Not Just Guns or Butter, but What Came First—Guns or Butter? Introducing GVAR to International Relations

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Abstract

This is the abstract.

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I. Introduction

"Power is the ultimate aphrodisiac," said Henry Kissinger (Kissinger 1973). Since the dawn of social and political science, power has been a key object of multiple research projects as well as served as a crucial explanation for others (Lasswell and Kaplan 1950). In recent decades a prevailing notion became present in International Relations, which sometimes takes the shape of a latent assumption, and sometimes as an explicit disclaimer, that the economic power is the most fundamental type of power—a sort of a condition for all other forms (Kennedy 1989; Luttwak 1990; Fukuyama 1992; Nau 1995; Kirshner 1997; Gilpin 2001; Brooks 2005; Ikenberry 2011). The argument is neatly summed by Organski, who claimed that economic power is a prerequisite for all other power capabilities, without a strong economy and good growth potential a dominant state stagnates and declines (Organski 1958, 299-306).

However, this claim has never been properly tested. For instance, Mearsheimer (2001, Ch. 3) dedicates a whole chapter in his masterpiece to explain how latent power matters to military power,[1] but he does not test this claim for great power relations, nor for international relations in general. Hence, are we taking this assumption for granted due to its sound causal pathway? Namely, states need good economy to purchase or make weapons[2]. However, if such a claim may be self-evident when it comes to relations between economic and military power, than this is not the case for relations between economic and political, and economic and cultural power.[3]

As such, if the literature offers assumptions about the nature of power and proposes causal relations between power factors,[4] than it should also provide general evidence that those are accurate. Nevertheless, such test is suspiciously missing from the International Relations scholarship. So far, the literature has not offered a general study which would test the assumption that economic power is a prerequisite of all other power factors. Several reasons may contribute to such a situation. First, the problem of measuring power, particularly political and cultural.[5] Second, the lack of appropriate methods of tackling this question. Third, the absence of unified theoretical framework of power that would allow for generalization of such test.

We acknowledge the first issue, but by no means should this limit scientific endeavors. Being aware of vices in databases and variables used to measure a concept should only motivate us to do additional primary research, as well as to reproduce existing studies with different variables from variety of data bases. Furthermore, being cognizant of the problem requires transparency,

not avoidance. Regarding the third point, it is very difficult to imagine that Political Science will ever develop an ultimate definition of power.[6] Still, this skepticism should not discourage us to advance power assessments, as well as limit scientific inquiries that are based on a specific definition. Therefore, this paper tackles the second problem—methodological. Namely, we introduce to Political Science a new time series method—Global Vector Autoregression (GVAR).[7] The latter, among other characteristics, enables a big N and big T analysis.[8] Therefore, it is ideal for testing such an assumption as relations between economic and military power.

As such, in this paper we focus solely on the relations between economic and military power factors. We use GVAR to determine which power factor drives the other—Granger causality (C. W. Granger 1969). We hypothesize that pre-World War One, it was military power that generated economic power—greater military, led to greater economic power. Moreover, we also expect in the second hypothesis that after the World War Two the relations would be reverse. Hence, it is the economic power that conditions military power. These two hypotheses derive from structural changes of international relations, such as advancement of technology, which contributes to slower fungibility of military power in modern time.[9] However, fungibility does not mean causality, it only refers to a possibility and the likelihood of that possibility—a resource to be used in more than one issue area.

We operationalize military and economic power using variables from Correlates of War Project, components of National Capability Index (Singer 1987). Namely, the number of military personnel, the amount of military expenditure, the amount of energy consumption, and the production of iron and steel. Furthermore, in GVAR model we also use Bilateral Trade data from the same database that is used as the foreign or structural variable.(Barbieri and O. M. Keshk 2016) Namely, in order to construct a GVAR model, one needs country specific data, as well as global variables, which generates the framework or weights of those country level numbers.[10] Our preliminary results confirm our hypothesis.

Hence, the paper proceeds by first positioning the question of relations between economic and military power in the broader literature on power. Second, we introduce the new method and GVAR model. Then we present our results and finally, elaborate our future research prospects and proposals regarding this scientific inquiry.

II. Power

The literature offers numerous ways how to think and understand power.[11] For the sake of clarity and being cognizant of the risk of oversimplification, we identify three approaches of conceptualizing power. First are the "dimensions of power"—"power to," "power over," "power with." Second are the faces of power. Third are power factors (economic, military, political, cultural). These three approaches may be distinct, but this does not mean that there are no commonalities, which can serve for new theory developments on power. However, we will leave this question of synthesis for a different paper.

