factor(sname)North Korea			3030.13
			(4057.04)
as.factor(sname)Norway			4391.78
			(4066.28)
as.factor(sname)Oman			2710.68
			(4057.04)
as.factor(sname)P. N. Guinea			-182.85
			(4057.04)
as.factor(sname)Pakistan			3750.40
			(4062.96)

as.factor(sname)Paraguay			-113.03
			(4057.04)
as.factor(sname)Peru			848.55
			(4057.41)
as.factor(sname)Philippines			1228.64
			(4101.55)
as.factor(sname)Poland			4664.41
			(4058.52)
as.factor(sname)Portugal			2941.35
			(4057.04)
as.factor(sname)Qatar			1012.32
			(4057.04)
as.factor(sname)Romania			1278.68
			(4057.04)
as.factor(sname)Russia			26818.51***
			(4107.78)
as.factor(sname)Russian Federation			222809.85***
			(13496.70)
as.factor(sname)Rwanda			-178.67
			(4058.52)
as.factor(sname)S. Africa			2762.60
			(4058.52)
as.factor(sname)Sao Tome and Principe			-201.45
			(4062.96)
as.factor(sname)Saudi Arabia			24013.35***
			(4057.04)
as.factor(sname)Senegal			-138.57
			(4058.52)
as.factor(sname)Serbia			1209.49
			(4060.37)
as.factor(sname)Seychelles			-218.03
			(4057.04)
as.factor(sname)Sierra Leone			-205.47
			(4057.04)
as.factor(sname)Singapore			4711.64
			(4057.04)
as.factor(sname)Slovakia			272.45
			(4167.01)
as.factor(sname)Slovenia			141.00
			(4107.78)
as.factor(sname)Somalia			-189.41
			(4057.04)
as.factor(sname)South Korea			17683.56***
			(4060.37)
as.factor(sname)Spain			10450.35*
			(4057.04)

as.factor(sname)Sri Lanka			463.27
			(4109.95)
as.factor(sname)Sudan			385.05
			(4057.04)
as.factor(sname)Suriname			-205.13
			(4057.04)
as.factor(sname)Sweden			5248.59
			(4057.04)
as.factor(sname)Switzerland			3384.91
			(4075.12)
as.factor(sname)Syria			1260.54
			(4057.04)
as.factor(sname)Tajikistan			-166.71
			(4057.04)
as.factor(sname)Tanzania			-96.73
			(4057.04)
as.factor(sname)Thailand			2921.43
			(4057.04)
as.factor(sname)Timor-Leste			-2080.55
			(5056.66)
as.factor(sname)Togo			-190.34
			(4057.04)
as.factor(sname)Tonga			-1180.94
			(4642.88)
as.factor(sname)Tunisia			185.37
			(4057.04)
as.factor(sname)Turkey			10179.32^{*}
			(4062.96)
as.factor(sname)Turkmenistan			-80.71
			(4057.04)
as.factor(sname)UAE			6096.75
			(4057.04)
as.factor(sname)Uganda			-29.77
			(4057.04)
as.factor(sname)UK			45521.73^{***}
			(4057.04)
as.factor(sname)Ukraine			2108.30
			(4066.28)
as.factor(sname)Uruguay			198.21
			(4057.04)
as.factor(sname)USA			413635.68^{***}
			(4057.04)
as.factor(sname)Uzbekistan			50.39
			(4057.04)
as.factor(sname)Venezuela			1682.76
			(4057.04)
as.factor(sname)Vietnam			1114.04
			(4057.04)

as.factor(sname)Yemen			757.97
			(4057.04)
as.factor(sname)Zambia			-107.78
			(4057.04)
as.factor(sname)Zimbabwe			26.85
			(4057.04)
as.factor(year)1992			244.82
			(1509.09)
as.factor(year)1993			-147.14
			(1500.33)
as.factor(year)1994			-69.17
			(1500.25)
as.factor(year)1995			-29.01
			(1500.20)
as.factor(year)1996			-27.15
			(1500.22)
as.factor(year)1997			-72.95
			(1500.38)
as.factor(year)1998			-176.30
			(1500.20)
as.factor(year)1999			-94.73
			(1498.13)
as.factor(year)2000			56.14
			(1498.11)
as.factor(year)2001			102.33
			(1498.35)
as.factor(year)2002			595.92
			(1496.48)
as.factor(year)2003			1365.83
			(1496.34)
as.factor(year)2004			2086.22
			(1496.34)
as.factor(year)2005			2623.36
			(1496.48)
as.factor(year)2006			2950.48^{*}
			(1495.29)
as.factor(year)2007			3752.03^{*}
			(1495.04)
as.factor(year)2008			4881.45^{**}
			(1495.29)
as.factor(year)2009			5219.22^{***}
			(1495.88)
as.factor(year)2010			5678.86^{***}
			(1495.29)
as.factor(year)2011			6329.93^{***}
			(1494.82)
R^2	0.00	0.77	0.87
Adj. R^2	-0.00	0.77	0.87

