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Female Empowerment and Economic Growth*

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Abstract

We discuss how inclusive institutions enhance technological change, the main driver of long-term economic growth. Specifically, institutions that promote female political empowerment advance technological change through a) increasing the number and variability of new ideas introduced in the economy and b) improving the selection of more efficient ideas. We test different implications from our argument by measuring three aspects of empowerment – descriptive representation, civil liberties protection, and civil society participation – across 182 countries and 221 years. Empowerment is positively related to subsequent growth, even when accounting for initial differences in income, past growth rates, democracy, and country- and year-fixed effects. The three sub-components of empowerment are also, individually, related to growth, although not as strongly as the aggregated concept. The relationship is retained across different regimes, time periods, and geographic contexts, but is clearer for "Non-Western" countries. Finally, empowerment enhances TFP growth, a proxy for technological change.

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1 Introduction

To what extent does a country's economic development rely on its political institutions? A large literature spanning economic history, economics, and political science has been preoccupied with this broad, and very important, question for decades (North, 1990; Rodrik, Subramanian and Trebbi, 2004; Gerring et al., 2005; Acemoglu and Robinson, 2012). Yet, we lack a clear understanding of which specific institutions are more and less important, despite researchers acknowledging that "good institutions" enhance development. A second literature emphasizes the role of inclusion of more particular social groups in positions of power and decision-making, with a special focus on the inclusion of women. Female empowerment is not only a normative ideal in itself, but may have instrumental value for other valuable outcomes (e.g., Sundström et al., 2017), including economic development (e.g., Duflo, 2012).

In this paper, we bridge these two literatures by focusing on how open and inclusive political institutions influence countries' trajectories of economic development by empowering and including a broad population group that is otherwise often excluded, namely women. We rely on a broad definition of female political empowerment, which includes increased capacity for women to influence political decision-making through three pathways: 1) descriptive political representation; 2) freedom of choice, guaranteed by protected civil liberties; and 3) opportunity to express their voice. Existing studies on political institutions and development have mainly focused on how institutions influence capital investments. Yet, growth economists propose that technological change is *the* main driver of long-term growth ([Romer, 1990; Acemoglu, 2008). We present an argument and empirical analysis indicating how female empowerment contributes to technological change. Specifically, our theoretical argument focuses on how institutional features that promote female political empowerment affect technological change through a) increasing the number and variability of new ideas introduced in the economy and b) improving how efficiently the best, new ideas are adopted. Women constitute the majority of the adult population in many countries, and excluding women from processes of idea generation and selection should have substantial implications for a society's ability to generate technological change.

We test various implications from this argument using extensive data from the Varieties of Democracy (V-Dem) project (Coppedge et al., 2020) to measure the three mentioned aspects of female political empowerment. Across 182 countries and time series extending for 221 years, we find robust evidence that female political empowerment (FPE) is positively related to subsequent GDP per capita growth. This relationship holds up when accounting for initial differences in economic development, democracy levels, and country- and year-fixed effects. When disaggregating FPE into its sub-components, we find that descriptive political representation, civil liberties protection, and civil society participation are all, individually, related to growth. Further, the overall relationship between FPE and growth is retained across different contexts, but is stronger and more robust for "Non-Western" than for "Western" countries. Finally, when disaggregating the sources of economic growth, we find that FPE enhances total factor productivity growth, a proxy for technological change.

In the following, we first review relevant studies on institutions and economic growth, before we consider studies on the consequences of political inclusion and representation of women, more specifically. Next, we present our theoretical argument on how female political empowerment enhances technological change, which, in turn, enhances economic growth. We thereafter present our data and research design, before we present and discuss our empirical results. In the concluding section, we discuss the real-world relevance of our findings. For many people, including political leaders, female political empowerment is of intrinsic normative value, and additional motivation for ensuring equal participation and protection of rights across genders is not needed. Insofar as women's rights are human rights (Bunch, 1990), women should have the same basic opportunities as men, including an equal say in decisions on how to govern society. Yet, countries across the world still vary enormously in how empowered women are, politically. The "business case" that we present might contribute to incentivizing initially hesitant leaders and social groups – albeit for instrumental reasons – to improve female political empowerment.

2 Relevant literatures

In this section, we provide a brief overview of the theoretical and empirical literatures that serve as building blocks for our argument, which is presented in the following section. We first review studies on (immediate and deep) determinants of economic growth, focusing on arguments and evidence pertaining to how institutions shape technological change. Next, we review studies addressing how different aspects of female empowerment influence economic outcomes.

2.1 Economic growth, and the role of institutions

Growth economists have, for decades, studied the "immediate determinants" of growth (e.g., Barro and Sala-i Martin, 2004; Helpman, 2004; Acemoglu, 2008). Several theoretical models specify how different such determinants feed into growth processes (e.g., Solow, 1956; Mankiw, Romer and Weil, 1992; Romer, 1990) and "growth accounting" exercises (e.g., Young, 1995; Klenow and Rodriguez-Clare, 1997; Baier, Dwyer Jr. and Tamura, 2006) have assessed how much of growth in national income or production (both typically measured by GDP per capita) come from the various determinants. Immediate determinants are either classified as factor inputs in production processes – notably labour hours, physical capital, human capital, land, and natural resources – or as ways in which these inputs are combined into producing output, referred to by the broad concept of "technology". This concept covers specific production technologies, but also ideas about economic policies and how economic processes are organized. The presumed relative importance of different immediate determinants in influencing short-, medium-, and long-term growth varies across theoretical models. Yet, the most prominent ones – both among so-called neo-classical- and endogenous growth models – highlight that accumulation of factor inputs, such as labor and capital, may boost growth in the short- to medium term, but not in the longer term (as returns to accumulating more inputs decrease). In contrast, technological change drives long-run growth.[1]

The introduction of new ideas and production technologies to an economy can come from domestic innovation *or* from the adoption (and possibly adaptation) of technology developed abroad. Several economists focus primarily on processes of innovation for understanding technological change. Romer (1990), for example, introduces a “new growth model”, where profit-maximizing firms contribute to technological change by innovating and supplying a wider variety of new products. Grossman and Helpman (1991) and Aghion and Howitt (1992) model technological change as generated by firms investing in innovation of improved products that replace existing products of inferior quality. Yet, since ideas are “non-rivalrous” (see Romer, 1993), production and organization technologies can, at least in principle, be used to enhance efficiency also in other countries than where they originate from. Indeed, most production and organization technologies in use in any current economy come from abroad. Diffusion of foreign technology is especially important for small countries and poor countries far away from the “global technological frontier”. Hence, in order to understand technological change, and thereby persistent differences in growth rates across countries, we must understand why some countries are better than others at adopting production techniques and ideas developed elsewhere, and at diffusing them within their economies.

So-called “evolutionary growth models” (see, e.g., Nelson and Winter, 1982; Nelson, 2005; Verspagen, 2005) are relevant in this regard. This strand of growth theory has developed models that draw on key notions from evolutionary biology to assess which factors enhance the adoption of new and more efficient technologies. The two key inputs to such processes are a) an increased variety of new ideas being introduced to the economy – partly from domestic processes of innovation, but notably through diffusion of ideas from abroad – and b) mechanisms for ensuring the selection of the more efficient ideas. A large variety of

[1] We remark that the sharp distinction between how factor inputs and technology feed into growth is a simplification; investments in new machinery may introduce new technology (Nelson, 2005) and high human capital levels facilitate the adoption of more efficient technologies (Kremer, 1993*a*).

competing ideas and technologies enhances economic efficiency, especially when it is unclear *a priori* how ideas and technologies will work in practice; economic actors learn how effective they are from processes of trial and error (North, 2005). Regarding the selection of ideas, this process reduces variety as new techniques are adopted through learning and less efficient techniques are discarded. An economy thus requires the steady introduction of novel ideas to keep up variety. Factors that simultaneously allow for the introduction of new ideas and enable improved selection and diffusion processes are therefore especially likely to enhance technological change. This insight is central in our theoretical argument below.

So-called *deeper determinants* of economic growth (Rodrik, Subramanian and Trebbi, 2004) are located prior in the causal chain to the immediate determinants discussed above. Suggested deeper determinants include cultural norms and practices, various geographic features, and demographic factors (see, respectively, Landes, 1998; Diamond, 1997; Kremer, 1993*b*). Yet, the perhaps most studied deeper determinant is "good institutions" (e.g., North, 1990; De Long and Shleifer, 1993; Rodrik, Subramanian and Trebbi, 2004; Acemoglu, Johnson and Robinson, 2001; Acemoglu and Robinson, 2012). By influencing which economic policies are selected, and determining the expected costs and risks to investors, institutions presumably affects capital accumulation (e.g., North, 1990; Bizzarro et al., 2018). But, more importantly for long-term growth, institutions may also influence innovation and the adoption of new technologies. For example, institutions ensuring the protection of intellectual property rights may strengthen incentives for firms to invest in innovation activities (Romer, 1990). Further, protection of civil liberties (Knutsen, 2015) or competitive multi-party elections (North, Wallis and Weingast, 2009) may enhance both the *variety* of ideas introduced into the economy and improve *selection* of the more efficient ideas. Open and inclusive political institutions "more readily generate a range of solution to problems; they more readily experiment with solutions to problems; and they more readily discard ideas and leaders who fail to solve them" (North, Wallis and Weingast, 2009: 134). By enabling different population groups – and thus more creative minds – to enter political debates and take part in economic interactions, open and inclusive institutions enhances technological change, and thereby growth.

Despite the plausibility of the argument that "institutions matter" for growth, scholars have yet to conclude on exactly which particular institutions that matter the most. Some authors focus on features of the public administration (Evans and Rauch, 1999; Fukuyama, 2014). Others argue that low levels of corruption and impartiality determine development outcomes (Rothstein and Teorell, 2008). Yet others highlight the role of institutionalized political parties (Bizzarro et al., 2018). Finally, democracy, and especially competitive multiparty elections, is another prominent explanation for economic growth, although empirical results are not robust (Przeworski et al., 2000; Gerring et al., 2005; Acemoglu et al., 2019). In this paper, we focus on institutions that further female political empowerment. We argue that such institutions enhance growth through enhancing both the variety of new ideas *and* the selection of more efficient ones, thereby leading to more rapid technological change. Before we present our argument, however, we review existing studies that relate aspects of female empowerment to economic outcomes.

2.2 Economic consequences of female empowerment

Several studies have proposed that gender equality and female empowerment may relate to economic outcomes, including growth and its immediate determinants (for reviews, see Cuberes and Teignier, 2014; Duflo, 2012; Kabeer and Natali, 2013). The most intensively studied outcomes are female labor participation and education outcomes.