Dimensions of power see power as either agential, structural, or relational (Qin 2018). "Power to" refers to the possession of the resources by a specific actor. Hence, it is linked with capabilities of states, which can be latent or already manifested. Namely, the more of a certain capability a state has, the more powerful it is. This is a straightforward logic; hence politicians and strategists like to operate with it (Deibel 2007). "Power over" refers to influence and control over outcomes or over other actors and their behavior (Hart 1976). As such, it bears a structural element, where the structure of international relations is favorable for certain states. "Power with" sees power residing in relations between A and B and therefore, both can draw from it. Thus, different type of relations lead to different levels of power in those relations. In fact, it is argued that the only way power is found is through the process of determining a consensus of goals and values among diverse interests (Arendt 1970). Deriving from these three dimensions of power Barnett and Duvall have presented their systemic, precise, and general typology of power (Barnett and Duvall 2005).

Another way of classifying power is through the so called "faces of power." Such a classification developed gradually throughout the decades after the end of the World War Two and resides in the notion that power needs to be understood as a cause. Hence, the "faces of power" look for causal pathways through which power functions. Digeser sums it up: "Under the first face of power the central question is, 'Who, if anyone, is exercising power?' Under the second face, 'What issues have been mobilized off the agenda and by whom?' Under the radical conception, 'Whose objective interests are being harmed?' Under the fourth face of power the critical issue is, 'What kind of subject is being produced?' " (Digeser 1992, 980) Namely, the first face sees power as coercion behind the decision of making B do what A wants. It stresses direct contact between A and B (Dahl 1957). Yet, Bachrach and Baratz (1962) expanded the causal mechanism of power and identified

that power also lies in the ability of A to make B do what A wants it to without with affection. They have called this the 'Second Face of Power.' Thus, B may do what A wants not only because A has an authority over B, but it also may be the case that B likes A and wants to please it. However, a 'third face of power' further expanded the causal mechanisms of power. It looks at the mechanism of subliminal ideological causes of shaping others' interest, rules and in international relations (Lukes 1974). Finally, the fourth 'face of power' postulates that subjectivity or individuality is not biologically given. Subjects are understood as social constructions, whose formation can be historically described. Thus, power works through the identity construction of A's and B's (Digeser 1992).

The third approach of looking at power is to look at a particular domain of state interaction. Subsequently, each domain has its unique sources of power and causal mechanisms how that power functions. As stated, Mann (1986) determined economic, military, political, and ideological power domains.

III. Modeling "Butter and Guns" in a Global Setting: Presenting the GVAR Methodology

I. GVAR: Country-specific Equations and Granger-causality Tests

Global vector auto-regressive models (GVAR) are a special category of vector auto-regressive models (VAR). Following Box-Steffensmeier et al. (2014, 164), define a VAR model as follows,

$$\mathbf{x}_{it} = \boldsymbol{\alpha}_i + \boldsymbol{\Phi}_i \mathbf{x}_{i,t-p} + \mathbf{u}_{it} \tag{1}$$

where $\mathbf{x}_{it}$ is a $k_i \times 1$ vector of endogenous variables which are lagged p times on the right-hand side, and where $E(\mathbf{u}_{it}) = 0$. Now, following Mauro and Pesaran (2013, 14), define a GVAR model with p lags for country i as follows,

$$\mathbf{x}_{it} = \boldsymbol{\alpha}_i + \boldsymbol{\Phi}_i \mathbf{x}_{i,t-p} + \boldsymbol{\Lambda}_{1i} \mathbf{W}_t + \boldsymbol{\Lambda}_{2i} \mathbf{W}_{t-p} + \mathbf{u}_{it} \tag{2}$$

where $\mathbf{x}_{it}$ is a $k_i \times 1$ vector of domestic (i.e. endogenous) variables, $\mathbf{W}_t$ is a $k_i \times 1$ vector of weakly-exogenous foreign variables, and $\mathbf{u}_{it}$ is a serially uncorrelated and cross-sectionally weakly dependent process. As it becomes apparent, the inclusion of foreign variables $\mathbf{W}_t$ in Equation 2

is one of the main characteristics of the GVAR approach, and the main difference with the VAR equation described in Equation 1. In simple, the Global vector autoregressive GVAR model in Equation 2 explains $\mathbf{x}_{i,t}$ as a function of past values $\mathbf{x}_{i,t-p}$ lagged p times, at the same time that it weights these dynamics by weakly-exogenous foreign variables $\mathbf{W}_{t-p}$ (weights which are captured by parameters $\mathbf{\Lambda}_{ni}$).