Num. obs.	3356	3085	3356

Appendix C: Country-weights for synthetic Germany

Country	Weight
Netherlands	0.718
Sweden	0.117
USA	0.109
Italy	0.056

Appendix D: Weights assigned to each predictor variable for Germany SC

Predictor variable	Weight
mil_spend	0.001
FFL_lead1	0.016
deaths_any	0.023
dictator1	0.003
prop_female	0
left_exe1	0
involve	0.005
oecd	0.28
labour_full	0
recovery	0.289
internal_recovery	0.043
dems	0.015
dics	0.025
parliamentary_c1	0.004
mixed_c1	0
eu	0.052
both.conflicts	0.062
pwomenmin_int	0.112
gdpppp	0.069

Appendix E: Mean of each predictor variable in treated and synthetic Germany

Predictor variable	Treated	Synthetic	Sample Mean
mil_spend	3.493131e+04	4.005540e+04	6.225628e+03
FFL_lead1	0.000000e+00	9.000000e-03	5.000000e-03
deaths_any	0.000000e+00	9.600000e-02	8.000000e-02
dictator1	0.000000e+00	0.000000e+00	2.020000e-01
prop_female	2.690800e+01	2.891900e+01	9.039000e+00
left_exe1	4.620000e-01	6.630000e-01	2.670000e-01
involve	1.000000e+00	1.000000e+00	5.140000e-01
oecd	1.000000e+00	1.000000e+00	1.670000e-01
labour_full	4.853800e+01	5.093200e+01	4.997700e+01
recovery	0.000000e+00	7.500000e-02	2.190000e-01
internal_recovery	0.000000e+00	0.000000e+00	1.910000e-01
dems	1.000000e+00	1.000000e+00	5.060000e-01
dics	0.000000e+00	0.000000e+00	3.030000e-01
parliamentary_c1	0.000000e+00	8.910000e-01	2.070000e-01
mixed_c1	1.000000e+00	0.000000e+00	9.200000e-02

eu	1.000000e+00	8.550000e-01	1.090000e-01
both.conflicts	0.000000e+00	9.600000e-02	1.930000e-01
pwomenmin_int	2.486500e+01	2.381700e+01	1.009800e+01
gdpppp	2.009231e+12	1.350295e+12	3.154170e+11