Regarding the former, Esteve-Volart (2004) presents a theoretical model indicating the inefficiency and negative economic consequences of excluding women from labor participation. In this model, individuals are born with a given talent, and restricting the access of women to managerial positions leads to loss of talent in the positions where they are the most productive. This gives diminished innovation and slower technology adoption, thereby reducing productivity growth. Such exclusion of women thus gives lower equilibrium wages, both for male and female workers. Further, restricting the type of work women can do, more generally in the economy, to only home production, reduces income also due to the inherently lower productivity of such production. Finally, both types of exclusion – from managerial positions and from general production in certain sectors – leads to lower investment in human capital, which further contributes to lower growth rates. Similarly, building a model of heterogeneous talents in a population, Cuberes and Teignier (2012) show how barriers for women to become managers significantly reduce the average talent available in the economy, and thereby aggregate productivity and income levels. Their cross-country estimates indicate that the loss in GDP per capita is about 12 percent when women cannot take managerial positions, and about 40 percent when women are completely excluded from the labor market. The estimated income loss in the mid-2000s for countries in the Middle East and North Africa, the region with the highest exclusion rates for women, is 27 percent.

Similarly, studies suggest that gender gaps in education hurt economic growth directly due to reduced human capital, with potential ramifications also for technological change (Klasen, 2002; Klasen and Lamanna, 2009; Knowles, Lorgelly and Owen, 2002; Thévenon et al., 2012). Education for women also carries other externalities, such as reduced fertility and improved child-care and child survival, that enhance the human capital of future generations, and thus growth (for reviews, see Mitra, Bang and Biswas, 2015; Duflo, 2012). Using panel data, Klasen and Lamanna (2009) and Thévenon et al. (2012) investigate the effects of gender gaps in education and labor force participation, and find that such gaps are associated with reduced economic growth. In OECD countries, on average, an additional year of education for girls is estimated to give 10 percent higher GDP per capita (Thévenon et al., 2012).

In sum, the literature convincingly shows that there is a positive relationship between higher education levels and labor force participation among women and economic growth. However, we know less about the effects of other types of female empowerment. Mitra, Bang and Biswas (2015) argue that gender equality is a multi-dimensional concept, consisting of distinct features that may have different effects on economic growth. Mitra, Bang and Biswas

(2015) thus create two distinct indices of female empowerment. They find that equality in economic opportunity (a combined index of a literacy gap, secondary enrollment gap and fertility rate) is associated with growth in developing countries, while equality in economic and political outcomes (index of labor force participation gap and percent of women in parliament) displays this association in developed economies. Yet, despite the evidence presented by Mitra, Bang and Biswas (2015), we still lack in understanding of exactly how the political exclusion of women, along different dimensions, affect economic growth. In the following, we argue that female political empowerment have positive implications for technological change in both developing and developed countries.

3 Argument

Following (Sundström et al., 2017), we adopt a broad definition of female political empowerment (FPE) as "a process of increasing capacity for women, leading to greater choice, agency, and participation in societal decision-making". Hence, we go beyond descriptive political representation and also cover freedom of choice guaranteed through civil liberties protection and the ability to voice ideas and preferences. Rather than focusing on whether women have access to particular resources such as education or land, we consider the extent to which women have access to political power and are able to distribute resources and influence decisions, more generally (Longwe, 2000). Before we dig deeper into the particular mechanisms, linked to various aspects of FPE and how they influence the variation in new ideas or the selection of more efficient ones, we summarize the core logic of the argument.

Figure 1 gives a graphical illustration of the main steps in the argument. Our concept of FPE has three sub-components. The first sub-component pertains to enhanced freedom of choice for women in different spheres, notably related to strengthened civil liberties. The second relates to improved representation for women in key arenas of political decision-making, including the legislature and executive. The third pertains to women being able

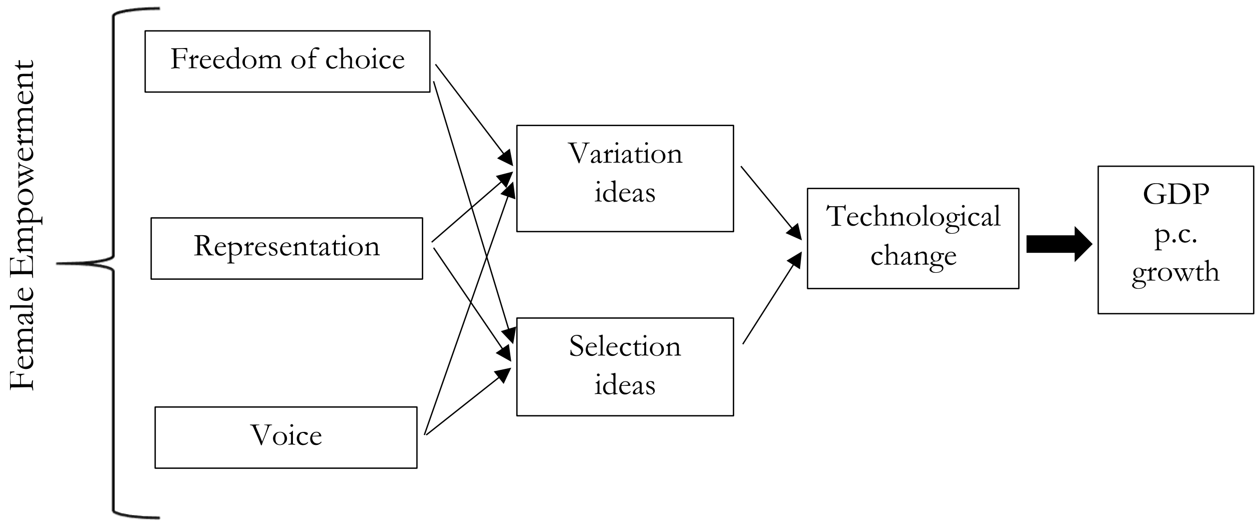

Figure 1: Sketch of the main components and links in our argument

to actively voice their preferences and ideas though various forms of civic participation. Political institutions that enhance any one of these sub-components may also enhance the rate of technological change. As Figure 1 shows, we surmise that all three sub-components have independent effects on the variety of new ideas introduced into the economy as well as the selection of more efficient ideas. These are the two key determinants of technological change, according to the evolutionary growth models reviewed above. Since technological change shapes economic growth, we further anticipate links between all three sub-components and GDP per capita growth rates, and an even stronger link between the aggregated concept of FPE and growth. Let us now turn to plausible, more specific mechanisms, which we sort according to FPE's three sub-components.

3.1 Descriptive political representation

Arguments along the lines of Esteve-Volart (2004), which suggest that excluding women (and thus about half the population of any country) from key positions is economically inefficient, can be translated to the area of political representation. Political arenas such as legislatures and executives (or local councils, for that matters) are where many vital decisions about how a society develops, including its economy, are made. If we assume that a) economic and other policies matter economic development, and b) the quality of policies depends on characteristics of the decision makers, we can expect that changes in descriptive political representation affect development.[2] Bringing in women in politics not only expands the country's "political talent pool", but evens increases the variance in other relevant characteristics of representatives such as types of experience, knowledge, or even policy preferences (e.g., Khan, 2017). This, in turn, enhances the quality of deliberation by bringing in new and different ideas, and thereby increases the chances of adopting policies that benefit a broad segment of the population (Mansbridge, 1999). Hence, improved descriptive representation of women may increase both the variation of policy ideas *and* improve the process of selecting the "best" such ideas.

Existing studies show systematic differences in the policy preferences of women and men (Khan, 2017). Given these differences, increased female representation may lead to the selection of certain policies that are (objectively) better at generating at least certain development outcomes. At the micro level, women invest more in goods and services that improve the well-being of families and that improve education and health-care outcomes (Duflo, 2012). At a more aggregate level, Miller (2008) shows that introduction of women suffrage in the United States was associated with declining infant mortality due to the qualitatively different issues that women placed on the political agenda, notably related to health-care. Elite-level analysis reveal that female candidates present themselves in a systematically distinct manner from men in campaigns and more often promote health-care and education issues (Kahn, 1993). These patterns are replicated in recent years and in online

[2]Phillips (1995), for example, highlights that the personal characteristics of representatives are relevant for the representation of the population and their interests, with further implications for which policies are produced. The basic premise is that descriptive representation is required to ensure that everyone's interests and points of view are heard and taken into account (Birnir and Waguespack, 2011). In political environments with competition for resources and agendas, *who* the political representatives are matter. If equal representation is not achieved, adopted policies will reflect the preconditions and preconceptions of the dominant group (Young, 2011).

behavior (Evans and Clark, 2016; Mechkova and Wilson, 2019). Swiss, Fallon and Burgos (2012) examine how descriptive representation influences child health across 102 developing countries from 1980-2005, and find that compared to countries with no women in parliament, countries meeting a 20-percent threshold experience increased rates of immunizations and infant- and child survival.

Improved descriptive representation also has symbolic significance (Pitkin, 1967), which could, in turn, have different substantive effects. A more representative government might be one that citizens trust more and are more likely to engage with (Mansbridge, 1999). Female voters may be more likely to contact female political representatives, perceiving that their interests are better defended by someone with similar background (Mechkova and Carlitz, 2018). Indeed, female citizens more often attend village meetings and express their points of view with women in the local leadership (Beaman et al., 2009). Such feedback and interactions between citizens and policy makers is crucial for identifying what policies are appropriate for the local context and for effectively implementing them, in practice, with downstream implications for productivity (Evans, 1995).

Better political representation can also enhance female participation in various economic arenas. Ghani, Mani and O'Connell (2013) examines mandated political representation at the local level in India, and find that higher female representation over extended time relates to greater female labor force participation, partly from increased public sector employment and partly from the building of infrastructure (e.g., related to roads and health-care) that facilitates women entering the labor force.[3] And, as proposed by Esteve-Volart (2004) and others, increased female labor force participation leads not only to a more heterogeneous pool of workers, but also to decision-makers in the economy, on average, being more talented, thereby enhancing productivity growth.

[3]Chattopadhyay and Duflo (2004) also find evidence from India that elected local leaders invest in infrastructure that is prioritized by citizens of their own gender.