Since we are substantively interested in weather "guns" *cause* "butter" or the other way around, in this paper we estimate country-specific bivariate Granger-causality tests within the GVAR framework.[12] The Granger-causality method was introduced in C. Granger (1969) and it seeks to investigate if some variable X Granger-causes another variable Y, or the other way around. A variable X is said to Granger-cause Y if predictions of Y based on lagged values of Y and lagged values of X perform better than explaining Y just with its own past values. Since Granger-causality tests are usually estimated by fitting VAR equations (Equation 1) we now derive the Granger-causality test within the GVAR framework. The substantive advantage of GVAR Granger-causality tests over regular Granger-causality tests is that estimates are weighted by the global economy, situating the domestic dynamics within the global context. More formally, we estimate the following GVAR Granger-causality system for every country i with p lags as follows:

$$\begin{aligned}
\mathbf{x}_{it} &= \boldsymbol{\alpha}_i + \mathbf{\Phi}_{1i}\mathbf{y}_{i,t-p} + \mathbf{\Phi}_{2i}\mathbf{x}_{i,t-p} + \mathbf{\Lambda}_{1i}\mathbf{W}_t + \mathbf{\Lambda}_{2i}\mathbf{W}_{t-p} + \mathbf{\Lambda}_{3i}\mathbf{W}_t + \mathbf{\Lambda}_{4i}\mathbf{W}_{t-p} + \mathbf{u}_{it} \\
\mathbf{y}_{it} &= \boldsymbol{\alpha}_i + \mathbf{\Phi}_{1i}\mathbf{x}_{i,t-p} + \mathbf{\Phi}_{2i}\mathbf{y}_{i,t-p} + \mathbf{\Lambda}_{1i}\mathbf{W}_t + \mathbf{\Lambda}_{2i}\mathbf{W}_{t-p} + \mathbf{\Lambda}_{3i}\mathbf{W}_t + \mathbf{\Lambda}_{4i}\mathbf{W}_{t-p} + \mathbf{u}_{it}
\end{aligned} \tag{3}$$

In our case, the vector $\mathbf{x}_{it}$ contains country-year levels of "military personnel," while vector $\mathbf{y}_{it}$ contains country-year levels of "iron and steel production." Both variables were systematized by the Correlates of War Project, particularly, the National Material Capabilities dataset (Singer, Bremer, and Stuckey 1972).[13] The dataset covers all countries in the world between 1816-2012.