Appendix F: Country-weights for synthetic Mozambique

Country	Weight
Djibouti	0.920
Lesotho	0.061
Mexico	0.015
Comoro Is.	0.001

Appendix G: Weights assigned to each predictor variable for Mozambique SC

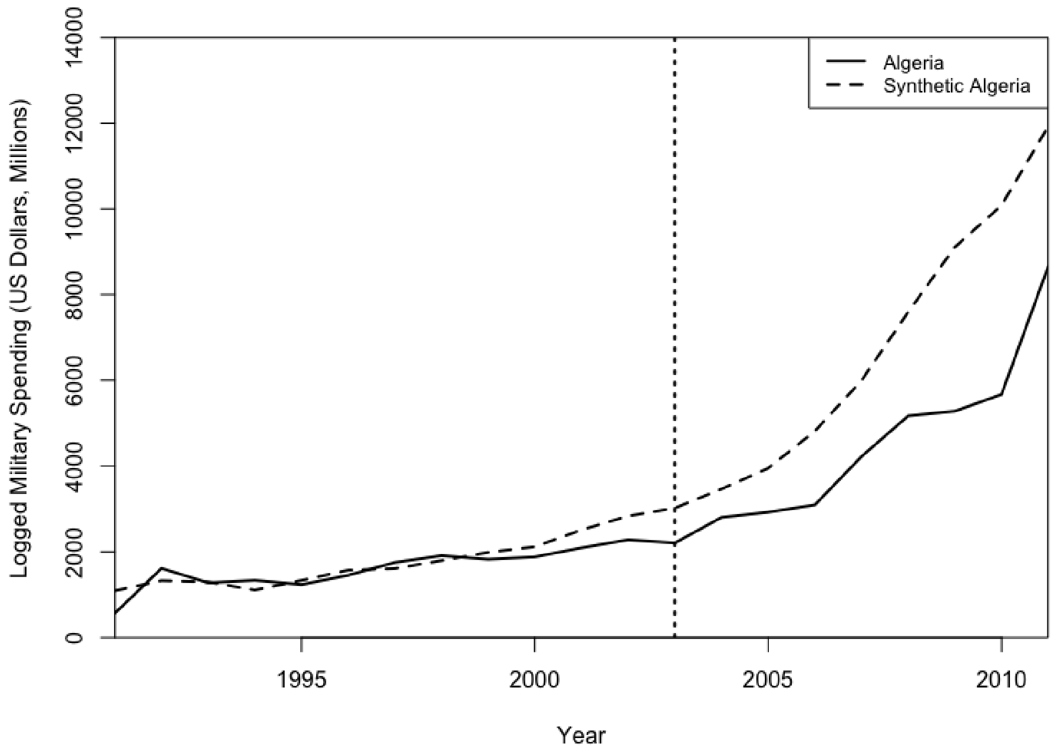
Predictor variable	Weight
mil_spend	0.905
FFL_lead1	0.006
deaths_any	0.045
dictator1	0.012
prop_female	0
left_exe1	0
involve	0
oecd	0.001
labour_full	0
recovery	0
internal_recovery	0
dems	0
dics	0.023
parliamentary_c1	0
mixed_c1	0
eu	0.001
both.conflicts	0
pwomenmin_int	0
gdpppp	0.007

Appendix H: Mean of each predictor variable in treated and synthetic Mozambique

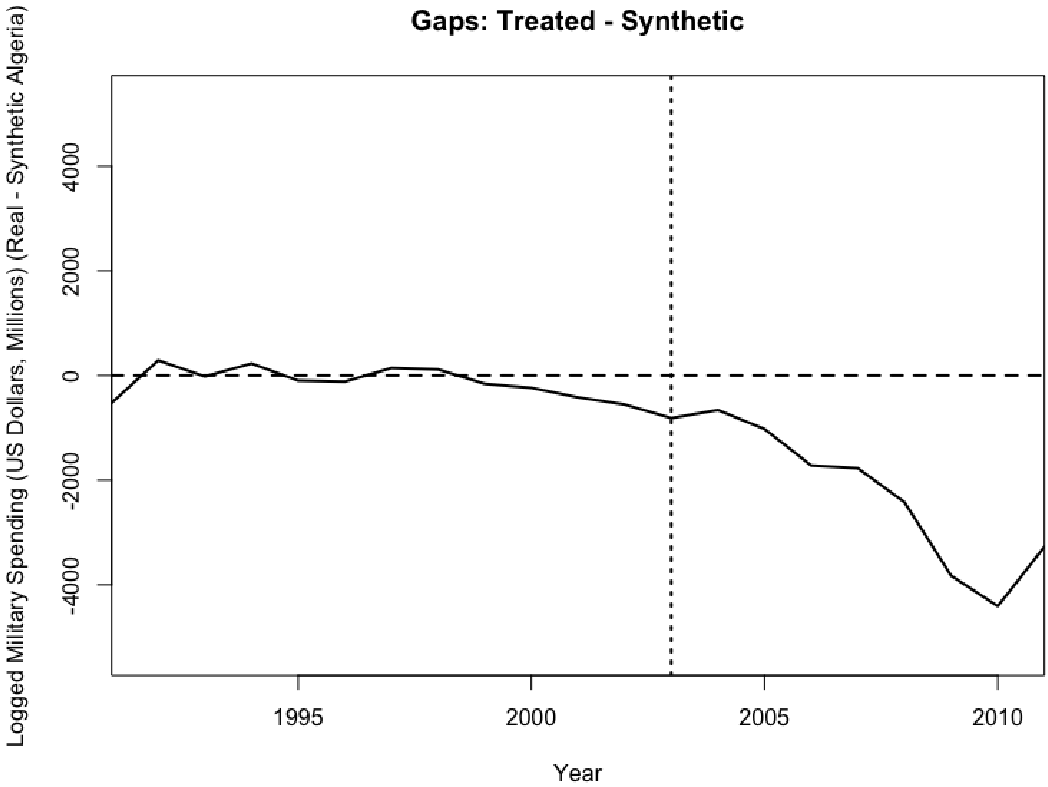
Predictor variable	Treated	Synthetic	Sample Mean
mil_spend	6.9994e+01	7.254000e+01	6.076221e+03
FFL_lead1	0.0000e+00	0.000000e+00	6.000000e-03
deaths_any	0.0000e+00	1.000000e-03	8.000000e-02
dictator1	0.0000e+00	6.000000e-03	2.020000e-01
prop_female	2.4425e+01	5.650000e-01	8.791000e+00
left_exe1	1.0000e+00	6.200000e-02	2.670000e-01
involve	3.3300e-01	2.370000e-01	5.090000e-01
oecd	0.0000e+00	1.100000e-02	1.670000e-01
labour_full	8.6917e+01	3.248800e+01	4.983400e+01
recovery	8.3300e-01	5.690000e-01	2.210000e-01
internal_recovery	8.3300e-01	5.680000e-01	1.900000e-01
dems	0.0000e+00	6.000000e-03	5.050000e-01