3.2 Freedom of choice

Civil liberties include various private and political liberties (e.g., freedom of expression and movement), physical integrity rights (e.g., freedom from forced labor and torture), as well as property rights and rule of law with access to impartially administered justice. Such liberties are differentially protected across countries and political systems, but also varies between groups within a country. Typically, women's liberties are worse protected than men's (e.g., World Bank, 2020*b*). This lack of protection for women may have downstream implications for macroeconomic performance. Several studies propose that the protection of different civil liberties matter for growth through affecting incentives to invest in capital and, notably, via influencing processes of innovation and idea diffusion (and thus technological change). Insofar as women constitute half of the population, arguments credibly linking the protection of civil liberties to technological change and economic growth should be highly relevant also when it comes to women's civil liberties, more specifically. We review two relevant such arguments.

One prominent "institutionalist explanation" of economic growth focuses on institutions that ensure property rights are protected for broad segments of the population (e.g., North, 1990; Acemoglu, Johnson and Robinson, 2001). Assessments of risks and the expected profits of prospective investment objects hinge on investors' perception of whether their future rights to the investment object (and revenue generated from it) are protected from theft, expropriation, and other infringements. If so, the expected returns to an investment object more likely outweigh expected costs, leading to more investments and thus higher income levels (Olson, 1993). Importantly for our argument focusing on technological change, well-functioning rule of law and stable property rights reduce various risks and expected costs of investing in costly research and development-related activities (e.g., North, 1990; Romer, 1990). Whenever poor property rights protection pertains to half the adult population (women), aggregated investment levels and productivity growth will decline.

Adding to the general argument, Goltz, Buche and Pathak (2015) find an interaction effect between rule of law and women's descriptive representation on female entrepreneurship – reforms aimed at stimulating women's economic participation, enforced by female political representatives, may be less effective when rule of law is weak. However, Goltz, Buche and Pathak (2015) consider rule of law at the country-level without accounting for women often facing disproportionate infringements. Goldstein and Udry (2008) study Ghana, where women have less secure tenure rights than men. This hinders women from leaving their land for a long fallow, despite the clear productivity benefits of this practice when fertilizers are too expensive. The result is lower productivity on female-owned plots, and even within the same household, women achieve significantly lower profits than their husbands (p.995). Similarly, Duflo (2012) proposes the relatively weaker property rights for women as an explanation for why households invest less in labor and fertilizers in plots owned by women.

The second type of argument focuses on private and political liberties – notably freedoms of speech, media, and movement – for increasing variation in new ideas and for selecting the more efficient ones.[4] Knutsen (2015) details how free speech and open debate allow entrepreneurs, decision-makers in firms, non-governmental organizations, bureaucrats, and politicians to better adopt and disseminate ideas from abroad and identify and discard less efficient solutions. Even when motivated by purely political reasons such as restricting opposition mobilizing against the regime, restrictions on communication and free speech may unintentionally suppress the diffusion of economically relevant ideas; in practice, it is very difficult to enforce restrictions on free speech that filter out politically from economically relevant ideas. In other words, different actors may more freely identify and disseminate new organization and production techniques when civil liberties are protected. Protection of such liberties also enables a more critical evaluation of ideas – including critical comparisons of new ideas and technologies to old, traditional ones – thereby enhancing the selection of more efficient ones. Knutsen (2015) finds empirical support for the notion that stronger civil

[4] Estrin and Mickiewicz (2011) considers the economic consequences of gender-specific violations of such rights, and finds that violations on freedom of movement affect women disproportionately, with negative consequences for female employment.

liberties protection enhance technological change and, subsequently, economic growth (see also Dahlum, Knutsen and Lindberg, 2018). This leads us to expect that stronger protection of civil liberties for women, more specifically, enhances technological change and economic growth.

3.3 Voice

Finally, we consider whether ordinary women are able to effectively voice their preferences and ideas through civic participation, be it through political discussions in the private sphere or through various organizations. As summarized by Sundström et al. (2017), to be politically empowered, women must have the opportunity to freely express political views, organize collectively, and be represented in the ranks of journalists. As already indicated in our discussion of civil liberties, the openness of societies aids the adoption of new and more effective technologies, as various freedoms of discussion, press, and organization promote the learning and critical assessment of new ideas. Further, in closed societies policy-development and innovation might be hindered if people are restricted from partaking in organizations and engaging in other forms of collective action. Non-governmental organizations – due to their specialized knowledge and by voicing the preferences of relevant, interested parties – play a prominent role in providing inputs to the formulation and effective implementation of policies (Evans, 1995). Restricting the ability of key population groups to organize and actively partake in civil society thus restricts relevant feedback to the government officials who formulate economic policies. In societies where civil society participation and information sharing between non-governmental organizations and the government is heavily regulated or even forbidden, fewer, unconventional inputs and viewpoints are presented to policy makers, making it harder for them to identify the full range of options or detect flaws in favored policies (North, 2005).

Women being included in political discussions and organizational life should thus improve the quality of policies by expanding the variety of inputs to policy-making processes (Birnir and Waguespack, 2011). Further, contexts with representation of diverse interests may also produce a more cooperative atmosphere, where minority groups are more likely to speak out to defend their interests and the dominant group more prepared to listen to different views (Kanter, 2008). Thus, in gender-inclusive organizations and societies, new and alternative viewpoints on economic policies may be stimulated, helping policy makers in the inherently difficult task of selecting efficient policies with potential macroeconomic benefits.

4 Data

Until recently, data limitations would have hindered our ability to systematically test implications from the above argument on extensive data material. However, the recent V-Dem dataset, v.9 (Coppedge, Gerring, Knutsen, Lindberg, Teorell, Altman, Bernhard, Fish, Glynn, Hicken, Lührmann, Marquardt, McMann, Pemstein, Seim, Sigman, Skaaning, Staton, Wilson, Cornell, Gastaldi, Gjerlow, Ilchenko, Krusell, Maxwell, Mechkova, Medzihorsky, Pernes, von Romer, Stepanova, Sundstrom, Tzelgov, Wang, Wig and Ziblatt, 2019; Coppedge, Gerring, Knutsen, Lindberg, Teorell, Altman, Bernhard, Fish, Glynn, Hicken, Lührmann, Marquardt, McMann, Paxton, Pemstein, Seim, Sigman, Skaaning, Staton, Cornell, Gastaldi, Gjerlow, Mechkova, von Romer, Sundstrom, Tzelgov, Wang, Wig and Ziblatt, 2019) contains measures are well suited for the purpose. The measures that we employ have extensive coverage and match up well with the theoretical concepts of interest by coding gender-specific features of political representation, civil liberties, and civil society participation. Hence, we can capture the different, relevant aspects of female political empowerment while simultaneously conducting stringent tests that require long time series, for example by including country- and year-fixed effects in our models.

We refer to Coppedge et al. (2020) for details on the construction, methodology and contents of the V-Dem dataset. But, in brief, the dataset is constructed to ensure measures that are comparable across countries and over time, and that carry a high degree of reliability and validity. The data-generating process and aggregation schemes for the different indicators and indices are fully transparent. About half of the indicators are more objective and coded by research assistants (e.g., share of adult population with de jure voting rights) and the other half are more evaluative in nature (e.g., extent of election violence) and assigned scores on the basis of expert surveys. Normally, at least five independent experts score each indicator (per country-year). Experts vary by question/subject area and country, and are recruited based on their documented expertise in the particular area. Thus, the raw data come from more than 3,200 experts, in total. V-Dem combines the assessments from different experts by using a Bayesian item response measurement model that takes into account each expert's reliability, determined, inter alia, by level of agreement with other country experts (for details, see Pemstein et al., 2018; Coppedge et al., 2020).

Concerning our main independent variable, we follow Sundström et al. (2017) in defining female political empowerment as a "a process of increasing capacity for women, leading to greater choice, agency, and participation in societal decision-making". We measure this concept by drawing on V-Dem's Female Political Empowerment index (FPE). This index consists of three sub-indices, which are equally-weighted in the aggregation of the overall index by taking the simple average. The first sub-index is the *women's civil liberties index*, which largely captures our theoretical freedom of choice sub-component. It is formed by taking the point estimate from a Bayesian factor analysis on four expert-coded items. The second sub-index is the *women's civil society participation index*, which is a latent factor variable estimated on three items and roughly corresponds to the theorized voice sub-component of female political empowerment. The final sub-index is the *women's political participation index*, which captures the representation sub-component and is constructed by averaging two indicators. Table 1 lists all indicators included in each of the three sub-indices. The aggregated FPE ranges from, 0–1, where 1 indicates high level of female political empowerment.

Our main dependent variable is GDP per capita growth, measured in annualized, percentage terms. We mainly draw on estimates of Ln GDP per capita from Fariss et al. (2017),

Table 1: Components and indicators entering V-Dem's Women Political Empowerment Index

Female Political Empowerment Index	
Women civil liberties index	Freedom of domestic movement women
	Freedom from forced labor women
	Property rights women
	Access to justice women
Women civil society participation index	Freedom of discussion women
	CSO women's participation
	Percent female journalists
Women political participation index	Power distributed by gender
	Lower chamber female legislators

but also run tests employing GDP data from the Maddison project (Bolt and van Zanden, 2013). The former data source allows us to extend the analysis back to 1789 and include 182 polities in our benchmark regression, whereas the latter extend back to 1800 and allow us to include 163 polities. The estimates on (ln) GDP per capita data from Fariss et al. are arrived at by using a dynamic latent trait model and drawing on information from different, existing GDP and population datasets, including the Maddison data.[5] One benefit with Fariss et al.'s latent model estimation routine is that it mitigates various kinds of measurement error. These data also mitigate missing values by imputation. For tests conducted on the original Maddison series, we interpolate these data – which are often measured every tenth year in the 1800s – by assuming constant growth rates across intervals with missing data. Since the Fariss et al. time series are imputed, and predictions are presumably poorer for observations without scores even on the extensive Maddison series, many error-prone observations are likely dropped when using the original Maddison series. In sum, the two GDP sources have different validity and reliability issues, and should complement each other well.

Our second dependent variable pertains to technological change. While researchers have aimed to capture technological change with several indices and proxies (see, e.g., Knutsen, 2015), most measures lack extensive time series or cross-country coverage. The most commonly used proxy among growth economists is growth in Total Factor Productivity (TFP).

[5]Indeed, we use the version of the Fariss et al. estimates that are benchmarked in the Maddison time series.

TFP growth is basically calculated as residual economic growth after removing growth stemming from changes in physical capital, human capital, and labor supply.[6] We draw on the extensive TFP data from Baier, Dwyer Jr. and Tamura (2006), which cover 145 countries with several time series extending back to the 19th century – the earliest measurement is the United Kingdom in 1831. Baier, Dwyer Jr. and Tamura (2006) draw on various sources to produce their growth accounting estimates, notably the Penn World Tables, World Development Indicators, the Maddison project, and Mitchell's historical statistics (for details, see Baier, Dwyer Jr. and Tamura, 2002: pp. 24–26). Given the paucity of relevant historical data sources, Baier et al. only calculate TFP with uneven intervals, and with years of measurement differing across countries. Typically, the time series include a data point for about every tenth year. We therefore follow the approach in Knutsen (2015), and interpolate these time series by assuming constant annual growth rates in TFP in between two observations.