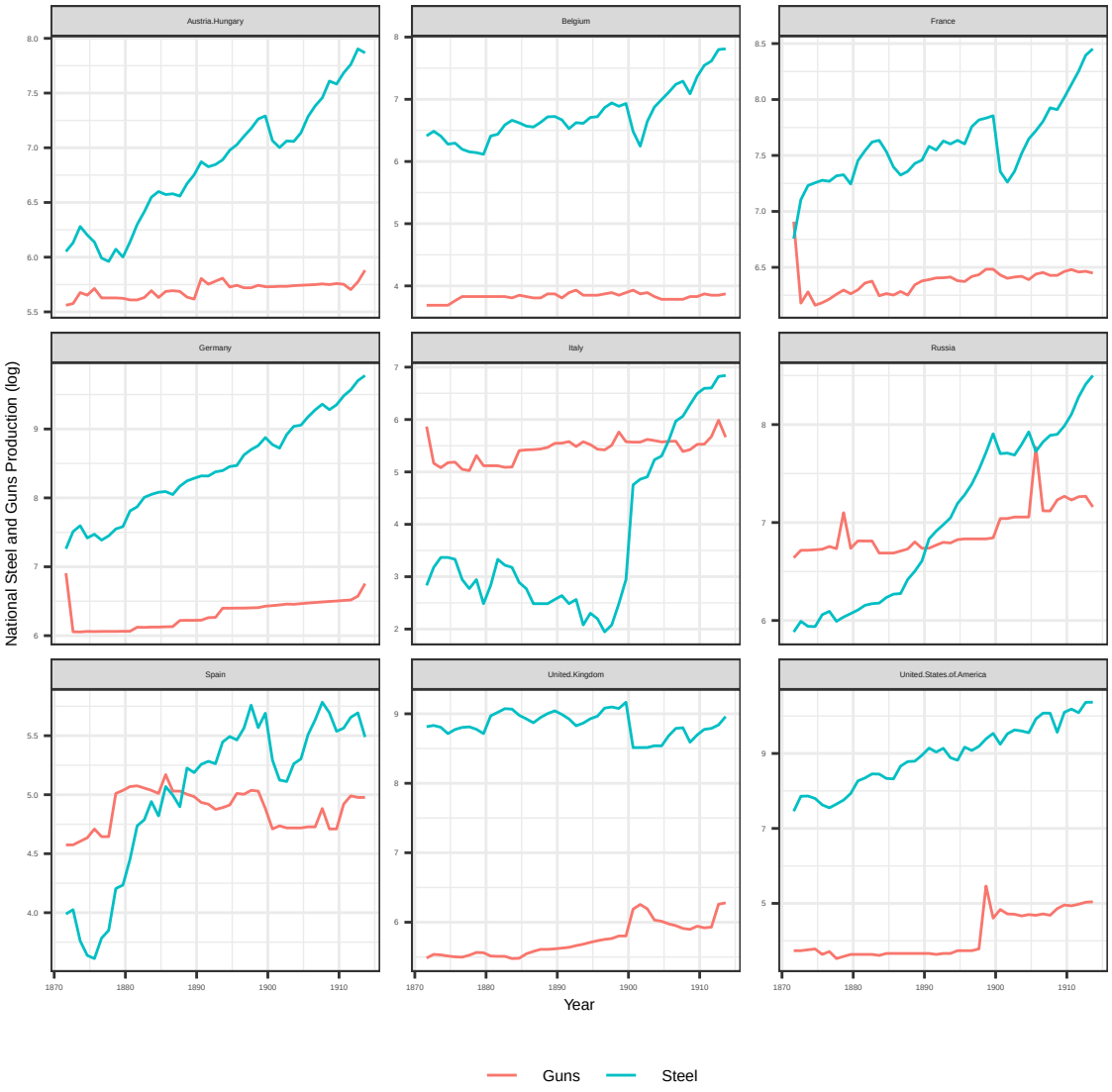

Figure 1: National Steel and Guns Production (log), 1871-1913.
Note: *Variables are "milper" and "irst." Both were obtained from Singer, Bremer, and Stuckey (1972).*

Also, the vector of foreign variables is the single variable "dyadic trade" which measures bilateral trade flows between two countries. This variable was constructed by the same project but in the Trade dataset (Barbieri, Keshk, and Pollins 2009; Barbieri and O. Keshk 2016)[14] and was used to construct the weight matrix $\mathbf{W}$. The matrix is a square matrix which has all K countries in both its columns and rows with zeros as diagonal elements. The matrix represents bilateral trade among two countries measured by the *flow1* and the *flow2* variables. The former measures imports from a country (*importer1*) to another country (*importer2*), and the latter measures the reverse dyad, i.e. imports from *importer2* to *importer1*. More formally, $\mathbf{W}$ contains t sub-matrices (one sub-matrix per year) with dimensions $k \times k$ for a total of $\mathbf{K}$ countries such that,

$$\mathbf{W}_t = \begin{bmatrix} & \mathbf{i}_1 & \mathbf{i}_2 & \mathbf{i}_3 & \dots & \mathbf{i}_K \\ \mathbf{i}_1 & 0 & f_{21} & f_{31} & \dots & i_{K1} \\ \mathbf{i}_2 & f_{12} & 0 & f_{32} & \dots & i_{K2} \\ \mathbf{i}_3 & f_{13} & f_{23} & 0 & \dots & i_{K3} \\ \vdots & \vdots & \vdots & \vdots & \ddots & \vdots \\ \mathbf{i}_K & f_{1K} & f_{2K} & f_{3K} & \dots & i_{KK} \end{bmatrix}$$

Every W_t matrix weights all K country-specific Granger regressions described in Equation 3. Every K system is weighted by the other $K-1$ countries. And as Equation 3 shows, the GVAR methodology also considers p lags of the $\mathbf{W}$ matrix. Following the literature on Granger-causality tests we focus our attention model-specific f-tests (one per country) which tests if all variables in the model are jointly significant. Then null is that there is no Granger causality.

II. Results

Figure 2 shows country-specific p-values of the Granger-causality f-tests obtained when fitting Equation 3 (detailed results shown in Table A1, Table A2 and Table A3). The plot shows that during the $1871-1913$ period, in 44% of the countries, butter Granger-caused guns. This percentage changes to 38%, and to 33% for the hegemonic countries during the $1955-2012$ period. In other words, in 45.5% of the instances, guns Granger-caused butter for the $1955-2012$ period. These results strongly suggest that the guns-butter "causal" relationship reverses during the late 20th century.