dics	1.0000e+00	9.890000e-01	3.050000e-01
parliamentary_c1	0.0000e+00	0.000000e+00	2.070000e-01
mixed_c1	0.0000e+00	0.000000e+00	9.300000e-02
eu	0.0000e+00	0.000000e+00	1.090000e-01
both.conflicts	1.6700e-01	3.870000e-01	1.970000e-01
pwomenmin_int	4.7120e+00	1.250000e+00	9.857000e+00
gdpppp	6.1000e+09	1.414458e+10	3.063721e+11

Appendix I: Military spending trajectories for Algeria and Synthetic Algeria (placebo)



Appendix J: Gap in the trajectory of military spending for Algeria and Synthetic Algeria (placebo)



Appendix K: Country-weights for synthetic Algeria (placebo)

Country	Weight
Gambia	0.277
Tunisia	0.205
Uganda	0.201
Jordan	0.113
China	0.075
Egypt	0.067
Nepal	0.045
Sweden	0.016

Appendix L: Weights assigned to each predictor variable for Algeria SC (placebo)

Predictor variable	Weight
mil_spend	0.048
FFL_lead1	0.197
deaths_any	0.08
dictator1	0.044
prop_female	0.028
left_exe1	0.116
involve	0.014
oecd	0.012
labour_full	0.002
recovery	0
internal_recovery	0.056
dems	0.062

dics	0.056
parliamentary_c1	0.03
mixed_c1	0.039
eu	0.033
both.conflicts	0.013
pwomenmin_int	0.079
gdpppp	0.092

Appendix M: Mean of each predictor variable in treated and synthetic Algeria (placebo)

Predictor variable	Treated	Synthetic	Sample Mean
mil_spend	1.648090e+03	1.815255e+03	6.279482e+03
FFL_lead1	0.000000e+00	1.000000e-03	5.000000e-03
deaths_any	0.000000e+00	4.100000e-02	8.100000e-02
dictator1	5.380000e-01	5.060000e-01	1.980000e-01
prop_female	5.485000e+00	9.292000e+00	9.081000e+00
left_exe1	4.620000e-01	3.950000e-01	2.640000e-01
involve	8.460000e-01	6.490000e-01	5.100000e-01
oecd	0.000000e+00	1.600000e-02	1.690000e-01
labour_full	1.152300e+01	5.325500e+01	5.043000e+01
recovery	0.000000e+00	1.090000e-01	2.220000e-01
internal_recovery	0.000000e+00	6.200000e-02	1.930000e-01
dems	0.000000e+00	5.100000e-02	5.120000e-01
dics	4.620000e-01	4.430000e-01	3.010000e-01
parliamentary_c1	0.000000e+00	5.100000e-02	2.090000e-01
mixed_c1	0.000000e+00	0.000000e+00	9.300000e-02
eu	0.000000e+00	1.100000e-02	1.100000e-01
both.conflicts	1.000000e+00	2.700000e-01	1.840000e-01
pwomenmin_int	1.830400e+01	1.573600e+01	1.000100e+01
gdpppp	2.256154e+11	2.622139e+11	3.164735e+11