In the Appendix, we present descriptive statistics and map distributions of the main variables discussed above. Regarding data sources and measures for the control variables, we introduce them in the next section when discussing our different regression specifications.

5 Empirical analysis

We start out by assessing the empirical implication that countries where women are empowered politically experience more rapid economic growth. Next, we detail this relationship by considering whether it applies to different geographical and temporal contexts, but also by looking more closely into whether particular sub-components of female empowerment drive the results. Finally, we investigate the relationship between FPE and TFP growth.

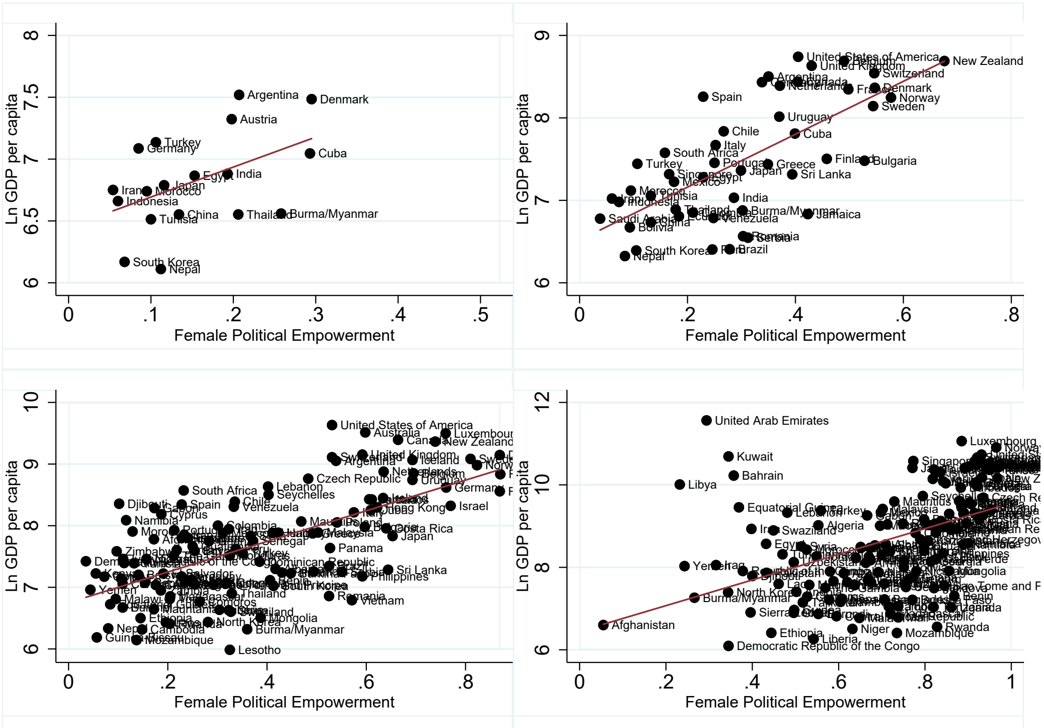

Figure 2: Scatter-plots, overlaid with (bivariate) best-fit lines and 95% confidence intervals, for Female Political Empowerment (data taken from V-Dem; x-axes) and Ln GDP per capita(data taken from the Maddison project; y-axes) in the years 1830 (top-left), 1900 (top-right), 1950 (bottom-left) and 2000 (bottom-right).

5.1 Main analysis: Female empowerment and economic growth

Before we present our benchmark panel regression, we consider some descriptive statistics and cross-country correlations. The scatterplots in Figure 2 illustrate the positive cross-country correlation that have existed – and been fairly persistent through modern history – between our Female Political Empowerment (FPE) index and Ln GDP per capita as measured by the Maddison project. Figure 3 shows equivalent plots based on the Fariss et al. data. More specifically, the panels display scores and the best linear fit from the years 1830, 1900, 1950, and 2000. Also for (annual) GDP per capita growth rates, there is a clear difference, on

[6]Since it is calculated as residual growth after, TFP growth can stem from other processes than technological change that are left unaccounted for in the growth accounting exercise. These include increases in prices for major exports and natural resource discoveries. Yet, technological change is widely considered as the main source behind TFP growth, especially in the longer run, by growth economists.

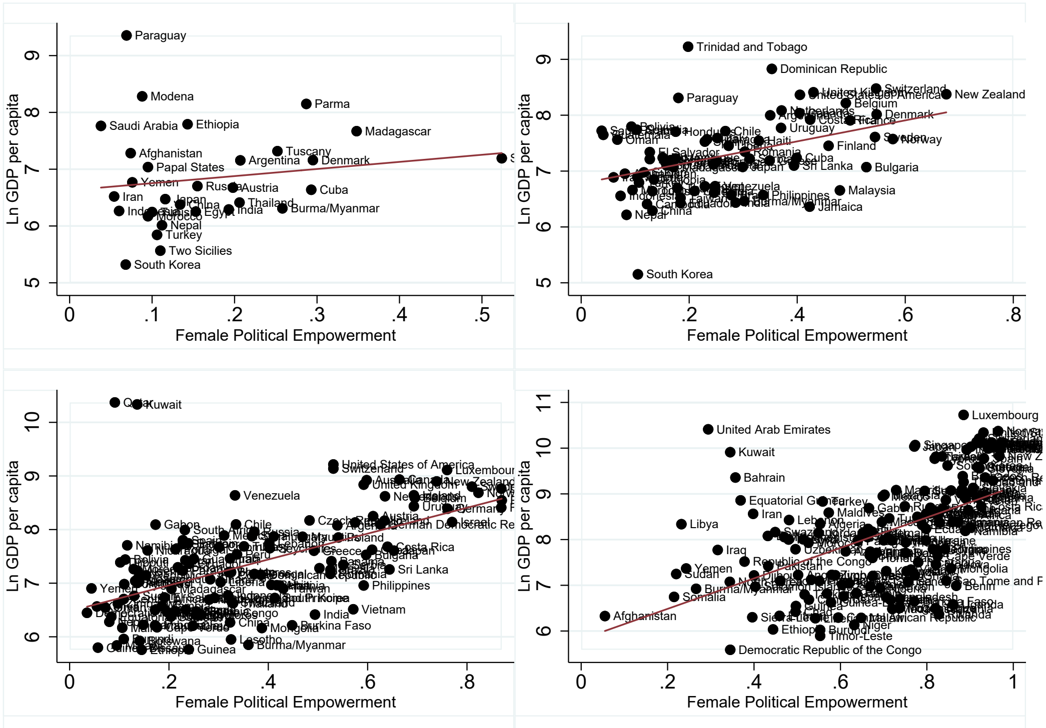

Figure 3: Scatter-plots, overlaid with (bivariate) best-fit lines and 95% confidence intervals, for Female Political Empowerment (data taken from V-Dem; x-axes) and Ln GDP per capita(data taken from Farris 2017; y-axes) in the years 1830 (top-left), 1900 (top-right), 1950 (bottom-left) and 2000 (bottom-right).

average, between countries that have low and high female political empowerment. When dividing the 21,853 observations into quartiles on the FPE index – with 0.172 marking the cut-off for the lowest quartile, 0.344 the median, and 0.611 the highest quartile – we find that average growth rates, based on the Fariss et al. data, increase monotonically and quite substantially with FPE quartiles. The lowest quartile of FPE observations has an average GDP per capita growth rate of 0.2 percent, and the second quartile grows, on average, at 0.6 percent. In contrast, the third quartile exhibited average growth of 1.5, whereas the upper quartile grew at 2.7. When using the Maddison time series (Bolt and van Zanden, 2013), which has numerous missing observations particularly among colonies and 19th century countries, the corresponding growth rates are, respectively, 1.2, 1.2, 2.0, and 2.9. Countries where women are politically empowered display much higher economic growth, on average.

Yet, the strong, positive correlation may stem from various sources, including the reverse causal relationship and that different (observable or unobservable) confounders systematically affect both female empowerment and growth in particular directions. For instance, political-historical and cultural characteristics that are prevalent in certain countries (e.g., in Western Europe and North America) could enhance both female empowerment and growth. Alternatively, confounding may come from time-specific factors; certain decades of modern history may have given birth to ideological or technological trends that boosted female empowerment as well as growth. For these reasons, our benchmark OLS specification includes both country- and year-fixed effects. Further, we cluster errors by country to account for panel-level heteroskedasticiy and autocorrelation.

The theoretical discussion suggested that substantial time may pass before the hypothesized effect from female empowerment is transmitted – via public policies and, in turn, their impact on the behavior of firms and other economic agents – to technological change and observed GDP per capita growth rates. While the exact lag-time of these processes are hard to theorize and identify, we assume a five-year lag in our benchmark. We also test specifications where we measure growth closer (in time) to or further away from the independent variables. We start out by analyzing country-years as unit of analysis to capture as much information as possible and thus maximize efficiency. Yet, we also try out 5- and 10-year panel structures, which have the benefits of smoothing out measurement errors and further mitigating autocorrelation.