Gist of the paper

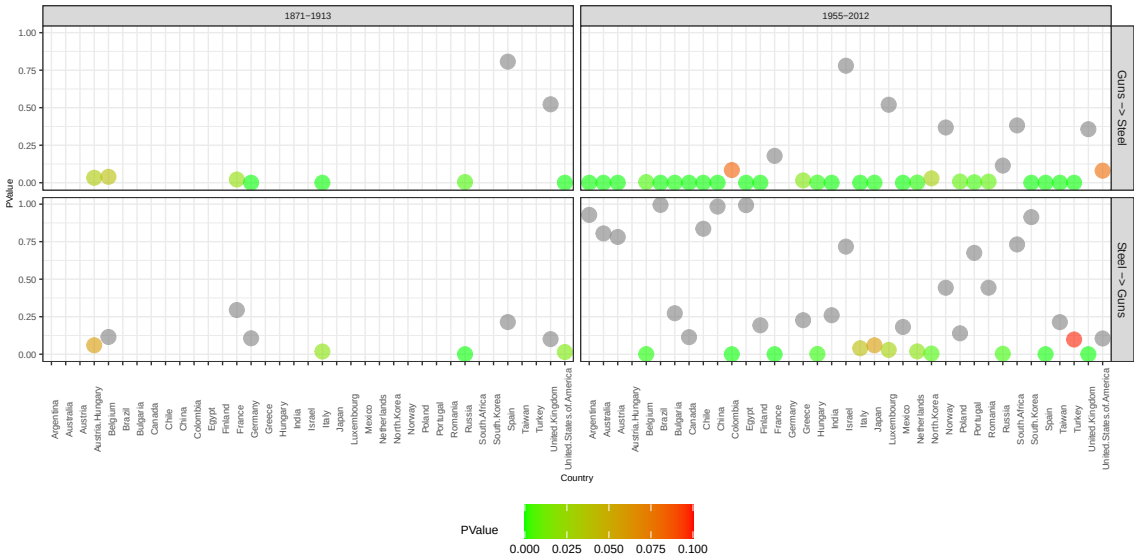

Figure 2: P-Values of the Country-specific Granger-causality F-Tests, 1871-2012.
Note: *Plot shows country-specific p-values of the Granger-causality f-tests obtained when fitting Equation 3 (detailed results shown in Table A1, Table A2 and Table A3). The plot shows that during the 1871-1913 period, in 44% of the countries, steel Granger-caused guns. This porcentage changes to 38% and to 33% for the hegemonic countries during the 1955-2012 period.*