Appendix N: Code to estimate placebo treatment effects for all control units

```
## Germany synth

gersynth <- read.csv("final/repdata/ger_synth.csv")

dataprep_out_ger <- dataprep(foo = gersynth,
                             predictors = c("mil_spend",
"FFL_lead1", "deaths_any", "dictator1", "prop_female",
"left_exe1",
                                            "involve", "oecd",
"labor_full", "recovery", "internal_recovery", "dems", "dics",

"parliamentary_c1", "mixed_c1", "eu", "both.conflicts",
"pwomenmin_int", "gdpppp"),
                             dependent = "mil_spend",
                             unit.variable = "country_no",
                             time.variable = "year",
```

```
                              treatment.identifier = 1,
                              controls.identifier = c(2:87),
                              time.predictors.prior =
c(1991:2003),
                              time.optimize.ssr = c(1991:1997),
                              unit.names.variable = "sname",
                              time.plot = 1991:2011
)

synth_out_ger <- synth(dataprep_out_ger)

## Mozambique synth

mozsynth <- read.csv("final/repdata/moz_synth.csv")

dataprep_out_moz <- dataprep(foo = mozsynth,
                              predictors = c("mil_spend",
"FFL_lead1", "deaths_any", "dictator1", "prop_female",
"left_exe1",
                                             "involve", "oecd",
"labor_full", "recovery", "internal_recovery", "dems", "dics",

"parliamentary_c1", "mixed_c1", "eu", "both.conflicts",
"pwomenmin_int", "gdpppp"),
                              dependent = "mil_spend",
                              unit.variable = "country_no",
                              time.variable = "year",
                              treatment.identifier = 1,
                              controls.identifier = c(2:87),
                              time.predictors.prior =
c(1991:2002),
                              time.optimize.ssr = c(1991:1997),
                              unit.names.variable = "sname",
                              time.plot = 1991:2009
)

synth_out_moz <- synth(dataprep_out_moz)

## Germany full placebos

ger_plac <- generate.placebos(dataprep_out_ger, synth_out_ger,
Sigf.ipop = 2)

ger_full_placebos_plot <- mspe.plot(ger_plac,
                                     discard.extreme = F,
                                     mspe.limit = 20,
                                     plot.hist = F,
                                     title = NULL,
                                     xlab = "Post/Pre RMSE
ratio",
```

```
                                    ylab = "Logged Military
Spending (US Dollars, Millions")

## Mozambique full placebos

moz_plac <- generate.placebos(dataprep_out_gmoz,
synth_out_moz, Sigf.ipop = 2)

moz_full_placebos_plot <- mspe.plot(moz_plac,
                                    discard.extreme = F,
                                    mspe.limit = 20,
                                    plot.hist = F,
                                    title = NULL,
                                    xlab = "Post/Pre RMSE
ratio",
                                    ylab = "Logged Military
Spending (US Dollars, Millions")
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This is an interesting paper which evaluates the effect of female political leadership on state military spending using fixed-effect and synthetic control designs. The paper is very nicely motivated, and seeks to answer a clear causal question that speaks to an important literature in political science and public policy. It was encouraging to see you two of the methods from the course used in a complementary way to answer the same question, and in general your implementation of these methods was good. It was also good, in the FE model, that you thought to include an extensive set of time-varying covariates (though at least one of these - the female defence minister dummy - is post-treatment to the presence of a female executive).

I have some suggestions for improvement:

First, though you clearly strong intuitions regarding selection bias and other issues related to causal inference, it would have been helpful to provide a little more discussion of the potential outcomes framework, and how it helps us to clarify issues such as selection bias and the fundamental problem of causal inference.

Second, though it was good to see both SC and 2WFE models in the paper, your discussion of each method (and particularly the SC model) was a little truncated. I am mostly convinced that you understood what you were doing with these models, but devoting a little more space to the exposition of each would have been helpful.

Third, where are the estimates of the time-varying coefficients for the FE model? I don't see them in table 2? Also, did you make any attempt to assess the parallel trends assumption for this model? I couldn't see anything in the paper.

Fourth, you say that you are using *log* military spending as the outcome, but I don't think that can be true given the regression coefficients you report and the Y-axes of your SC plots. An increase of 219 in log spending would be unimaginably large!

Fifth, your discussion of the SC model was a little brief. Why did you choose Germany and Mozambique for the SC? Why are these cases informative? You are also missing discussion of how the SC was constructed. What, exactly, was the donor pool? Why were those countries the most appropriate to select? Which covariates were included in the analysis? These issues are central to the SC model and so merited at least some discussion.

Finally, although it was good that you conducted an in-space placebo with Algeria, I would have liked to see a full permutation inference where you comapred the treatment effects for Germany and Mozambique to all other countries.

Overall, however, there is good work here. Well done!