Concerning other covariates than the country- and year-fixed effects, we intentionally keep our benchmark specification sparse to minimize missing due to listwise deletion and, more importantly, mitigate post-treatment bias. The latter concern pertains to the possibility that variables such as democracy or state capacity may be affected by female political empowerment. Controlling for such institutional features could thus "block off" relevant indirect effects that we want to capture as part of our estimated, overall relationship. Hence, the only additional covariate in our benchmark is initial Ln GDP per capita, as richer countries likely have better track-records of female empowerment, but also – due to standard conditional convergence mechanisms (Barro and Sala-i Martin, 2004) – slower growth rates. In alternative specifications, we introduce more covariates that may – even if we risk introducing post-treatment bias – also act as confounders. One example of such a (questionable) extra control is regime type, as democracy may both causally affect female empowerment *and* be influenced by it. (Indeed, even the conceptual boundaries between democracy and FPR are unclear, as both consider, e.g., political participation and protection of rights.) Hence, we test models excluding and models including democracy, as measured by V-Dem's Polyarchy index (Teorell et al., 2019)

Model 1.1 in Table 2 is the benchmark OLS specification on growth with country-year as unit of analysis and using the GDP data from (Fariss et al., 2017). As discussed, this model controls for country- and year- fixed effects in addition to initial Ln GDP per capita. The dependent variable is the annual percentage change in GDP per capita five years after independent variables are measured, i.e., the growth rate in $t + 5$. The model draws on 15,879 country-year observations from 182 countries, with maximum time series extending across 221 years. As expected, there is a positive relationship between FPE and growth, which is statistically significant at the 1% level. The point estimate indicates that going from the first quartile score on FPE (.20; e.g., Italy under Mussolini in the 1930s) to the third quartile score (.61; Australia in the 1950s) increases annual GDP per capita growth with about 0.9 percentage points. The long-term consequences of such a difference in growth rates are substantial. Consider two countries, A and B, that start out with identical GDP per capita levels; and where A starts growing at a 0.9 percentage point higher rate. After 10 years, A's GDP per capita is about 9 percentage points higher than B's. After 20 years, this difference has increased to 20 percent, and after 40 years to 43 percent. If we consider an even larger change in FPE, going from the 10th percentile (.11; The Two Siciles in the 1820s or Sudan in the 1920s) to the 90th (.82; Canada or New Zealand in the 1970s), the corresponding numbers for, respectively, 10, 20 and 40 years are differences in GDP per capita of about 16, 35 and 84 percent. If the estimates of Model 1.1 are on point, improving female political empowerment has substantial consequences for long-term developments in income. As shown by the equivalent Model 1.2, which uses GDP data from Maddison, the result is robust to using different data sources for measuring income level and growth.

Table 2: Main analysis: Fixed effects OLS regressions on GDP per capita growth or Ln GDP p.c. measured in $t+5$

	(1.1)	(1.2)	(1.3)	(1.4)	(1.5)	(1.6)
	DV: GDP p.c. growth in year t+5		DV: Ln GDP p.c. in year t+5			
Panel length	1 yr	1 yr	1 yr	1 yr	5 yrs	5yrs
GDP data source	Fariss	Maddison	Fariss	Maddison	Fariss	Maddison
	b/(t)	b/(t)	b/(t)	b/(t)	b/(t)	b/(t)
Female pol. empowerment	2.158***	1.967**	0.110***	0.114**	0.151***	0.123**
	(2.719)	(2.151)	(2.763)	(2.508)	(2.915)	(2.439)
Ln GDP per capita	-1.237***	-2.533***	0.937***	0.892***	0.922***	0.888***
	(-5.101)	(-8.268)	(64.898)	(64.526)	(45.493)	(63.205)
Country dummies	Y	Y	Y	Y	Y	Y
Year dummies	Y	Y	Y	Y	Y	Y
N	15879	13362	15880	13364	3165	2762
Countries	182	163	182	163	180	162
Max time series	221	215	221	215	44	44
R^2	0.029	0.085	0.945	0.948	0.933	0.947

Notes: *p<0.1; **p<0.05; ***p<0.01. Errors are clustered by country. Covariates measured 5 years before DV.

One alternative way of specifying growth models, which is popular among growth economists and has some distinct advantages (and disadvantages) from using GDP per capita growth as dependent variable, is using forward-lagged Ln GDP per capita level as the dependent variable.[7] This alternative specification is less affected by measurement errors and other sources of "noise" (business cycle fluctuations, big changes in prices for export products, natural disasters, etc.), since GDP per capita growth rates can fluctuate widely from year to year. Further, employing forward-lagged Ln GDP p.c. in, say, $t+5$ instead of GDP per capita growth from $t+4$ to $t+5$ allows us to also capture any short-term effects that might exist, since we capture changes in income across the entire period from when initial Ln GDP is measured (t) rather than only growth at the period's end. The downside is that this specification magnifies autocorrelation problems, since GDP levels display much higher correlation with past GDP levels compared to current and past growth rates, and that it

[7]Mathematically, estimating the coefficient of a variable of interest on Ln GDP per capita level in $t+1$, controlling for Ln GDP per capita in t, is equivalent to estimating the coefficient of this variable on GDP per capita growth from t to $t+1$ (Hoeffler, 2002).

models conditional convergence dynamics less well – growth is no longer a linear function of past income levels. Given these pros and cons of these different specifications, we opted to test both versions. Models 1.3 and 1.4 thus replicate Models 1.1 and 1.2, respectively, but with Ln GDP per capita in $t + 5$ as the dependent variable. FPE remains robust also to this specification choice.

Yet, we noted how using Ln GDP per capita as dependent variable magnifies autocorrelation issues, which may influence results even if we cluster the errors by country. To mitigate this issue, we followed another conventional approach used by growth economists and re-estimated Models 1.3 and 1.4 on 5-year panels. When measuring the dependent variable with 5-year intervals, there is weaker correlation with past realizations of the outcome than when measuring it with 1-year intervals. Results are reported in Models 1.6 and 1.7, and once again FPE is robust.

In sum, neither the source of GDP data, the exact specification of the dependent variable, nor choice of panel structure affects the main result; there is a clear relationship between female political empowerment and subsequent economic growth.

5.2 Robustness tests

In order to further investigate sensitivity, we ran additional robustness tests. Most of these tests are reported in the Appendix, but we present a selection of important ones in Table 3. Model 2.1 is equivalent to Model 1.1 from Table 2. This is our benchmark using Fariss et al. GDP data and growth as dependent variable, and we include it in Table 3 simply to ease comparisons with the alternative specifications.

First, we investigated whether the FPE result is sensitive to choice of lag-structure (see also Figure 4). Model 2.2 alters the benchmark by measuring growth only one year after the covariates. This specification is thus intended to capture only short-term effects. FPE remains highly significant ($t = 3.3$), and the coefficient actually increases in size, suggesting a strong boost in short-term growth from improved female empowerment. This finding is somewhat surprising, given the theoretical discussion on the time it may take for changes in political features to translate into new policies and subsequently technological change.

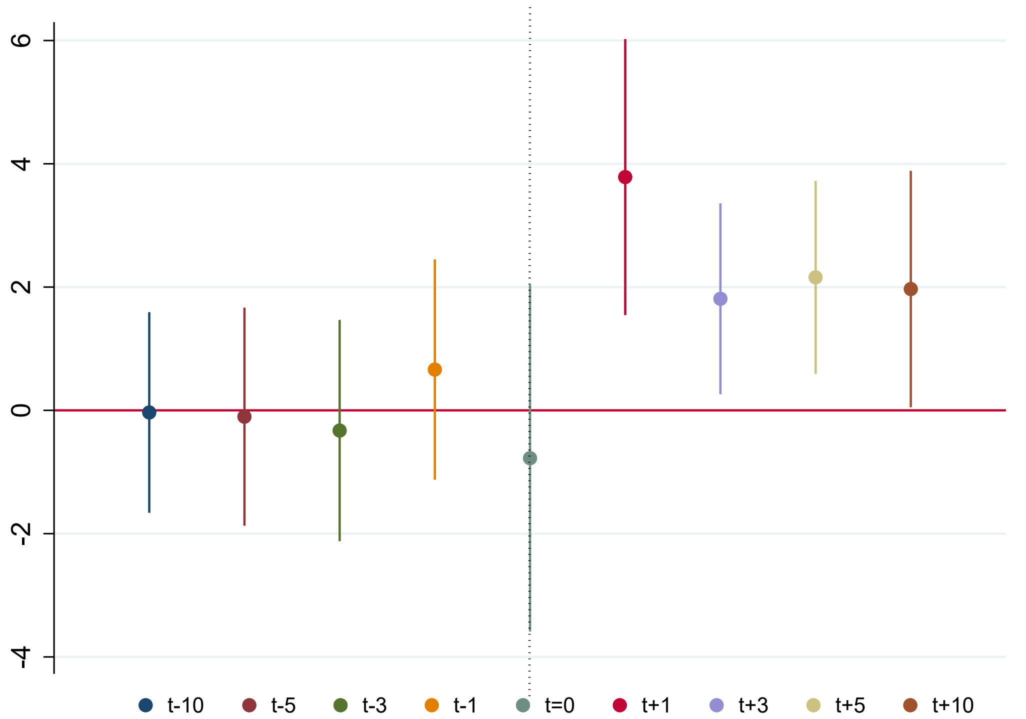

Figure 4: Benchmark OLS Model (similar to 1.1, Table 2), but with GDP p.c. growth measured with various leads and lags relative to Female Political Empowerment Index. When lag structure is indicated as $t - x$ $[t + x]$, outcome is measured before [after] covariates.

Indeed, the latter result raises concerns that FPE might be correlated with trends in growth due to other causal patterns (e.g., reverse causality) than the theorized effect. However, we tested whether FPE is correlated with contemporaneous growth, and it is not; FPE is statistically insignificant and even flips sign (see Figure 4). Moreover, FPE is not related to growth when the latter is measured before the former. We tested both 1-, 3-, 5- and 10-year lags on growth and neither are systematically correlated with current FPE; t-values vary between -0.4 and +0.7 and coefficients are small in magnitude. We will return to alternative specifications that deal with endogeneity concerns related to past trends in growth confounding the relationship. In brief, we do not find evidence that such patterns are driving our result. Hence, the most plausible interpretation of the result in Model 2.2 is, in fact, that there exists a short-term effect of FPE on growth, in addition to the (theoretically less surprising) medium-term effect captured by our benchmark.

As Models 2.3 (growth measured in $t+3$) and 2.4 (growth measured in $t+10$) show, the relationship is also robust to assuming alternative intermediate and longer-term effect lags. The FPE coefficient remains statistically significant at 5% and sizeable, even if somewhat attenuated relative to the benchmark.

As discussed, we kept our benchmark sparse to mitigate post-treatment bias. We did not, for example, control for democracy level, as this might be affected by female empowerment – controlling for democracy could thus block a relevant indirect effect. However, more democratic regimes might more easily experience improvements in female empowerment, for example because female voters are susceptible to vote to reward, or otherwise pressure, parties into adopting political and institutional changes that enhance female representation in politics. If democracy also enhances growth (Gerring et al., 2005; Acemoglu et al., 2019), omitting democracy from the regression could lead to (upward) omitted variable bias for FPE. Model 2.5 therefore adds V-Dem's Polyarchy index to the benchmark. Holding scores on this index constant has the additional benefit of accounting for potential subjective coder biases in the V-Dem data. For example, fast-growing economies *could* be evaluated in an artificially positive manner on different political measures by country-experts, if strong economic performance induces overall positive impressions of the country's politics. Such a bias would, presumably, jointly affect FPE and Polyarchy, and controlling for Polyarchy should thus purge the FPE coefficient of this bias. Yet, FPE remains significant at 5% and actually increases somewhat in size, from 2.2 to 2.6, when controlling for Polyarchy. Likewise, FPE retains a value of 2.2 and is significant at 5% in Model 2.6, which controls for a proxy of state capacity, namely V-Dem's indicator on impartial and rule-following public administration.