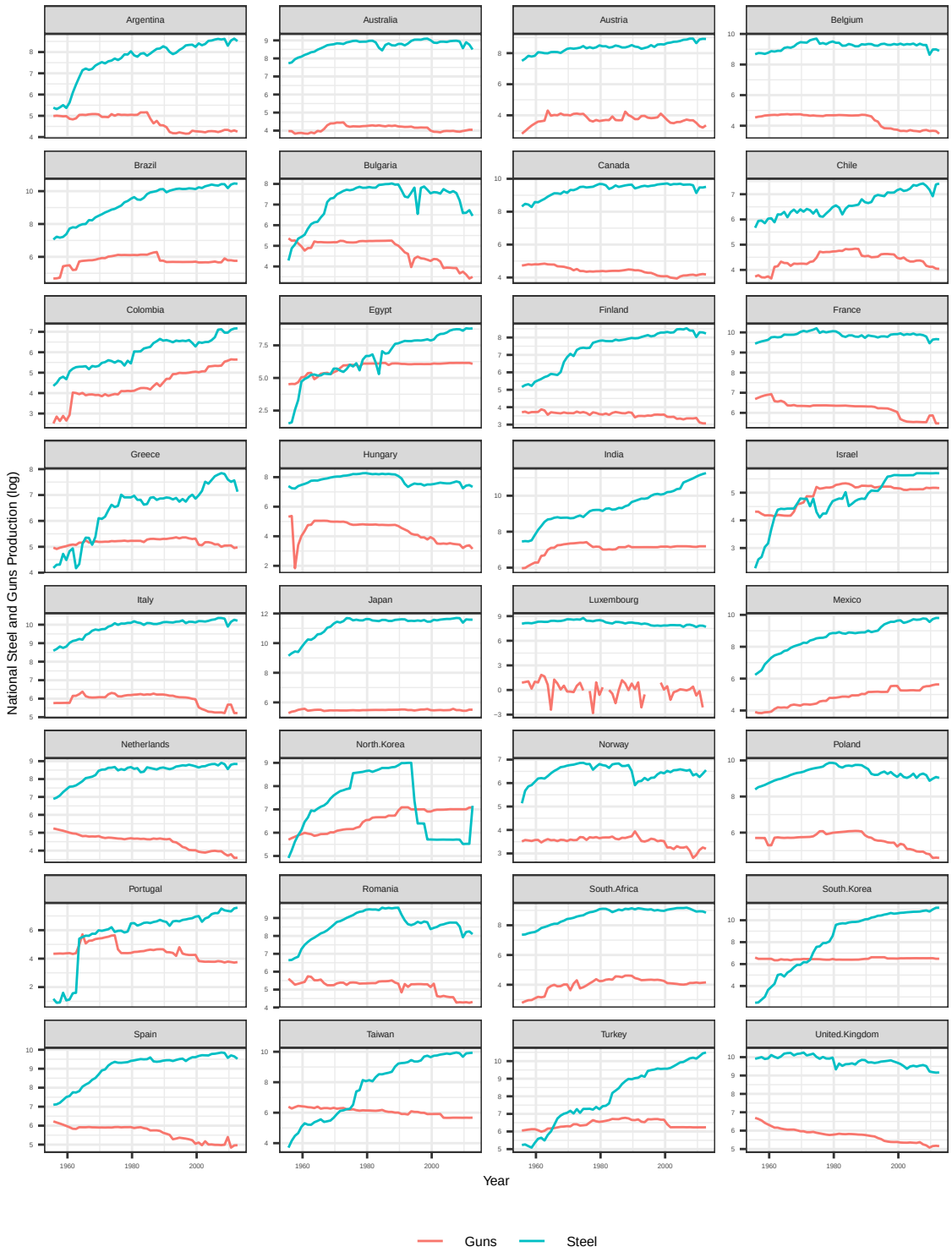

Figure 3: National Steel and Guns Production (log), 1955-2012.
Note: *Variables are "milper" and "irst." Both were obtained from Singer, Bremer, and Stuckey (1972).*

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Word count: 1,172

IV. Appendix

I. Appendix

Table A1: *Bivariate Gobal Granger Causality Tests of the World Political Economy,* 1871-1913

	Granger Relationship	**F-Test**	**P-Value**	**DF**	**Adjusted R-sq**	**Lags**
Austria-Hungary	butter → guns	2.16	0.06	8,31	0.192	1
	guns → butter	2.48	0.03	8,31	0.233	
Belgium	butter → guns	1.781	0.11	16,19	0.263	5
	guns → butter	2.339	0.04	16,19	0.38	
France	butter → guns	1.27	0.29	8,31	0.052	1
	guns → butter	2.72	0.02	8,31	0.261	
Germany	butter → guns	1.844	0.11	8,31	0.148	1
	guns → butter	7.891	0	8,31	0.586	
Italy	butter → guns	2.777	0.02	16,19	0.448	5
	guns → butter	6.801	0	16,19	0.726	
Russia	butter → guns	8.725	0	16,19	0.779	5
	guns → butter	3.595	0	16,19	0.543	
Spain	butter → guns	1.454	0.21	8,31	0.085	1
	guns → butter	0.554	0.81	8,31	-0.101	
United Kingdom	butter → guns	1.85	0.1	16,19	0.28	5
	guns → butter	0.966	0.52	16,19	-0.016	
United States	butter → guns	2.942	0.01	8,31	0.285	1
	guns → butter	8.608	0	8,31	0.609	

Table shows country-specific Granger-causality F-tests. Last column shows number of domestic lags used per every country-specific Granger model. Number of lags for endogenous variables = 2. Number of lags for foreign variables = 2. Max number of lags for estimating the country-specific VAR model = 5. Information criteria for optimal lag length = AIC. Deterministic variables: Trend and constant.