Table 3: Selected robustness tests

	(2.1)	(2.2)	(2.3)	(2.4)	(2.5)	(2.6)	(2.7)	(2.8)	(2.9)	(2.10)	(2.11)	(2.12)	(2.13)	(2.14)
	1-year panels; DV: GDP p.c. growth									5-year panels; DV: Ln GDP p.c.				
DV measured in	$t+5$	$t+1$	$t+3$	$t+10$	$t+5$	$t+5$	$t+5$	$t+5$	$t+5$	$t+5$	$t+10$	$t+5$	$t+5$	$t+5$
	b/(t)	b/(t)	b/(t)	b/(t)	b/(t)	b/(t)	b/(t)	b/(t)	b/(t)	b/(t)	b/(t)	b/(t)		
FPE	2.158***	3.785***	1.810**	1.968**	2.629**	2.172**	1.453	2.141***	2.495*	0.151***	0.278***	0.166***	0.329**	0.314**
	(2.719)	(3.335)	(2.306)	(2.025)	(2.567)	(2.434)	(1.351)	(2.715)	(1.937)	(2.915)	(3.117)	(3.293)	(2.151)	(2.099)
Ln GDP p.c.	-1.237***	-2.402***	-0.967***	-1.484***	-1.291***	-1.239***	-1.637***	-1.197***	-1.798***	0.922***	0.852***	1.037***	0.989***	1.030***
	(-5.101)	(-4.044)	(-4.328)	(-5.074)	(-4.998)	(-4.909)	(-6.058)	(-5.134)	(-5.696)	(45.493)	(25.255)	(10.618)	(50.431)	(6.467)
Polyarchy					-0.579				-0.824					
					(-0.817)				(-0.943)					
Imp. public adm.						-0.001			-0.063					
						(-0.012)			(-0.438)					
Resource dep.							-0.038**		-0.038**					
							(-2.209)		(-2.178)					
Ln population								0.241	-0.306					
								(1.041)	(-1.096)					
Ln GDP p.c. $t-5$												-0.105		-0.039
												(-1.102)		(-0.246)
Ln GDP p.c. $t-10$												-0.007		
												(-0.268)		
Ln GDP p.c. $t-15$												0.003		
												(0.154)		
Country dummies	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
Year dummies	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
N	15879	16645	16256	14947	15552	15857	10716	15879	10510	3165	2987	2732	3165	3018
R^2	0.029	0.035	0.027	0.031	0.029	0.028	0.135	0.029	0.139	0.933	0.877	0.949		
Instruments													126	126
Hansen J-test													.76	.81
Ar(2)													.08	.86
AR(3)													.63	.48

Notes: *p<0.1; **p<0.05; ***p<0.01. Errors are clustered by country.
GDP data are from Fariss et al. (2017). Models 1–12 are estimated by OLS and Models 13-14 by System GMM.

Model 2.7 adds a measure of natural resource dependence (share of GDP from oil, natural gas, coal and minerals) from Miller (2015) to the benchmark. While FPE remains sizeable, with a coefficient of 1.5, it is no longer statistically significant at conventional levels ($t = 1.4$). However, further analysis shows that much of this attenuation is due to the changing sample; missing data on the resource dependence variable truncates the sample from 15,879 to 10,716 observations. When re-running the benchmark (Model 2.1) on this reduced sample, the FPE point-estimate is 1.8 and the t-value is 1.6. In Model 2.8, which controls for Ln population and where the sample is again expanded to 15,879 observations, FPE is similar in size and significance to the benchmark. Moreover, in the "kitchen-sink" specification (Model 2.9), which simultaneously controls for Polyarchy, impartial administration, natural resource dependence and population, FPE is actually higher than in the benchmark (2.5) with a p-value of 0.055.

We conducted similar tests for 5-year panel specifications using Ln GDP per capita as dependent variable. Model 2.10 replicates Model 1.5 from Table 2, measuring the dependent variable five years after the covariates. Model 2.11 maintains the 5-year panel set-up, but measures the outcome 10 years (i.e., two panel periods) after the covariates. This change actually strengthes the relationship quite substantially, increasing the FPE coefficient from 0.15 to 0.28. This change was to be expected with Ln GDP p.c. as dependent variable. With income being measured at the end of a 10-year period, we capture *both* the shorter- and medium-term effects of a change in FPE. Further, in Model 2.12, we tested for the potential endogeneity to prior trends in income growth by including three additional lags of the dependent variable ($t - 5$, $t - 10$, and $t - 15$, in addition to Ln GDP p.c. measured in t; the dependent variable is measured in $t + 5$). By doing so, we follow the approach by Acemoglu et al. (2019) to account for pre-treatment patterns in income growth. The FPE coefficient and corresponding t-value increase somewhat when doing so. Once again, there are few empirical indications that historical trends in income growth confound the observed relationship between FPE and subsequently measured growth.

Still, we conducted one additional type of test to account for potential endogeneity in FPE, running so-called System Generalized Method of Moments (GMM) models. These models are attuned to estimating relationships involving sluggish variables such as FPE (see Blundell and Bond, 1998). In System GMM specifications, lags of differences in variables are used to instrument for current levels, and, likewise, lags of levels are used to instrument for current differences. The specifications reported in Table 3 model only FPE as endogenous and use the second and third lags for instrumentation (to keep the instrument count below the the number of cross-section units, see Roodman, 2009).[8] Alternative specifications are reported in Appendix Table A.3. Model 2.13 includes only the first lag of the dependent variable as regressor, whereas 2.14 includes the first and second lags. Both specifications report a statistically significant FPE coefficient that is substantially higher than in the OLS models. While the Ar(2)-test in Model 2.13 gives some reason for concern that residual autocorrelation affects results, the specification tests for Model 2.14 suggest that this model may yield a consistent estimate of the effect of FPE on growth. This estimate is both positive and substantially sizeable.

In sum, there is fairly strong evidence, from different panel regressions, that improvements to female political empowerment enhances subsequent economic growth.

5.3 Assessing potential heterogeneity in the relationship

We wanted to check if the identified pattern is consistent across time periods, geographical contexts, and political regime types, or if it is much stronger in some settings than others. For these particular tests on heterogeneity, our theoretical argument does give clear *a priori* expectations. If anything, we expected the relationship to be relatively persistent across contexts, as our argument points to mechanisms that should not be contingent on being in a particular region, historical period or regime type – female political empowerment should enhance the variation in new ideas and the selection of more efficient ones in different

[8]The instrument count is also a function of number of panel units. Hence, well-specified GMM models are impossible to achieve for the country-year set-up.

contexts.

We ran different tests to assess potential heterogeneity in the relationship (see Appendix Table A.4 for interaction model tests). Figure 5 (top panel) presents regression coefficients on FPE with 95% confidence intervals from straightforward split-sample tests, where we estimate the benchmark Model 1.1., but on limited samples. The leftmost coefficients pertain to, respectively, pre- and post-WWII samples. The two middle coefficients pertain to, respectively, "Western" (Western European countries, Canada, United States, Australia, and New Zealand) and all other countries. Finally, the two rightmost coefficients pertain to, respectively, democracies and autocracies, where we use the Lexical Index of Electoral Democracy by Skaaning, Gerring and Bartusevičius (2015) and require competitive elections and universal suffrage for coding a regime as democratic. Interestingly, results indicate a somewhat stronger and clearer estimated effect of female empowerment in autocratic contexts (where the rate of technological change is, overall, lower Knutsen, 2015). Further, the estimated relationship is stronger for the pre-WWII era than the period from 1946 and onwards, and the relationship is present and clear in "non-Western" countries, but not in "Western" countries.

We note, however, that the split sample results based on fewer units and/or shorter time series are sensitive to specification choices. For instance, when omitting country-fixed effects, the relationship is large and highly significant also across the 31 included Western countries (as well as across the 151 non-Western ones). And, when omitting year-fixed effects the relationship is large and significant both in the pre-WWII and post-WWII samples. The bottom panel of Figure 5 shows fairly similar results when omitting both the country-and year-fixed effects simultaneously. In this specification, the estimated relationship is also virtually similar (and highly significant) across regime types. While we would not put too much trust in the latter estimates, with omitted variables biases possibly affecting results, they serve to illustrate the more sensitive nature of the split-sample results.

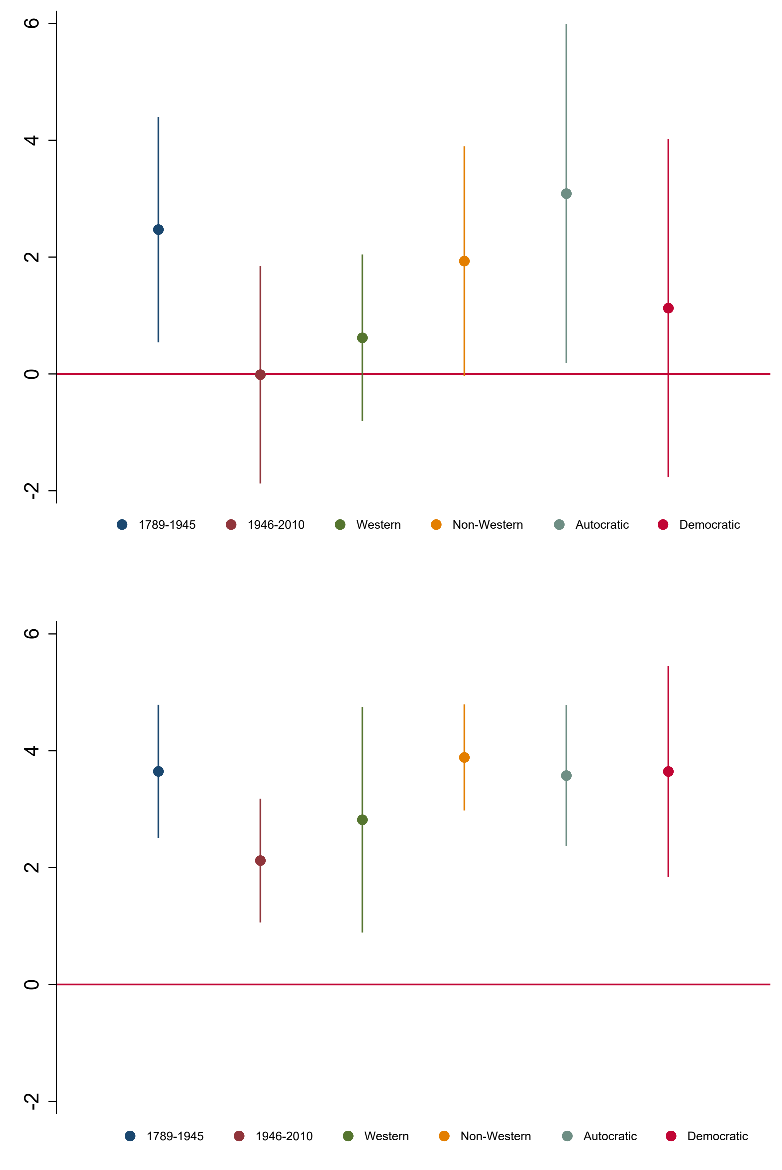

Figure 5: Coefficient plots with 95% confidence intervals for Female Political Empowerment Index on limited samples, restricted by time period, geography, or regime type. Top panel: Coefficients are from equivalents to benchmark Model 1.1, Table 2. Bottom panel: Corresponding coefficients for specifications that omit country- and year-fixed effects, but are otherwise similar to Model 1.1., Table 2.