Table A2: *Bivariate Gobal Granger Causality Tests of the World Political Economy,* 1955-2012 *(A)*

	Granger Relationship	F-Test	P-Value	DF	Adjusted R-sq	Lags
Argentina	butter → guns	0.422	0.93	10,44	-0.12	1
	guns → butter	7.765	0	10,44	0.556	
Australia	butter → guns	0.629	0.8	12,41	-0.092	2
	guns → butter	5.618	0	12,41	0.511	
Austria	butter → guns	0.656	0.78	12,41	-0.084	2
	guns → butter	7.305	0	12,41	0.588	
Belgium	butter → guns	3.842	0	12,41	0.392	2
	guns → butter	3.001	0	12,41	0.312	
Brazil	butter → guns	0.237	0.99	12,41	-0.209	2
	guns → butter	9.498	0	12,41	0.658	
Bulgaria	butter → guns	1.269	0.27	12,41	0.057	2
	guns → butter	4.286	0	12,41	0.427	
Canada	butter → guns	1.69	0.11	10,44	0.113	1
	guns → butter	5.055	0	10,44	0.429	
Chile	butter → guns	0.561	0.84	10,44	-0.088	1
	guns → butter	7.313	0	10,44	0.539	
Colombia	butter → guns	4.855	0	18,32	0.581	5
	guns → butter	1.737	0.08	18,32	0.21	
Egypt	butter → guns	0.219	0.99	10,44	-0.169	1
	guns → butter	5.471	0	10,44	0.453	
Finland	butter → guns	1.428	0.19	12,41	0.088	2
	guns → butter	5.041	0	12,41	0.478	
France	butter → guns	8.235	0	16,35	0.694	4
	guns → butter	1.442	0.18	16,35	0.122	
Greece	butter → guns	1.344	0.23	18,32	0.11	5
	guns → butter	2.39	0.02	18,32	0.334	
Hungary	butter → guns	3.363	0	12,41	0.349	2
	guns → butter	3.711	0	12,41	0.38	
India	butter → guns	1.287	0.26	14,38	0.072	3
	guns → butter	6.048	0	14,38	0.576	
Israel	butter → guns	0.702	0.72	10,44	-0.058	1
	guns → butter	0.63	0.78	10,44	-0.073	
Italy	butter → guns	2.151	0.04	10,44	0.176	1
	guns → butter	11.365	0	10,44	0.657	
Japan	butter → guns	1.876	0.06	16,35	0.216	4
	guns → butter	4.079	0	16,35	0.491	
Luxembourg	butter → guns	2.296	0.03	10,44	0.194	1
	guns → butter	0.925	0.52	10,44	-0.014	
Mexico	butter → guns	1.436	0.18	16,35	0.12	4
	guns → butter	8.525	0	16,35	0.702	
Netherlands	butter → guns	2.483	0.02	10,44	0.216	1
	guns → butter	3.73	0	10,44	0.336	
North Korea	butter → guns	2.875	0	18,32	0.403	5
	guns → butter	2.143	0.03	18,32	0.292	
Norway	butter → guns	1.02	0.44	10,44	0.004	1
	guns → butter	1.122	0.37	10,44	0.022	
Poland	butter → guns	1.57	0.14	12,41	0.114	2
	guns → butter	2.745	0.01	12,41	0.283	
Portugal	butter → guns	0.749	0.68	10,44	-0.049	1
	guns → butter	3.265	0	10,44	0.296	
Romania	butter → guns	1.019	0.44	10,44	0.004	1
	guns → butter	2.878	0.01	10,44	0.258	
South Africa	butter → guns	0.686	0.73	10,44	-0.062	1
	guns → butter	1.102	0.38	10,44	0.019	
South Korea	butter → guns	0.448	0.91	10,44	-0.114	1
	guns → butter	9.019	0	10,44	0.598	
Spain	butter → guns	4.66	0	10,44	0.404	1
	guns → butter	4.92	0	10,44	0.421	
Taiwan	butter → guns	1.382	0.21	12,41	0.08	2
	guns → butter	5.667	0	12,41	0.514	
Turkey	butter → guns	1.696	0.1	14,38	0.158	3
	guns → butter	25.426	0	14,38	0.868	
United Kingdom	butter → guns	9.085	0	10,44	0.6	1
	guns → butter	1.139	0.36	10,44	0.025	

Table shows country-specific Granger-causality F-tests. Last column shows number of domestic lags used per every country-specific Granger model. Number of lags for endogenous variables = 3. Number of lags for foreign variables = 3. Max number of lags for estimating the country-specific VAR model = 5. Information criteria for optimal lag length = AIC. Deterministic variables: Trend.