Next, we assessed whether the finding for the composite FPE index is driven by one particular sub-component. We remind that the aggregated index consists of three sub-indices – on civil liberties, political participation, and civil society participation – capturing distinct aspects of female empowerment, and that our theoretical argument suggested that all three aspects should contribute to enhance technological change, and thus growth.

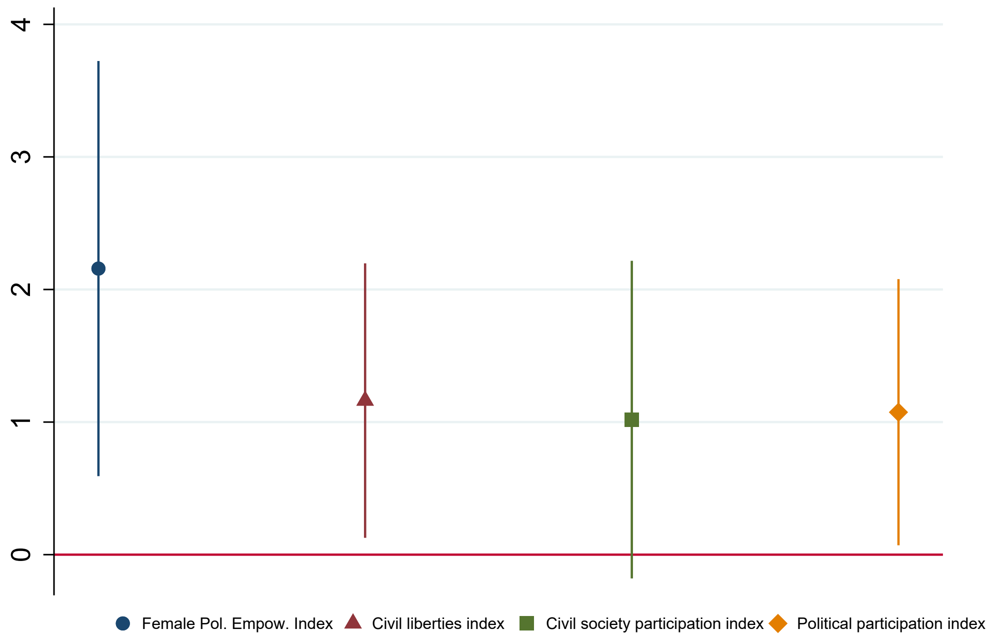

Figure 6: Coefficient plots with 95% confidence intervals for Female Political Empowerment Index and its three sub-indices. All coefficients are from equivalents to the benchmark Model 1.1, Table 2, with annual GDP per capita growth in $t + 5$ as dependent variable. All indices range from 0–1.

As anticipated, all three sub-indices are individually related to subsequent growth rates. Figure A.1 displays coefficient plots with 95% confidence intervals for specifications akin to the benchmark Model 1.1, Table 2. As for the aggregated FPE, all indices range from 0 to 1, and coefficients are thus comparable. Interestingly, the composite index estimate is around twice the size of the sub-indices, which are strikingly similar in size. Going from minimum to maximum on any of these sub-indices is predicted to increase GDP per capita growth rates by 1.0 to 1.2 percentage points, and all three coefficients are *at least* weakly significant (10% level).[9] Moreover, all three sub-indices, and especially civil liberties and political

[9]When we include all three sub-indices simultaneously in the benchmark, the civil society index turns very close to 0, whereas the civil liberties (1.2; t = 1.7) and political participation (0.9; t = 1.4) indices basically retain their sizes but obtain lower t-values.

participation, are quite robust to specification changes such as altering the dependent variable specification (Ln GDP p.c. instead of GDP p.c. growth) or using Maddison GDP data. In sum, there is evidence that the different, theorized aspects of female empowerment carry an independent relationship with subsequent growth, *and* that the relationship is even stronger for the composite concept than for any of the individual sub-components.

5.4 Female empowerment and technological change

Finally, we turn to investigating another, and more specific, implication from our argument, namely that improvements in female political empowerment should enhance technological change. That is, even when disregarding economic growth coming from investments in physical or human capital, we should find that FPE is related to higher residual growth, which is presumably driven mainly by improvements in production or organization technologies.

To test this expectation, we draw on the above-described, extensive TFP data from Baier, Dwyer Jr. and Tamura (2006). To recapitulate, these data were arrived at via a comprehensive growth accounting exercise on 145 countries and the longest time series (United Kingdom) extends from 1831–2000. When following the interpolation procedure used by Knutsen (2015), we can re-run our benchmark – substituting Ln GDP per capita from Model 1.3, Table 2 with Ln TFP – on 6827 country-year observations from 142 countries. This specification is reported as Model 3.1 in Table 4. It reveals a positive and significant (5% level) relationship between FPE and Ln TFP measured five years later, conditional on initial level of Ln TFP and country- and year-fixed effects. As for Ln GDP per capita, the FPE coefficient increases markedly in size (from .10 to .16) once measuring the outcome 10 years instead of 5 years after the covariates in Model 3.2. This latter observation suggests that there are longer term benefits to technological efficiency from increased female political empowerment, beyond the notable short-term benefits.

Yet, we discussed for the growth regressions how certain variables, notably including democracy level, may be relevant controls, even if adding them could introduce post-treatment

Table 4: Fixed effects OLS regressions on Ln Total Factor Productivity (TFP)

	(3.1)	(3.2)	(3.3)	(3.4)	(3.5)	(3.6)	(3.7)
			1-year panels			5-year panels	
DV measured in	$t+5$	$t+10$	$t+5$	$t+5$	$t+5$	$t+5$	$t+5$
	b/(t)	b/(t)	b/(t)	b/(t)	b/(t)	b/(t)	b/(t)
Female political empowerment	0.097**	0.157**	0.077	0.077*	0.087**	0.108**	0.109*
	(2.274)	(2.023)	(1.387)	(1.693)	(2.059)	(2.031)	(1.657)
Ln TFP	0.931***	0.636***	0.933***	0.941***	0.909***	0.938***	0.940***
	(37.354)	(12.490)	(35.683)	(31.914)	(32.693)	(36.227)	(34.915)
Polyarchy			0.018				-0.001
			(0.468)				(-0.022)
Resource dependence				-0.002***			
				(-2.743)			
Ln population					-0.056**		
					(-2.140)		
Country dummies	Y	Y	Y	Y	Y	Y	Y
Year dummies	Y	Y	Y	Y	Y	Y	Y
N	6827	6124	6790	6227	6689	1456	1447
R^2	0.838	0.606	0.837	0.839	0.832	0.825	0.824

Notes: *p<0.1; **p<0.05; ***p<0.01. Errors are clustered by country.

bias for FPE. The same points apply here. Model 3.3 therefore includes V-Dem's Polyarchy Index as an additional control, and this attenuates the FPE coefficient by about 20 percent (from 0.097 to 0.077) relative to the benchmark. Moreover, FPE now turns statistically insignificant at conventional levels ($t = 1.4$). We also tested a model controlling for V-Dem's impartial public administration described above, and – similarly to the results for Model 3.3 controlling for Polyarchy – the relationship turns insignificant. In contrast, the positive relationship between FPE and Ln TFP measured five years later is robust to controlling for natural resource dependence (Model 3.4) or population size (Model 3.5). Still, and in contrast with the GDP per capita regressions, the FPE coefficient on TFP growth is sensitive to the control strategy.

The lack of robustness for the relationship with TFP growth may stem from different factors. First, the GDP regressions included far more country-year observations, thus giving us more efficient estimates and a lower likelihood of conducting Type II errors. Further, the results for Models 3.1–3.5 may be weakened by measurement error induced from the interpolation routine in the country-year panels. The TFP data are originally measured with intervals of several years (typically 10) between each data point, and the interpolation procedure may artificially smooth out growth across these longer intervals. Hence, Models

3.6 (benchmark) and 3.7 (adding Polyarchy) employ 5-year panel units. While results are fairly similar, the FPE coefficient is somewhat larger in size and now weakly significant in the model including Polyarchy. In sum, there is some, but not completely robust, evidence suggesting that FPE is related to faster subsequent technological change, as measured by TFP growth.

6 Conclusion

We have argued that political institutions that enhance key aspects of female political empowerment – pertaining to the representation, voice, and active participation of women in politics and civil society – influence a country's rate of technological change. Such empowerment should enhance technological change both through affecting the variety of new ideas introduced into the economy as well as the selection of the more efficient ideas. Since technological change is the key "immediate determinant" of long-term economic growth, we also anticipate that female political empowerment has a substantial effect on economic development.

Drawing on data from 182 countries and time series extending back to 1789, we found fairly robust evidence for different implications from our argument. The most robust evidence pertains to the implication that female political empowerment is positively related to subsequent economic growth. This relationship holds up for different measurement strategies and statistical specifications. Reassuringly, the relationship holds up when accounting for country- and year-fixed effects, and female political empowerment is only correlated with subsequently measured growth and not with contemporaneous or previous growth rates. Second, as anticipated from our argument, measures capturing all three sub-components of female political empowerment are individually linked to growth. Third, we also find relatively (though not completely) robust evidence indicating that female political empowerment relates to TFP growth, an indicator of technological change.

Our results could have real-world relevance, insofar as some decision makers are more concerned with economic performance than questions of justice and equity in representation, inclusion, and protection of civil liberties across. We show that the inclusion of women in politics may not only be justified by intrinsic, normative motives. There is also a more instrumental "business case" for female empowerment, which might sway otherwise reluctant social groups and decision makers to work for, or at least acquiesce to, the inclusion of women in decision-making.

There is persistent under-representation of women in politics and lacking protection of women's civil liberties. Despite some progress, worldwide, in recent decades, countries – and especially middle and low income countries – still vary a lot in female political empowerment (World Bank, 2020*b*). In many places, there are still substantial restrictions on women's opportunities to participate in the economy on equal footing with men. Around a third of the world's countries restrict the freedom of movement for women, 40 percent have legal restrictions on women's decisions to join and remain in the labor force, and around 40 percent discriminate against women in their property rights legislation. Finally, in 115 countries, World Bank experts judge, women cannot run a business in the same way as men (World Bank, 2020*b*). These striking inequalities are reflected in the composition of the political institutions that have the power to influence the relevant legislation. In 2019, only 24.6 on parliamentary seats worldwide were held by women (World Bank, 2020*a*), and the corresponding number for cabinet seats was 20.7 (Union and women, 2019). Still today, there is ample room for increased representation of and participation by women in many countries. Our results suggest that, in these countries, there is also corresponding room for more rapid technological change and economic development.

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A Online Appendix

In this appendix we present descriptive statistics and various robustness tests that were mentioned, but not reported in tables or figures, in the paper. First, we present descriptive statistics for all core variables used in the analysis, with histograms displaying the distribution of our main independent and dependent variables. Second, we present additional robustness tests employing the GDP data from Maddison. Thereafter, we present additional GMM specifications on 5- and 10-year panels. Next, we show alternative tests on heterogeneity of the relationship across time, space, and regime type, using interaction models rather than split-sample tests. Finally, we show robustness tests for the regressions with the three sub-indices of our main Female Empowerment Measure as alternative independent variables.

Table A.1: Descriptive statistics for main variables used in our analysis

Variable (source)	N	Mean	Std. dev.
GDP p.c. growth (Fariss et al.)	20,622	1.202878	9.975378
GDP p.c. growth (Maddison)	16,525	1.945244	7.374358
Ln GDP p.c. (Fariss et al.)	20,828	7.602531	1.062199
Ln GDP p.c. (Maddison)	16,695	8.048396	1.139924
Ln TFP (Baier et al.)	8,462	4.842124	.4978569
Female Political Empowerment (V-Dem)	21,853	.4072885	.2660364
Women's Civil liberties (V-Dem)	26,348	.4201775	.2949111
Women's Civil Society Participation (V-Dem)	26,000	.3535175	.2746444
Women's Political Participation (V-Dem)	22,200	.4072169	.3147054
Polyarchy (V-Dem)	24,995	.2634506	.2614406
Impartial public administration	26,160	-.1091299	1.432628
Resource dependence (Miller)	13,529	3.560869	9.716799
Ln population (Fariss et al.)	20,828	8.516353	1.687284

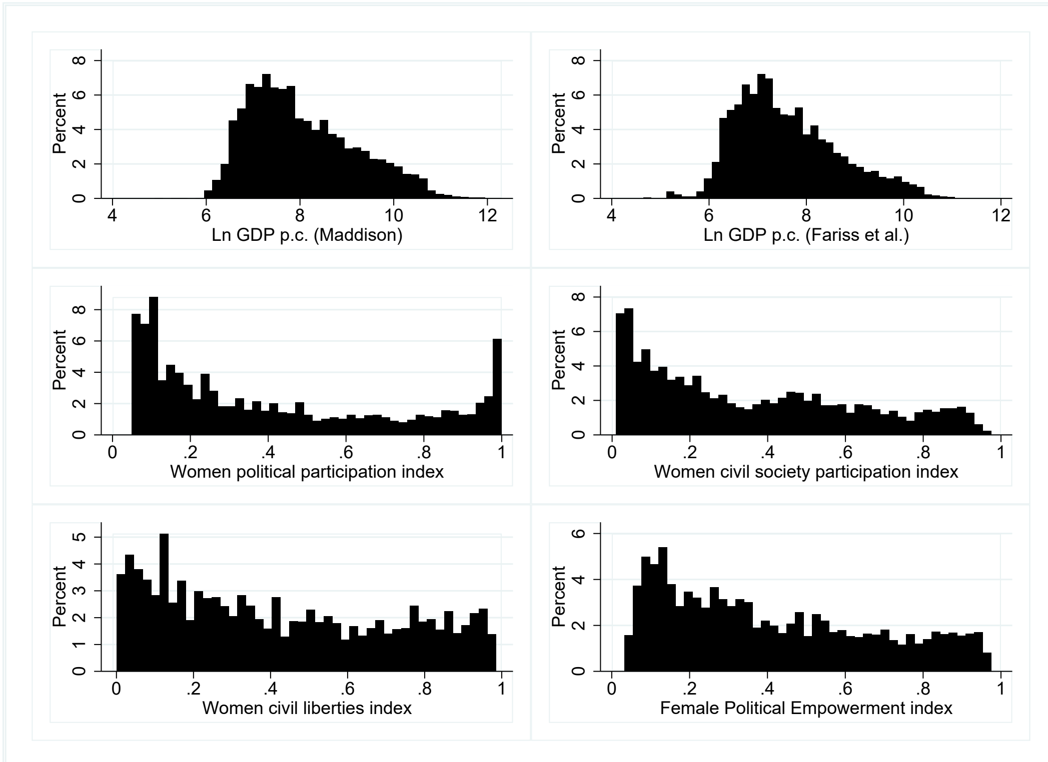

Figure A.1: Histograms over Female Political Empowerment Index and its sub-indices as well as Ln GDP per capita (from different sources). Y-axes measure percent of observations.

Table A.2: Selected robustness tests, using Maddison GDP p.c. data

	1-year panels; DV: GDP p.c. growth									5-year panels; DV: Ln GDP p.c.				
DV measured in	$t+5$	$t+1$	$t+3$	$t+10$	$t+5$	$t+5$	$t+5$	$t+5$	$t+5$	$t+5$	$t+10$	$t+5$	$t+5$	$t+5$
	b/(t)	b/(t)	b/(t)	b/(t)	b/(t)	b/(t)	b/(t)	b/(t)	b/(t)	b/(t)	b/(t)	b/(t)		
Female pol. emp.	1.967**	1.557	2.290**	2.058**	2.234*	1.645	2.409**	1.787*	3.020*	0.123**	0.231***	0.164***	0.440***	0.435***
	(2.151)	(1.562)	(2.465)	(2.344)	(1.823)	(1.589)	(2.279)	(1.857)	(1.939)	(2.439)	(2.636)	(3.385)	(3.290)	(3.478)
Ln GDP p.c.	-2.533***	-2.031***	-2.429***	-2.685***	-2.537***	-2.569***	-3.402***	-2.589***	-3.511***	0.888***	0.759***	0.971***	0.972***	0.975***
	(-8.268)	(-6.412)	(-7.633)	(-9.308)	(-8.070)	(-8.171)	(-9.155)	(-7.861)	(-8.711)	(63.205)	(27.543)	(27.570)	(43.187)	(8.696)
Polyarchy					-0.103				-0.246					
					(-0.106)				(-0.238)					
Imp. public adm.						0.079			-0.074					
						(0.631)			(-0.435)					
Resource dep.							-0.032		-0.031					
							(-1.210)		(-1.155)					
Ln population								-0.226	-0.503*					
								(-0.868)	(-1.800)					
Ln GDP p.c. $t-5$												-0.082**		0.006
												(-2.070)		(0.052)
Ln GDP p.c. $t-10$												-0.044		
												(-1.399)		
Ln GDP p.c. $t-15$												0.021		
												(0.752)		
Country dummies	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
Year dummies	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
N	13362	14036	13697	12540	13172	13362	9721	13021	9535	2762	2600	2367	2762	2630
R^2	0.085	0.081	0.085	0.085	0.086	0.085	0.108	0.087	0.109	0.947	0.896	0.952		
Instruments													129	129
Hansen J-test													.18	.20
Ar(2)													.13	.18
AR(3)													.22	.61

Notes: *p<0.1; **p<0.05; ***p<0.01. Errors are clustered by country.
Models 1–12 are estimated by OLS and Models 13-14 by System GMM.

Table A.3: Alternative System GMM specifications

Endogenous regressors	FPE				FPE and (lagged) Ln GDP p.c.			
Lags used for instrumentation	3–4				2–3			
GDP source	Fariss et al.		Maddison		Fariss et al.		Maddison	
	b/(t)	b/(t)	b/(t)	b/(t)	b/(t)	b/(t)	b/(t)	b/(t)
Female pol. emp.	0.318**	0.098	0.347**	0.418***	0.280***	0.281***	0.143**	0.101**
	(2.046)	(0.653)	(2.339)	(2.751)	(2.975)	(3.002)	(2.331)	(2.135)
Ln GDP p.c.	0.994***	1.435***	1.004***	1.153***	0.981***	0.949***	0.988***	1.093***
	(43.498)	(8.280)	(44.015)	(9.355)	(45.490)	(9.937)	(83.086)	(22.363)
Ln GDP p.c.$t-5$		-0.435**		-0.170		0.038		-0.109**
		(-2.509)		(-1.384)		(0.444)		(-2.105)
Year dummies	Y	Y	Y	Y	Y	Y	Y	Y
N	3165	3018	2762	2630	3165	3018	2762	2630
Instruments	123	123	126	126	251	329	257	337
Hansen J-test	0.527	0.222	0.479	0.000	1.000	1.000	1.000	1.000
Ar(2)	0.663	0.283	0.099	0.310	0.497	0.262	0.587	0.295
Ar(3)	0.043	0.040	0.845	1.000	0.999	0.058	0.078	0.331

Notes: *p<0.1; **p<0.05; ***p<0.01. 5-year panel units; DV measured in year $t+5$.

Table A.4: Interaction specifications assessing heterogeneity according to time period, region, and regime type

	b/(t)	b/(t)	b/(t)
Female political empowerment	2.313**	2.029**	2.965**
	(2.258)	(2.338)	(2.598)
Female pol. emp. X post-WWII dummy	-0.182		
	(-0.189)		
Female pol. emp. X Western countries (dummy)		0.627	
		(0.787)	
Female pol. emp. X Democracy (dummy)			0.331
			(0.321)
Democracy			-0.463
			(-0.757)
Ln GDP p.c.	-1.233***	-1.268***	-1.511***
	(-4.925)	(-4.795)	(-5.412)
Country dummies	Y	Y	Y
Year dummies	Y	Y	Y
N	15879	15879	12760
R^2	0.029	0.029	0.085

Notes: *p<0.1; **p<0.05; ***p<0.01. OLS with errors clustered by country.