Table A3: *Bivariate Gobal Granger Causality Tests of the World Political Economy,* 1955-2012 *(B)*

	Granger Relationship	**F-Test**	**P-Value**	**DF**	**Adjusted R-sq**	**Lags**
China	butter → guns	0.252	0.98	9,45	-0.142	2
	guns → butter	83.191	0	9,45	0.932	
Russia	butter → guns	3.663	0	7,48	0.253	1
	guns → butter	1.775	0.11	7,48	0.09	
United States	butter → guns	1.821	0.1	7,48	0.095	1
	guns → butter	1.961	0.08	7,48	0.109	

Table shows country-specific Granger-causality F-tests. Last column shows number of domestic lags used per every country-specific Granger model. Number of lags for endogenous variables = 2. Number of lags for foreign variables = 2. Max number of lags for estimating the country-specific VAR model = 5. Information criteria for optimal lag length = AIC. Deterministic variables: NA.

Notes

1. They described it as perhaps the most fundamental in the whole Political Science; whereas Elster (1976, 245-70, 249) is even more assertive arguing that power is the most important single idea in Political Theory.

2. Some studies have posed a similar research questions—generally touching upon the relations between the economy and military or strategy, e.g.: Baldwin (1985), Beckley (2010), and Copeland (2014). Moreover, Power Transition literature defined economic growth and development as a primary source of international change, and Gross Domestic Product has been identified as the parsimonious indicator of satisfaction with the status quo, see for example Organski and Kugler (1980), Lemke and Werner (1996), and Soysa, Indra, and Park (1997). However, these are inquiries about the change in the international system, not of power *per se*. International Political Economy also posed ontologically different questions and has not offered a comprehensive research on power. It is primarily interested in the political decision to prefer economic benefits or security, as if these two issues would be mutually exclusive—the question of "Power or plenty," for instance Viner (1948), Katzenstein (1977), Gowa (1994), Hafner-Burton and Montgomery (2008), Findlay and O'rourke (2009), and Cohen (2017). For an insightful analysis on false exclusivity of the economic and security interests, see Norrlof and Wohlforth (2016).

3. We decided to use the term culture, and not ideological, as it is often referred to in the literature (e.g Mann (1986)). Although we agree with Mann regarding the concept and what it implies, we think the name carries a negative connotation, relating mostly to Marxist traditions where it has been identified with false consciousness. Nevertheless, the ideational dimension of power should not be understood as something negative. Identity is also something positive. Thus, to avoid any prejudgments, we talk about cultural, which is neutral in its connotation, not ideology.

4. Military, economic, political, and cultural power factors (Mann 1986).

5. On this issue see Hohn (2014).

6. There is no lack of definitions and conceptualizations of power, which have been hotly debated for

decades. See: Russel (1938), Simon (1953), Hunter (1953), March (1955), Mills (1956), French and Raven (1959), Bachrach and Baratz (1962), Lukes (1974), Oppenheim (1976), Stokman, Ziegler, and Scott (1985), Digeser (1992), and Scott (1994).

7. GVAR was introduced in 2004, see Pesaran, Schuermann, and Weiner (2004). It "was developed in the aftermath of the 1997 Asian financial crisis to quantify the effects of macroeconomic developments on the losses of major financial institutions. It was clear then that all major banks are exposed to risk from adverse global or regional shocks, but quantifying these effects required a coherent and simple-to-simulate global macroeconomic model. The GVAR approach provides a useful and practical way of building such a model, and, although developed originally as a tool for credit risk analysis, it soon became apparent that it has numerous other applications Chudik and Pesaran (2016)."

8. This was so far not possible to perform. PVAR allowed for small N and big T, and Arellano-Bond linear dynamic panel-data estimation is used for big N and small T. On particularities of GVAR and how they relate to other time series methods see Mauro, Filippo, and Pesaran (2013), Bouvet, Brady, and King (2013), Canova and Ciccarelli (2013), Schnucker (2017), and Alzuabi, Caglayan, and Mouratidis (2020).

9. On the debate on fungibility of power see Art (1996, 1999) and Baldwin (1999).

10. "Through the use of foreign variables, the GVAR is able to account for bilateral inter-relationships amongst countries, and therefore control for spillovers on the basis of cross-country exposure. Additionally, the use of foreign variables allows the GVAR to scale up in a coherent manner and include a larger number of variables than possible in a VAR. Unlike a PVAR model, a GVAR also maintains the capability of giving country-level estimates " (Fund 2016).

11. A good overview is Baldwin (2016).

12. We acknowledge that without proper experimentation and randomization there cannot be proper causation. Consequently, and following the Granger methodology, we employ a rather lose definition of "causation" and explore if lagged values of a variable *forecast* another variable.

13. Version 5.0.

14. Version 4.0.